Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Aletta Margaretha du Plessis (Alretha)

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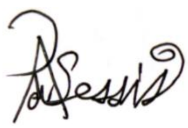
Promoter*:* *Doctor M. de Milander*

Co-promoter*: Professor F.F. Coetzee*

DECLARATION BY STUDENT

I, Alretha du Plessis, declare that the thesis that I herewith submit for the Doctoral Degree in Human Movement Sciences at the University of the Free State is my independent work and that I have not previously submitted it for a qualification at another institution of higher education. I further concede the copyright of this thesis in favor of the University of the Free State. This thesis was carried out in article format, and the role of each author is stipulated in the table below. The co-authors further provide permission that the articles in this thesis may be submitted for degree purposes.

Name and Surname of the author	**Contribution and role of the author in the articles**
Mev. Alretha du Plessis (AduP) (M.A. HMS Kinderkinetics)	AduP was responsible for the completion of the study and data gathering.
Dr. Monique de Milander (MdeM) (Ph.D. Human Movement Sciences)	MdeM was the study's promotor and contributed to the articles by guiding structure and content.
Prof. Frederik F. Coetzee (FC) (Adjunct Professor Exercise and Sport Sciences)	FC was the co-promotor of the study and guided the writing of the articles.
Me. Mariette Nel (MN) (Biostatistician)	MN was the biostatistician involved in the study and provided input during the study's planning and analysis.



Mrs. A.M. du Plessis
30 November 2020

DECLARATION BY PROMOTORS

I declare and approve the submission of this thesis and the articles as fulfilment for the Doctoral Degree's requirements in Human Movement Sciences at the University of the Free State. I further declare that the articles in this thesis have been approved. Lastly, I confirm that this thesis has not been submitted as a whole or partially for examination purposes before.

Dr. Monique de Milander
Promotor
30 November 2020

Prof. Frederik F. Coetzee
Co-promotor
30 November 2020

DEDICATION

This thesis is dedicated to all children who experience motor difficulties. Live with confidence, follow your dreams and reach for the stars.

A message to every child:

You are braver than you believe, stronger than you seem and smarter than you think – A.A. Mine.

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Success is not final, failure is not fatal, it is the courage to continue that counts –
Winston S. Churchill

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ABSTRACT

Introduction: Developmental coordination disorder (DCD) is a motor skill disorder that affects children worldwide, with various prevalence rates reported in the literature. Approximately 60% of children in South Africa (SA) come from low socio-economic (SE) environments. It is, therefore, essential to determine the prevalence of possible DCD in these environments. Although various screening tools are available for identifying possible DCD, teachers' ability to use the Movement Assessment Battery for Children-2 (MABC-2) Checklist has not been established. Furthermore, children with DCD and possible DCD will continue to experience motor difficulties if motor intervention is not provided. A motor intervention guideline for children with DCD in SA in the field of Kinderkinetics has not been established.

Objectives: The first objective was to determine the prevalence of possible DCD in Grade 1 (Gr. 1) learners in a low SE environment in Mangaung, SA, using the MABC-2 Performance Test. Secondly, the study aimed to establish teachers' ability to identify Gr. 1 learners with possible DCD in low SE environments using the MABC-2 Checklist. Finally, an e-Delphi survey was used to develop a motor intervention framework as a guideline for Kinderkineticists to help children with DCD or possible DCD within the South African context.

Methodology: Two hundred and forty-two (N=242; 51.2% boys, 48.8% girls) Gr. 1 learners, 6–8-year-old from a low SE environment (quintile 1–3 schools) in Mangaung Metro, Motheo District, Free State (FS) Province, participated in study objective one. Possible DCD prevalence was determined using the MABC-2 Performance Test. For the second objective, the study was conducted in the same environment. Gr. 1 learners 6–8-year-old (N=200; 49.5% boys, 50.5% girls) and 29 female class teachers of the Gr.1 learners participated in the study. The convergent validity of the MABC-2 Performance Test and Checklist completed by teachers was determined. Lastly, for objective three, 29 Kinderkineticists in SA with expert experience participated in a three-round online e-Delphi survey by answering questions related to motor intervention for children with possible DCD.

Results: The results of objective one showed that the prevalence of possible DCD found in the Gr. 1 learners was 9.9%. The gender results indicated a possible DCD prevalence of 10.5% for boys and 9.3% for girls. No statistically significant difference between the boys and girls was found ($p=0.94$). The results concerning objective two indicated that the movement specialists identified more learners (90%) in the non-DCD group (> 15th percentile) than the teachers (54%). The teachers wrongfully identified 46% of the learners with possible DCD, who were not identified with possible DCD according to the movement specialists. The movement specialists identified 10% of the learners with possible DCD. Only a slight agreement ($\kappa=0.17$) was found between the MABC-2 Performance Test and Checklist when the ≤ 15th percentile was used as a cut-off score. The sensitivity was 85% and the specificity 58%. In the e-Delphi survey, consensus (80%) was reached on 51/89 questions in round one, 89/144 for round two, and 12/30 in round three. A motor intervention framework was developed using the feedback of each round from the participants where consensus was reached.

Conclusion: The prevalence of possible DCD in low SE environments in Mangaung of Gr. 1 learners was higher than the worldwide estimated prevalence of DCD (5–6%). It is recommended that when teachers use the MABC-2 Checklist, the Performance Test should be performed in conjunction with the Checklist to obtain the most reliable results. A motor intervention framework was developed as a first draft to use as a guideline by Kinderkineticists, focusing on intervention planning, goal-setting, intervention approaches, intervention apparatus, intervention delivery mode, additional role players, settings, dosage, and evaluation.

Keywords: checklist; children; developmental coordination disorder; e-Delphi survey; Kinderkinetics; low socio-economic environment; motor intervention; Movement Assessment Battery for Children 2nd edition; prevalence; teachers

SUMMARY

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Introduction: Developmental coordination disorder (DCD) is a motor skill disorder that affects children worldwide, with diverse prevalence rates reported in the literature. Children experience motor difficulties that impact their performance in daily living activities and result in various secondary problems. Findings in the literature emphasised that children from some countries show better motor abilities in low socio-economic (SE) environments. Conversely, impaired motor abilities have been observed in low SE environments. Almost 60% of children come from low SE environments in South Africa (SA). It is, therefore, critical to determine the prevalence of possible DCD in these environments. Early identification of motor difficulties related to possible DCD in low SE environments is essential. The emphasis has been put on teachers to identify motor difficulties associated with possible DCD in low SE environments of SA. Although various screening tools are available for identifying possible DCD, the ability of teachers to use the Movement Assessment Battery for Children-2 (MABC-2) Checklist in identifying possible DCD has not been established in low SE environments in SA. Children with DCD will continue to experience motor difficulties if motor intervention is not provided. National intervention guidelines to follow when working with children with DCD in SA in the field of Kinderkinetics have not been established, and findings regarding the success of a Kinderkinetics motor intervention for children with DCD or possible DCD are limited.

Objectives: The study had three objectives. The first objective was to determine the prevalence of possible DCD in Gr. 1 learners in a low SE environment in Mangaung, SA, using the MABC-2 Performance Test. Secondly, the study aimed to establish teachers' ability to identify Gr. 1 learners with possible DCD in low SE environments using the MABC-2 Checklist. Finally, the third objective was to use an e-Delphi survey to develop a motor intervention framework as a guideline for Kinderkineticists to help children with DCD or possible DCD within the South African context.

Methodology: Objective one consisted of an empirical study with a cross-sectional design and included one testing procedure. Two hundred and forty-two (N=242) Gr. 1 learners, 6–8-year- old, from a low SE environment (quintile 1–3 schools) in Mangaung Metro, Motheo District, Free State (FS) Province, took part in study objective one. Of the 242 learners, 51.2% were boys, and 48.8% were girls. Possible DCD prevalence was determined using the MABC-2 Performance Test completed by movement specialists (Kinderkineticists). Learners were categorised in the possible DCD group if their MABC-2 Performance Test results fell at or below the 15th percentile (moderate to severe motor difficulties). For the second objective, a cross-sectional design was used and focused on a quantitative research method to collect data. The cross-sectional design included one assessment tool with two parts (MABC-2 Performance Test and Checklist). Both were used to identify possible DCD. The study was conducted in the same environment. Gr. 1 learners 6–8-year-old (N=200) participated in the study (49.5% boys and 50.5% girls) and 29 female class teachers of the Gr.1 learners participated in the study. The MABC-2 Performance Test was completed by movement specialists (Kinderkineticists in training), and the class teachers completed the MABC-2 Checklist. Afterwards, the convergent validity of the MABC-2 Performance Test and Checklist was determined. Lastly, for objective three, 29 Kinderkineticists in SA with expert experience participated in a three-round online e-Delphi survey by answering questions related to motor intervention for children with possible DCD. The participants' average age was 33.5 years and included 6.9% males and 93.1% females, with an average of 11.3 years' experience with children.

Statistical analysis for objective one and two was done by means of the statistical analysis software package, SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were calculated for categorical data and medians and ranges for numerical data. The 95% confidence interval (CI) was used to determine the prevalence of possible DCD in objective one. Learners were compared by gender using the chi-square test or Fisher's exact test for small samples. A probability level of $p \leq 0.05$ was accepted for statistical significance. For objective two, Bowker's test for symmetry was calculated for paired categorical data. The difference in the total score was calculated and compared using the signed-rank test. The kappa (κ) coefficient and 95% CI were used to determine the convergent validity between the MABC-2 Performance Test and the MABC-2 Checklist. Sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios were calculated. Lastly, objective three made use of the University of the Free State (UFS) EvaSys Survey System to analyse the participants' responses quantitatively. The EvaSys program analysed descriptive statistics of the participants. Consensus of 80% and more indicated agreement. The researcher analysed the responses to open-ended questions and incorporated the questions in the next round and the final motor intervention framework.

Results: The results of objective one showed that the prevalence of possible DCD found in the Gr. 1 learners was 9.9%. Of the 242 learners, 24 fell in the at or below 15th percentile group (moderate to severe motor difficulties). In total, 90.1% of the learners (n=218) fell in the non-DCD group. The gender results indicated a possible DCD prevalence of 10.5% for boys and 9.3% for girls. No statistically significant difference between the boys and girls was found on the total score (p=0.94) and the subtests manual dexterity (p=0.26), aiming and catching (p=0.16) and balance (p=0.10). Regarding the MABC-2 subtests, 27.7% of the learners had a possible DCD for manual dexterity, 5.0% for aiming and catching, and 8.7% for balance. The results indicated that the learners had more difficulty with manual dexterity (fine motor component).

The results concerning objective two indicated that the movement specialists identified more learners (90%) in the non-DCD group (> 15th percentile) than the teachers (54%). The teachers wrongfully identified 46% of the learners with possible DCD, who were not identified with possible DCD according to the movement specialists. The movement specialists identified 10% of the learners with possible DCD. Only a slight agreement (κ=0.17) was found between the MABC-2 Performance Test and Checklist when the ≤ 15th percentile was used as cut-off score, and κ=0.14 when the ≤ 5th percentile, 6th–15th percentile and > 15th percentile was used. The sensitivity was 85%, indicating that of the 20 learners identified with possible DCD with the MABC-2 Performance Test, 17 were also identified by the teachers using the MABC-2 Checklist. The specificity was 58%. The specificity result demonstrates that of the 180 learners identified without DCD with the MABC-2 Performance Test, 105 were also identified without DCD by the teachers. The remaining 75 were wrongly identified with possible DCD.

The results of objective three found that consensus (80% agreement) was reached on 51 of the 89 questions in round one. Ninety-four comments from the open-ended questions were reviewed and compiled into questions and statements for round two. A total of 144 statements and questions were included for round two, with consensus being reached on 89 statements. The 15 open-ended questions and 57 comments from round two were compiled into statements and questions for round three. The last round included 30 statements, with consensus being reached on 12 statements. A motor intervention framework was developed by using the feedback from the participants of each round where consensus has been reached.

Conclusion: Based on the findings, it is concluded that the prevalence of possible DCD in low SE environments in Mangaung of Gr. 1 learners was higher than the estimated prevalence of DCD of 5–6%. The findings highlight the importance of identifying learners with possible DCD as early as possible, especially in low SE environments. When teachers use the MABC-2 Checklist, it is recommended that the Performance Test should be performed in conjunction with the Checklist to obtain the most reliable results. A further recommendation is to develop strategies to create more awareness of motor skill problems. Learners' motor difficulties in low SE environments emphasise the importance of early identification and adequate intervention. Motor intervention is proposed as an important approach to help children with DCD or possible DCD. A motor intervention framework was developed as a first draft to use as a guideline by Kinderkineticists, focusing on intervention planning, goal-setting, intervention approaches, intervention apparatus, intervention delivery mode, additional role players, settings, dosage and evaluation. Heterogeneity of the different secondary problems children with DCD or possible DCD experience should be taken into consideration when planning the motor intervention. This research presents the first motor intervention framework for Kinderkineticist in SA and will play a valuable role in helping children with DCD or possible DCD.

TABLE OF CONTENTS

Declaration by student .... **i**
Declaration by promotors .... **ii**
Dedication .... **iii**
Acknowledgments .... **iv**
Abstract .... **vi**
Summary .... **viii**
List of tables .... **xviii**
List of figures .... **xx**
List of abbreviations .... **xxi**

Chapter 1: Introduction and problem statement **1**
1.1 Introduction: Orientation to the study **1**
1.2 Background **1**
1.3 Problem statement **11**
1.4 Objectives **14**
1.5 Significance of the study **15**
1.6 Research methodology **16**
1.7 Ethical considerations **16**
1.8 Structure of the thesis **17**
1.9 Conclusion **19**
1.10 References **20**

Chapter 2: Literature Review: Assessment, identification and intervention of developmental coordination disorder and low socio-economic environments ... **38**
2.1 Introduction **38**
2.2 Terminology and definitions of developmental coordination disorder **40**
2.3 Prevalence of developmental coordination disorder **43**
2.3.1 Research findings on the prevalence of developmental coordination disorder using the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, 4th and 5th editions 45

2.3.2	Research findings on the prevalence of possible developmental coordination disorder based on the original Movement Assessment Battery for Children	47
2.3.3	Research findings on the prevalence of possible developmental coordination disorder based on the Movement Assessment Battery for Children 2nd edition	49
2.3.4	Research findings on the prevalence of possible developmental coordination disorder using the Bruininks Oseretsky Test of Motor Proficiency, 1st and 2nd editions	51
2.3.5	Research findings on the prevalence of motor difficulties using the Developmental Coordination Disorder Questionnaire	53
2.3.6	Summary of findings regarding the prevalence of developmental coordination disorder and possible developmental coordination disorder	54
2.3.7	Prevalence of developmental coordination disorder, possible developmental coordination disorder and motor difficulties in boys and girls	56
2.4	**Socio-economic environments ....**	**60**
2.4.1	Relationship between socio-economic environment and motor ability	65
2.5	**Characteristics and symptoms of children with developmental coordination disorder ....**	**69**
2.5.1	Primary characteristics and symptoms of children with developmental coordination disorder	69
2.5.2	Secondary characteristics and symptoms of children with developmental coordination disorder	70
2.5.3	Co-occurring factors with developmental coordination disorder	75
2.6	**Aetiology of developmental coordination disorder ....**	**76**
2.7	**Assessment and diagnosis of developmental coordination disorder**	**78**
2.7.1	Assessment methods and tools to identify possible developmental coordination disorder	79
2.7.1.1	Bruininks Oseretsky Test of Motor Proficiency	80
2.7.1.2	Movement Assessment Battery for Children	81

2.7.1.2.1 Reliability of the Movement Assessment Battery for Children 2nd edition 82
2.7.1.2.2 Validity of the Movement Assessment Battery for Children 2nd edition 83
2.7.2 Assessment methods and screening tools to identify motor difficulties 83
2.7.2.1 Developmental Coordination Disorder Questionnaire '07 85
2.7.2.2 Movement Assessment Battery for Children-2 Checklist 86
2.7.2.2.1 Reliability of the Movement Assessment Battery for Children 2nd edition Checklist 87
2.7.2.2.2 Validity of the Movement Assessment Battery for Children 2nd edition Checklist 87
2.7.2.2.3 Research findings on the convergent validity of the Movement Assessment Battery for Children Checklist with the Movement Assessment Battery for Children Performance Test 88
2.7.2.2.4 Teachers and the Movement Assessment Battery for Children-2 Checklist 92
2.8 Interventions for developmental coordination disorder 94
2.8.1 Planning, goals and focus areas of developmental coordination disorder intervention 96
2.8.2 Intervention approaches and programmes for developmental coordination disorder 98
2.8.2.1 Task-oriented intervention approaches (activity-oriented and participation-oriented intervention approaches 101
2.8.2.2 Process-oriented approaches (Body function-oriented approaches) 105
2.8.2.3 Combined intervention approaches 108
2.8.3 Role players for interventions for developmental coordination disorder 110
2.8.4 Individual and group interventions for developmental coordination disorder 114
2.8.5 Frequency, duration and number of sessions of intervention for developmental coordination disorder 117
2.8.6 Settings of intervention for developmental coordination disorder 119
2.8.7 Other aspects to consider for intervention 120

2.9 **Conclusion** **122**
2.10 **References** **125**

Chapter 3: Article 1
Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa **170**
Abstract **172**
3.1 **Introduction** **173**
3.2 **Methodology** **177**
3.2.1 Study design 177
3.2.2 Participants 178
3.2.3 Measuring instrument 179
3.3 **Statistical analysis** **181**
3.4 **Ethical consideration** **181**
3.5 **Results** **182**
3.6 **Discussion** **185**
3.7 **Conclusion** **189**
3.8 **Limitations** **189**
3.9 **Acknowledgments** **190**
3.10 **Competing interests** **190**
3.11 **Author's contributions** **191**
3.12 **Funding information** **191**
3.13 **Data availability statement** **191**
3.14 **Disclaimer** **191**
3.15 **References** **192**

Chapter 4: Article 2
The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder **200**
Abstract **202**
4.1 **Introduction** **203**
4.2 **Methodology** **209**
4.2.1 Study design 209

4.2.2	Participants	210
4.2.3	Procedure	211
4.2.4	Measuring instruments	212
4.3	**Statistical analysis**	**215**
4.4	**Ethical considerations**	**215**
4.5	**Results**	**216**
4.6	**Discussion**	**219**
4.7	**Conclusion**	**223**
4.8	**Limitations**	**224**
4.9	**Acknowledgments**	**224**
4.10	**Competing interests**	**225**
4.11	**Author's contributions**	**225**
4.12	**Disclaimer**	**225**
4.13	**References**	**226**

Chapter 5: Article 3

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective **235**

	Abstract	**238**
5.1	**Introduction**	**239**
5.2	**Methodology**	**242**
5.2.1	Ethical clearance	242
5.2.2	Research design	242
5.2.3	Participants	243
5.2.4	Procedure	245
5.2.5	Data collection	245
5.2.6	Validity and Reliability of the e-Delphi	246
5.2.7	Analysis of data	247
5.3	**Results**	**247**
5.4	**Discussion**	**255**
5.5	**Practical application**	**263**
5.6	**Conclusion**	**263**
5.7	**References**	**267**

Chapter 6: Summary, conclusions, recommendations, and limitations 271

6.1 Summary 271

6.2 Conclusions 279

6.2.1 Objective one 279

6.2.2 Objective two 279

6.2.3 Objective three 280

6.3 Limitations and recommendations 281

6.4 General recommendations 287

6.5 References 294

Appendix A: Ethics documents of the study **295**

Appendix B: Consent department of education **302**

Appendix C: Consent forms **304**

Appendix D: Movement Assessment Battery for Children-2 Performance Test Objective 1 .... **331**

Appendix E: Movement Assessment Battery for Children-2 Checklist Objective 2 .... **333**

Appendix F: E-Delphi questions Objective 3 .... **334**

Appendix G: Journal guidelines South African Journal of Childhood Education **370**

Appendix H: Journal guidelines South African Journal For Research in Sport, Physical Education and Recreation **377**

Appendix I: Article accepted in the South African Journal of Childhood Education **383**

Appendix J: Proof of article submissions to journals **393**

Appendix K: Letter of Acknowledgement: Language editing **401**

LIST OF TABLES

Chapter 2: Literature Review: Assessment, identification and intervention of developmental coordination disorder and low socio-economic environments

Table 2.1: Four criteria as set out by the DSM-5 .... **42**

Table 2.2: Gender differences in the prevalence of DCD **56**

Table 2.3: Gender differences in the prevalence of possible DCD determined by means of standardised motor tests **57**

Table 2.4: Gender differences in the prevalence of motor difficulties determined by means of other screening tools **59**

Chapter 3: Article 1

Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa

Table 3.1: Published findings of the difference between boys and girls regarding the prevalence of developmental coordination disorder **176**

Table 3.2: Characterisation of participants (n=242) in terms of gender and age **182**

Table 3.3: Percentage of learners without or with possible developmental coordination disorder **183**

Table 3.4: Distribution of the total group of learners (n=242) without and with possible developmental coordination disorder within the three Movement Assessment Battery for Children-2nd edition subtests **183**

Table 3.5: Differences between boys and girls on the Movement Assessment Battery for Children 2nd edition total test score and subtests **184**

Table 3.6: Comparison of this study with previously reported findings on the prevalence of developmental coordination disorder in different countries, with socio-economic environment not taken into account **188**

Chapter 4: Article 2

The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder

Table 4.1: Findings on the percentage of children with motor skill difficulties identified by teachers using the MABC original and 2nd edition (MABC-2) Checklist **206**

Table 4.2: Distribution of learners (n=200) in terms of gender and age **216**

Table 4.3: Percentage of learners (n=200) without or with possible developmental coordination disorder (DCD) **217**

Table 4.4: Inter-rater agreement between the MABC-2 Performance Test and the MABC-2 Checklist with the three cut-off scores **217**

Table 4.5: Inter-rater agreement between the MABC-2 Performance Test and the MABC-2 Checklist with the non-DCD group and possible DCD group **218**

Table 4.6: Sensitivity, specificity, positive- and negative predictive values and likelihood ratios of positive and negative test of the MABC-2 Performance Test and the MABC-2 Checklist **219**

Chapter 5: Article 3

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective

Table 5.1: International clinical practice recommendations on the intervention of DCD **241**

Table 5.2: Demographic information of the e-Delphi participants **248**

Table 5.3: Statements and questions reaching consensus in round one of the e-Delphi survey **250**

Table 5.4: Statement and questions reaching consensus (≥ 80%) in rounds two and three of the e-Delphi survey **252**

LIST OF FIGURES

Chapter 2: Literature Review: Assessment, identification and intervention of developmental coordination disorder and low socio-economic environments

Figure 2.1: Modification of the Pearlin's stress process framework for children with DCD **73**

Figure 2.2: International Classification of Functioning, Disability, and Health ... **100**

Figure 2.3: Flow chart for treatment, intervention, and evaluation of DCD.......... **121**

Chapter 5: Article 3

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective

Figure 5.1: Flow diagram of the e-Delphi process followed **244**

Figure 5.2: Kinderkinetics motor intervention framework for children with DCD or possible DCD **266**

LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ADHD	Attention Deficit Hyperactivity Disorder
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
BOT SF:	Bruininks Oseretsky Test of Motor Proficiency Short Form
BOT-2:	Bruininks Oseretsky Test of Motor Proficiency 2nd edition
BOTSF-2	Bruininks Oseretsky Test of Motor Proficiency 2nd edition Short Form
CO-OP	Cognitive Orientation to Daily Occupational Performance
CPR-DCD	International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of DCD
DCD:	Developmental Coordination Disorder
DCDQ	Developmental Coordination Disorder Questionnaire
DCD Q'07	Developmental Coordination Disorder Questionnaire 7th edition
DD	Developmental Dyslexia
DSM-5	Diagnostic Statistical Manual of Mental Disorders 5th edition
DST	Dynamic Systems Theory
EACD	European Academy of Childhood Disability
ECD	Early Childhood Development
FS	Free State

ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th revision
ICF	International Classification of Functioning, Disability and Health
MABC:	Movement Assessment Battery for Children – original edition
MABC-2:	Movement Assessment Battery for Children 2nd edition
NTT	Neuromotor Task Training
NW	North West
PDMS-2:	Peabody Developmental motor scale 2nd edition
PE:	Physical Education
SAPIK	South African Professional Institute of Kinderkinetics
SE	Socio-economic
SES:	Socio-economic status
SA	South Africa
SLI	Specific Language Impairments
TGMD	Test of Gross Motor Development
WHO	World Health Organization

CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

1.1 Introduction: Orientation to the study

This thesis provides evidence from the published literature to provide background and context to the current study. The research is presented in the form of chapters and interrelated articles. It should be noted that the articles can also be interpreted as stand-alone entities. Chapter 1 serves as the introduction to the research on developmental coordination disorder (DCD) and is intended to provide the reader with an overview of the research study.

1.2 Background

Motor difficulties associated with DCD negatively impact around 6% of school-aged children and hinder participation in movement activities (American Psychiatric Association [APA], 2013:74; Kokstejn, Psotta & Musalek, 2015:66). Low participation in movement activities by school-aged children diagnosed with DCD interferes with the child's academic performance, physical development, and performance in activities of daily living (Ali, El-Tohamy & Mousa, 2016:2; Asonitou, Koutsouki, Kourtessis & Charitou, 2012:1004; Lingam, Hunt, Golding, Jongmans & Emond, 2009: e698; Zwicker, Suto, Harris, Vlasakova & Missiuna, 2018:72). Motor abilities are required to complete daily activities such as getting dressed independently, writing and reading, as well as play (APA, 2013:74; Schoemaker, Smits-Engelsman & Jongmans, 2003:426; Zhu, Obel, Basso & Olsen, 2010:908). These motor abilities are delayed in children with DCD (APA, 2013:74). Consequently, limited motor abilities will result in the child experiencing lower fitness levels (Demers, Moffet, Hébert & Maltais, 2020:1089; Zwicker et al., 2018:72), difficulty in planning and completing tasks (Caçola, 2014:102; Rosenblum, 2015:212), struggling to cope in school (Zwicker et al., 2018:72) and experience psychological issues (Caçola, Romero, Ibana & Chuang, 2016:175; Karras, Morin, Gill, Izadi-Najafabadi & Zwicker, 2019:91).

Developmental coordination disorder is defined by the Centre for Childhood Disability Research in Canada (CanChild) as:

> 'a motor skill disorder with a delay in the development of motor skills, or difficulty coordinating movements. The delay results in a child being unable to perform common everyday tasks. Children with DCD do not have an identifiable medical or neurological condition that explains their coordination problems' (CanChild, 2020).

Terms such as possible DCD, suspected DCD, or at risk for DCD are used in research studies to describe children with motor difficulties and motor skill impairments where a comprehensive neurodevelopmental assessment has not been conducted, and the criteria proposed by the APA (2013) in the *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition (DSM-5) for DCD have not been met (Alesi, Pecoraro & Pepi, 2019:287; Delgado-Lobete, Santos-Del-Riego, Pértega-Díaz & Montes-Montes, 2019:33; Lingam et al., 2009:e694; Valentini, Getchell, Logan, Liang, Golden, Rudisill & Robinson, 2015:42). Common characteristics observed in 'children with DCD are clumsy and uncoordinated' movements that occur during motor tasks (Caçola, 2014:98). General difficulties such as body awareness problems, low muscle strength, poor fine- and gross motor performance, and a lack of fluent sequencing of movements, can be observed (Caçola, 2014:98). Furthermore, motor tasks will be executed slower and with less accuracy than typically noted in developing children (Gasser-Haas, Sticca & Seiler, 2020:1).

It has been reported in the literature that every child with DCD is unique (Caçola & Lage, 2019:2). Motor difficulties are experienced by children with DCD, however the child may also experience other developmental constraints and secondary challenges and therefore DCD is labelled as heterogeneous (Caçola, 2014:100). The secondary challenges experienced are not the same for each child and can further differ in terms of the level of severity and type of motor difficulties experienced (Aertssen, Bonney, Ferguson & Smits-Engelsman, 2018:95; Caçola & Lage, 2019:3; Gonzalez, Mon-Williams, Burke & Burke, 2016:1; Preston, Magallón, Hill, Andrews, Ahern & Mon-Williams, 2017:866; Sugden & Chambers, 2007:524). The secondary challenges that may develop due to the motor difficulties experienced by children with DCD include emotional and social problems (Li, Graham & Cairney, 2018:7; Missiuna et al., 2014:1203; Noordstar & Volman, 2020:7;

Zwicker et al., 2018:72). Furthermore, the motor difficulties cause lower participation levels in everyday physical activity, leading to a sedentary lifestyle (Batey, Missiuna, Timmons, Hay, Faught & Cairney, 2014:268; Cermak, Katz, Weintraub, Steinhart, Raz-Silbiger, Munoz & Lifshitz, 2015:170; Green, Lingam, Mattocks, Riddoch, Ness & Emond, 2011:1340; Yu, Burnett & Sit, 2018:2095). A sedentary lifestyle tends to increase overweight and obesity (Cermak et al., 2015:17; Hendrix, Prins & Dekkers, 2014:421; Zhu, Cairney, Li, Chen, Chen & Wu, 2014:1732). Overweight and obesity result in in higher risks of cardiovascular disease (Joshi, Missiuna, Hanna, Hay, Faught & Cairney, 2015:316) and lower physical fitness levels (Aertssen et al., 2018:94; Cermak et al., 2015:171; Zhu et al., 2014:1732).

Part of the DCD diagnosis emphasises academic problems due to the motor difficulties experienced (De Milander, Coetzee & Venter, 2015b:58; Harrowell, Hollén, Lingam & Emond, 2018:20). In school, handwriting skills are used every day. However, due to the fine motor skill challenges experienced by children with DCD, these children display poor handwriting abilities (Huau, Velay & Jover, 2015:328; Prunty & Barnett, 2017:216; Rosenblum, 2015:210). Low handwriting abilities cause learning-related problems in areas such as mathematics (Gomez, Piazza, Jobert, Dehaene-Lambertz, Dehaene & Huron, 2015:176) and other cognitive areas (Asonitou & Koutsouki, 2016:131; Sumner, Pratt & Hill, 2016:16). Considering the secondary problems and consequences of DCD described in the literature, various prevalence reports have also been published (De Milander, Coetzee & Venter, 2016a:58; Deshpande, Thakkar & Joshi, 2019:10; De Waal, Pienaar & Coetzee, 2018:5; Kokstejn et al., 2015:64; Kourtessis, Tsougou, Maheridou, Tsigilis, Psalti & Kioumourtzoglou, 2008:96; Lingam et al., 2009:e698; Tsiotra, Flouris, Koutedakis, Faught, Nevill, Lane & Skenteris, 2006:126).

The APA (2013:75) reported DCD to be prevalent in 5%–6% of school-aged children. However, various countries have reported different prevalence results. The prevalence of DCD varies across several studies ranging from 0.8%–4.3% when using the DSM 4th and 5th editions (DSM-4 and DSM-5) (Cardoso, Magalhães & Rezende, 2014:179; Girish, Raja & Kamath, 2016:111). The prevalence of possible DCD has also been reported in the literature. Possible DCD is referred to as motor abilities far below the child's age group. A child can be identified with possible DCD using standardised motor assessment tools, such as the Movement Assessment Battery for Children original (MABC) and 2nd edition

(MABC-2) assessment tools (Alesi et al., 2019:287; Delgado-Lobete et al., 2019:33). An indication of moderate motor difficulties (6th–15th percentile) and severe motor difficulties (≤ 5th percentile) has been presented in the literature (Henderson, Sugden & Barnett, 2007:84). An indication of possible DCD is identified below the 15th percentile (Alesi et al., 2019:287; Henderson et al., 2007:114). Prevalence rates of possible DCD ranging from 6.5%–15% (De Milander, Coetzee & Venter, 2014:1081; Kokstejn et al., 2015:64) have been reported. Accordingly, the prevalence of moderate motor difficulties (6th–15th percentile) ranges from 10.5% to 29% (Dos Santos, Contreira, Caruzzo, Passos & Vieira, 2015:81; Wessels, Pienaar & Peens, 2008:499), whereas the prevalence of severe motor difficulties (≤ 5th percentile) ranges from 1.6% to 36.5% (Kourtessis et al., 2008:96; Pienaar, 2004:79). Lastly, when conducting a parent questionnaire, the literature reported possible DCD prevalence ranging from 5.9%–30% (Ali et al., 2016:5; Barba, Luiz, Pinheiro & Lourenço, 2017:27). In South Africa (SA), various studies of possible DCD has been published (De Waal et al., 2018:5; Pienaar, 2004:78; Van der Walt, Plastow & Unger, 2020:1; Venter, Pienaar & Coetzee, 2015:173; Wessels et al., 2008:499).

Earlier research in the North West Province of SA on 688 children 10–12 years of age, with 60% of them being from low socio-economic (SE) environments, reported severe motor difficulties in 36.5% of the children (Pienaar, 2004:78). Another study in the same province on 99 younger children 6–7 years of age from various SE environments, determined severe motor difficulties in 23% of the children (Wessels et al., 2008:499). These two studies further determined moderate motor difficulties in 24.8% (Pienaar, 2004:79) and 29% (Wessels et al., 2008:499) of the children. In addition to these two North West Province studies, a more recent study in the same province on 53 younger children between 3–5 years of age found a lower prevalence of severe motor difficulties (11.32%), but a similar prevalence of moderate motor difficulties (28.30%) (Venter et al., 2015:173) than the previous studies. It has further been pointed out that children in a high SE environment experience more severe motor difficulties (22.73%) than children in a low SE environment (3.23%) (Venter et al., 2015:178), which are contradicting to most studies reporting more severe motor difficulties in low SE environments (De Waal et al., 2018:5; Van der Walt et al., 2020:1). The reason provided was that parents from the high SE environment tended to keep their children indoors to protect them against environmental dangers and crime, resulting in children not being exposed to sufficient physical activity (Venter et al., 2015:177). Another reason pointed out in this study was that many of these children were put into day-care facilities where physical activity and gross motor development opportunities are limited (Venter et al., 2015:177).

In contrast, a study in the Zeerust district of SA in both low and high SE environments has determined that possible DCD was higher in low SE environments (De Waal et al., 2018:5). Recent research in the West Coast region of SA supported the findings of De Waal et al. (2018:5) and determined that the child's low SE status was more evidently associated with motor difficulties (Van der Walt et al., 2020:1). A possible reason for higher motor difficulties in low SE environments could be that children attending schools in low SE environments have limited availability of resources (playground equipment) (Van der Walt et al., 2020:1). In addition, schools in high SE environments have well-established resources, facilities, and exposure to physical education (Edginton, Chin, Amusa & Toriola, 2012:436; Pienaar & Kemp, 2014:177). It has further been argued that schools in low SE environments do not have access to teachers who have specialised knowledge in physical education and cannot improve motor difficulties (Fadiji & Reddy, 2020:4; Graven, 2013:4). Studies conducted in other countries have also reported more insufficient motor abilities in children living in low SE environments (Hardy, Reinten-Reynolds, Espinel, Zask & Okely, 2012:e397; Venetsanou & Kamaba, 2010:324). Despite the literature reporting the differences between low and high SE environments with regard to motor difficulties, a study by Amador-Ruiz, Gutierrez, Martínez-Vizcaíno, Gulías-González, Pardo-Guijarro and Sánchez-López (2018:541) in Spain determined that children's SE environment did not influence their motor competence.

With reference to previous results on the prevalence of DCD reported in other provinces in SA, a study conducted in the Free State (FS) Province has determined a prevalence of possible DCD (moderate and severe motor difficulties) in 15% of 559 children 5–8 years in a high SE environment (De Milander et al., 2014:1081). Similarly, Van der Walt et al. (2020:5) recently reported possible DCD in 14.5 % of 138 children (5–7 years) in the West Coast District of SA. The discrepancies regarding the prevalence of DCD in different countries have further been identified in the two gender groups. A higher prevalence of DCD has been found in boys (Ali et al., 2016:5; Beltrame, Capistrano, Alexandre, Lisboa, Andrade & Felden, 2017:108; Cardoso et al., 2014:179; Hua, Jin, Gu, Liu, Zhang & Wu, 2014:3092; Kirby & Sugden 2007:184; Wade & Kazeck, 2018:490; Wessels et al., 2008:499; Zwicker, Missiuna, Harris & Boyd, 2012:575). The APA suggests a boy-to-girl ratio of 2:1 (APA, 2013); however, the gender ratio in different countries varies considerably between 1.6:1 and 7.3:1 (De Milander et al., 2014:1082; Kadesjö & Gillberg, 1998:823), depending on the methods used to identify children in the respective studies. Another aspect to consider is that population-based studies show closer ratios between the genders than clinical studies (Venter et al., 2015:177).

Boys tend to have higher tendencies due to comorbidities such as attention deficit hyperactivity disorder (ADHD) (Blank et al., 2019:278). Another reason for high tendencies in boys, is that more boys than girls are born preterm (Larsen, Mortensen, Martinussen & Andersen, 2013:1021; Du, Ke, Wang, Hua, Duan & Barnett, 2020:5). Babies born preterm tend to have more motor coordination difficulties (Delgado-Lobete et al., 2019:3). Although boys tend to have better ball skills, girls outperform them with fine motor skills and balance tasks (Deshpande et al., 2019:11; Kokstejn et al., 2015:65). Nevertheless, studies in the literature have documented a higher prevalence of DCD in girls, with girl-to-boy ratios of 1.1:0.5 (Girish et al., 2016:111) and 3.3:1.7 (Kokstejn et al., 2015:64). Girish et al. (2016:114) have indicated that the reason for girls having a higher prevalence of DCD than boys in India, is because girls are not encouraged to take part in physical and sports activities. In SA, it has been argued that cultural differences could explain why girls have a higher prevalence than boys, as girls often have to conduct chores indoors, whereas boys participate in outdoor physical activities (Venter et al., 2015:176).

Various factors can contribute to the wide variety of prevalence rates of DCD in different countries. First, it could be explained in light of the different diagnostic criteria and assessment tools used; secondly, due to the diversity of populations and SE environments; thirdly, due to the sampling methods described in the literature; and lastly, due to the different definitions used (APA, 2013:73; Beltrame et al., 2017:108; Cardoso et al., 2014:179; De Milander et al., 2014:1081; Dos Santos et al., 2015:81; Girish et al., 2016:110; Lingam et al., 2009:e698; Tsiotra et al., 2006:126; Valentini, Coutinho, Pansera, Dos Santos, Veira, Ramalho & De Oliveira, 2012:381; Van der Walt et al., 2020:2). Considering that most of the prevalence reports in the literature from SA used the MABC-2 Performance Test, it should be considered that the performance test has been developed internationally and is not culturally sensitive, which could negatively impact children's performance on the MABC-2. However, despite the MABC-2 being recommended as the assessment tool for identifying motor difficulties (Blank et al., 2019:261), a gold standard measuring instrument in SA does not exist.

In terms of the diagnostic criteria, it is recommended that the DSM-5 be used to diagnose DCD (APA, 2013:74). Criterion A states that the coordinated motor skills of the child should fall far below the child's age, provided that they received the opportunity to learn motor skills. Criterion B states that the motor difficulties the child experience should influence the child's performance during daily living activities and academic performance. Criterion C states that the onset of these motor difficulties should occur in the early developmental period of the child. Finally, Criterion D states that the motor difficulties experienced are not due to intellectual, visual or other neurological impairments (APA, 2013:74).

In order to meet Criteria A and B of the DSM-5, various assessment methods should be used, such as norm-referenced motor assessments conducted by therapists, and validated parent and teacher questionnaires to assess for motor proficiency (Barnett, 2008:114; Blank et al., 2019:260; Henderson et al., 2007:5; Missiuna et al., 2011:549; Wilson, Crawford, Green, Roberts, Aylott & Kaplan, 2009:183). Furthermore, information on daily living activities in various environmental contexts from multiple sources (child, teachers, parents, therapists) using previous history, interviews and self-reports are important (Blank et al., 2019:267). Even though input from children, parents and teachers is essential, the importance of more research regarding input from schools, particularly teachers, to identify children experiencing motor difficulties, has been emphasised (Barnett, 2008:124; Missuna et al., 2011:557). The emphasis on teachers involved in children’s lives is particularly relevant in low SE environments of SA, where many parents are not part of their children's lives during the day due to work requirements, and many parents are not equipped to identify motor difficulties in their children (Engel-Yeger, Rosenblum & Josman, 2010:93; Kalam, Francke, Jainodien, Petersen, Silo & Turnbull, 2016:61).

Another reason for the emphasis on teachers being relevant in low SE environments, are due to therapists' limited resources and availability in low-income schools and the high costs of assessments, children experiencing motor difficulties are missed and may never receive the necessary intervention (Van der Walt et al., 2020:5). Statistics South Africa (SSA) indicated in 2020 that more than 60% of school-aged children are considered to be poor and face barriers in accessing healthcare services (SSA, 2020). Even though healthcare provision is free of charge for children in the public sector, there is limited staff availability and a lack of transport to and from therapists (Van der Walt et al., 2020:1). Consequently, the assessment tool might be costly and not available to all therapists in the public health setting, meaning that children may not be assessed using the recommended standardised tools for formal diagnostic purposes (Schoemaker, Flapper, Verheij, Wilson, Reinders-Messelink & De Kloet, 2006:668). Lastly, therapists are not always available in these communities where limited availability of resources is another problem (Ferguson, Jelsma, Jelsma & Smits-Engelsman, 2013:2459; Smits-Engelsman, Neto, Draghi, Rohr & Jelsma, 2020:9).

Therefore, the priority should be for teachers to screen school-aged children at community level for characteristics of possible DCD. The American Academy of Pediatrics (AAP) (2019) has emphasised the importance of more research to determine the effectiveness of screening tools. Instruments previously used to assist with the identification of motor difficulties include the Motor Observation Questionnaire for Teachers (Van Dellen, Vaessen & Schoemaker, 1990:140), the parent and teacher focused Early Years Movement Skills Checklist (Chambers, 2000:67), the Developmental Coordination Disorder Questionnaire '07 (DCD Q'07) completed by parents (Wilson et al., 2009:183), and the MABC-2 Checklist, completed by adults (parents, teachers) and therapists, such as physio- and occupational therapists, to rate the motor competence of a child (Henderson et al., 2007:3).

The MABC-2 Checklist has been identified as a screening tool that could be used by teachers. However, discrepancies regarding the suitability of the MABC-2 Checklist to identify motor difficulties have been noted (Barnett 2008:117; De Milander, Coetzee, & Venter., 2016b:1001; De Milander, Du Plessis & Coetzee, 2019:56; Schoemaker, Niemeijer, Flapper & Smits-Engelsman, 2012:373). Further discrepancies have been found on whether teachers and therapists identify the same children with motor difficulties (Missiuna et al., 2011:550; Schoemaker, Flapper, Reinders-Messelink & De Kloet, 2008:191). It is unclear whether the MABC-2 Checklist is a suitable screening tool in SA with its diverse SE environments (Uys & Pienaar, 2010:131). The norms used for the MABC-2 Checklist are based on a United Kingdom sample of children (Henderson et al., 2007:127), and norms for children from low-income populations are not available (Smits-Engelsman et al., 2020:9). Considering the concerns raised, another factor to take into account is the limited findings reported in the literature on the revised version of the MABC-2 Checklist and the inconsistencies in the results (Blank et al., 2019:259; De Milander et al., 2016b:995; De

Milander et al., 2019:54; Dimitropoulou, Evaggelinou, Kourtessis, Mouratidou, Tsigili & Ellinoudis, 2019:23; Schoemaker et al., 2012:369).

A research study conducted in Belgium that included 500 children between the age of 5–8 years and their teachers, found that the teachers were able to identify only 41% of children as having possible DCD with the MABC-2 Checklist (Schoemaker et al., 2012:372). The findings were similar to those reported by De Milander et al. (2016b:993), who determined that 46.5% of the children were identified with possible DCD in a sample of 545 South African children between the ages of 6–8 years, when teachers completed the MABC-2 Checklist. Also, a more recent study in Greece on 584 children between 5–12 years demonstrated that primary school teachers had a slightly better ability (52.7%) to identify possible DCD by using the MABC-2 Checklist (Dimitropoulou et al., 2019:31). However, research recently carried out by De Milander et al. (2019:54) found teachers to have a low ability (35.6%) to identify children with possible DCD in a sample of 323 SA children 5–8 years of age. It is important to note that both the studies conducted in SA were in a high SE environment. De Milander et al. (2016b:1002) have highlighted the importance of conducting more research in SA in various SE environments.

Together with the range of assessment options used to treat and identify children with possible DCD, various intervention approaches and strategies have been identified in the literature (Ashkenazi, Weiss, Orian & Laufer, 2013:469; Au, Chan, Lee, Chen, Chau & Pang et al., 2014:994; Coetzee & Pienaar, 2013:4076; Howie, Campbell, Abbott & Straker, 2017:3; Noordstar, Van der Net, Voerman, Helders & Jongmans, 2017:167; Thornton, Licari, Reid, Armstrong, Fallows & Elliott, 2016: 3). Approaches include body function-oriented (process-oriented), activity-oriented and participation-oriented (task-oriented) approaches (Smits-Engelsman, Vinçon, Blank, Quadrado, Polatajko & Wilson, 2018:96). Smits-Engelsman et al. (2018:92) summarised that a body function-oriented approach aims to 'improve body functions and prevent significant deviation or loss of body function or structure.' In contrast, an activity-oriented approach aims to 'improve the execution of a task or skill.' Lastly, the goal of a participation-oriented approach is to 'improve the child's participation in real-life situations' (Smits-Engelsman et al., 2018:92). The main aim of any intervention in children identified with DCD is to improve the motor difficulties experienced by these children and increase their ability to function to the best of their abilities during everyday life (Chambers & Sugden, 2016:116). The recent international clinical practice recommendations on the definition, diagnosis, assessment, intervention and psychosocial aspects of DCD (CPR-DCD) have provided a useful framework and insight for intervention (Blank et al., 2019:242). However, the CPR-DCD recommendations have suggested that these guidelines should be adapted to country-specific and culture-specific environments (Blank et al., 2019:244).

Despite the CPR-DCD recommendations, various other opinions and viewpoints regarding intervention have been published in the literature. Preston et al. (2017:866) asserted that several of the literature's interventions have useful features and should be used in future research to determine an appropriate intervention framework. In contrast, Pienaar and Lennox (2006:80) and Pienaar (2016:232) suggested a combination of methods and intervention approaches depending on the problems experienced by children with DCD. Smits-Engelsman et al. (2018:99) recommended activity- and body-function-oriented interventions in combination with functional tasks. Preston et al. (2017:866) and Ferguson et al. (2013:2451) also suggested task-oriented interventions. The task-oriented approaches should focus on real-life situations selected by the child, focusing on functional motor outcomes (Caçola et al., 2016:174; Ferguson et al., 2013:2452). Lastly, Zwicker, Rehal, Sodhi, Karkling, Paul, Hilliard and Jarus (2015:174) highlighted the importance of cognitive intervention in improving the child's functional motor goals. Considering the various opinions in the literature, further inconsistencies regarding interventions have been reported.

A lack of information regarding the dosage (durations, frequencies, number of sessions) of intervention programmes (Preston et al., 2017:866) has been identified in the literature. The question has been raised on whether group interventions were practical and could be considered for use in environments where unaffordability or limited available resources for intervention occurs (Ferguson et al., 2013:2450; Smits-Engelsman et al., 2018:99). Inconsistencies in intervention approaches regarding group-based versus individual intervention and intervention outcomes have been reported (Smits-Engelsman et al., 2018:73). Smits-Engelsman et al. (2018:99) pointed out that uncertainty regarding the importance of including parents, teachers and relevant others involved in the child’s life, should be included in the intervention programme. Further questions have been raised regarding the effectiveness of various recommended intervention approaches, and one of the main shortcomings listed in the literature was the limited availability of population-based interventions (Camden, Wilson, Kirby, Sugden & Missiuna, 2015:154).

The appropriate intervention approach should be identified and used for children with DCD; however, research is limited regarding the effectiveness of the various interventions that are available, specifically regarding the improvement of motor difficulties (Davidson & Williams, 2000:495; Pienaar & Lennox, 2006:70; Preston et al., 2017: 865; Sugden & Chambers, 2003:546).

From this literature background, it is clear that increasing attention is being paid to children presenting motor difficulties and described as 'clumsy' or 'physically awkward' by parents, teachers and healthcare professionals. These difficulties are often associated with coexisting conditions, which, if not addressed effectively, may result in a myriad of secondary problems that can affect the child's functioning and participation in life roles through childhood, into adolescence, and into adulthood. The literature further points out the variation in prevalence, assessments and interventions for children with DCD that exists, which leads the literature review to the problem statement of the thesis.

1.3 Problem statement

Children and educators living in low SE environments have fewer opportunities to participate in sport and play activities (Senekal, Seme, De Villiers & Steyn, 2015:2). The limited opportunities raise the concern that children experience restrictions pertaining to literacy, resources and healthcare facilities (Steyl & Phillips, 2014:2). These barriers are present in under-resourced schools with no modern infrastructure, which cannot provide children with adequate opportunities for gaining knowledge and motor skills (Pienaar & McKay, 2014:103). With inadequate knowledge and skills, children living in low SE environments are more likely to experience motor difficulties and developmental deficits than same-aged children growing up in higher SE environments (Pienaar, 2004:77). Amidst these concerns about motor difficulties in school-aged children in countries globally, De Milander et al. (2016a:50) have reported heightened concern regarding the high occurrence of motor difficulties likely experienced by children in SA. It is further necessary to note that most of the research on the prevalence of DCD was conducted in the North West Province of SA, and more studies in other regions and provinces are required.

Venter et al. (2015:177) argued that a child's SE status should be considered as a possible reason for more motor difficulties experienced by children in SA. However, findings in SA in this regard are contradictory, and inconsistent findings have been reported on the association and relationship between motor abilities and SE environments. No prevalence data on motor difficulties related to DCD among children between 6–8 years in the low SE environment of the Mangaung district in central SA are available. Uys and Pienaar (2010:141) identified two important aspects to be researched: first, research on motor difficulties in SA's low SE environments; second, to research the educational level of teachers and parents to provide adequate opportunities for motor skill acquisition at home and school for children in the country.

Another gap observed in the literature is that inconsistencies and challenges have been found within the various reported standardised assessment tools, or the assessment measures used to identify motor difficulties in children with DCD (Cardoso et al., 2014:183). These challenges include that standardised tests can only be conducted, scored and interpreted by suitably qualified professionals, are expensive to acquire specifically in countries outside the United Kingdom and the United States due to the exchange rate, and are often lengthy to conduct (Smits-Engelsman et al., 2020:9). Therefore, teachers have been identified in the literature as possible role players to observe characteristics of motor difficulties that can lead to the identification of possible DCD. Research in SA regarding teachers' ability to identify motor difficulties using the MABC-2 Checklist in a low SE environment has not been conducted and should be established. The priority is to use teachers in the school community to identify physical features in children that can be indicative of possible DCD, by using a screening tool (De Milander et al., 2016b:1002). The teachers can provide support and assistance by referring the children who experience motor difficulties to a multidisciplinary team for formal neurodevelopmental evaluations (Asunta, Viholainen, Ahonen, Cantell, Westerholm, Schoemaker & Rintala, 2017:69; Blank et al., 2019:260).

Lastly, the secondary problems mentioned in this background are alarming and raise concerns for children identified with DCD. Camden et al. (2015:154) have emphasised that DCD is still widely unrecognised, and it is a real problem that many families do not have access to services to help their children to overcome the primary and secondary problems they experience. Therefore, early identification of DCD and effective motor intervention are needed to limit secondary challenges (Deshpande et al., 2019:9; Kourtessis et al., 2008:98;

Venter et al., 2015:180). One of the aims of the CPR-DCD recommendations by Blank et al. (2019:244) is to determine the importance of an interdisciplinary approach with physicians and therapists from various disciplines. However, limited information is available regarding the role of a Kinderkineticist in the South African context working withing an interdisciplinary approach and within a population-based environment.

Kinderkinetics is a professional field in SA specialising in children's movement and physical activity from birth to 13 years of age. Kinderkinetics focuses on 'scientifically based and individualised exercise programmes in psycho-motor, physical, and neuro-motor development' (Pienaar, 2009:51). One of the essential goals of Kinderkinetics is to promote the typical motor development of young children and provide intervention programmes for children with developmental disorders to maintain an active, healthy lifestyle (South African Professional Institute of Kinderkinetics [SAPIK], 2020). Kinderkinetics services could be of value for children in SA diagnosed with DCD or possible DCD, and can play a supplementary role in a multidisciplinary therapeutic team. Research regarding Kinderkinetics motor intervention programmes for children with possible DCD and DCD exist (Coetzee & Pienaar, 2013:4074; De Milander, Du Plessis & Du Randt, 2014:54; De Milander, Coetzee & Venter, 2015a:25; Ernst, 2003:5-6; Peens, 2005:134; Peens & Pienaar, 2007:114; Pienaar & Lennox, 2006:70). However, more recent studies are required and although Kinderkineticists receive training on the best practice recommendations to follow for DCD intervention (Pienaar, 2020:219) research conducted with experience of Kinderkineticists in the practice environment regarding a motor intervention programme framework for children with DCD has not been conducted. Blank et al. (2019:245) indicated that due to country- and culture-specific service provision for individuals with DCD in different countries, international standards should be adapted for local, national conditions. Therefore, it is essential to identify a motor-intervention framework for children with DCD or possible DCD in Kinderkinetics within the South African context.

By conducting the comprehensive literature review, various research findings regarding the prevalence of DCD, assessment tools to identify possible DCD and interventions to improve children's motor difficulties with DCD or possible DCD, have been investigated. However, limited research has been conducted on the prevalence of possible DCD in SA, especially research explicitly focusing on children in low SE environments. A gap has further been established in the availability of assessment tools to screen for motor difficulties in children with DCD within a school environment. The MABC-2 Checklist has not been evaluated as a possible screening tool used by teachers in SA's low SE environments. The country has a diverse population with many children (60%) living in low SE environments. It is essential to use tools and people who can identify motor difficulties as early and as affordable as possible to help these children earlier. However, various motor intervention approaches for children with DCD have been described in the literature. A motor intervention framework to address motor difficulties in children with DCD or possible DCD, specifically in the field of Kinderkinetics, has not been established.

The following three research questions that arose from this literature background have been addressed in this study:

1.3.1 What is the prevalence of possible DCD in Gr. 1 learners in a low SE environment in Mangaung, SA, using the MABC-2 Performance Test?

1.3.1 Are teachers able to identify Gr. 1 learners in low SE environments with possible DCD using the MABC-2 Checklist?

1.3.3 What is the recommended motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African context?

1.4 Objectives

The objectives of the research study were:

1.4.1. to determine the prevalence of possible DCD in Gr. 1 learners in a low SE environment in Mangaung, SA, using the MABC-2 Performance Test;

1.4.2. to establish the ability of teachers to identify Gr. 1 learners with possible DCD in low SE environments using the MABC-2 Checklist; and

1.4.3. to use an e-Delphi survey to develop a motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African context.

1.5 Significance of the study

By addressing the research questions, overall awareness of DCD and possible DCD in SA within low SE environments can be raised by providing the Department of Basic Eduction with information regarding the results. The study has significance as it provides results on the prevalence of possible DCD in the Mangaung district's low SE environment. To the researcher's knowledge, this was the first study conducted to determine the prevalence of possible DCD in the low SE environments of Mangaung, FS Province. By determining the prevalence of possible DCD, increased awareness of DCD and possible DCD could ensure earlier intervention, not only for children with DCD, but also for children experiencing motor difficulties in general. This study's results and findings will encourage future research in other districts of the FS and more provinces in SA. The findings may enable the researcher to raise awareness and inform the Department of Basic Education on DCD and the consequences of this disorder among children in low SE environments. Furthermore, the study may create opportunities to equip teachers in identifying motor difficulties and refer them for support to the necessary professionals, such as Kinderkineticists. The Department of Basic Education could be made aware by the researcher of the MABC-2 Checklist that could be used by teachers to consider as a possibility to identify motor difficulties. Furthermore, the Department of Basic Education could arrange with professionals such as Kinderkineticists, Occupational Therapists and Physiotherapists to train teachers to use the MABC-2 Checklist.

Finally, this research provides the first draft of a motor intervention framework based on expert input in the field, for possible use by Kinderkineticists in SA. The draft motor intervention framework will provide the opportunity to pilot the guidelines to determine if the intervention is relevant and useful in its application. Such a motor intervention framework may have the potential to assist children with DCD in overcoming challenges in motor difficulties and addressing other secondary problems associated with DCD, especially in a South African population-based environment that varies from other countries with regard to culture, SE environments and public health support. Improvement in motor abilities will lead to increased participation, improved physical activity and a better quality of life. The possible value of the Kinderkinetics profession and role of a Kinderkineticist in addressing motor difficulties within a school environment could be emphasised.

Publishing the results of this research study in peer-reviewed journals and the possibility to present the results at national and international congresses will share the importance of raising awareness of DCD in SA and aim to improve Kinderkinetics service delivery in motor intervention for children with DCD. The Kinderkineticist, who is equipped with extensive motor development knowledge, could be identified as one of the principal professions in SA in the management and support of children with DCD, and might further contribute to a multidisciplinary approach to address secondary problems experienced by children with DCD. With the vast population of SA, the limited availability of therapists and resources and shortage of healthcare staff, is a challenge (Cullinan, 2006). The availability and role of Kinderkineticists to manage and assist children with DCD might overcome that challenge.

1.6 Research methodology

A quantitative approach using a cross-sectional study design was used to meet the first two objectives of the research study. Furthermore, an exploratory e-Delphi method to gather quantitative opinions were used to achieve the third objective. More information on the specific methods used to meet each of the objectives with regard to participants, measuring instruments, procedures and statistical analysis, is provided in each of the three articles.

1.7 Ethical considerations

The study was approved by the Health Sciences Research and Ethics Committee (HSREC) of the University of the Free State (UFS) (UFS-HSD2017/1363), and the Department of Basic Education of the FS granted permission to conduct the study before data collection commenced. Participation in the study was voluntary. The principals of the schools provided informed consent for their schools to be part of the research study. The children's parents provided written informed consent for their child's participation, with the child providing assent to participate. The teachers have also provided written informed consent for their participation in completing the MABC-2 Checklist. Experts selected for participation in the e-Delphi survey also provided informed consent. All participant information was kept confidential. The study was conducted in line with the ethical principles for medical research involving human subjects, as outlined in the Declaration of Helsinki (World Health Organization [WHO], 2001).

1.8 Structure of the thesis

1.8.1. This thesis is presented in an article format. The thesis consists of six chapters. The introductory chapter is followed by a literature review, three articles, and a concluding chapter. Each chapter includes a reference list at the end. The Harvard referencing style has been employed in Chapters one, two, and six, while the referencing style in the articles (Chapters three, four and five) is in accordance with journal-specific guidelines and requirements. Minor changes have been made to the layout of the articles to ensure ease of reading. The margins will be the same throughout with 1.5-line spacing and the writing will be justified. Tables are presented in the text, and the article's headings are numbered.

1.8.2. Chapter one introduces the background, problem statement, research questions, objectives, significance of the research, research methodology and ethical considerations. A short literature review provides insights into the gaps observed in the current literature. A summary of the structure of the thesis is provided.

1.8.3. Chapter two provides a comprehensive overview of the current and relevant literature related to this study. Topics in the literature review include the terminology applicable to and definitions of DCD, the prevalence of DCD and possible DCD, SE environments, characteristics, symptoms and aetiology of DCD, the assessment and diagnosis of DCD, and general and motor interventions for children with DCD. Several international studies' findings published in the literature were reviewed, as limited research has been conducted on DCD in SA. However, wherever available, research in SA relevant to this study was consulted.

1.8.4. Chapter three is presented as an article and reports on the prevalence of DCD (objective one). The article is titled 'Prevalence of possible DCD among Grade 1 learners in low SE environments in Mangaung, SA'. The article was written according to the author's guidelines for the *South African Journal of Childhood Education* (Appendix G). See page 370. The article was submitted for peer-review and subsequently accepted for publication. [Citation: Du Plessis, A.M., De Milander, M., Coetzee, F.F. & Nel, M. 2020. Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa. *South African Journal of Childhood Education*, 10(1): a836. https://doi.org/10.4102/sajce.v10i1.836]. (Appendix I). See page 383.

1.8.5. Chapter four contains the research results that address objective two and is presented in the form of an article. The article is titled 'The ability of teachers to identify Grade 1 learners in low SE environments with possible DCD'. The article was written in accordance with the applicable guidelines for authors and submitted to the *South African Journal of Childhood Education* (Appendix G) see page 370, where it was under peer review at the time of completing the thesis. Feedback was received after the first round of review and has been provisionally accepted, pending minor revisions requested by the reviewers.

1.8.6. Chapter five is presented in article format and addresses objective three. The article is titled 'Kinderkinetics motor intervention framework for children with DCD: an e-Delphi perspective.' The article was written in accordance with the guidelines for authors of the *South African Journal for Research in Sport, Physical Education and Recreation* (Appendix H) see page 377, where it has been submitted for peer review at the time of completing the thesis.

1.8.7. Chapter six contains the summary and conclusions of the study. The recommendations for practice and future research are presented. It further describes the limitations and value of the study. A conclusion of the thesis completes this chapter.

The MABC-2 Performance Test and MABC-2 Checklist, referenced in Chapters three and four, are standardised. Due to copyright protection, the data sheets and relevant information are not included in the thesis. The e-Delphi questions for each round of the survey that were used in this research study are presented in Appendix F, see page 334.

1.9 Conclusion

In this introductory chapter, a holistic overview of the research study was provided. An indication of the chapters of the thesis and the research articles addressing the research objectives was provided. The following chapter provides an in-depth overview discussion of the literature regarding the assessment, identification and intervention of DCD, as well as DCD among children living in low SE environments.

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CHAPTER 2

LITERATURE REVIEW: ASSESSMENT, IDENTIFICATION AND INTERVENTION OF DEVELOPMENTAL COORDINATION DISORDER AND LOW SOCIO-ECONOMIC ENVIRONMENTS

2.1 Introduction

Motor skills play an important part in children's movement, physical fitness, health and well-being (Kokštejn, Psotta & Musálek, 2015:65). The literature has provided various reports over the years on children who experience motor difficulties, which influence their coordination, the performance of daily activities and motor abilities (Ferreira et al., 2019:344; Gasser-Haas, Sticca & Seiler, 2020:2; Li, Graham & Cairney, 2018:7). One of the many disorders related to motor difficulties is developmental coordination disorder (DCD) (American Psychiatric Association [APA], 2013:74). DCD occurs in children all over the world. However, variation in the prevalence rates reported in the literature has been noted, and inconsistent reports on whether a low socio-economic (SE) environment influences motor abilities, have been published (Amador-Ruiz, Gutierrez, Martinez-Vizcaíno, Gulías-González, Pardo-Guijarro & Sánchez-López, 2018:541; Hardy, Reinten-Reynolds, Espinel, Zask & Okely, 2012:e397; Uys & Pienaar, 2010:135).

Many people living in low SE environments in South Africa (SA) have limited access to resources, especially educational equipment and home resources (Fadiji & Reddy, 2020:4). Equipment and assessment tools that are available to identify motor difficulties and provide therapeutic intervention, are not affordable for parents of children living in low-income communities (De Milander, Coetzee & Venter, 2016a:1002; Steyl & Phillips, 2014:2). Therefore, it is essential to identify a cost-effective method that teachers can use to identify children with possible DCD. Children do not outgrow DCD, but their motor skills can be improved with appropriate intervention (Montgomery, Glegg, Boniface & Zwicker, 2018:3; Smits-Engelsman, Vinçon, Blank, Quadrado, Polatajko & Wilson, 2018:98).

Early intervention and therapy should be provided for children with motor difficulties (Caçola, Miller & Williamson, 2017:16; Lipkin & Macias, 2020:5). Therapy may be offered in various settings, such as a local clinic, the outpatient department at a hospital for public sector patients, and private practices. However, some of these services are limited in low SE environments, in addition to inadequate numbers of health professionals required to provide intervention in these areas (Ncho & Wright, 2013:6). Private practices may also be too far to reach for parents and children in low SE environments (Valentini, Coutinho, Pansera, Dos Santos, Veira, Ramalho & De Oliveira, 2012:382–383). Therapists can provide various intervention approaches and programmes to aid children identified with DCD to improve their motor abilities (Ashkenazi, Weiss, Orian & Laufer, 2013:469; Au, Chan, Lee, Chen, Chau & Pang, 2014:994; Coetzee & Pienaar, 2013:4076; Thornton, Licari, Reid, Armstrong, Fellows & Elliott, 2016:983).

International clinical practice recommendations on the definition, diagnosis, assessment, intervention and psychosocial aspects of DCD (CPR-DCD) have recently been published (Blank et al., 2019:243). The importance of using these recommendations as a guideline for intervention and adapting the recommendations by considering the country-specific and culture-specific environments and requirements of a specific country, has been emphasised (Blank et al., 2019:245). If the CPR-DCD recommendations are adapted to country-specific requirements, South African professionals' inputs should explicitly be directed at intervention. Furthermore, understanding that motor difficulties are one of the main problems experienced by children with DCD, it has become essential to identify a motor intervention framework with the South African context taken into account. Considering the aspects mentioned above, the prevalence rates of DCD, prevalence and living conditions (resource availability & school environment of) low SE environments, assessment methods to identify motor difficulties, and intervention approaches for DCD, are the focus of this literature review.

The aim of this research study was to (i) examine the prevalence of possible DCD in a low SE environment of Mangaung in the Free State (FS) Province of SA, using the MABC-2; (ii) determine if teachers could play a role in early identification of possible DCD when using the Movement Assessment Battery for Children 2nd edition (MABC-2) Checklist), and (iii) develop a motor intervention framework to use in the field of Kinderkinetics to assist children identified with DCD or possible DCD. Information on the prevalence of DCD and teachers' ability to identify possible DCD in low SE environments is limited, and research on a motor intervention framework for DCD or possible DCD in the field of Kinderkinetics has not been done before.

First, the study aimed to determine the prevalence of possible DCD in Mangaung, Motheo District, of the FS Province in SA. The focus was on children attending schools in a low SE environment. Previously published reports documented in the literature review regarding this aim will include the prevalence rates of DCD within various countries and specifically SA when using different assessment methods. SE classifications, together with the role of SE environments on motor abilities, will be explained. The second aim was to establish if teachers could identify possible DCD in Gr. 1 learners within a low SE environment. Therefore, the literature review will highlight the various assessment methods used to identify possible DCD and emphasise the MABC-2 Performance Test and MABC-2 Checklist findings when completed by teachers. The literature review will briefly discuss the reliability and validity of the MABC-2.

Lastly, the aim was to develop a motor intervention framework to use in Kinderkinetics for children with DCD or possible DCD within the South African context. The various motor intervention approaches and recommendations available in the literature will be discussed. Finally, the role of a Kinderkineticist regarding motor intervention for children with possible DCD and DCD will be highlighted. Terminology and definitions of DCD and other aspects relevant to this research study will be presented, after which further discussions will follow. The symptoms, characteristics, co-occurring disabilities and aetiology of DCD will be described briefly. To understand DCD, various terminology and definitions that exist will be discussed next.

2.2 Terminology and definitions of developmental coordination disorder

Over time, diverse terminology has been used to describe a child with motor coordination problems. These terms include clumsy child syndrome, dyspraxia, physically awkward child (Davidson & Williams, 2000:498; Henderson & Barnett, 1998:451; Peters, Barnett & Henderson, 2001:408), motor coordination deficit (Polatajko & Cantin, 2005:251), perceptual-motor dysfunction (Sugden & Chambers, 2003:546), sensory integration dysfunction (Henderson & Barnett, 1998:451) and poor motor coordination skills (Barnhart, Davenport, Epps & Nordquist, 2003:731). The various terms used may be profession- or country-specific (Henderson & Henderson, 2003:3; Magalhães, Missiuna & Wong, 2006:937). The World Health Organization (WHO) (1992:196) and the American Psychiatric Association (APA) (2000:449) had emphasised the importance of identifying a consensus term (terminology) and definition to describe the motor difficulties experienced, to improve communication between multidisciplinary professionals, including healthcare experts and teachers. Furthermore, using a single standard term is essential to eliminate the confusion that hinders research within this field (Henderson & Barnett, 1998:452; Henderson & Henderson, 2003:3).

In 1987, the term *developmental coordination disorder* (DCD) was first introduced (Polatajko & Cantin, 2005:251) and used in conjunction with various other names. In 1994, a consensus meeting in London themed 'A disability in search of a definition' was held, as a common name and definition had not yet been agreed on. The meeting agreed that the term DCD should be used when referring to a child with moderate to severe motor coordination problems (Barnett, 2008:113; Polatajko, Fox & Missiuna, 1995:3). Later it was further established that the child should meet the four criteria for a diagnosis of DCD proposed by the APA in the *Diagnostic Statistical Manual of Mental Disorders* 5th edition (DSM-5) (APA, 2013). It was further recommended to use DCD as a keyword when conducting research, and using a common name would simplify the pooling of similar or comparable search data (Magalhães et al., 2006:938). According to Magalhães et al. (2006:941), the process to name and define DCD as best as possible had by then been ongoing for more than a decade. The APA (2000, 2013) later defined DCD as a neuro-developmental disorder.

DCD is defined by the *International Statistical Classification of Diseases and Related Health Problems*, 10th Revision (ICD-10) (WHO, 2019) as follows:

> 'A disorder in which the main feature is a serious impairment in the development of motor coordination that is not solely explicable in terms of general intellectual retardation or of any specific congenital or acquired neurological disorder. Nevertheless, in most cases, a careful clinical examination shows marked neurodevelopmental immaturities such as choreiform movements of unsupported limbs or mirror movements and other associated motor features, as well as signs of impaired fine and gross motor coordination' (WHO, 2019).

The APA (2013) uses the DSM-5 criteria to define DCD. Overall, the key components of the definition of the ICD-10 are consistent in these criteria, as described in Table 2.1. To be diagnosed with DCD, a child must meet the four criteria set out in the DSM-5 (APA, 2013; Blank et al., 2019:252).

Table 2.1. Four criteria as set out by the DSM-5 (APA, 2013; Blank et al., 2019:252).

Criteria	Description
Criterion A	Acquiring and execution of coordinated motor skills are far below the expected level for age, given the opportunity for skill learning.
Criterion B	Motor skill difficulties significantly interfere with the activity of daily living and impact academic/school productivity, prevocational and vocational activities, leisure, and play.
Criterion C	Onset is in the early developmental period.
Criterion D	Motor skill difficulties are not better explained by intellectual delay, visual impairment, or other neurological conditions that affect movement.

The diagnostic criteria proposed in the DSM-5 provide an adequate benchmark, and most definitions of DCD refer to these criteria (Polatajko & Cantin, 2005:251; Sugden, Kirby & Dunford, 2008:174). Other descriptions have also been published in the literature. Duchow, Lindsay, Roth, Schell, Allen & Boliek (2019:83) described DCD as:

> 'motor impairments that significantly impact a child's ability to perform daily living activities and cognitive disability activities, visual impairment, and other neurological conditions affecting movement are ruled out.'

Also, Caçola (2014:98) refers to DCD as children who experience 'clumsy' and 'uncoordinated' movements that significantly influence performing tasks naturally to children without these motor coordination problems. Cairney, Veldhuizen, Kurdyak, Missiuna, Faught & Hay (2007:987) explain DCD as low motor proficiency abilities that will influence the child's social skills and abilities, which affect academic performance. However, these low abilities are not due to psychiatric, neurological or medical conditions.

Considering all the definitions and descriptions provided for DCD, it is clear that the fundamental aspects remain consistent. Children with DCD show poor motor coordination abilities early in their developmental period, even if they have appropriate skill acquisition opportunities, and these motor difficulties have an influence on the child's day-to-day functioning and academic performance. The motor difficulties experienced are not due to intellectual delays or other neurological conditions. Considering that DCD is related to motor abilities and motor skills, the terms relevant to this study are described below.

Motor development is 'the process by which an individual progresses from simple movement to complex motor skills' (Haywood & Getchell, 2014:5). Motor ability is defined as the ability to use motor components, such as coordination, balance and reaction time, to execute movements with proficiency in many motor skills (Oxford Dictionary, 2007). A motor skill is a skill learned by the child and aids the child in performing movement activities without any hesitation and includes voluntary movements of the head, body and limbs (Magill, 2011:3). When a child is skilled in motor performances, it means that the child has adequate fine motor control, motor coordination, body coordination, strength and agility (Bruininks & Bruininks, 2005:1). To have good motor abilities, the child needs to be exposed to various motor skills and movements (Sigmundsson, Trana, Polman & Haga, 2017:2). If a child experiences motor difficulty, the child will have a delay in movement and experience a delay in the initial movement that he or she intended to do (EduCLIME, 2020).

Fine motor skills involve the body's smaller muscles and completing finer tasks such as writing and cutting with scissors (Magill, 2011:7). On the other hand, gross motor skills include actions of the large muscles and consist of locomotor skills (running, jumping, galloping), stability skills (balancing on one leg, sitting up straight) and manipulation skills (ball skills such as kicking, throwing, catching) that form part of fundamental movement skills (Veldman, Jones, Santos, Sousa-Sá & Okely, 2018:1226). Fundamental movement skills are movement behaviours classified into three stages: initial, elementary and mature, and consist of basic movements such as locomotor activities, manipulative activities and stability activities (Gallahue & Ozmun, 2007:505).

Knowing that children with DCD experience poorer motor abilities, it is essential to know how prevalent DCD is in children.

2.3 Prevalence of developmental coordination disorder

The APA (2013) stipulates that a child should meet all four criteria of the DSM-5 to be diagnosed with DCD. If all four criteria of the DSM-5 are not met, terms such as 'possible

DCD', 'at risk for DCD' and 'suspected DCD' are used, and more of the recent literature tends to not refer to the term DCD, but instead to 'motor challenges', 'motor difficulties' and 'motor skill impairment' (Alesi, Pecoraro & Pepi, 2019:287; Delgado-Lobete, Santos-del-Riego, Pértega-Díaz & Montes-Montes, 2019:33; Duchow et al., 2019:83; Lingam, Hunt, Golding, Jongmans & Emond, 2009:e694; Valentini, Getchell, Logan, Liang, Golden, Rudisill & Robinson, 2015a:42). For this research study, the terms *possible DCD* and *motor difficulties* will be used to report the prevalence findings reported in the literature if the DSM-5 has not been used.

The APA (2013) reported that 5–6% of school-aged children have DCD based on the 4 criterion of the DSM-5, which is the most frequently reported prevalence. However, various prevalence estimates in different countries have been documented (Giagazoglou, Kabitsis, Kokaridas, Zaragas, Katartzi & Kabitsis, 2011:2577). These prevalence estimates range from low (0.8%) (Girish, Raja & Kamath, 2016:111) to high (19.9%) (Tsiotra, Flouris, Koutedakis, Faught, Nevill, Lane & Skenteris, 2006:126). The prevalence rates reported in the literature vary due to the different definitions used, the type of population being studied, and the various techniques in which diagnostic criteria or assessment methods have been used to identify DCD (Biotteau, Danna, Baudou, Puyjarinet, Velay, Albaret & Chaix, 2019:1874; Cardoso, Magalhães & Rezende, 2014:180; Carslaw, 2011:87; Kokštejn et al., 2015:65; Valentini, Getchell et al., 2015:41).

For a comprehensive diagnosis, a motor test should be conducted, and factors outside the child's control (culture and SE environments) that influence motor abilities should be excluded (the child should have adequate opportunity for skill acquisition) (Blank et al., 2019:274). However, it will have to be proven that culture and SE environments do limit skill acquisition opportunities. Furthermore, a comprehensive assessment that includes clinical history, examination, parents and teachers' considerations, an explanation of motor difficulties that are not due to a medical, neurological, psychological, social or cultural background, should be used to fully diagnose a child with DCD (Blank et al., 2019:256). Therefore, for the purpose of this study, if a DCD diagnosis has not been made in the literature findings, and if motor difficulties in children are found to fall far below the child's age, the terms *possible DCD* and *motor difficulties* will be used. These terms have also been used in other reports if a DCD diagnosis had not been made (Alesi et al., 2019:287; Delgado-Lobete et al., 2019:33; Duchow et al., 2019:83).

According to various assessment methods and SE environments, the prevalence findings reported in the literature are discussed next.

2.3.1 Research findings on the prevalence of developmental coordination disorder using the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, 4th and 5th editions

A population based study in Avon, South West England, on 6 990 children 7–8 years of age, found a prevalence of 1.8% and observed that DCD was more evident in children from low SE groups when using the DSM-4 criteria (Lingam et al., 2009:e696). The MABC Performance Test was used to determine criteria A, academic achievement and a 23-item measure of activities of daily living parent questionnaire derived from the Schedule of Growing Skills 2 and Denver Developmental Screening Test 2 were used for criteria B, hospital and community health service notes and educational records as well as using the International Statistical Classification of Diseases, 10th Revision were used for criteria C, IQ at 8.5 years using the Wechsler Intelligence Scale for Children three were used for criteria D of the DSM in the study (Lingam et al., 2009:e695). Similar to the West England study, a population based study conducted in an urban setting in Korea on 568 children between 8–9 years of age reported a prevalence of 1.09% (Lee, Jung, Lee, Lim, Lee, Jung, Lee, 2019:5). Criteria A was determined using the 15th percentile cul-off score of the MABC-2, criteria B was determined by identifying a score below 55 with the DCDQ’07 and if academic performance and physical education adherence were not above average, criterion C was determined by looking at the participants age on the school records and criteria D was determined by observing the health records (Lee et al., 2019:3).

In contrast, a very low prevalence (0.8%) was documented in India on 2 282 children between 6–15 years old (Girish et al., 2016:111). The studies in Korea and India used the DSM-5 criteria (Girish et al., 2016:111; Lee et al., 2019:5). The study in India made use of the Assessment Battery for Children with Developmental Coordination Disorder test and children with a score below the 20th percentile was identified with definite motor skill impairments and between 20 and 50th percentile with a risk for motor skill impairments. All children identified with at risk and definite motor skill impairments were included (Girish et al., 2016:110), criteria B was determined by the Functional Independence Measure for children scale to determine daily functional skills and if the specific criterion score for their age was not reached it was assumed that the activities of daily living of the child is affected (Girish et al., 2016:110). Furthermore, the continuous and comprehensive education system to assess academic achievement. A pass percentage of 80% was used as the cut off score for academic performance. Criteria C was determined by interviewing the parents to identify coordination problems and children who experienced coordination difficutlies up until age 5 was positive for criteria C (Girish et al., 2016:110). Criteria D was determined by the physician of the school to diagnose visual, developmental or neurological conditions as well as an individual interview with each child by a physiotherapist to rule out neuro-musculoskeletal abnormalities (Girish et al., 2016:109). A child with visual, developmental and neurological conditions were excluded. Lastly the Raven's Progressive Matrices intelligence test was used and a score of grade 3 and above were excluded (Girish et al., 2016:109). In die Indian study, is was further established that children living in semi-urban environments showed a higher prevalence of DCD than children living in rural areas (Girish et al., 2016:111).

One of the reasons for the controversies in these studies' results is that the children's epidemiological information depends on how strict the selection criteria have been applied, and that inconsistent application could account for some variability in the results (Blank et al., 2019:250). The study conducted in Korea used more items to evaluate motor performance than the study in South West England (Lingam et al., 2009:e694, e695), which might be one explanation for the discrepancies in the reported prevalence. The study in India used stricter interview strategies by professionals than the study in Korea who only used the student's health record (Lee et al., 2019:3). Another reason for the difference in prevalence might be the geographical and cultural variation between different countries (Lee et al., 2019:5). Lingam et al. (2009:e696) reported a higher prevalence of DCD in low SE environments, whereas Girish et al. (2016:113) found a higher prevalence of DCD in middle to higher SE environments. Limited research is available where the 4 criterion of the DSM have been strictly used to determine the prevalence of DCD. Although the criteria are used in studies, not all 4 criterions have been used. One of the reasons could be that it is challenging to meet all the criteria of the DSM-5, mainly when large groups and population-based samples are used (Delgado-Lobete et al., 2019:37).

Further controversies have been reported in the literature when using only a motor proficiency test or screening tool to identify possible DCD (DSM-5 Criteria A and B) (Lee et al., 2019:1). It is important to note that it cannot be said that a child has DCD if only a standardised motor test, such as the MABC, has been used. However, standardised motor tests and screening tools or questionnaires can be used to identify potential motor difficulties (Delgado-Lobete et al., 2019:37), and findings have been reported in the literature.

2.3.2 Research findings on the prevalence of possible developmental coordination disorder based on the original Movement Assessment Battery for Children

Children's motor skill proficiency is categorised within three levels when making use of the Movement Assessment Battery for Children (MABC). The categories are no motor difficulties (> 15th percentile), moderate motor difficulties (6th–15th percentile), or severe motor difficulties (≤ 5th percentile) (Henderson, Sugden & Barnett, 2007:114). When children fall within the moderate and severe motor difficulties categories (≤ 15th percentile), they have been described as having possible DCD (Alesi et al., 2019:287; Delgado-Lobete et al., 2019:33; Duchow et al., 2019:83).

Findings on the original version of the MABC when using the 5th percentile as cut-off score (severe motor difficulties) have been reported in the following studies. In a high-income area of Japan, a low prevalence of possible DCD (1.8%) was observed in 133 children 7–8 years of age (≤5th percentile) (Miyahara et al., 1998:690). Similar results (1.6%) were later reported in a younger group (3.4–6.3 years) of 364 Greek children who lived in urban communities (≤5th percentile) (Kourtessis, Tsougou, Maheridou, Tsigilis, Psalti & Kioumourtzoglou, 2008:96). In both of these studies, a relatively small sample size was used, which might be a reason for the low prevalence (Kourtessis et al., 2008:97; Miyahara et al., 1998:695). The study in Japan has highlighted that children were exposed to sports activities that enhanced their motor abilities, especially balance, which could be an explanation for the low occurrence of motor difficulties (Miyahara et al., 1998:695).

Despite the low prevalence found in these two studies, higher prevalence rates were identified in three different Brazilian studies. One study reported a prevalence of 11.4% in 581 children 7–10 years old (≤5th percentile) (Dos Santos, Contreira, Caruzzo, Passos & Vieira, 2015:81). On the contrary, the other two studies identified a very high prevalence

(≤5th percentile) of 19.9% (1 587 children, 4–12 years) (Valentini et al., 2012:381) and 17.8% (1 056 children, 4–10 years) (Valentini, Clark & Whitall, 2015b:975). The variation in these findings might be attributed to different inclusion criteria and evaluation approaches applied to the participants. It was further stated that children from low SE environments experienced more motor difficulties and were at risk for possible DCD (Valentini, Clark et al., 2015:977). The reason for the lower motor abilities in the literature studies were ascribed due to their low SE environments that limits having many experiences in motor activities because of limited exposure to education and also social and family factors (Valentini, Clark et al., 2015:975). Another reason for the low SE environments in Brazil to have higher levels of possible DCD, is the limited space available to execute motor activities and restricted financial resources (Dos Santos et al., 2015:84).

Finally, two population based studies conducted in the North West (NW) Province of SA reported that 23% (99 children, 6–7 years from low, middle and high SE environments) (Wessels, Pienaar & Peens, 2008:499) and 36.5% (688 children, 10–12 years) (Pienaar, 2004:79) of children in their studies were identified with severe motor difficulties (≤5th percentile). Sixty percent of the sample in the study by Pienaar (2004:78) included children from low SE environments. Another study in the NW province on the children (30 children, 4–12 years) of farm workers (low SE environments) reported 20% with severe DCD (severe motor difficulties, ≤5th percentile) (Prinsloo & Pienaar, 2003:157) and correlate with the findings of Wessels et al (2008:499). From these findings, it could be assumed that high rates of severe motor difficulties are present in SA and present higher occurrences than the studies in Brazil, which is also an upper middle income country. According to Pienaar (2004:87), children who experience severe motor difficulties do not necessarily have access to therapists in their environment, which can be a reason for the higher prevalence rate of motor difficulties. Furthermore, malnutrition experienced by many of these children might influence motor development (Pienaar, 2004:87). Therefore, the researcher recommended that the norms of the MABC Performance Test should be adjusted if a researcher want to use the test in SA (Pienaar, 2004:75). The above literature findings provided insight on the prevalence of severe motor difficulties (≤5th percentile) when the original MABC was used. Further reported results were found regarding moderate motor difficulties (6th–15th percentile).

Moderate motor difficulties (6th–15th percentile) in 10.5% (Dos Santos et al., 2015:81), 15% (Valentini, Clark et al., 2015:975) and 16.8% (Valentini et al., 2012:381) of children, respectively, were reported in three studies conducted in Brazil. Similarly, 10.8% of children in the Greek sample had moderate motor difficulties (6th–15th percentile) and is similar to the findings in the NW province with a moderate DCD indication of 10% (Prinsloo & Pienaar, 2003:157). In contrast, two South African studies pointed out that 29% of the children were identified with moderate motor difficulties (6th–15th percentile) in the one study (Wessels et al., 2008:499) and 24.8% in the earlier study (Pienaar, 2004:79), indicating a relatively high prevalence rate of children experiencing moderate motor difficulties in SA. Lingam et al. (2009:e696) combined the moderate and severe motor difficulties (possible DCD; ≤ 15th percentile) and reported a prevalence of 4.9% in their study in South West England. The lower prevalence of possible DCD in their study could be due to the study's longitudinal nature with differential drop-out of participants. The lack of educational awareness can be one of the reasons for the higher prevalence rates in the lower SE group (Lingam et al., 2009:e698). Apart from the prevalence reports on possible DCD based on the original MABC, research findings where the MABC 2nd edition was used, have also been published.

2.3.3 Research findings on the prevalence of possible developmental coordination disorder based on the Movement Assessment Battery for Children 2nd edition

Kokštejn, Musálek, Šťastny and Golas (2017:194–195) reported severe motor difficulties (≤ 5th percentile) in 2.5% of 121 children (6.5 years) living in Prague in the Czech Republic, and 10.7% of children exhibiting moderate motor difficulties (6th–15th percentile). However, the sample size was small, and a clear indication of the prevalence of severe motor difficulties representative of the whole Czech Republic could not be established (Kokštjen et al., 2017:199). In contrast, in a study in Brazil (787 children, 7–10 years), a higher (7.1%) prevalence of severe motor difficulties (≤5th percentile) was found, although a similar (11.3%) prevalence of moderate motor difficulties (6th–15th percentile) was reported (Beltrame, Capistrano, Alexandre, Lisboa, Andrade & Felden, 2017:108) than in the Czech Republic study. In comparison, the prevalence of severe motor difficulties (≤5th percentile) in the Zeerust district of SA was found to be 6.34%, while moderate motor difficulties (6th–15th percentile) have been observed in 14.93% of children (8.65–10.64 years) in this study (De Waal, Pienaar & Coetzee, 2018:5). These findings were similar to those reported by

Beltrame et al. (2017:108). The 221 children (10.5 years) in the Zeerust study were from both low SE (quintile 1–3 schools) and higher SE environments (quintile 4–5 schools), with a higher prevalence of possible DCD (≤15th percentile) in low SE environments (De Waal et al., 2018:3, 9).

In another South African study in the NW Province on 53 children 3–5 years of age, severe motor difficulties (≤5th percentile) occurred in 11.32% of the children, while moderate motor difficulties (6th–15th percentile) were recorded in 28.30% of the children (Venter, Pienaar & Coetzee, 2015:173). Concerns have been raised with regard to identifying motor difficulties before five years of age, because some children might be slightly delayed in their motor development but will catch up with their age group (Blank et al., 2019:257). Another aspect to consider is that the child might show variability in cooperation and motivation to complete a motor assessment at that age, which might impact the accuracy of the findings (Blank et al., 2019:257; Venter et al., 2015:180).

Venter et al. (2015:173) pointed out that more children (22.73%) in high SE environments experienced severe motor difficulties (≤5th percentile) than children living in low SE environments (3.23%). Conversely, more children in the low SE environment experienced moderate motor difficulties (35.48%) than children in the high SE environment (18.18%) (Venter et al., 2015:173). Despite published findings predominantly highlighting a higher prevalence of severe motor difficulties in a low SE environment, Venter et al. (2015:173, 177) found the opposite. A reason pointed out was that children from high SE environments in this area in SA were most likely put into day-care centers during the day while their parents were working, with less opportunity for physical activity and gross motor development. It was also noted that when the 15th percentile was used as a cut-off score (possible DCD), the prevalence was closely similar in the low (38.71%) and the high (40.91%) SE environments (Venter et al., 2015:174). Research findings when the 15th percentile was used as the cut-off point (possible DCD) with the MABC-2 are discussed next.

Kokštejn et al. (2017:195) reported a prevalence of possible DCD (≤15th percentile) of 13.2%. Similarly, 15% of children were identified with possible DCD from a high SE environment in the FS province (559 children, 5–8 years) (De Milander, Coetzee & Venter, 2014:1081) and 14.5% in the West Coast region of SA (138 children, 5–7 years) (Van der

Walt, Plastow & Unger, 2020:4). The study on the West Coast further confirmed that children from low SE areas would likely present more motor difficulties than children from higher SE settings (Van der Walt et al., 2020:5). In agreement with these two studies, a study in China that is also a upper income country such as SA reported possible DCD (≤15th percentile) in 11.8% of 647 children six years of age (Hua, Jin, Gu, Liu, Zhang & Wu, 2014:3092) which are similar to the findings of the SA studies (De Milander et al., 2014:1081; Van der Walt et al., 2020:4). Kokštejn et al. (2015:64) identified a lower prevalence of 6.5% in older children. Finally, in a more recent study in Spain on 562 children 4–6 years of age, possible DCD (≤15th percentile) had a prevalence of 9.9% (Amador-Ruiz et al., 2018:541).

In addition to the various prevalence rates determined by means of the MABC, prevalence rates for possible DCD were also reported when conducting the Bruininks Oseretsky Test of Motor Proficiency (BOT).

2.3.4 Research findings on the prevalence of possible developmental coordination disorder using the Bruininks Oseretsky Test of Motor Proficiency, 1st and 2nd editions

The Bruininks-Oseretsky Test of Motor Proficiency 2nd edition (BOT-2) is a performance-based test similar to the MABC-2, with both tests being used to evaluate motor skills (Lane & Brown, 2015:161). However, the BOT-2 takes longer to perform because of a broader range of motor skills being evaluated (Bruininks & Bruininks, 2005:1; Lane & Brown, 2015:161).

The BOT-2 Complete Form (BOT CF) has been used in an Indian study on 516 children 5–15 years of age (Dhote, Tushar & Ganvir, 2017:2). A cut-off score of 2 or less were used to categorise a child in the DCD group (Dhote et al., 2017:5). The prevalence results were categorised according to age groups and 0% of the children younger than eight years and older than 14 years were identified with possible DCD. In children eight and nine years of age, the prevalence was 3.16%, while 1.85% of children 10 and 11 years old, and 2.0% of children 12 and 13 years old, were identified with possible DCD. However, the difference between age groups was not statistically significant (Dhote et al., 2017:5). The prevalence in the 10- and 11-year-old group (1.85%) was substantially lower than earlier reported in a study (8% and 19%) using the BOT Short Form (BOT SF) on 11-year-old children in Greece and Canada (Tsiotra et al., 2006:126). However, a higher percentile cut-off score (12) was used to categorise these children in a DCD group and could therefore be the reason for a higher prevalence rate. Also the results could differ due to the complete form used in the Indian study and only the short form used in the Greece and Canada study. The BOT SF is an abbreviated form of the test with fewer items derived from the full form that is used as a screening tool (Bruininks & Bruininks, 2005:6). The results identified 8% of 591 children in Canada with possible DCD and 19% of 329 Greek children, when using the 12th percentile rank as cut-off scores. Children from Greece were relatively inactive compared to the Canadian children, which was proposed as an explanation for the higher prevalence of possible DCD in the Greek cohort. It has therefore been argued that physical activity is important for motor skill development and that lifestyle variations between different countries could influence the prevalence of DCD (Tsiotra et al., 2006:126).

A study on 816 children with a mean age of 6.84 years in the NW Province, SA, identified 1.6% of children in the well below average category (<2 percentile) for motor proficiency and 49.63% of children below average (3-17 percentile) when using the BOT-2 SF (2nd edition) (Pienaar & Kemp, 2014:170,172). The results reported by Pienaar and Kemp (2014:177) raised further concerns about the large numbers of children experiencing motor difficulties in SA. One of the reasons identified in their study for the higher rates was that children are exposed to an environment where winning in school sport is important. Therefore, the children and their coaches/teachers focus on winning and not going through the development steps of reaching their motor development goals. Another reason for the higher prevalence rates in the reported study could be the variability that occur in motor development during this young age (Pienaar & Kemp, 2014:174).

In addition to the standardised, norm-referenced measurement (MABC-2 and BOT-2 Complete Form [BOT CF]) and the screening tools (BOT-2 SF) used to identify possible DCD, other screening tools can be used to identify motor difficulties and establish whether a standardised test should be used for further identification of possible DCD.

2.3.5 Research findings on the prevalence of motor difficulties using the Developmental Coordination Disorder Questionnaire

The Developmental Coordination Disorder Questionnaire (DCDQ) is completed by parents and categorise children in a 'probably not DCD' or 'indication of or suspected DCD' group (Wilson & Crawford, 2007:1–3). A study in Spain using the DCDQ European Spanish version in a sample of 460 children 6–12 years of age, found an indication of or suspected DCD in 12.2% of the children (Delgado-Lobete et al., 2019:37). The researchers pointed out that suspected DCD was relatively high in Spain and might be due to the disorder being unknown and underdiagnosed (Delgado-Lobete et al., 2019:37). These findings are comparable to the results of a study conducted in the FS province of SA on 281 children (6–8 years) from high SE environments, with an indication of or suspected DCD prevalence of 11% when parents completed the 2007 version of the test (DCDQ'07) (De Milander, Du Plessis & Coetzee, 2019:35). On the contrary, an indication of or suspected DCD had a lower prevalence (6%) in a sample of 750 children 5–12 years of age from an urban area in India (Deshpande, Thakkar & Joshi, 2019:10).

Similarly, an indication of or suspected DCD has been idenified in 5.9% of 1 025 children (5–15 years) in Egypt (Ali, El-Tohamy & Mousa, 2016:5). The children in the suspected DCD category did not participate in any sports, and the younger children did not attend a nursery school (Ali et al., 2016:7). Comparing the results of Ali et al. (2016:5), De Milander et al. (2019:35) and Deshpande et al. (2019:10) with a Brazilian study on 130 children 5–14 years of age that used the DCDQ Brazil version, a much higher prevalence (30%) of an indication of or suspected DCD has been found (Barba, Luiz, Pinheiro & Lourenço, 2017:27). Barba et al. (2017:27) were of the opinion that the high prevalence could be attributed to the use of only one assessment tool and one source (the parents) to assess the children.

An alternative parent-reported screening questionnaire that can also be completed by teachers is the MABC Checklist (Henderson et al., 2007:91). Research findings where the MABC Checklist has been used to determine the prevalence of possible DCD are limited and outdated. Studies reporting on the ability of teachers' or parents' to identify children with motor difficulties and literature findings determining the psychometric properties of the MABC Checklist will be discussed in the assessment section of the literature review. The prevalence of DCD or possible DCD was not the main focus of these studies (De Milander et al., 2016a:993; Ellinoudis, Kyparisis, Gitsas & Kourtessis, 2009:308; Junaid, Harris, Fulmer & Carswell, 2000:160; Piek & Edwards, 1997:59; Schoemaker, Smits-Engelsman & Jongmans, 2003b:429).

2.3.6 Summary of findings regarding the prevalence of developmental coordination disorder and possible developmental coordination disorder

The prevalence rate of DCD was low (0.8% to 1.8%) when the DSM-4 and DSM-5 criteria were applied in studies conducted in South West England, Korea and India. Barba et al. (2017:27) were of the opinion that the more assessment tools used and the more professionals involved in the diagnosis of DCD, the more accurate the diagnosis would be. This opinion might explain the reason for lower prevalence rates when these studies are compared to studies where only one or two of the DSM criteria was considered. When considering the published findings of possible DCD by means of the original MABC, it could be concluded that the prevalence of possible DCD ranges from 1.6% to 19.9% for severe motor difficulties in other countries, and that SA reported disturbing ranges of 23% and 36.5%. Studies reported in the literature determined that the prevalence of moderate to severe motor difficulties ranged from 11.8% to 15% when the MABC-2 was used. Again, an increased prevalence of motor difficulties was reported from SA studies. When specifically considering the findings reported when conducting the BOT-2 SF in SA, a very high number of 49.63% of children fell in the below average category (Pienaar & Kemp, 2014:170,172). Therefore, the prevalence rates documented for SA raise concerns regarding the motor skill abilities of children in SA. The DCDQ has further provided more controversies with prevalence rates ranging from 6% to 30%, and SA studies reported an indication of or suspected DCD in 11% of children. Furthermore, several reasons for these controversies have been stipulated in the literature and highlighted the differences between SE environments.

From the literature findings on the prevalence of DCD and motor difficulties, it appears that the majority has reached consensus that more children from low SE environments will experience motor difficulties. According to Van der Walt et al. (2020:5), the reason for children in low SE environments to experience a higher prevalence of possible DCD might be that children in low SE environments do not have access to sufficient resources for therapy. Consequently, these children are not identified as early as possible and do not receive the necessary therapy to improve their motor development. Another aspect to consider is that malnutrition occurs in poor environments and has an influence on a child's motor skill development (Pienaar, 2004:87; Van der Walt et al., 2020:5). Furthermore, playground facilities at no-fee schools (low SE environments) are a limited resource identified in SA, which may have an impact on these children's motor skill development (Van der Walt et al., 2020:5). The involvement of parents to provide stimulation is limited (Kalam, Francke, Jainodien, Petersen, Silo & Turnbull, 2016:61), with challenging environmental factors such as environmental toxins, health problems (De Witt & Lessing, 2016:106) and being unsafe to play outdoors (Kalam et al., 2016:61), which further result in restricted motor development. Despite all these reasons, some studies have also highlighted the opposite, reporting that motor difficulties are more evident in high SE environments. An explanation for this is the unsafe environments to play outside (Kalam et al., 2016:61) and many children living in high SE environments spend more time watching television or playing games on their mobile phones (Pienaar & Kemp, 2014:174). This conclusion is discussed based on the review of the literature.

Other factors contributing to the different prevalence rates of motor difficulties and possible DCD reported in the literature, can be that the exposure to various sports activities in different countries may vary (Miyahara et al., 1998:695). Furthermore, not all the studies' samples were of the same size, had the same risk factors, or used the same methods and procedures to identify possible DCD (Beltrame et al., 2017:111). Another reason for differences in the prevalence of possible DCD found in the literature is whether a clinical-based sample or population-based sample has been used. It seems that the population-based samples were limited and tended to have a higher prevalence of motor difficulties (Venter et al., 2015:177). More recently, Lee et al. (2019:5) explained that the prevalence of DCD would vary between countries due to cultural and geographical differences. Lastly, some children in South Africa do not attend Early Childhood Development (ECD) centers or preschool before entering Grade 1 (Gr. 1), which may also account for some children not reaching the required skill level (Kalam et al., 2016:62). It has further been noted that applying the DSM-5 criteria tends to find lower prevalence rates for DCD in comparison to a motor performance test such as the MABC-2 (Lee et al., 2019:6), which further contributes to the controversies.

Controversies regarding the prevalence of DCD, possible DCD and motor difficulties in male and female children have also been reported.

2.3.7 Prevalence of developmental coordination disorder, possible developmental coordination disorder and motor difficulties in boys and girls

The prevalence of DCD (Table 2.2), possible DCD (Table 2.3) and motor difficulties (Table 2.4) when comparing the two genders is summarised in the tables.

Table 2.2. Gender differences in the prevalence of DCD.

Reference	Country	Age (years)	Boys:girls ratio	Indication	Instrument used
Girish et al. (2016:111)	India	6–15	0.5:1.1	Boys < girls	DSM-5
Lee et al. (2019:4)	Korea	8–9	1.6:1	Boys > girls	DSM-5
Lingam et al. (2009:e696)	South West England	7–8	1.9:1	Boys > girls	DSM-4

The study conducted in India (Girish et al., 2016:111) was the only one of the three studies using the DSM-5 criteria that determined a slightly higher prevalence of DCD in girls than in boys. An explanation that was given for the higher prevalence of DCD in girls, was that boys had more exposure to play and sports activities. The expectation for girls' to participate in sports in India is not high (Girish et al., 2016:114). Although gender differences were observed in all three studies, none of the differences were statistically significant (Lee et al., 2019:4; Lingam et al., 2009:e695). A factor that could have contributed to the minimal difference between the boys and girls in Korea and South West England, might be the children's age (7–9 years) (Lee et al., 2019:5).

Table 2.3. Gender differences in the prevalence of possible DCD determined by means of standardised motor tests.

Reference	**Country**	**Age (years)**	**% per gender or boys:girls ratio**	**Indication**	**Instrument**
Amador-Ruiz et al. (2018:541)	Spain	4–6	50.6:49.4	Boys > girls	MABC-2
Beltrame et al. (2017:108)	Brazil	7–10	9.1:5.2 (≤ 5th percentile) 12.5:10.2 (6th–15th percentile)	Boys > girls	MABC-2*
De Milander et al. (2014:1082)	SA, FS	5–8	1.6:1	Boys > girls	MABC-2*
De Waal et al. (2018:4)	SA, Zeerust	8–10	24.49:18.70 (≤ 15th percentile)	Boys<girls	MABC-2
Kokštejn et al. (2017:196)	Czech republic	6.5	1.7:3.3 (≤ 5th percentile)	Boys < girls	MABC-2
Kourtessis et al. (2008:96)	Greece	3.4–6.3	5:1 (≤ 5th percentile) 2:10 (6th–15th percentile)	Boys > girls	MABC
Peens & Pienaar (2007:115)	SA, NW	7–9	17.9:10.9 ((≤ 15th percentile)	Boys>girls	MABC
Pienaar (2004:81)	SA, NW	10–12	57:67	Boys < girls	MABC
Pienaar & Kemp (2014:172)	SA, NW	6.84	51.3:48.7	Boys > girls	BOT-2 SF*
Prinsloo & Pienaar (2003:160)	SA, NW	4–12	10:10 (≤ 5th percentile) 3.3:6.7	Boys=girls Boys<girls	MABC
Valentini et al. (2012:381)	Brazil	4–12	16.9:23.2 (≤ 5th percentile) 17:16.5 (6th–15th percentile)	Boys > girls Boys < girls	MABC*
Valentini, Clark et al. (2015:975)	Brazil	4–10	15:20.8 (≤ 5th percentile) 14.8:15.1 (6th–15th percentile)	Boys < girls	MABC*

Venter et al. (2015:174)	SA, NW	3–5	4.76:15.63 (≤ 5th percentile)	Boys < girls	MABC-2
			23.81:31.25 (6th–15th percentile)		
Wessels et al. (2008:499)	SA, NW	6–7	13:10 (≤ 5th percentile)	Boys > girls	MABC
			15:14 (6th–15th percentile)		

*Significant difference

Despite most of the studies showing a higher prevalence of possible DCD in boys, some studies have identified a higher prevalence in girls. Boys predominantly have a higher prevalence of DCD because of the type of physical and outdoor activities in which they are involved (Pienaar & Kemp, 2014:175). Boys tend to participate in activities involving ball skills, but lack balance and fine motor skills (Amador-Ruiz et al., 2018:541; Kokštejn et al., 2017:198). As shown in Table 2.3, the study in the Czech Republic identified more girls with possible DCD than boys (Kokštejn et al., 2017:196) when using the MABC-2. The boys in this study tended to spend more time on physical activities, such as recreational and sports activities, increasing their motor performance (Kokštejn et al., 2017:198). In SA, the study on the younger children (3–5 years) found a higher prevalence in girls than boys, with only a significant difference between boys and girls for aiming and catching, where the boys performed better (Venter et al., 2015:174). Venter et al. (2015:177) reported that the following might be reasons why DCD is higher in girls than boys: Cultural differences between boys and girls, education is seen as a higher value for boys to have than for girls and therefore boys get more exposure which result in better motor development. When observing possible DCD identified by means of the original MABC, Pienaar (2004:84) determined that girls tended to show a higher prevalence than boys, and a reason to consider was that girls' activity levels decrease when they reach 10–12 years of age, which might influence their motor performance. Lastly De Waal et al (2018:4) also pointed out that boys have a higher possible DCD prevalence than girls and reported that boys portrayed poorer coordination than girls. According to the opinion of De Waal et al (2018:8) perceptual differences between genders contribute to boys having more difficulty.

A study conducted in low-income communities in Brazil found a statistically significant higher prevalence of possible DCD in girls than boys (Valentini, Clark et al., 2015:974). The researchers asserted that exposure to physical activities and physical education differed between girls and boys in Brazil, and that girls were less encouraged to participate, which might result in more motor difficulties (Valentini, Clark et al., 2015:976). Although the results summarised in Table 2.3 did show differences between boys and girls, limited research showing a significant difference between the genders has been conducted. The gender differences in the prevalence of motor difficulties using various screening tools are highlighted in Table 2.4.

Table 2.4. Gender differences in the prevalence of motor difficulties determined by means of other screening tools.

Reference	Country	Age (years)	% per gender or boys:girls ratio	Indication	Instrument used
Cardoso et al. (2014:179)	Brazil	7–8	54.1:45.9	Boys > girls	DCDQ Brazil version; Assessment of Motor Coordination and Dexterity; MABC-2
Delgado-Lobete et al. (2019:37)	Spain	6–12	53.0:47.0	Boys > girls	DCDQ European Spanish version
Deshpande et al. (2019:10)	India	5–12	1.8:1	Boys > girls	DCDQ'07

Boys showed a higher prevalence of motor difficulties than girls when the DCDQ was used. In all three studies, the parents only perceived activities related to ball skills as very good, but girls tended to show much more accurate skills in all of the activities and tasks. Boys were more inclined to participate more in ball coordination activities and gross motor activities than girls, whereas girls demonstrated better performance in other aspects required for motor abilities (Delgado-Lobete et al., 2019:37).

Tables 2.2 to 2.4 provide a clear summary of DCD prevalence among the two genders. The main findings support evidence of higher prevalence rates of DCD in boys, although some studies reported a contradictory outcome. Differences between boys and girls can be attributed to the different levels at which each gender participates in physical activity (Ali et al., 2016:8). Boys tend to show more control over their movements and perform better in gross motor activities (Deshpande et al., 2019:11; Gallahue & Ozman, 2007:255). Ball skills in boys develop earlier than in girls, which can contribute to their well-performed aiming and catching ability (Barnett et al., 2016:1685; Giagazoglou et al., 2011:2581; Kokštejn et al., 2015:66). It is, however, interesting to note that boys are more likely to have coordination difficulties than girls (Delgado-Lobete et al., 2019:31). Girls enjoy activities that require fine motor skills and perform well with manual dexterity tasks and balance (Deshpande et al., 2019:11; Junaid & Fellowes, 2006:8; Kokštejn et al., 2015:65). Fine motor skills, such as writing, are essential for academic performance in school. Gross motor skills, such as jumping, are essential for participating in sports activities and natural play abilities (Blank et al., 2019:267). Another aspect to consider is that gross motor skills are important for the development of fine motor skills (Wessels et al., 2008:503).

To summarise, the literature highlights controversies in the prevalence of DCD in various countries, and more studies reported a higher prevalence in boys than in girls. The literature review on the prevalence of DCD further provides evidence that varying prevalence rates of DCD have been observed in different SE environments. Even though the diagnostic criteria and assessment methods have been listed as one reason for the controversies in the prevalence of DCD, another explanation for these inconsistencies may be SE environments and cultural differences (Lee et al., 2019:5; Valentini et al., 2012:382).

A thorough understanding of SE environments is essential to put children's abilities in low SE environments of SA in perspective.

2.4 Socio-economic environments

SE environment is defined as a person's or group's position within specific social and economic factors (Oxford Dictionary, 2019). A Gini index point is provided for each country by the World Bank. It was developed by the Italian statistician Corrado Gini in 1912 as a measure of the distribution of income across a population (Westphall, 2020:1), and indicates the inequality within a country (or population) according to household and individual income (Liu & Gastwirth, 2020:61; Westphall, 2020:1). A Gini index point of 0 (0%) represents perfect equality (all individuals have the same income). A Gini index point of 1 (100%) represents a perfect inequality (where one person has all the income and the rest have nothing). In contrast, a value over 1 represents a negative income or wealth (Westfall, 2020). High-income inequality in SA is currently reflected by a Gini index of 63% (0.63) (World Bank, 2020), while the FS Province has a Gini index of 0.60 (Statistics SA, 2019). SA is a developing and middle-income country and comprises various cultures, ethnic groups, languages, environments and SE status groups (Edginton, Chin, Amusa & Toriola, 2012:436; Pienaar, Barhorst & Twisk, 2013:374). Children living in a developing country are at higher risk of experiencing developmental problems due to poor health, low nutritional intake and poverty (De Witt & Lessing, 2016:106).

When evaluating a person's SE status, the components taken into account include poverty, income, occupation, environmental factors, working conditions, socio-cultural factors, and education (Ncho & Wright, 2013:1). All of these factors influence one another. Low SE environments in SA are experiencing a housing crisis due to the dense inner cities, extensive informal settlements, and crowded township areas (Narsai, Taylor, Jinabhai & Stevens, 2013:370). This housing crisis causes challenges such as poverty, overcrowded living conditions, parents' lack of education, lack of parental involvement in the child's school career (Kalam et al., 2016:61), as well as daily challenges in an emotionally and physically demanding environment (Botha-Verhage & Jacobs, 2017:203). The emotional and physical demands are further increased by the high unemployment rate and the uncertainty of knowing if re-employment will occur (Ferreira, 2005:205). On the contrary, people who have more control over their work also have better health, managing skills, and social relationships (Ncho & Wright, 2013:1). Therefore, earning a living is an essential factor. However, the working conditions of people living in low SE environments may cause stress (Ncho & Wright, 2013:5), that can lead to psychological morbidities such as anxiety and depression (Ncho & Wricht, 2013:8), making them less responsive in their parenting responsibilities.

It is reasonable to assume that a household's income determines the financial situation in which the child lives and will impact the child's level of poverty and education (Ncho & Wright, 2013:1). Poverty has an influence on where people can afford a house, and poor neighbourhoods are usually located near appalling environments such as industrial areas and toxic waste sites, with exposure to environmental toxins and limited safe water resources

(Adler & Newman, 2002:66; Ncho & Wright, 2013:6). The environments are unsafe, restricting children to play outside (Ncho & Wright, 2013:6). Children who live in poverty may experience a disorganised home environment, which further exposes them to negative factors such as fewer educational resources and equipment, for example balls, scooters and balance beams (Kalam et al., 2016:59). These negative factors may cause developmental delays, mental disorders and health problems (De Witt & Lessing, 2016:106; Kalam et al., 2016:61; Pienaar & Lennox, 2006:69).

Many people living in low SE environments experience a lack of knowledge regarding health-related matters (Ncho & Wright, 2013:5), resulting in parents not being able to recognise medical or developmental problems in a child. Some parents cannot identify fundamental developmental skill problems and are not aware of the expected childhood development level at a specific age (Roopnarine, Logie, Davidson, Krishnakumar & Narine, 2015:243). Some of these parents may also have low levels of education and lack of access to information on parenting skills and training (Ncho & Wright, 2013:6), which can influence the child's motor development. Many children from low SE environments experience a lack of knowledge and stimulation because they enter primary school (Gr. 1) without attending an ECD center or pre-primary school (Grade R) (Kalam et al., 2016:62). Furthermore, preschool fees are too expensive for many parents (Kalam et al., 2016:62), resulting in educational and motor skill deficits.

Educational problems are experienced in half of the school-aged children living in impoverished environmentts (Graven, 2013:4), causing difficulties in shaping children's future occupational opportunities and earning potential. Education is one of the most fundamental components determining SE status (Adler & Newman, 2002:61). Research further emphasises the significant influence that the SE status of a child's family has on his or her educational achievement (Taylor & Yu, 2009:2). Children living in low SE environments receive less stimulation (Goodway & Branta, 2003:40) and experience learning restrictions. They have more essential home duties (cleaning, cooking, caring for infants) (Du Plessis, Naudé & Viljoen, 2003:22). They may therefore struggle with perceptual-motor performance leading to decreased educational performance (Pienaar et al., 2013:377).

The education system in SA categorises schools into five quintiles according to a poverty classification system (SE status) and is further linked to the school's geographical location (Borkum, 2012:363; Ogbonnaya & Awuah, 2019:106; Pienaar & McKay, 2014:110). Each quintile represents how much funding a school will receive and is based on a formula that determines the allocation (De Villiers et al., 2012:2). The national poverty quintile ranges from no-fee schools to fully paid schools (Borkum, 2012:365; Fadiji & Reddy, 2020:4). Quintile four and five schools are attended by children from a high SE environment and do not receive much funding from the government, whereas quintile one to three schools are attended by children from low SE environments and receive more funding from the government (Borkum, 2012:367; Ogbonnaya & Awuah, 2019:106; Pienaar & Kemp, 2014:176).

According to the 2011 national census (Statistics SA, 2011) the Mangaung Municipality which is situated in the FS province of SA had a population size of 747 431 people, of which 26.9% were children younger than 15 years of age. Of these children, 4.3% did not attend school. The unemployment rate in this municipality was 27.7% in 2011 (Statistics SA, 2011), and in 2016, the poverty rate was 41.1% (Statistics SA, 2016). It is acknowledged that some of these values may no longer be accurate at the current time, but updated information will only become available following the 2021 national census (Statistics SA, 2016).

The FS Province is divided into five different districts: Fezile Dabi, Lejweleputswa, Thabo Mofutsanyana, Xhariep, and the Motheo District. Mangaung is situated in the Motheo District, and based on the most recent numbers in 2020, the Motheo District has approximately 160 primary schools. Of these schools, 18 are quintile five schools, eight are quintile four, 54 are quintile three, 24 are quintile two, and 53 are quintile one schools, which confirms the large number of schools being situated in low SE environments (Department of Basic Education Free State, 2020). According to these numbers, 131 schools of 160 schools in the Motheo District are quintile one to three schools.

According to Fadiji and Reddy (2020:4), 65% of children living in SA attend quintile one to three schools. Children attending quintile one to three schools (low SE environment) tend to receive a lower level of quality education at school (Pienaar et al., 2013:376; Pienaar & McKay, 2014:103) due to limited resources and teachers with a lower level of specialised training, such as physical education (PE) experts (Fadiji & Reddy, 2020:4; Graven, 2013:4;

Pienaar, 2004:88). Researchers have found that improved PE opportunities are available in high SE environment schools due to their well-established resources, facilities and more exposure to PE (Edginton et al., 2012:436; Pienaar & Kemp, 2014:177). Although PE is indicated in all schools' curricula, it has been pointed out that the physical activity lessons that should take place during the week, do not exist in low SE environment schools (De Villiers et al., 2012:9).

The lack of physical activity in low SE environments can be attributed to teachers with insufficient PE experience (Pienaar, 2004:88), teachers being overworked, inadequate availability of facilities, limited equipment and equipment that is not age-appropriate, and limited support available to children who experience motor difficulties (Aertssen, Bonney, Ferguson & SmitsEngelsman, 2018:96; Kahts, Du Randt & Venter, 2017:42; Ogbonnaya & Awuah, 2019:113; Pienaar & Kemp, 2014:178). The support that can be offered to a child with motor difficulties is further negatively influenced by classroom overcrowding and large student-to-teacher ratios, which may be as high as 50:1. Large classes mean that less individual attention can be paid to children (Kalam et al., 2016:61; Ogbonnaya & Awuah, 2019:113). In turn, motor difficulties have a negative impact on the child's ability to participate in physical activities and sport (Edginton et al., 2012:436; Pienaar, 2004:88).

Less than half of children living in low SE environments of the United Kingdom meet the recommended 60 minutes of daily physical activity (Eyre, Duncan, Birch, Cox & Blackett, 2015:237), and almost no structured play and organised sport take place (De Villiers et al., 2012:9). The physical activity participation of children living in low SE environments is not only affected by the quintile level of the school they attend, but also by factors such as limited resources (play parks, equipment, facilities) in the community and unsafe environments (lack of parental supervision, high prevalence of gangster groups, violence, crime and exposure to drugs at a young age). All these factors will reduce participation in play and sports activities and contribute to lower participation levels (Kalam et al., 2016:61). A lack of physical activity may also aggravate the child's existing motor difficulties, especially those in quintile one to three schools where less opportunities are available (Ferguson, Naidoo & Smits-Engelsman, 2015:148). A matter of concern is that children living in low SE environments do not have adequate opportunities to practice and master their motor skills (Delgado-Lobete et al., 2019:38).

2.4.1 Relationship between socio-economic environment and motor ability

Bronfenbrenner (1977:513) had identified genetic and environmental factors that could influence the development of a child and used the bio-ecological model of learning to illustrate children's development. Motor development is related to the child's biological and environmental conditions and how they interact with each other (Sigmundsson et al., 2017:5). The model states that a child is present in one setting but within various locations that start with the child and continues towards family, work and society (Duerden & Witt, 2010:110). The model includes the microsystem, mesosystem, exosystem and macrosystem (Bronfenbrenner, 1977:514; Nobre, Coutinho & Valentini, 2014:264). Development occurs due to the interaction between these systems (Duerden & Witt, 2010:110). The microsystem represents the immediate environment and context of the child (gender, age, health). The mesosystem refers to the relationships between the microsystem factors (influences of the immediate environment), such as the home, family and friends. The exosystem includes aspects that can influence the child of which the child is not part (organisational and institutional factors), such as healthcare and social services. Finally, the macrosystem involves the child's cultural context (Bronfenbrenner, 1977:514, 515; Bronfenbrenner & Morris, 2006:795).

They dynamical systems theory (DST) emphasises the child's interaction with the environment and how the task (activity/movement) have an influence on how development and learning new movements will occur (Sigmundsson et al., 2017:1). A movement requires the movement of the child's body and how the child's body will interact with the environment in which the child finds him-/herself (Sigmundsson et al., 2017:2). How these three aspects (task, child, environment) interact, will determine motor behaviour and motor development (Sigmundsson et al., 2017:9). The task constraints are usually referred to as the goals or rules of the movement that should be followed, the child constraints include factors such as the height and weight or experience of the child, and the environmental constraints are aspects such as temperature and the surface, as well as physical barriers, accessibility and SE status (Colombo-Dougovito, 2017:142; Sigmundsson et al., 2017:5). The DST employed some of the bio-ecological model principles and identified factors in the environment that have an impact on the child's motor development, such as socio-cultural aspects, social values and the SE environment (Sigmundsson et al., 2017:5). From these findings published in the literature, it is evident that both the bio-ecological and the DST model demonstrate that environmental factors can influence motor development.

The child's environmental surroundings living in low SE environments in SA play a role in the child's development and may result in developmental motor delays (Kahts et al., 2017:42). Children from low SE environments have limited opportunities to develop appropriate motor skills and may, as a result, be at a higher risk to experience motor development delays (Pienaar & Kemp, 2014:177; Robinson & Goodway, 2009:534; Valentini et al., 2012:382; Valentini et al., 2015a:977). The development process is determined according to genetic and environmental factors (Venetsanou & Kambas, 2010:324). Environmental factors include the family's SE status, the parents' educational level, the social-cultural context, and whether siblings are available to help children develop (Venetsanou & Kambas, 2010:324). If the family of the child has a low educational level, the child may acquire DCD and motor coordination skill problems (Delgado-Lobete et al., 2019:38). Therefore, it can be argued that living conditions can have a negative effect on a child's motor development and motor abilities (Venetsanou & Kambas, 2010:324). Venter et al. (2015:171) further pointed out that the low SE environment plays a role in the severity of children's motor difficulties.

Children spend much of their time at school, and it is essential to implement strategies in the school system to ensure that children have sufficient opportunities to develop motor skills (Venetsanou & Kambas, 2010:324). It has further been documented that the suitable age-appropriate equipment, adequate supervision, and specific culturally acceptable activities for each age group, can promote the development of children's motor abilities (Venetsanou & Kambas, 2010:324). Considering that many schools accommodate children from diverse cultural backgrounds, it could be a challenge. Although it has been stipulated in the literature that lower SE environments pose a significant risk for motor difficulties, the opposite has also been reported (Gomez & Sirigu, 2015:274). Children growing up in high SE environments have more access to technological devices such as television, cell phones and tablets, resulting in longer hours of screen time (Pienaar & Kemp, 2014:174). Children use and rely a lot more on technology as a source of entertainment, also leading to increased screen time (Reus & Mosley, 2018:12). Masur, Flynn & Olson (2016:119) have determined that exposure to screen time affects a child's development due to less playing. Furthermore, more screen time increases unhealthy food consumption, leading to a higher body mass index (BMI) and reduced physical activity (Reus & Mosley, 2018:19). Less physical activity leads to decreased motor development and motor abilities (Ferguson, Naidoo et al., 2015:159; Tsiotra et al., 2006:126). The findings with regard to both low and high SE environments support the view that motor performance is influenced by what is happening in the environment.

Although motor abilities can be affected by screen time usually available in high SE environments, findings based on a review of the literature showed that some children from high SE environments have better performance in locomotor skills and fundamental motor skills (Barnett et al., 2016:1683). Fundamental motor skills such as locomotor, stability and object manipulation skills are the building blocks for more complex movements such as running, jumping, standing on one leg, grasping and hand manipulation (Gallahue & Ozmun, 2007:51). These skills are the foundation to execute more specialised movements associated with sports participation and leisure activities (Gallahue & Ozmun, 2007:51). In contrast to high SE environments, the fundamental motor skills of some school-aged children living in low SE environments in SA have been identified to be lower than expected due to the limited availability of qualified PE teachers (Kahts et al., 2017:42), and limited access to resources and equipment (Pienaar & Kemp, 2014:176, 177; Uys & Pienaar, 2010:140).

A study in the Western Cape of SA specifically pointed out that children and teachers have fewer opportunities to participate in assessments of motor abilities and activities (Senekal, Seme, De Villiers & Steyn, 2015:2). Fewer opportunities for developing motor skills will limit the child's ability to develop specific motor skills (Barnett et al., 2016:1683). Specific motor skills, such as fine motor skills (Pienaar, 2004:88; Pienaar & Kemp, 2014:176; Uys & Pienaar, 2010:140) and balance (Pienaar, 2004:88), may be more difficult to acquire for many children living in low SE environments. A study conducted by Labuschagne (2005:87) on 20 children between 5–6 years with the aim to determine the motor and sensory development of boys and girls in a low SE environment have reported that the children had poor motor development and specifically pointed out that their balance, object manipulation and visual motor abilities was more than 12 months behind their age group (Labuschagne, 2005:84; Pienaar, Labuschagne & Peens, 2007:318). Pienaar et al (2007:319) further pointed out that sensory and motor stimulation should be a priority for children from low SE environments due to their poor ability. On the contrary, some research has pointed out that children in low SE environments might perform better in gross motor activities due to spending more time outside (free play activities) and moving over and under natural obstacles in the environment (Uys & Pienaar, 2010:140; Veldman et al., 2018:1228). Good gross motor skill performance is mostly noticed in boys with improved object control skills, becasue of more motivation and support for participating and enjoying sports in their communities (Barnett et al., 2016:1683).

In Brazil a study aimed to determine if the SE level of 7–10-year-old children would influence whether a child is identified with motor skill impairments, and has confirmed that children living in a low SE environment had a higher risk (Dos Santos et al., 2015:84). Most of the children in their study lived in a low SE environment and they identified 10.5% of the children with moderate risk of possible DCD and 11.4% with severe risk of possible DCD (Dos Santos et al., 2015:82). Similar to Dos Santos et al. (2015:82), a study in the North of England on children 4–7 years of age found higher motor proficiency levels in children living in high to middle-income communities, while children from a lower-income community were identified with impaired fine and gross motor abilities (Morley, Till, Ogilve & Turner, 2015:510).

A study on possible DCD in Spanish children 4–6 years old has determined that children living in low SE environments performed better at aiming and catching activities and the one-legged balance (Amador-Ruiz et al., 2018:541). The researchers pointed out that SE status in their study did not influence the motor performance of the children (Amador-Ruiz et al., 2018:541), whereas Graven (2013:1) supported the notion of a large gap in motor performance between children from high and low SE environments. Lingam et al. (2009:e697) shared the same views as Graven (2013:1) and stated that children from a low SE environment are at a higher risk for DCD.

The balance and object manipulation skills of 3–5-year-old children from low SE environments were better than children from the higher SE environment of Potchefstroom, NW Province in SA (Venter et al., 2015:180). Although not comparable due to age difference, another study on older children (7 years of age) in the same province (Pienaar & Kemp, 2014:176) reported findings similar to those of Venter et al. (2015:180). It is, however, interesting to note that Venter et al. (2015:174) observed no significant differences in the prevalence of possible DCD in children from low and high SE environments (38.71% and 40.91%, respectively). However, the group of children from high SE environments presented with a higher prevalence (22.7%) of severe motor difficulties than the low SE group of children (3.2%) (Venter et al., 2015:174). Early research by Cloete, Pienaar and Coetzee (2006:18) on 645 children between 10–12 years living in SA, and a recent study by De Waal et al. (2018:9) in the Zeerust District of SA, reported higher tendencies of possible DCD in low SE environments. Of note is that despite the number of years that have passed since 2006 to 2020, the same tendencies occur. Another study by De Waal & Pienaar (2020:678) have determined that the overall motor performance of children from low SE environments are poor. The authors further recommended that the negative influence of SE environments on the child's motor performance should be addressed as early as possible and focus on the involvement of the parents and the school to increase stimulation (De Waal & Pienaar, 2020:681).

To conclude, the prevalence of DCD varies not only in different countries, but also in the SE environments as well as between boys and girls. The prevalence of DCD or possible DCD in SA is a matter of great concern, considering the high number of children living in low SE environments with limited resources and opportunities that contribute to motor difficulties. Therefore, it is necessary to understand and recognise the symptoms, characteristics and concomitant factors observed in children with DCD.

2.5 Characteristics and symptoms of children with developmental coordination disorder

According to literature findings, DCD is a heterogeneous condition that presents with varying symptoms and characteristics (Biotteau, Albaret, Lelong & Chaix, 2017:436; Graham et al., 2018:2). The characteristics and symptoms of DCD can be divided into primary and secondary characteristics. The section on primary characteristics will highlight the main features of children with DCD, and secondary characteristics will identify the secondary challenges resulting from the motor difficulties experienced.

2.5.1 Primary characteristics and symptoms of children with developmental coordination disorder

Children with DCD primarily experience difficulties in learning acquisition and executing motor activities (APA, 2013). Due to the difficulty experienced in conducting motor tasks, the child with DCD will show difficulties with regard to self-care (dressing themselves), social and recreational activities (riding a bike) and academic performance (writing) (APA, 2013). During a motor activity, one of the main problems experienced by children with DCD is the difficulty to complete movements fluently (Jelsma, Geuze & Smits-Engelsman, 2020:183). The child tends to display many movement variations during the first attempt at an activity (Jelsma et al., 2020:183). These movements and actions are executed at a slower pace, with less accuracy, and require much more effort, leading to difficulty in planning and completing a task (Caçola, 2014:102; Jarus et al., 2015:123; Rosenblum, 2015:212). Task execution is a challenge for children with DCD (Cantin, Ryan & Polatajko, 2014:230) due to lower motor abilities such as gross motor skills, fine motor skills, general coordination (Deshpande et al., 2019:11; Jelsma, Ferguson, Smits-Engelsman & Geuze, 2015:220), and postural control (static and dynamic balance) (Ali et al., 2016:8; Fong, Ng, Chung, Ki, Chow & Macfarlane, 2016:63; Jelsma et al., 2020:184; Speedtsberg, Christensen, Andersen, Bencke, Jensen & Curtis, 2017:5). A study conducted in SA, NW province on low SE enviornmnet children (9–12 years) reported a high percentage of fine motor difficulties in the children with DCD (Prinsloo & Pienaar, 2003:162). The above mentioned motor difficulties cause other secondary challenges.

2.5.2 Secondary characteristics and symptoms of children with developmental coordination disorder

DCD and motor difficulties cause motor learning problems, such as difficulties with retention and transfer of information, slower short-term motor learning (Jarus et al., 2015:123, 219) and lower processing speed (Sumner, Pratt & Hill, 2016:16). Sensory processing challenges in children with DCD occur due to the low participation levels in physical activities (Kim, 2020:6). Also, the opposite happens where the low participation levels and functional ability problems in children with DCD are caused by the sensory processing problems experienced (Allen & Casey, 2017:556; Delgado-Lobete, Pertéga-Díaz, Santos-del-Riego & Montes-Montes, 2020:7; Kim, 2020:4; Mikami et al., 2020:8). Low participation levels and lower functional abilities impact the child at home (getting dressed by themselves, especially doing buttons and shoelaces), at school (writing and reading, using scissors, drawing, painting), during play (ball skills and balance activities such as standing on one leg) and using cutlery (spoon, fork, knife), consequently resulting in limited physical activity and sport participation (Asonitou, Koutsouki, Kourtessis &

Charitou, 2012:1003; Bo, Colbert, Lee, Schaffert, Oswald & Neill, 2014:2035; Caçola, 2014:103; Cermak, Katz, Weintraub, Steinhart, Raz-Silbiger, Munoz & Lifshitz, 2015:170; Dewey, Creighton, Heath, Wilson, Anseeuw-Deeks, Crawford & Sauve, 2011:43; Edwards et al., 2011:679).

Motor abilities are essential for taking part in physical activity, and the more skilled a child is, the higher the level of participation will become (Straker et al., 2011:3). Participation in leisure time activities and everyday physical activity has been identified as a problem experienced by children with DCD (Batey, Missiuna, Timmons, Hay, Faught & Cairney, 2014:268; Cermak et al., 2015:170; Green, Lingam, Mattocks, Riddoch, Ness & Emond, 2011:1340; Yu, Burnett & Sit, 2018:2095). In a recent study, parents perceived their children with DCD to have low participation levels within their communities, at home and at school (Coussens et al., 2020:241). When motor abilities are impaired, personal issues such as positive feelings towards self, control over situations, character and overall behaviour, are affected negatively (Cairney, Rigoli & Piek, 2013: 227). Therefore, the child with DCD tends to avoid participating in PE at school and experiences school-related task difficulties and academic learning challenges (Caçola, 2014:103; Deshpande et al., 2019:11; Lingam, Golding, Jongmans, Hunt & Ellis, 2010:e1114; Pienaar et al., 2013:376; Zwicker, Suto, Harris, Vlasakova & Missiuna, 2018:70).

Children with DCD experience various academic challenges. Mathematic skill difficulties in counting tasks, subitising (the ability to instantly and accurately recognise the number of objects present in a small set or group) (Gomez & Huron, 2020:8), numerical skills (De Milander, Coetzee & Venter, 2016b:59), processing symbolic and non-symbolic numbers (Gomez, Piazza, Jobert, Dehaene-Lambertz, Dehaene & Huron, 2015:175), number fact retrieval and procedural calculation are experienced (Pieters, Desoete, Van Waelvelde, Vanderswalmen & Roeyers, 2012:1134). Handwriting difficulties, such as forming graphomotor symbols and letters (Adi-Japha & Brestel, 2020:11; Bo et al., 2014:2042; Zwicker et al., 2018:70), generating form and size, as well as temporal variability in repetitive letter writing, are experienced (Bo et al., 2014:2042; Caçola, 2014:102; Cheng, Chen, Tsai, Shen & Cherng, 2011:2592; Di Brina, Averna, Rampoldi, Rossetti & Penge, 2018:402; Huau, Velay & Jover, 2015:329; Prunty & Barnett, 2017:10). Handwriting challenges further cause the child to struggle to perform lengthy writing tasks (Huau et al., 2015:328; Rosenblum, 2015:210). Due to difficulty in writing, challenges with spelling and reading in children with DCD are observed (De Waal et al., 2018:7; Harrowell, Hollén, Lingam & Emond, 2018:19; Lingam et al., 2010:e1115; Rafique & Northway, 2015:7), resulting in lower grades and academic achievement (Caçola, 2014:102). Despite the academic challenges experienced by children with DCD, other aspects at school are further influenced.

Children with DCD do not participate in school sport because of lower fitness levels (lower strength, less power and poor explosive strength) and a sedentary lifestyle (Demers, Moffet, Hébert & Maltais, 2020:1088; Farhat et al., 2015:217; Zhu, Cairney, Chen, Chen & Wu, 2014:1731; Zwicker et al., 2018:72). A sedentary lifestyle in a child with DCD may lower overall physical health (Karras, Morin, Gill, Izadi-Najafabadi & Zwicker, 2019:93). Due to low levels of physical activity, children are at increased risk of overweight and obesity (Aertssen et al., 2018:96; Cairney & Veldhuizen, 2013:56; Cermak et al., 2015:171; Hendrix, Prins & Dekkers, 2014:419; Zhu et al., 2014:1732). In the NW province of SA, a study was conducted on 346 girls (10–12 years) to determine the relationship between obesity and DCD and a high percentage of obesity were found in one of the groups with DCD, also indicating low physical activity levels (Pienaar, Bell & Dreyer, 2007:234). All these factors mentioned will result in a child being selected last for a sports team, or the child will not be considered for the team at all, which will have a direct effect on a child's mental health and self-esteem (not feeling important or good enough) (Caçola, Romero, Ibana & Chuang, 2016:175; Li, Graham et al., 2018:8; Li, Kwan, Clark, Hay, Faught & Cairney, 2018:248; Zwicker et al., 2018:71). The child's' self-perceived social acceptance (Noordstar & Volman, 2020:6) and emotional well-being may further be negatively impacted by both the school experience and the fact that they avoid participating in a sport that leads to social isolation (Zwicker et al., 2018:71).

Consequently, a child with DCD may experience behavioural and psychosocial problems (Biotteau et al., 2017:436; Caçola et al., 2016:175; Karras et al., 2019:91; Pratt & Hill, 2011:1255). Children with DCD often do not receive sufficient support (Zwicker et al., 2018:71) and without help, the child will not feel accepted by their peers (Cermak et al., 2015:170; Gasser-Haas et al., 2020:9). The child who withdraws from social events may experience social communication difficulties, will have an increased fear of 'going to fail', experience criticism from peers, and develop depression and anxiety (Draghi, Cavalcante Neto, Rohr, Jelsma & Tudella, 2020:18; Harrowell et al., 2018:19; Karras et al., 2019:91;

Li, Graham et al., 2018:8; Noordstar & Volman, 2020:6; Slater, Hillier & Civetta, 2010:171; Zwicker et al., 2018:71).

The modified Pearlin's stress process model has identified many problems and characteristics in children with DCD, such as peer problems, self-worth, self-competence and social support (Cairney et al., 2013:232), and highlights some of the aspects experienced and how they act with each other. Figure 2.1 demonstrates the modification of Pearlin's stress process framework for children with DCD.

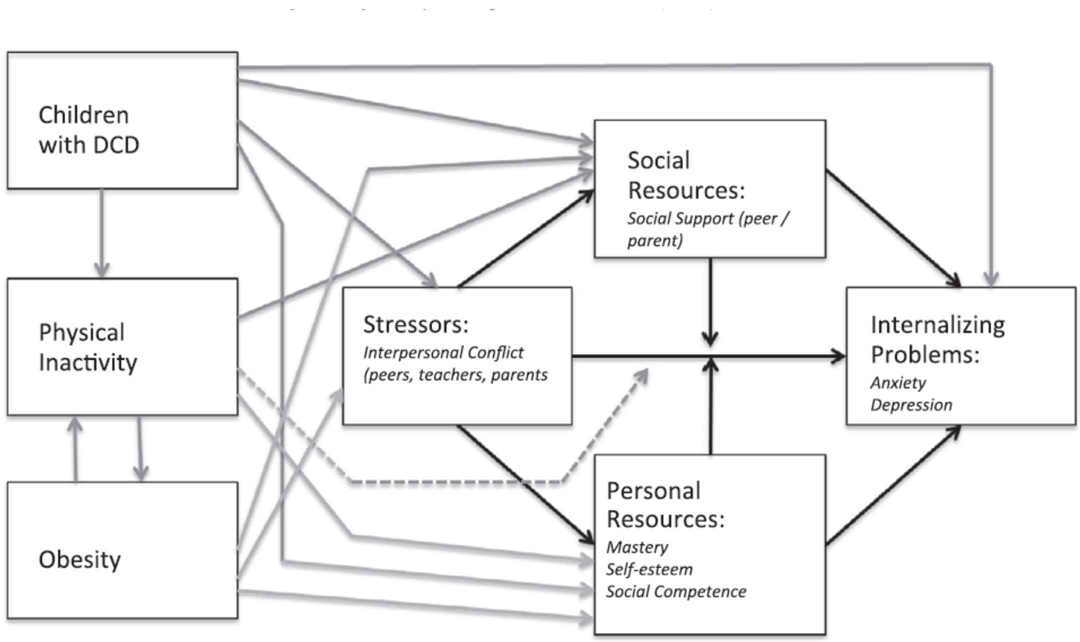

Figure 2.1. Modification of the Pearlin's stress process framework for children with DCD (Cairney et al., 2013:233).

The model demonstrates that depression and anxiety may occur due to physical inactivity and obesity in children with DCD. The presence of DCD, lower levels of physical activity, and overweight and obesity lead to interpersonal conflict in key relationships, social and personal resources, and directly influences the child's mental health (Cairney et al., 2013:231). These factors further lead to behavioural problems (Cermak et al., 2015:170; Van den Heuvel, Jansen, Reijneveld, Flapper & Smits-Engelsman, 2016:46). Behavioural problems are also caused by the sensory difficulties experienced in children with DCD (Delgado-Lobete et al., 2020:6; Fong, Ng et al., 2016:63).

There is a relationship reported between motor difficulties and visual-perception (Cheng, Ju, Chang, Chen, Pei, Tseng & Cheng, 2014:2178; De Waal et al., 2018:8), ocular muscle control (Coetzee & Pienaar, 2011:897), visual-motor task performance (Cantin et al., 2014:230), and eye-limb coordination, all representing challenges experienced by children with DCD (Rafique & Northway, 2015:2). Coetzee and Pienaar (2011:896) highlighted in their study that ocular muscle control functions showed significant correlations with ball skills. Furhtermore children with motor difficulties may also have low visual tracking ability, predictive control problems, and short dynamic internal representations of target and hand motion (Ferguson, Duysens & Smits-Engelsman, 2015:24). Predictive modeling problems occur when the child cannot perform the task as accurately as their peers when they need to imagine and complete a complex activity or task (Bhoyroo, Hands, Wilmut, Hyde & Wigley, 2019:6). Further difficulties experienced by children with DCD are related to executive functioning skills such as keeping focus, inhibitory control, working memory, and cognitive control (Pratt, Leonard, Adeyinka & Hill, 2014:1586; Sartori, Valentini & Fonseca, 2020:298; Wilson, Ruddock, Rahimi-Golkhandan, Piek, Sugden, Green & Steenbergen, 2020:6). For children with DCD, executive functioning tasks with visuospatial and motor demands are more challenging than verbal tasks and verbal working memory (Leonard, Bernardi, Hill & Henry, 2015:211; Maziero, Tallet, Bellocchi, Jover, Chaix & Jucla, 2020:671; Sartori et al., 2020:299; Sumner et al., 2016:16). Cognitive processing problems, such as planning, simultaneous coding, internal modeling and attention, have been found in some children with DCD (Asonitou & Koutsouki, 2016:131; Chang & Yu, 2016:13) and influence motor learning (Steenbergen, Krajenbrink, Lust & Wilson, 2020:2).

From the literature findings on the primary and secondary challenges experienced by children with DCD, it is clear that the main problem is motor difficulties that influence daily functioning tasks. The motor difficulties further cause secondary challenges such as low participation, low physical fitness, psychosocial and emotional problems, academic difficulties, impaired executing functioning, and visual and cognitive problems. Despite all the symptoms, characteristics and secondary problems associated with DCD, other co-occurring factors also play a role and are common in children with DCD (Gomez & Sirigu, 2015:274).

2.5.3 Co-occurring factors with developmental coordination disorder

Children with DCD may show co-occurrences with attention deficit hyperactive disorder (ADHD) (Cardoso et al., 2014:180; Karras et al., 2019:91). Research conducted by Zwicker, Missiuna, Harris & Boyd (2012:576) found that 50% of children with ADHD experience motor difficulties related to DCD. Noda et al. (2013:2915) identified writing problems as common characteristics of children with DCD and ADHD. In agreement with Noda et al. (2013:2915), a SA study in the Gauteng province (Brakpan) on 95 children with a mean age of 6.9 years confirmend that the fine motor skills of children with ADHD that were also identified with DCD are low (Du Toit & Pienaar, 2014:69). Children with DCD may experience attention difficulties and tend to be hyperactive (Biotteau et al., 2017:434; Harrowell et al., 2018:19; Jarus et al., 2015:123).

Autism spectrum disorder (ASD) is another co-occurring disorder related to DCD (Bhat, 2020:642), and has been found to be underdiagnosed in children with motor difficulties (Bhat, 2020:642). A study in the United States reported that 86.9% of children with ASD are at risk for motor difficulties, and 15.1% have DCD (Bhat, 2020:642). Similarly, an earlier study in the United Kingdom reported co-occurring motor difficulties in children with ASD (Sumner et al., 2016:17).

Another co-occurring disorder with DCD identified in the literature is developmental dyslexia (DD), characterised by specific reading disabilities despite academic support (Biotteau, Chaix & Albaret, 2015:79; Biotteau et al., 2017:424; WHO, 1993). Reading disabilities and DD can further be related to learning disabilities and have recently been reported as a co-occurring factor associated with DCD (Di Brina et al., 2018:392). Earlier findings by Flapper and Schoemaker (2013:761) have raised awareness of specific language impairments (SLI) in children who also meet the DCD diagnosis and experience gross and fine motor skill problems. Children with both DCD and SLI have further been identified with oro-motor control difficulties affecting these children's motor system (Ho & Wilmut, 2010:613). Lastly, recent research by Duchow et al. (2019:89) has pointed out the probability that children with childhood apraxia of speech, also have possible DCD and should be considered for intervention.

Considering the co-occurrence of DCD with other disorders, it is clear that motor difficulties are present in these developmental conditions. Therefore, it is important to take an accurate medical, developmental and educational history in all children presenting with motor difficulties, as pointed out by Blank et al. (2019:276). Ideally, appropriate clinical assessment should be undertaken and interpreted according to established clinical guidelines to identify the presence of DCD and/or co-occurring conditions (Blank et al., 2019:245). However, it is not always possible in low SE environments due to the limited number of therapists and facilities available, as noted in this literature review.

It is clear that numerous symptoms, characteristics and co-occurring conditions have been identified in children with DCD, and that not all children with DCD experience the same challenges. For this reason, the aetiology of DCD is challenging, as it has not been attributed to a single particular cause, and is therefore unknown (Blank et al., 2019:15).

2.6 Aetiology of developmental coordination disorder

Various controversial viewpoints have been proposed previously regarding the aetiology of DCD (Martin, Piek & Hay, 2006:111). Comparing the view of Martin et al. (2006:111) with Biotteau et al. (2015:79) and Du et al. (2020:2), further compounds the confusion. The definitive cause of DCD is still unknown and unexplained. Assigning cause in the case of DCD is difficult due to the frequent co-occurrence of other conditions. For this reason, it has often been proposed that there may be a shared aetiology between co-occurring conditions (such as ADHD, ASD, SLI) (Gomez & Sirigu, 2015:273).

Other factors, such as child-related, genetic and environmental factors, could be linked to the cause of DCD. Preterm birth, being born small for gestational age or with low birth weight, postnatal steroid exposure, starting to walk after fifteen months of age, and mothers who smoked during pregnancy, can be associated with a diagnosis with DCD or possible DCD (Delgado-Lobete et al., 2019:34; Larsen, Mortensen, Martinussen & Andersen, 2013:1021; Lingam et al., 2009:e697; Zwicker, Yoon, MacKay, Petrie-Thomas, Rogers & Synnes, 2013:122). Preterm birth has been identified as one of the more decisive factors related to the cause of DCD (Davis, Ford, Anderson & Doyle, 2007:329; Du et al., 2020:5; Larsen et al., 2013:1021). One of the reasons for preterm birth being a factor, is that the preterm baby's central nervous system has not reached maturity, which directly influences psychomotor development (Delgado-Lobete et al., 2019:38).

Research in China on 3–10-year-old children evaluated whether obstetric factors, such as prenatal, perinatal, neonatal and family environmental challenges, can have an influence on children developing DCD, and it was confirmed that problems related to these factors could cause DCD in children (Du et al., 2020:5). Another study on 170 children in Finland, where the children had been evaluated from birth to 11 years of age, found that children born very preterm still experienced DCD at the age of 11 years (Uusitalo et al., 2020:6). These findings clearly support a strong correlation between preterm birth and DCD as a contributing factor. Another causative factor has been identified from a more neurological perspective.

The World Health Organization (WHO, 2002) is of the opinion that the aetiology of DCD might be related to the central nervous system. However, due to the complexity of the motor learning process, the evidence varies and raises even more questions on the cause of DCD (Du et al., 2020:2). Questions have been put forward on whether the difficulties experienced by children with DCD, could be related to the working memory causing the disorder, or whether it is simply one of the characteristics associated with the disorder (Maziero et al., 2020:671). Working memory, however, is part of the more significant term executive functioning, which further includes reasoning, problem-solving, multitasking, planning and inhibition processes, and could also be considered as a reason for DCD. However, a statement has been made that problems with executive functioning cannot provide valid reasons for motor coordination difficulties (Sugden, 2018:501). The research by Sugden (2018:502) has nevertheless pointed out that challenges in planning and organisation of movements might be one part of executive functioning that could be a reason for DCD. Another aspect to consider is that the neural structure and function of children with DCD are different from typically developing children, and neuro-maturational factors can be a possible contributing factor to the aetiology of DCD (Blank et al., 2019:13).

Other aspects that have also been connected to the cause of DCD are genetic factors and environmental influences (Blank et al., 2019:24; Gomez & Sirigu, 2015:274). It is important to consider the living conditions of a child within their environment, community and at home, to determine whether those circumstances might influence motor abilities (Blank et al., 2019:259). The DSM-5 criteria are in accordance with the statement by Blank et al.

(2019:259), explaining that the risk for DCD may be higher due to environmental factors (APA, 2013). Therefore, it is essential to understand that children's SE environment might be a possible reason for DCD in children, as pointed out in this literature review.

To conclude, one discrete aetiology for DCD should not be speculated, because a definite cause for DCD has not been identified (Blank et al., 2019:24; Gomez & Sirigu, 2015:273). Furthermore, it should be accepted that there might be more than one cause due to the wide variety of problems and factors associated with DCD (Caçola, 2014:103; Gomez & Sirigu, 2015:274). As stated in the literature, it would be suggested to not focus on the aetiology but rather on the risk factors associated with DCD (Du et al., 2020:1). Considering that various symptoms, characteristics and the unknown aetiology of DCD are typical features of the condition, it is essential to identify DCD as soon as possible using the DSM-5 criteria and appropriate assessment methods to address these problems (Deshpande et al., 2019:11; Rivard, Missiuna, McCauley & Cairney, 2012:43).

2.7 Assessment and diagnosis of developmental coordination disorder

It is important to understand the evaluation and assessment methods used to identify DCD in children; however, controversial findings have been reported (Cardoso & Magalhães, 2012:17). There is not one instrument or assessment method available that could be regarded as the gold standard for the diagnosis of DCD (Kirby & Sugden, 2010:572). It has been documented that many assessment tools can be used to determine the presence of possible DCD (Asunta, Viholainen, Ahonen & Rintala, 2019:11). One of the main questions that have been asked in the literature is when it would be the right time to start suspecting DCD. Harris, Mickelson and Zwicker (2015:659) pointed out that the possibility of DCD should be suspected when the parent, caregiver or teacher expresses their concern regarding a child's clumsy behaviour, academic performance, and when gross and fine motor skill difficulties are observed. When DCD is suspected, the child should be evaluated. It has further been recommended that children should not be diagnosed with DCD before the age of five years due to the variability in motor development among children of a young age (Blank et al., 2019:257).

The DSM-5 is the recommended method to use for diagnosing DCD in children (APA, 2013). According to Blank et al. (2019:260), a multidisciplinary team of healthcare professionals qualified to apply and interpret the DSM-5 criteria should be used. All four the criteria described in the DSM-5 should be met before a diagnosis can be made (APA, 2013). The DSM-5 criteria include the following: A) the child's learning and performance in motor activities and tasks is noticeably lower than what is expected for the child's age and the opportunities the child receives; B) the low motor performance has an influence on the child's performance in daily living activities or academic success; C) the difficulties experienced by the child has commenced during the initial development stage of the child, and D) the challenges experienced by the child is not due to an intellectual disability or a neurological condition. (APA, 2013). There is currently no instrument to evaluate all the criteria as stipulated by the DSM-5. Therefore, many different assessment methods and tools are used (Gasser-Haas et al., 2020:2).

The MABC-2 Performance Test and BOT-2 are some of the assessment methods used to evaluate criterion A of the DSM-5. The DCDQ'07 and the MABC-2 Checklist can be used for criterion B. A medical history and evaluation should also be completed to assess the child in terms of criteria C and D (APA, 2013). The medical history obtained by completing a form will provide information on any noted physical or neurological disorders that can influence the child's motor ability (Blank et al., 2019:258). A psychological assessment should be conducted to eliminate cognitive and intellectual problems (Barba et al., 2017:27; Blank et al., 2019:258). Barba et al. (2017:27) pointed out that the diagnosis will be more accurate if a number of different assessment methods are used to address the requirements for assessment of the DSM-5 criteria.

2.7.1 Assessment methods and tools to identify possible developmental coordination disorder

One of the criteria (criterion A) of the DSM-5 requires a motor assessment to determine the child's motor abilities (APA, 2013). The motor assessment should be a norm-referenced, valid, reliable test and needs to focus on measuring different areas of motor proficiency (Blank et al., 2019:263). Motor assessments are usually performed directly with the child and evaluate the child's performance on motor tasks' when conducted by a suitably qualified professional such as a therapist (occupational therapists, physiotherapists and kinderkineticists) (Martins, Lisboa, Lopes & Beltrame, 2020:506). Several motor assessment methods and tools are available to use for identifying motor difficulties (Martins et al., 2020:501). The MABC-2 (Henderson et al., 2007:3) and the BOT-2 (Bruininks & Bruininks, 2005:5) are norm-referenced motor proficiency tests and two of the most commonly used assessment methods to identify motor difficulties associated with DCD (Missiuna, Cairney, Pollock, Russell, Macdonald, Cousins, Veldhuizen & Schmidt, 2011:549; Novak, 2013:171; Venetsanou, Kambas, Ellinoudis, Fatouros, Giannakidou & Kourtessis, 2011:2).

2.7.1.1 Bruininks Oseretsky Test of Motor Proficiency

The BOT-2 is the latest version of the BOT and known as a motor proficiency test that evaluates fine- and gross motor skills in individuals 4–21 years of age (Bruininks & Bruininks, 2005:8). The BOT-2 has been used in clinical practice, specifically with individuals who have possible DCD as part of the diagnostic process for DCD (Blank et al., 2019:262). The BOT-2 consists of four motor composites (fine manual control, manual coordination, body coordination, and strength and agility). Under the composites, eight subtests are assessed (fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper limb coordination, and strength) (Bruininks & Bruininks, 2005:5). The motor composites can be interpreted separately and used to determine overall motor proficiency by calculating a total motor composite score. The results are categorised into age equivalents and descriptive categories (well above average, above average, average, below average, and well below average) (Bruininks & Bruininks, 2005:28). There is also the BOT-2 SF), an abbreviated test that takes between 15 and 20 minutes to complete (Bruininks & Bruininks, 2005:6). The short form includes 14 test items from the BOT-2 representing all eight subtests and provides an overall motor proficiency score (Bruininks & Bruininks, 2005:6). The short form is considered a screening tool that can indicate if a full test should be conducted. Another more recent abbreviated form is the BOT-2 Brief Form comprising of 12 items from the BOT-2, which is used to screen for motor difficulties, especially in small areas where space is a problem (Bruininks & Bruininks, 2005:2).

Blank et al. (2019:261) identified the following strengths of the BOT-2: (i) photographs in the manual provide extra cues and support; (ii) the face validity of the items are representative of childhood motor activities; (iii) the test has good construct validity; (iv) it has moderate to strong interrater and test-retest reliabilities; and (v) the norms are up to date.

The BOT-2 further demonstrates fair to good validity and good specificity, even though the specificity is lower than that of the MABC-2. Considering that the BOT-2 has good reliability and validity, it has not been used much in research. Therefore, it does not present as many research results and findings as the MABC-2. The MABC-2 has been identified as a moderate to good test to identify children with possible DCD (Blank et al., 2019:261) and is discussed in the next section.

2.7.1.2 Movement Assessment Battery for Children

The MABC-2 is a standardised test consisting of a Performance Test, a Checklist, and a manual to assist with an intervention (Henderson et al., 2007:3). The MABC-2 Performance Test involves evaluating the child directly. It is one of the tools used most frequently as an objective assessment of the motor skill proficiency component outlined in criterion A of the DSM-5 (Blank et al., 2019:261; Schoemaker, Niemeijer, Flapper & Smits-Engelsman, 2012:369). The MABC-2 has been developed to support professionals in evaluating children's motor performance abilities between the age of 3–16 years (Henderson et al., 2007:3) and is the revised version of the original MABC created in 1992 (Henderson et al., 2007:113). The MABC-2 consists of eight activities to evaluate three subtests named manual dexterity (three activities), aiming and catching (two activities) and balance skills (three activities) (Blank et al., 2019:261; Henderson et al., 2007:17).

The test is conducted within three age bands with different activities to evaluate the three subtests. Age band one focuses on 3–6 years, age band two on 7–10 years, and age band three on 11–16 years (Blank et al., 2019:261; Henderson et al., 2007:3). Age-adjusted standard scores and percentiles, and the total test score, are provided for these three groups. The total test score can be interpreted in terms of cut-off points and a traffic light system (Henderson et al., 2007:4). The green zone indicates no motor difficulties (normal range, > 15th percentile), while the amber zone indicates moderate motor difficulties (being at risk, 6th–15th percentile). The red zone means that severe motor difficulties (≤ 5th percentile) are observed and stipulates the need for intervention. Children falling in the red zone (≤ 5th percentile) are described in the literature as having probable DCD, and children in the amber zone (6th–15th percentile) as at risk for DCD (Valentini, Clark et al., 2015:970). Therefore, children are identified with possible DCD when they fall at or below the 15th percentile (moderate to severe motor difficulties) (De Waal et al., 2018:3). The standard scores are transformed from the distribution of the raw scores, and if the standard score is three or less, the child will need help. A score of one or more can put the child into the at-risk category (Henderson et al., 2007:84). The higher the score, the better developed the child's motor abilities.

An assessment tool's validity and reliability can give an indication whether the tool can be used as an effective instrument (Barnett, 2008:115). The MABC-2 is a valid and reliable test instrument (Blank et al., 2019:261; Ellinoudis, Evaggelinou, Kourtessis, Konstantinidou, Venetsanou & Kambas, 2011:1051).

2.7.1.2.1 Reliability of the Movement Assessment Battery for Children 2nd edition

According to the MABC-2 manual, the MABC-2 is a reliable test with a reliability coefficient of 0.77 (manual dexterity), 0.84 (aiming and catching), and 0.73 (balance), as well as 0.80 for the total test score for children 3–16 years of age when a population sample in the United Kingdom was used (Henderson et al., 2007:136). Also, higher reliability (0.97) was found in a research study on 6–12-year-old children in Taiwan (Wuang, Su & Su, 2012:163). When specifically looking at the test-retest reliability of the MABC-2 Performance Test, a study on 183 children between 36–64 months old in Northern Greece determined good reliability with interclass correlation coefficient scores of 0.82 for manual dexterity, 0.61 for aiming and catching, 0.90 for balance and 0.85 for the total test score (Ellinoudis et al., 2011:1049). Another study on 36–48-month-old children in Germany found interrater reliability of 0.74–0.85 and test-retest reliability of 0.94, indicating good to excellent reliability (Smits-Engelsman, Niemeijer & Van Waelvelde, 2011:1375).

The reliability has further been found to be good for the tasks conducted and measurement of the three components of the MABC-2 (manual dexterity, balance, and aiming and catching) (Smits-Engelsman et al., 2011:1366). Furthermore, an acceptable internal consistency was established for manual dexterity (0.51), balance (0.66), and aiming and catching (0.70) (Ellinoudis et al., 2011:1049). In the Taiwanese study, excellent internal consistency (0.90) with Cronbach scores of 0.81 for manual dexterity, 0.84 for aiming and catching, 0.88 for balance, and 0.97 for the total test score were observed, confirming the high reliability of the test (Wuang et al., 2012:163).

2.7.1.2.2 Validity of the Movement Assessment Battery for Children 2nd edition

Validity represents the degree to which the assessment tool measures what it aims to measure, and is further explained where theory and evidence support the test (Harman, 2008:238; Bruininks & Bruininks, 2005:56; Henderson et al., 2007:137). The validity of the MABC-2 is labeled as fair to good regarding the construct validity and concurrent validity with the BOT-2 (Blank et al., 2019:261; Smits-Engelsman et al., 2011:1375). Good convergent validity of the tasks has been reported (Schulz, Henderson, Sugden & Barnett, 2011:1366). Furthermore, the discriminant validity has been established due to the moderate correlations between ability factors and the structural validity of the MABC-2 (Schulz et al., 2011:1368). The components of the MABC-2 show a good correlation with the total test score (manual dexterity 0.76; balance 0.73; aiming and catching 0.65) (Henderson et al., 2007:142). In another study, Ellinoudis et al. (2011:1049) observed good test-retest reliability (manual dexterity 0.74; balance 0.71; aiming and catching 0.70) and confirmed that the MABC-2 is valid for the evaluation of possible DCD (moderate to severe motor difficulties). The specificity (percentage of children identified without motor difficulties with the Performance Test, who is also identified without motor difficulties with the Checklist) of the MABC-2 is good, although the sensitivity (percentage of children identified with moderate and severe motor difficulties with the Performance Test, who is also identified with moderate and severe motor difficulties with the Checklist) is slightly lower (Blank et al., 2019:261). The content validity of the MABC-2 is good and relevant to all children (Schulz et al., 2011:1366).

2.7.2 Assessment methods and screening tools to identify motor difficulties

It has previously been recommended in the literature that identifying children early with motor difficulties is important in order to increase early intervention (Cairney et al., 2007:991; Schoemaker, Flapper, Verheij, Wilson, Reinders-Messelink & De Kloet, 2006:668; Wessels et al., 2008:503). These recommendation has continued in more recent studies stating that early intervention is critical to overcoming motor difficulties (Caçola et al., 2017:16; Lipkin & Macias, 2020:5). A suggested method to use is self-administered screening questionnaires that can be completed by teachers and parents. The findings by means of these questionnaires will result in the referral of children with noted concerns for more formal developmental evaluation by a qualified therapist, who can then further propose suitable intervention (Dimitropoulou, Evaggelinou, Kourtessis, Mouratidou, Tsigili & Ellinoudis, 2019:31; Blank, Smits-Engelsman, Polatajko & Wilson, 2012:68; Henderson et al., 2007:3; Schoemaker et al., 2006:668; Wilson, Crawford, Green, Roberts, Aylott & Kaplan, 2009:183). Questionnaires and checklists include more observations of the child during everyday life, with the focus on the home environment when completed by parents, and the school environment when completed by teachers (Martins et al., 2020:506).

Even though parents' input is important to provide insight into self-care, self-maintenance and the child's performance at home (Kaiser, Albaret & Cantell, 2015:5), various factors may influence their perception. These factors include parents not having the professional qualification to evaluate a movement (Martins et al., 2020:505), and parents being more inclined to perceive their children's movement abilities higher than it is to avoid a poor reflection on their parental abilities (Lalor & Brown, 2016:22). Blank et al. (2019:258) were of the opinion that the screening instruments used for DCD are not valid and reliable when used in population samples. It can, however, be used within a clinical setting (Asunta et al., 2019:10). Being able to use the screening instrument only in a clinical setting is a problem because motor assessments are expensive and time-consuming, making it difficult in areas where a large group of children needs to be screened (Blank et al., 2019:258; Loh, Piek & Barrett, 2009:39; Schoemaker et al., 2006:668). Therefore, it is still important to conduct more studies on whether screening tools could not be recommended for use by teachers in a population-based setting.

Screening instruments are used to meet criterion B of the DSM-5 and should include activities of daily living (Schoemaker et al., 2012:368). It has been recommended that more than one source (parents, child, teachers, relevant others) should be involved (Blank et al., 2019:259). Various screening questionnaires are available, such as the Teacher Estimation of Activity Form (TEAF) (Faught, Cairney, Hay, Veldhuizen, Missiuna & Spironello, 2008:179), the Motor Observation Questionnaire for Teachers (van Dellen, Vaessen & Schoemaker, 1990:148), the Motor Skills Checklist (MSC), the DCDQ'07, and the MABC Checklist (Bhoyroo et al., 2019:259; Schoemaker et al., 2012:372). A systematic review conducted by Asunta et al. (2019:9) has established that selecting a screening questionnaire will depend on its purpose. Blank et al. (2019:259) have pointed out that limited research findings on many questionnaires and checklists have been reported in the literature. The

DCDQ'07 has been used more frequently in research on DCD, whereas studies reporting on the MABC-2 Checklist are represented to a limited extent.

2.7.2.1 Developmental Coordination Disorder Questionnaire'07

The DCDQ'07 is a questionnaire completed by parents to screen for possible DCD (moderate to severe motor difficulties) in children 5–15 years of age (Wilson et al., 2009:191). The DCDQ'07 is the latest version and was previously known as the DCDQ, which focused on 8–14-year-old children (Wilson, Thomas & Maruff, 2002:491). The DCDQ was revised when the author (Wilson) determined that children as young as five years could be screened for suspected DCD (Wilson et al., 2009:185). The questionnaire was further identified as a screening tool that can be used to partially determine criterion B of the DSM-5 (Bhoyroo et al., 2019:2; Blank et al., 2019:19; Karras et al., 2019:87; Wilson et al., 2009:193). The questionnaire is cost-effective and requires less time to complete than standardized motor performance tests (Ferreira et al., 2019:345; Rivard et al., 2012:48).

The questionnaire focuses exclusively on functional performances within the child's natural environment, and the parents compare these performances with their peers (Rivard et al., 2012:43; Wilson et al., 2009:193). The DCDQ'07 consists of 15 questions, includes a score sheet (Wilson & Crawford, 2007:4), and comprises three motor behaviour focus points: control during movement, fine motor skills/handwriting and general coordination (Ferreira et al., 2019:345; Wilson & Crawford, 2007:4). The parent is required to answer each question by making use of a 5-point Likert scale ranging from one ('not at all like your child') to five ('extremely like your child') (Wilson & Crawford, 2007:1–3). The score for each item is transferred to the score sheet and summed to obtain a total score. The total score is interpreted within three age groups with different cut-off scores, and categorises the child in a 'probably not DCD' group or 'indication of or suspected DCD' group (Wilson & Crawford, 2007:4). The higher the score, the better the child's motor abilities (Ferreira et al., 2019:345).

Although Blank et al. (2019:19) recommended using the DCDQ'07 to address criterion B of the DSM-5, it is important to note that the questionnaire can only be completed by parents (Wilson & Crawford, 2007:10). Furthermore, it has been asserted that parents should have an educational background to have the ability to identify motor difficulties in their children (Engel-Yeger, Rosenblum & Josman, 2010:93). It is therefore important to consider that some parents in low SE environments in SA do not have an adequate level of education. The reason can be that some of them did not attend school or do not have the ability to read or write, which is required to complete the questionnaire. In addition, some parents are not involved in their children's lives during the day due to work-related responsibilities (Kalam et al., 2016:61). Parents might further not have an adequate level of literacy to understand and complete the questionnaire independently (Martins et al., 2020:507). Although a structured interview can be conducted, there is not always someone available, and more research is required to determine its efficacy (Lalor & Brown, 2016:22). A recommendation has been made that if the professional wants the teacher to complete the DCDQ'07, the parent should assist the teacher (Wilson & Crawford, 2007:10), which is not always possible. The MABC-2 Checklist can, however, be completed by teachers, and Schoemaker et al. (2012:372) reported evidence that the MABC-2 Checklist is a better predictor of DCD when compared with the results of the MABC-2 Performance Test.

2.7.2.2 Movement Assessment Battery for Children-2 Checklist

The MABC-2 Checklist is a questionnaire completed by parents or other professionals (therapists or teachers) working with the child (Henderson et al., 2007:91). The MABC-2 Checklist can be completed for children 5–12 years of age to identify motor difficulties (Henderson et al., 2007:114). The MABC-2 Checklist further evaluates a broad variety of functional motor performances. The evaluation of functional motor performances is important to identify possible DCD due to the various motor problems observed in children with DCD. Therefore the MABC-2 Checklist can be used to determine criterion B of the DSM-5 (Schoemaker et al., 2012:372). The MABC-2 Checklist is divided into three sections: (i) 'movement in a static and/or predictable environment'; (ii) 'movement in a dynamic and/or unpredictable environment'; and (iii) 'non-motor factors that might affect movement' (Henderson et al., 2007:92). The adult completing the checklist is required to rate motor behaviours in an everyday setting. Afterwards, the results are summed to a total score, which gives an indication whether a child falls within a normal range (green zone), moderate motor problems (amber zone), or severe motor problems (red zone) category (Henderson et al., 2007:91). Children in the amber and red zone can be identified with possible DCD (moderate to severe motor difficulties) (De Milander et al., 2019:35).

2.7.2.2.1 Reliability of the Movement Assessment Battery for Children 2nd edition Checklist

The MABC-2 manual does not stipulate the reliability results of the MABC-2 Checklist, although it does mention that the overlaps between the original and the 2nd edition Checklist may show similar reliability (Henderson et al., 2007:154). Therefore, the evidence of the reliability of the MABC-2 Checklist remains limited (Brown & Lalor, 2009:94). A study conducted in the UK on 7- and 9-year-old children using the original MABC Checklist confirmed a good (0.91) test-retest correlation with 7-year-olds and an acceptable (0.77) test-retest correlation with the 9-year-olds (Henderson et al., 2007:155). Schoemaker, Smits-Engelsman et al. (2003:436) have previously reported that the original MABC Checklist is reliable, attributable to the test items' various focus areas. These researchers further confirmed an excellent test-retest reliability of 0.96 when conducted on 184 children 6–11 years of age (Schoemaker, Smits-Engelsman et al., 2003:431). The original MABC Checklist and the MABC-2 Checklist show good internal consistency, and each question reports on functional motor performance (Schoemaker, Smits-Engelsman et al., 2003:436; Schoemaker et al., 2012:372). A study in SA on 94 children between 9–12 years in the North West province with the aim to examine the teachers' reliability of the MABC Checklist indicated good internal consistency (Lombard & Pienaar, 2003:182). However only section 1 and 5 of the Checklist was completed in this study and a cronbach alpha value of 0.92 (section 1) and 0.87 (section 2) was established (Lombard & Pienaar, 2003:182).

2.7.2.2.2 Validity of the Movement Assessment Battery for Children 2nd edition Checklist

The original MABC Checklist has good discriminative validity compared to a random group and those referred by a professional (Schoemaker, Smits-Engelsman et al., 2003:437). The study by Lombard and Pienaar (2003:182) indicated good construct validity for the original MABC Checklist and moderate correlations of the section 1 and 5 of the Checklist were found when compared with the subsections of the MABC Performance Test. Schoemaker et al (2012:372) confirmed that the MABC-2 Checklist could discriminate between the group with motor difficulties and the group without when the second edition is used. The MABC-2 Checklist shows good construct validity (0.94), indicating that all the items measure the same construct (Schoemaker et al., 2012:371). Research is, however, limited. Limitations are specifically noticed when observing the convergent validity of the MABC-2 Checklist.

Convergent validity, also known as concurrent validity, is determined when the MABC-2 Performance Test and MABC-2 Checklist agreement is calculated (Schoemaker et al., 2012:370). One of the objectives of the current study was to determine the teachers' ability to identify possible DCD when using the MABC-2 Checklist. Therefore, convergent validity should be established. The convergent validity will be discussed in more detail.

A value (kappa coefficient) is determined to evaluate agreement between the MABC-2 Performance Test and the MABC-2 Checklist. To rate the agreement, values lower than 0 indicate no agreement, 0–0.20 slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, and 0.81–1 almost perfect agreement (Landis & Koch, 1977). To further establish agreement, the sensitivity, specificity, positive predictive and negative predictive values are evaluated. The recommended predictive values when using the 15th percentile as cut-off scores for the MABC-2 is 80% sensitivity and 90% specificity (American Psychological Association, 1985). Sensitivity regarding the MABC-2 Performance Test and the MABC-2 Checklist means the degree to which the same children who were identified with moderate and severe motor difficulties by the Performance Test was also identified with moderate and severe motor difficulties with the Checklist. (Schoemaker, Flapper, Reinders-Messelink & De Kloet, 2008:195). In contrast, specificity means the degree to which the same children who were identified with no motor difficulties by the Performance Test was also identified with no motor difficulties with the Checklist (Ellinoudis et al., 2009:291).

2.7.2.2.3 Research findings on the convergent validity of the Movement Assessment Battery for Children Checklist with the Movement Assessment Battery for Children Performance Test

To determine the convergent validity, the sensitivity of the MABC-2 Checklist should be determined. Considering that limited results on the MABC-2 Checklist have been reported, findings on the sensitivity of the original MABC Checklist will first be highlighted. Relatively low sensitivities (14.3%, 15th percentile cut-off score; 11.1%, 5th percentile cut-off score) have been reported in the early research on 103 Canadian children with mean age of eight years, when the MABC Checklist was completed by the teachers (Junaid et al., 2000:160). Comparing the results of Junaid et al. (2000:160) with an early study on 9–10-year-old children from Perth, Australia, a sensitivity of 25% when the class teachers completed the MABC Checklist was found. The teachers were able to identify only eight of the 32 children with possible DCD, showing moderate and severe motor difficulties (Piek & Edwards, 1997:59). Research conducted a few years later on 330 Greek children, when the PE teachers completed the MABC Checklist, found similar results (27.1% sensitivity) (Ellinoudis et al., 2009:307). Of the 59 children identified with moderate and severe motor difficulties with the MABC Performance Test, only 16 were identified with moderate and severe motor difficulties by the teachers using the MABC Checklist (Ellinoudis et al., 2009:289).

In another study on 98 children with a mean age of 107.4 months, the sensitivity was reported at 44%, and the MABC Checklist was completed by PE teachers (Green, Bishop, Wilson, Crawford, Hooper, Kaplan & Baird, 2005:5). Contrary to these findings, a very high sensitivity (more than 80 %) was found on 184 Dutch children 6–12 years of age, indicating that more than 80% of the children who failed the MABC Performance Test were also correctly identified with the MABC Checklist by the class teachers (Schoemaker, Smits-Engelsman et al., 2003:437).

Even though Schoemaker, Smits-Engelsman et al. (2003:437) determined a very high sensitivity score, lower than 80% scores were reported from two South African studies conducted with the MABC-2 Checklist. When the MABC-2 Checklist was completed by the class teachers of 545 Gr. 1 children, a sensitivity of 46.5% was found (De Milander et al., 2016a:1001), whereas when completed by parents on 281 children with a mean age of six years and four months, a sensitivity of 65.8% was reported (De Milander et al., 2019:37). These studies were conducted in the FS Province in a high SE environment. Another earlier study in Belgium reported results that were similar to the findings of De Milander et al. (2016a:1001), with a 41% sensitivity when the MABC-2 Checklist was completed by five class teachers of 8-year-old children (Schoemaker et al., 2012:371). A recent study involving 584 Greek children 5–12 years old has determined a 50.7% sensitivity when the ≤ 5th percentile was used as a cut-off score and 50.6% when the 6th–15th percentile cut-off score was used (Dimitropoulou et al., 2019:30). Only one study of all the research in the literature review met the desired 80% rate for sensitivity (American Psychological Association, 1985) and was conducted with the original MABC Checklist. Another aspect to consider is that studies do not report the SE environments where these assessments took place, raising questions. Next, the specificity findings are discussed.

The specificity refers to the percentage of children identified without motor difficulties with the MABC Performance Test, who is also identified without motor difficulties with the MABC Checklist (Junaid et al., 2000:160). The two South African studies reported moderate ability of the parents (64.4%) (De Milander et al., 2019:37) and teachers (70.3%) (De Milander et al., 2016a:1000) to correctly identify children without DCD by means of the MABC-2 Checklist. In contrast, a Canadian study identified a high specificity for both the 15th (97.8%) and 5th (98.9%) percentile cut-off scores using the original MABC Checklist (Junaid et al., 2000:160). Another high specificity (90%) was found by Shoemaker et al. (2003:437) with the original MABC Checklist. However, a slightly lower specificity (88%) was found in the Belgian study when the 15th percentile cut-off was used with the MABC-2 Checklist (Schoemaker et al., 2012:371).

Compared to the findings of Schoemaker et al. (2012:371), Ellinoudis et al. (2009:291) found a specificity of 81.6%, whereas Green et al. (2005:6) reported a specificity of 74% with the original MABC Checklist. Lastly, Dimitripoulou et al. (2019:30) determined specificity scores of 80.7% for both the ≤ 5th and 6th–15th percentile cut-off scores. The MABC-2 Checklist showed high ability of the teachers to identify no motor difficulties in the literature, however, the desired score of 90% (American Psychological Association, 1985) had only been reported in two studies conducted with the original MABC Checklist (Junaid et al., 2000:160; Schoemaker, Smits-Engelsman et al., 2003:437). Furthermore, inconsistencies have been reported on the overall agreement between the MABC-2 Checklist and the MABC-2 Performance Test.

A slight agreement (0.14) between the original version of the MABC Performance Test and the MABC Checklist have been found (Ellinoudis et al., 2009:306; Green et al., 2005:6). Similarly, a slight agreement of 0.11 (De Milander et al., 2016a:1001) was found in SA with the MABC-2 Checklist. A study in SA in the North-West province using the original version of the MABC Checklist reported a low to moderate agreement between section 1 and 5 of the Checklist and the subcomponents of the Performance Test (Lombard & Pienaar, 2003:171) which is slightly better than the findings of Ellinoudis et al (2009:306) and Green et al. (2005:6). The results further reported better agreement between the DCD group than the non DCD group (Lombard & Pienaar, 2003:171). In comparison, Dimitropoulou et al. (2019:29) reported a fair agreement of 0.28 in their study and agreed (0.28) with Schoemaker et al. (2012:370). Dimitropoulou et al. (2019:31) determined a moderate agreement (0.44) when the MABC-2 Checklist was completed by preschool teachers, a fair agreement when completed by primary school teachers, and a slight agreement (0.15) when completed by PE teachers. Preschool teachers were the best predictors when using the MABC-2 Checklist (Dimitropoulou et al., 2019:31).

A moderate agreement (0.44) has been determined by Schoemaker, Smits-Engelsman et al. (2003:437) between the original MABC Performance Test and the MABC Checklist. Similarly, the early Canadian study reported a moderate agreement (0.60) between the original MABC Performance Test and the MABC Checklist when completed by class teachers (Junaid et al., 2000:160). Piek & Edwards (1997:60) also reported a moderate agreement (0.51) in their study. In contrast, when parents completed the MABC-2 Checklist in a SA study on 5–8-year-old children, a low agreement (0.18) was found (De Milander et al., 2019:37). A study conducted in Brazil on children 7–8 years of age found no agreement (0.05) between the MABC-2 Performance Test and the MABC-2 Checklist when completed by parents (Martins et al., 2020:506). These results clearly highlight the controversies in the literature.

Considering the results regarding the sensitivity, specificity and the overall agreement between the MABC Checklist and the Performance Test, it is clear that the majority of the results did not indicate good sensitivity when the original version of the MABC was used. This finding means that teachers could not use the original MABC Checklist to identify the same occurrences of motor difficulties as the MABC Performance Test. There was, however, one study that determined an 80% sensitivity (Schoemaker, Smits-Engelsman et al., 2003:437). When the second edition of the MABC-2 Checklist was used, slightly better results were obtained. However, it did not reach the recommended 80% sensitivity. Although better results have been found with the MABC-2 Checklist, it is difficult to determine a clear indication on the sensitivity and the value of whether the MABC-2 Checklist can be used to identify motor difficulties, as limited results on the second edition are documented. More research is therefore required.

Blank et al. (2019:259) have recently pointed out that the MABC-2 Checklist has not been researched sufficiently. By observing the literature, this is especially true in SA, where limited studies using the MABC-2 Checklist were reported. The SA results reported low agreements, and a reason for the low agreement in SA might be that the MABC-2 Checklist contains items or questions that are not suitable for the population of children living in SA (De Milander et al. 2016a:1001). Research in SA is limited on whether the MABC-2 Checklist can be a useful assessment tool for teachers to identify moderate to severe motor difficulties (possible DCD) in children. Furthermore, the two SA studies using the MABC-2 Checklist have been conducted in higher SE environments, and no results in a low SE environment in SA when completing the second edition Checklist have been published.

2.7.2.2.4 Teachers and the Movement Assessment Battery for Children-2 checklist

According to Capistrano, Ferrari, De Souza, Beltrame and Cardoso (2015:104), the MABC-2 Checklist results will differ, depending on which adult completes the Checklist, for example, parents, PE teachers and class teachers. Teachers are known to vary according to experience. Some teachers have many years of experience, and others have little experience, which might influence how the MABC-2 Checklist is interpreted (De Milander et al., 2016a:1000). Many class teachers required to complete the MABC-2 Checklist are not trained in assessing motor performance in children, which makes the teachers feel insecure when asked to provide input regarding the child's motor skills (Capistrano et al., 2015:104; Junaid et al., 2000:161; Schoemaker et al., 2012:373; Schoemaker, Smits-Engelsman et al., 2003:439). According to Lombard and Pienaar (2003:183), teahcers should be provided with additional information and suggestions on how to answer each question of the Checklist for more consistency in results. Even though the study by Lombard and Pienaar (2003:183) made use of the original version of the MABC Checklist, the recommendation could also be applicable to the MABC-2 Checklist. Schoemaker et al. (2012:373) argued that teachers are not trained to evaluate motor abilities and motor development in children, which may translate to an insufficient ability to identify motor difficulties in the classroom setting. It is also unclear whether teachers get the opportunity to observe the children when they are outside of the classroom during play activities, physical activity participation and sport participation.

Additionally, teachers do not receive the necessary training on how to complete the MABC-2 Checklist, which may further influence the results (Asunta et al., 2019:10). It has been noted that if teachers cannot identify the children who experience motor skill challenges, they may not receive the help needed (Junaid et al., 2000:163). A concern that has been stated is whether the MABC-2 Checklist is not too long for teachers to complete, considering their workload (Faught et al., 2008:179). Lombard & Pienaar (2003:168) also found that the teachers were unwilling to complete the Checklist due to the lack of time. Despite findings of limited training and long checklists, the opposite regarding teachers' value in completing the checklist has also been reported. Asunta et al. (2019:10) and Faught et al. (2008:187) have emphasised the important role teachers play in identifying children with motor difficulties and their opportunity to observe children in more than one environment (in class, on the playground, during sports). Jelsma et al. (2020:175) highlighted the importance of teachers in assessing children with possible DCD because they are usually the first to become aware that there are problems with the child's motor performance or that they may behave differently from their same-aged peers.

Suggestions have been made that the MABC-2 Performance Test, MABC-2 Checklist and other assessment tools should be used in combination. If the child score within the severe motor difficulty category on more than one of these assessments, where the MABC-2 should be the recommended test, they can be identified with possible DCD (Asunta et al., 2019:10; De Milander et al., 2019:41; Martins et al., 2020:507; Schoemaker, Smits-Engelsman et al., 2003:438; Smits-Engelsman et al., 2011:1376). However, this will not be feasible in the South African context in low SE environments, as stated earlier that poor communities cannot afford all these assessment tools. Assessments are expensive, and professionals to conduct these assessments are limited in low SE communities. From the literature, questions have been raised regarding which children should be screened using a questionnaire and who should be formally tested, and how this should be determined. Therefore, a suggestion to consider parents and teachers working in collaboration with each other has been put forward. However, teachers' perceptions could contribute more than parents due to the level of thoroughness when completing questionnaires, but teachers cannot evaluate motor skills in the home context (Martins et al., 2020:506).

From the literature review above regarding the convergent validity, uncertainties have been mentioned on whether teachers can use the MABC-2 Checklist to identify motor difficulties indicative of possible DCD in children. The results stipulated in the literature ranges from 11.1% to 80% sensitivity, 64.4% to 98.9% specificity and overall agreement of 0.11 to 0.60 between the Checklist and the Performance Test, indicating various results. Some of the studies have reported on the successful results when teachers complete the MABC Checklist (Junaid et al., 2000:160; Schoemaker et al., 2003:437; Schoemaker et al., 2012:371). Although the two SA studies in the FS province of SA on high SE environments reported low agreements between the MABC-2 Performance Test and Checklist (De Milander et al., 2019:37; De Milander et al., 2016a:1000), an earlier study by Lombard and Pienaar (2003:171) in the NW province of SA indicated a low to moderate agreement between the original MABC Performance Test and Checklist. Considering that low agreements do occur, it would be beneficial to develop adapted norms for the MABC-2 Checklist when conducted in SA. However, more research is required to support the development of new norms for SA and especially in the low SE environments. Therefore, it is necessary to conduct more research on the convergent validity to create an improved understanding of the ability of Teachers to use the MABC-2 Checklist to identify motor difficulties and to contribute to the knowledge base and insight into the specific discipline. Furthermore, it is important to conduct further research and determine if the MABC-2 Checklist could be used as a screening tool to identify motor difficulties in populations, due to standardised motor assessments being too expensive and time-consuming. Also, limited studies on the second edition is available.

Early diagnosis of DCD and motor difficulties identification are essential to start with appropriate early intervention (Barba et al., 2017:29).

2.8 Interventions for developmental coordination disorder and motor difficulties

Intervention is essential to address the problems experienced by children with DCD. Any type of intervention addressing motor difficulties and related problems to DCD is better for these children than conducting no intervention at all (Blank et al., 2019:267; Miyahara, Lagisz, Nakagawa & Henderson, 2017:733). Various intervention approaches and programmes have been described in the literature and evaluated to determine the current best evidence-based practice for children with DCD (Barnett, 2008:123; Blank et al., 2019:26; Blank et al., 2012:75; Coetzee & Pienaar, 2013:4082; Ernst, 2003:55; Hillier, 2007:5; Lee, Psotta & Vagaja, 2016:23; Lucas, Elliott, Coggan, Pinto, Jirikowic, McCoy & Latimer, 2016:7; Miyahara et al., 2017:737; Offor, Williamson & Caçola, 2016:171; Peens & Pienaar, 2007:114; Pienaar & Lennox, 2006:70; Preston, Magallón, Hill, Andrews, Ahern & Mon-Williams, 2017:863; Smits-Engelsman, Blank, Van der Kaay, Mosterd-Van Der Meijs, Vlugt-Van den Brand, Polatajko & Wilson, 2012:5; Smits-Engelsman et al., 2018:75; Yu et al., 2018:2081).

One of the main problems experienced by all children with DCD is motor difficulties, as documented in this literature review. Therefore, interventions focusing on improving motor difficulties in children with DCD are paramount (Montgomery et al., 2018:3; Smits-Engelsman et al., 2018:98). Motor intervention programmes aim to address motor difficulties (Yu et al., 2018:2077), increase motor skills, health performance, fitness and weight control (Amador-Ruiz et al., 2018:543; Cermak et al. 2015:170; Farhat et al., 2015:217), and enhance the relationships between peers regardless of impaired motor performance abilities (Gasser-Haas et al., 2020:9).

A recent systematic review and meta-analysis by Yu et al. (2018:2092) on motor intervention programmes for children with DCD concluded that 85% of motor intervention programmes improved children's motor performance. A previous meta-analysis by Smits-Engelsman et al. (2012:8) and a systematic review in 2018 found similar results (Smits-Engelsman et al., (2018:73). The latter study emphasised the importance of motor training in children with DCD (Smits-Engelsman et al., 2018:99). Besides improved motor performances, improvements in other areas, such as cognitive, emotional and psychological, and physical fitness, have been reported after using a motor intervention programme (Yu et al., 2018:2094). Studies in SA also reported on the importance of motor intervention programmes for children with DCD.

It is essential to plan, identify goals, have specific focus areas, have a key measure of the outcome of effectiveness, and have clear guidelines regarding exercise prescription and dosage (duration, frequency and the number of sessions) to conduct a successful motor intervention programme (Blank et al., 2019:267). Research has documented various findings on the planning, goal setting, focus areas, approaches, role players, duration, settings, and other aspects of an intervention for children with DCD and will be highlighted next.

2.8.1 Planning, goals and focus areas of developmental coordination disorder intervention

According to the CPR-DCD recommendations proposed by Blank et al. (2019:267), planning of interventions should include (i) identifying the strengths and the weaknesses the child experience in their environment (school, home, community) to increase the motor performance, activity execution, and participation of the child; (ii) prioritising the problems experienced by the child, family and teacher, and consider addressing the most severe problem first; and (iii) considering individual goal-setting and goals to perform activities during daily life and be able to participate (Blank et al., 2019:267). Further aspects to consider when planning an intervention programme are: (1) the age of the child to determine the level of development, (2) the experience of the child to determine the level of intervention, and (3) the personality of the child to assist in deciding, for example, if the individual intervention would be more beneficial than group intervention (Blank et al., 2019:272). Furthermore, researchers are of the opinion that it is important to consider gender differences when planning the motor intervention, because boys and girls experience different motor difficulties (Kokštejn et al., 2015:65; Pienaar, 2004:87).

In addition to these aspects mentioned above, when planning the intervention, it is important to consider the various secondary problems the child with DCD experiences (Biotteau et al., 2017:436; Lucas et al., 2016:14; Preston et al., 2017:866; Smits-Engelsman et al., 2018:97). Taking secondary problems into account can help to put children in subtypes according to their problems and plan the intervention accordingly; for example, overweight and obese children will be grouped together, and children with visual difficulties will be in another group (Aertssen et al., 2018:96). The heterogeneity will be observed during the diagnosis and assessment process before the intervention starts (Blank et al., 2019:269).

Psychosocial factors such as self-concept, efficacy, social support, and negative experiences with peers, directly influence participation in physical activity (Blank et al., 2019:266). Thus, these factors should be considered during the planning and monitoring of intervention for children with DCD (Blank et al., 2019:269; Li, Kwan et al., 2018:249). Information regarding psychosocial factors can guide the therapist with regard to treatment possibilities (Blank et al., 2012:74). For example, if the child experiences negative interaction with peers, the child will not want to participate in a group, and therefore an individual motor intervention should be provided. Throughout the intervention, the psychosocial factors the child is struggling with should be monitored to determine if improvement occurs as a result of motor skills development (Blank et al., 2019:268). Awareness of these social and emotional challenges may assist the therapist to determine if it should be taken into consideration when planning a motor intervention programme (Draghi et al., 2020:11; Noordstar & Volman, 2020:7). Even though social and emotional challenges will not directly be addressed in the motor intervention programme, the motor skills that cause the social and emotional challenges will receive attention.

A question has been raised about whether it would be beneficial for children to choose their own goals that they would like to achieve. Caçola et al. (2016:177) and Zwicker, Rehal, Sodhi, Karkling, Hilliard and Jarus (2015:172) confirmed that allowing some freedom of choosing their task or activity to reach a goal might decrease children's anxiety levels and promote engagement in tasks. However, it is important to note that selecting their own goals will not necessarily improve self-efficacy or physical activity (Zwicker et al., 2015:173). Therefore, Blank et al. (2019:267) emphasised using the child's individual goals as the primary focus when planning the motor intervention programme. The main objectives should further focus on the task level and participation level of the child (Blank et al., 2019:269; Li, Kwan et al., 2018b:248; Smits-Engelsman et al., 2018:98). It has also been recommended that the intervention programme should focus on the structural requirements of the task (the basic rules and techniques of a movement) (Cantin et al., 2014:230) to help the child overcome the slow and less accurate performance challenges (Caçola, 2014:102; Jarus et al., 2015:123; Rosenblum, 2015:212).

Other goals to focus on include incorporating fine motor skills in boys' and girls' intervention programmes and more ball type of skills for girls (Ali et al., 2016:8; Valentini et al., 2012:383). Furthermore, for children of preschool age, the focus should be on fundamental motor skills (locomotor, stability and object manipulation) (Hardy et al., 2012:e397). Lee et al. (2016:26) believe that large muscle groups and gross motor movements should improve motor difficulties. Furthermore, the CPR-DCD recommendations emphasise that the goal should be to enhance the child's general skills, the fundamental skills and specific skills the child struggles with during motor performance (Blank et al., 2019:270). Improving specific motor skills will increase play and participation in sports activities (Smits-Engelsman et al., 2018:96). Physical fitness with a focus on exercise tolerance and endurance through age-appropriate physical activity, is recommended to be a further goal when planning an intervention programme, due to many of these children struggling with overweight and obesity (Blank et al., 2019:271). The goals and focus of the motor intervention should be adapted and improved according to how the child's level of performance changes (Blank et al., 2019:267).

It is essential to provide sufficient opportunities for diverse activities and skills and varied practices to master the different activities (Valentini et al., 2012:382). A motor intervention aims to help the child with DCD to comfortably perform age-appropriate daily life activities (Blank et al., 2012:81). It has also been asserted that more information in the literature is required regarding goal setting, especially concerning the dose and outcomes of an intervention programme for DCD (Blank et al., 2012:74; Blank et al., 2019:269).

Many different indications and opinions have been mentioned and highlighted in the literature pertaining to which aspects to consider for planning and goals setting for intervention. First of all, it should be noted that the type of goals to focus on is individual goals. However, child-centered goals should also be incorporated. Furthermore, it has been viewed that environmental and psychosocial factors, and also the secondary problems experienced by the child, should be considered. Other aspects, such as gender differences, grouping children with the same problems together, focusing on aspects that will help determine if a group or individual-based interventions should occur, need to be considered during intervention planning. It is clear that researchers have widely diverse inputs, opinions and experiences and should be investigated thoroughly to determine the efficacy of all these considerations for planning and goal-setting of an intervention.

2.8.2 Intervention approaches and programmes for developmental coordination disorder

Various intervention approaches have been described in the literature and are subdivided into two main approaches, namely task-oriented and process-oriented (Miyahara et al., 2017:735; Smits-Engelsman et al., 2012:1; Sugden, 2018:502). The task-oriented approach focuses on teaching the child the task that should be learned, for example, to ride a bicycle (Blank et al., 2019:269; Sugden, 2018:502). This approach aims to improve a motor skill in a task that the child is struggling with and includes interventions such as neuromotor task training (NTT) (Ferguson, Jelsma, Jelsma & Smits-Engelsman, 2013:2450; Offor et al., 2016:172; Preston et al., 2017:863), cognitive orientation to daily occupational performance (CO-OP) (Polatajko & Mandich, 2004; Smits-Engelsman et al., 2018:97) and imagery training (Smits-Engelsman et al., 2012:2).

The process-oriented approach includes the teaching of different processes or using various activities to address the underlying problem of executing the task, such as riding a bicycle successfully (Blank et al., 2019:269; Sugden, 2018:502). Examples of process-oriented approaches are sensory integration intervention, kinaesthetic training, perceptual training, and combinations of these interventions. They include improving body functions such as strength and core stability in these children (Smits-Engelsman et al., 2012:2). Blank et al. (2019:269) have pointed out that the process-oriented approach previously tended to improve only the child's body function and structure, but not the child's motor skills and participation levels. However, according to more recent literature, the process-oriented approaches focus on the impact of the intervention on the child's activity and participation performance (Farhat, Masmoudi, Hsairi, Smits-Engelsman, Mchirgui, Triki & Moalla, 2015:1277; Jelsma, Geuze, Mombarg & Smits-Engelsman, 2014:416; Smits-Engelsman et al., 2018:73). In contrast, the task-oriented research started to report the impact of the intervention on the child's body function.

Various intervention approaches to address the different problems experienced by the child with DCD are available (Blank et al., 2012:76; Wilson, Ruddock, Smits-Engelsman, Polatajko & Blank, 2013:227). The International Classification of Functioning, Disability, and Health (ICF) conceptual framework is used to understand the impact that a health condition or disability has on a person's functioning and can be used across all countries, health conditions, and healthcare settings for intervention (Escorpizo & Bemis-Dougherty, 2015:201). When used for intervention, the framework focuses on the intervention that will maximise functioning (WHO, 2002:6). The term *functioning* in the ICF framework refers to all the body functions, activities and participation, whereas the term *disorder or disease* refers to the particular impairment, the limitations of the activity and participation restrictions (WHO, 2002:2). The ICF framework is presented in Figure 2.2.

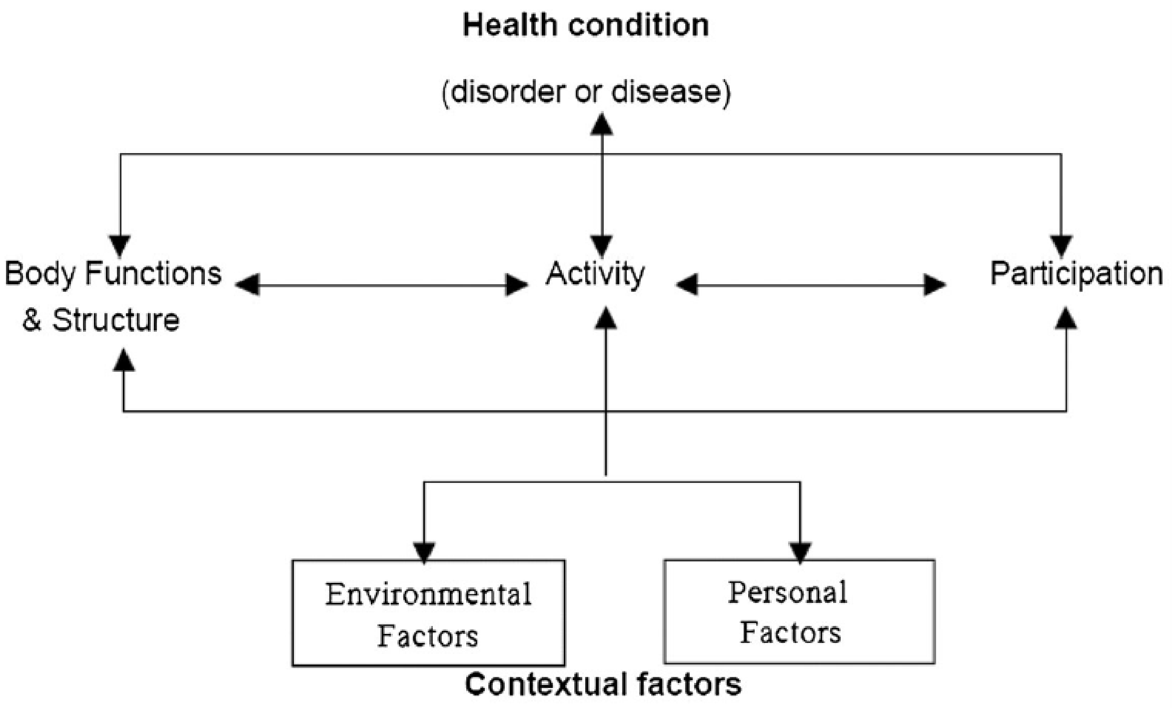

Figure 2.2. International Classification of Functioning, Disability, and Health (Escorpizo & Bemis-Dougherty, 2015:201).

The ICF framework associates the disability (in this case, DCD) with the interaction of body functions, body structure, activity, participation, environmental factors and personal factors, and promotes understanding of a child's functioning due to his or her health disorder (Escorpizo & Bemis-Dougherty, 2015:201). According to the WHO (2002:10),

> 'body functions are physiological functions of body systems; body structures are anatomical parts of the body; impairments are problems in body function or structure; activity is the execution of a task or action; participation is involvement in a life situation; activity limitations are difficulties an individual may have in executing activities; participation restrictions are problems an individual may experience in involvement in life situations, and environmental factors are the physical, social and attitudinal environment in which people live.' (WHO, 2002:10).

In an intervention for children with DCD, the ICF framework can be used as a guideline by considering body function and structure (motor, sensory, cognitive, emotional/affective function); activities of daily living (basic and instrumental skills); participation (at home, school and in the community) and acknowledge personal and environmental factors regarding the intervention planning (Blank et al., 2019:247). Therefore, the ICF has instead recommended using the terms *body function-oriented*, *activity-oriented* and *participation-oriented* approaches to describe the intervention for DCD (Smits-Engelsman et al., 2018:96; WHO, 2007).

The body function-oriented approach focuses on improving body functions and structure and is also referred to as the previously known process-oriented approach (Blank et al., 2019:270; Smits-Engelsman et al., 2018:92; WHO, 2007). The activity-oriented approach aims to improve tasks and skills (Blank et al., 2019:267; Smits-Engelsman et al., 2018:92; WHO, 2007). Furthermore, a participation-oriented intervention approach focuses on improving participation (Blank et al., 2019:270). The activity-oriented and participation-oriented approaches are also referred to as the previously known task-oriented approach (Blank et al., 2019:270; WHO, 2007). The activity-oriented approach includes the circumstances and environment in which the child lives and uses this activity after completing the intervention (Smits-Engelsman et al., 2018:92). When a splinter skill (repeating an activity numerous times to improve the skill) is used, criticism has been raised that although the child can now perform the skill, the child cannot perform the skill in all situations (Sugden et al., 2008:184). Therefore, it has been suggested to use the ICF framework during the intervention to link activity and participation goals to the disorder's goals regarding body structure and functioning goals (WHO, 2002:9). The findings by Sugden et al. (2008:184) highlighted the challenge of using one intervention approach in isolation.

2.8.2.1 Task-oriented intervention approaches (activity- and participation-oriented intervention approaches)

A task-oriented intervention approach concentrates on a task that is directly taught without highlighting the underlying processes, and aims to improve specific tasks through practice (Gibbs, Appleton & Appleton, 2007:537; Sugden & Chambers, 1998:140). It has been reported that the task-oriented approach focuses on the repetitiveness of the task, which in return assists in refining the gross motor skills of the child with DCD (Lucas et al., 2016:13). The motor intervention programme aims to practice the specific motor skills that the child finds difficult to execute (Lee et al., 2016:26), improve the motor goals that were set

(Zwicker et al., 2015:174), increase physical activity (Alloway & Warner, 2008:477) and facilitate participation (Smits-Engelsman et al., 2018:74) when a task-oriented approach is used. When planning the motor intervention programme using a task-oriented approach, Smits-Engelsman et al. (2018:73) have identified the following guidelines to follow: (i) the intervention must be meaningful for the child; (ii) it should be goal-oriented; (iii) the child needs to understand what he or she is going to learn and it should be connected to the specific circumstances of the child's difficulties; (iv) it is essential to consider the child's role; (v) the intervention should aim to improve functionality; and (vi) the parents should be actively involved in the intervention. The task-oriented intervention approach includes both fun and functional activities integrated with recreational tasks (Lucas et al., 2016:13). It has been shown to improve activities and body functions such as strength, balance and coordination of children with DCD (Smits-Engelsman et al., 2018:96).

Two of the most popular task-specific interventions are NTT and CO-OP interventions. The NTT is based on motor control and motor learning. It evaluates the strengths and weaknesses of functional performances and, secondly, assesses cognitive and motor control contributing to the motor skill difficulties (Shoemaker, Niemeijer, Reynders & Smits-Engelsman, 2003:156). For example, if a child finds it challenging to perform ball activities, the evaluation determined that if a child is in a secure and supportive environment, they perform better in ball skills. The task-oriented approach will focus more on psychological processes (Schoemaker, Niemeijer et al., 2003:156). Suppose the child is able to perform ball activities while standing still and being warned. In that case, the ball activities will be practiced in a more complex situation where the child is not in a stationary position and is not warned (Schoemaker, Niemeijer et al., 2003:156). Furthermore, the teaching process occurs according to motor learning principles (Schoemaker, Niemeijer et al., 2003:156).

The NTT focuses on meaningful activities during daily living to improve training transfer (Montgomery et al., 2018:3) and concentrates on task-specific skills (Smits-Engelsman et al., 2018:96). NTT has been identified as one of the most effective motor intervention programmes for children with DCD (Ferguson et al., 2013:2450; Offor et al., 2016:172; Preston et al., 2017:863; Smits-Engelsman et al., 2018:96; Smits-Engelsman et al., 2012:6), and increases the task performance and task satisfaction of a child with DCD (Montgomery et al., 2018:3). Furthermore, Smits-Engelsman et al. (2018:97) have confirmed that the NTT assists in the child's physical well-being. When conducting NTT, it was found that improvement occurs both in performing activities and body function outcomes (Smits-Engelsman et al., 2018:96), and is also beneficial for addressing gross motor difficulties (Offor et al., 2016:189). Research on 46 children 6–10 years of age compared NTT with virtual reality training and found significant improvements in motor performances, fitness and functional strength in children with DCD when the NTT approach is used (Ferguson et al., 2013:2459).

Another intervention that is quite successful is the CO-OP approach (Chan, 2007:40) and is effective in children from five years old (Taylor, Fayed & Mandich, 2007:129). The main aspect is cognitive strategies, assisting in skill achievement and addressing motor performance problems (Polatajko & Mandich, 2004; Smits-Engelsman et al., 2018:97). The activities included in the CO-OP approach are usually the ones that a child targets as essential or needs to master (Adams, Steenbergen, Lust & Smits-Engelsman, 2016:2). According to Armstrong (2012:534), the CO-OP approach can be viewed as problem-solving and help the child achieve at least three goals that the child has selected. A study conducted on ten boys of 8–10 years has determined that the children with DCD improved in the activities they struggled with, and showed increased participation and better physical activity levels when completing the CO-OP intervention (Thornton et al., 2016:7). Another CO-OP study during a summer camp on 12 children 7–12 years of age has concluded that the individual goals of each child, improved, and further established that a task-specific approach with a cognitive intervention could improve the functional motor goals of children with DCD (Zwicker et al., 2015:174).

Other cognitive approaches mentioned in the literature include programmes involving problem-solving and information processing (Mandich, Polatajko, Macnab & Miller, 2001:63), sensory process interventions (Gibbs et al., 2007:537), and group-oriented interventions (Dunford, 2011:292). Another cognitive approach known as the ecological intervention extends in two ways: intervention in a family, community, and environmental setting, and intervention that focuses on the actual control of movement using ideas from information processing and dynamic systems (Sugden, 2007:469). Various cognitive approaches can be used, and some are used more commonly than others.

Various other task-oriented motor intervention programmes have been described in the latest research. Active virtual gaming-based training such as video games, Wii Fit and PlayStation are more frequently used in DCD intervention (Blank et al., 2019:271; Smits-Engelsman et al., 2018:93) and can be activity-based or body-oriented based. An activity-based virtual reality training intervention on nine children 4–6 years of age was found to improve motor abilities, enjoyment and motivation in children with DCD (Ashkenazi et al., 2013:471). Jelsma et al. (2020:183) agreed with the findings of Ashkenazi et al. (2013:471) when reporting on their study of 48 6–12-year-old children who received Wii Balance training. Similarly, Hammond, Jones, Hill, Green & Male (2014:173) reported on their research involving 18 children 7–10-year-old that virtual game training (Wii Fit balance) has shown some success in children with DCD. They further pointed out that it could be a more cost-effective intervention strategy (Hammond et al., 2014:173) because they can do it at home.

The opposite has also been reported. A virtual reality training intervention on 21 children with DCD found that virtual training does not enhance motor coordination skills (Straker, Howie, Smith, Jensen, Piek & Campbell, 2015:156). However, Smits-Engelsman et al. (2018:93) have remarked that more research is required to determine the effectiveness of virtual gaming' as a DCD intervention approach. Another factor to consider is that virtual training does not put the child in real-life situations, might not be available to children in low resource environments, and raises questions on how the intervention will be transferred to participation in daily activities (Blank et al., 2019:271). It might, therefore, be more beneficial to consider sport- and play-related task-oriented approaches.

A sport- and play-related skill training intervention that focused on task-specific activities in 24 children 7–12 years old have determined that the intervention effectively improved motor skills of the children with DCD (Caçola et al., 2016:177). Likewise, another sport- and play-related skill training intervention focusing on balance training improved 6–10-year-old children's balance (Fong et al., 2016:10). When a single activity skill training was conducted, the researchers found improvement in the motor skills of 62 children 6–9 years of age doing taekwando (Fong, Tsang & Ng, 2012:94) and 52 children 9–10-year-old playing soccer (Tsai, Wang & Tseng, 2012:21). Furthermore, a balance training intervention programme on 20 children 8–9 years of age has successfully improved motor ability, body coordination and balance of children with possible DCD (Giagazoglou, Sidiropoulou, Mitsiou, Arabatzi & Kellis, 2015:18). Lastly, two studies investigating the effect of a task-specific motor skill training programme both reported improvement in gross and fine motor skills after the intervention on 41 boys with DCD 6–10 years of age (Farhat et al., 2015:1277), and 31 children of 7–10-year-old (Noordstar, Van der Net, Voerman, Helders & Jongmans, 2017:174).

The literature reporting on various task-oriented approaches highlighted its success and recommended using the task-oriented approach for intervention (activity-oriented and participation-oriented) (Blank et al., 2019:270; Lee et al., 2016:26; Lucas et al., 2016:13; Smits-Engelsman et al., 2018:96). Further studies on process-oriented approaches have been published.

2.8.2.2 Process-oriented intervention approaches (body function-oriented approaches)

The process-oriented intervention approach is described as the activities or interventions that address aspects or body functions in a child with DCD, that are required to execute various actions, especially performances in skills (Blank et al., 2012:76; Blank et al., 2019:271). It is believed that improved body functions will automatically enhance the performance of children with DCD (Blank et al., 2019:271). Sugden (2007:469) suggested that process-oriented approaches should be used because teaching a skill in daily activity is time-consuming. The sensory integration therapy intervention, kinaesthetic training, perceptual-motor training, motor imagery training and combinations of specific interventions have been identified as the process-oriented approach (Blank et al., 2012:76). The sensory integration intervention and motor imagery training has been documented most frequently in the literature for process-oriented approaches.

The sensory integration intervention was developed by Jean Ayres (cited by Leemrijse, Meijer, Vermeer, Adèr & Diemel, 2000:250; Sugden, 2007:468) in 1970, who believed that children who experience motor difficulties are likely to have a problem with processing sensory information. A sensory integration intervention focuses on sensory stimulation, including vestibular, proprioceptive, tactile and kinaesthetic stimuli, and further includes the child's neurological needs without improving specific skills (Davidson & Williams, 2000:497; Sugden, 2007:469). The intervention, which is usually conducted by occupational therapists, is based on the sensory input and integration part of the information processing model (Sugden 2007:468). The focus of sensory integration intervention is to increase motor development and higher cortical function such as cognition, attention and memory (Barnhart et al., 2003:726; Mandich et al., 2001:56). The sensory integration intervention method has previously been listed as one of the most common interventions used; however, the literature results are inconsistent and outdated, and the intervention's validity has been questioned (Armstrong, 2012:534; Smits-Engelsman et al., 2012:7). Lastly, it has been concluded that a sensory integration intervention cannot be recommended as a definite effective intervention for children with DCD, and more studies will have to be conducted in the future (Blank et al., 2019:271).

Motor imagery training intervention is another process-oriented intervention on which limited findings are available (Schuster et al., 2011:18; Smits-Engelsman et al., 2012:6; Wilson et al., 2002:495; Wilson, Adams, Caeyenberghs, Thomas, Smits-Engelsman & Steenbergen, 2016:55). Motor imagery training refers to the 'internal rehearsal of a future motor action without overt motor output' (Adams, Smits-Engelsman, Lust, Wilson & Steenbergen, 2017:2). It is further explained as 'the comparison between the predicted consequences of a movement (by using imagery) and the actual consequences of a movement' (Adams et al., 2016:2). Therefore, the child is forming an image (imagining) of how they are moving, but is not physically doing the movement (Adams et al., 2016:2; Blank et al., 2019:271). The advantage of motor imagery training is that the child learns how to build a motor image, improving predictive control (Adams et al., 2016:2). It has previously been documented that children with DCD experience the same process difficulties as children with motor imagery problems (Wilson et al., 2002:492). Therefore, it should be considered to conduct a motor imagery intervention when planning to help the child with DCD (Ferguson, Wilson & Smits-Engelsman, 2015:89). In Brisbane, Australia, children 7–12 years old with motor coordination difficulties who received intervention that involved motor imagery training, showed improved motor skills (Wilson et al., 2002:495).

Similarly, two more recent studies conducted on children diagnosed with DCD, 7–12 years of age, experienced improvement of motor skills when using motor imagery training (Adams et al., 2017:5; Wilson et al., 2016:59). One of the studies reported that the parents and children observed improvement in the motor ability (Adams et al., 2017:5). The study concluded that motor imagery training could be used as a successful type of intervention in children from seven years who is diagnosed with DCD. However, it is not recommended yet due to the limited information available (Adams et al., 2016:8; Adams et al., 2017:5). More research to determine the effect of motor imagery training on daily activities in children with

DCD is necessary (Smits-Engelsman et al., 2012:6; Steenbergen et al., 2020:4; Wilson et al., 2016:60). Further research should also include designing a well-developed motor imagery action plan (Bhoyroo et al., 2019:6).

Another type of process-oriented approach is a perceptual-motor intervention. Perceptual-motor training programmes focus on sensory and motor tasks to improve a child's motor ability (Mandich et al., 2001:60). Gallahue and Ozmun (2007:509) suggested that a perceptual-motor training programme should focus on remediation and readiness to encourage perceptual-motor development. Auxter, Pyfer, Zittel and Roth (2009:156) described perceptual-motor training as completing fine and gross motor activities to develop optimal functioning skills. Davidson and Williams (2000:498) indicated improvement in children with DCD. However, De Milander, Coetzee and Venter (2015:24) found that the improvement was not significant in children 6–8 years of age with DCD. Research on perceptual-motor intervention, however, is limited.

Other process-oriented approach interventions reported in the literature include the core stability programme. Various core stability exercises were conducted with a physioball on 22 children 6–12 years old, and it was found that the intervention enhanced motor proficiency in children with DCD (Au et al., 2014:1000). A strength training intervention on 30 children of 7–9 years has proven to increase static balance and strength in children with DCD (Kordi, Sohrabi, Kakhki & Attarzadech Hossini, 2016:532). A cardiorespiratory and endurance training intervention programme on 60 children showed that the children with DCD showed improved motor abilities (Tsai, Chang, Chen, Hung, Pan & Wang, 2014:181). Furthermore, a process-oriented study that focused on visual therapy (a combination of perceptual-motor and visual exercises) on children 7–8 years of age has established that ocular motor control improved in children with DCD (Coetzee & Pienaar, 2013:4082).

Considering that children with DCD experience body functionality challenges, it has been proposed that more body function intervention approaches should be conducted (Blank et al., 2019:271), and should be considered as an option to use as a motor intervention approach (Smits-Engelsman et al., 2018:96). However, the process-oriented approach has previously been documented as a weak approach for DCD motor intervention programmes (Smits-Engelsman et al., 2012:6). Blank et al. (2019:271) were of the opinion that the sensory integration training and kinaesthetic training interventions should not be recommended for

DCD children because of the limited findings. A further limitation is whether body function-oriented intervention will improve the child's body functions as well as the participation levels and activities of the child (Blank et al., 2019:271). Taking these limitations into consideration, suggestions to use a combined approach have been made in the literature.

2.8.2.3 Combined intervention approaches

A combined intervention approach referred to in this literature review can either mean combining one of the intervention approaches with another (for example, a task-oriented approach is combined with a process-oriented approach), or it can refer to the combination of more than one intervention within an approach.

One of the questions that have been raised in the literature is whether only one intervention approach should be used for children with DCD. However, it has been noted that one approach might include aspects or characteristics of another approach; for example, a task-oriented approach might involve some underlying cognitive processes (Lucas et al., 2016:14; Sugden, 2018:502). Previously, Mandich et al. (2001:60) determined that when an intervention approach was used individually, success was not that evident. They further reported that if a process-oriented approach was used and improvement was observed in motor abilities, these improvements were not apparent in the functional skills of the child with DCD (Mandich et al., 2001:60). Therefore, a combination approach should be considered an effective strategy to warrant a successful outcome in children with DCD (Wilson, 2005:819).

Early research by Leemrijse et al. (2000:452) involved a combination of the Le Bon Départ (motor performance intervention using music and rhythm) with sensory integration therapy. The results showed that limited to no improvement was observed in children with DCD. Davidson and Williams (2000:497) found that a sensory integration intervention combined with perceptual-motor training was ineffective in their research on 37 children. These two studies, however, involved a combination of two process-oriented approaches. More recently, the process-oriented intervention approaches (body function-oriented approaches) have been combined with task-oriented intervention approaches (activity-oriented approaches) (Smits-Engelsman et al., 2018:97).

A study in the NW province of SA provided a combined intervention approach that consisted of age specific motor development characteristics, perceptual and sensory components as well as a task-specific method to improve fundamental skills and resulted in improved balance (Pienaar & Lennox, 2006:79). Ball skills showed an improvement but it was not stactistically significant and although overall improvement of motor performance was found it was not significant (Pienaar & Lennox, 2006:79). The conclusion derived from their study was that the integrated approach in this instance was not that effective and task-specific approach during the intervention provided most of the statistical significant improvement (Pienaar & Lennox, 2006:80). Smits-Engelsman et al. (2012:6) also reported success when a task-oriented approach and traditional motor training intervention were combined. A recommendation by Yu et al. (2018:2095) has emphasised that the task-oriented approach should be the primary approach used and should be integrated with process-oriented approaches for successful intervention. On the other hand, Smits-Engelsman et al. (2018:99) suggested that any of the two approaches could be used (activity- and body function-oriented), but should be combined with functional tasks. Therefore, recommendations to use a combination approach could be considered.

Another SA study was conducted in the NW province (Potchefstroom) on children 7–9 years (413 children) from with 71 of them classified with DCD and aimed to analyze the effect of gender and ethnic groups on the success of a motor based intervention, integrated psycho-motor intervention and psychological intervention (Peens & Pienaar, 2007:114). The motor based intervention used the combined (integrated) approach and included task-specific intervention, kinaesthetic intervention and sensory integration (Peens & Pienaar, 2007:114). The results reported no significant difference between the two genders and the girls in the motor intervention group showed a decrease in anxiety where the boys showed an increase in anxiety (Peens & Pienaar, 2007:124). One of the reasons for the increase in anxiety with the boys could be that the boys realised that they experience motor problems during the intervention, however both genders in the motor intervention programme did improve on their motor proficiency and therefore an integrated approach can be successful (Peens & Pienaar, 2007:126). Peens et al (2008:325) confirmend the same results on the participants in their research article. An earlier study on 36 children 4–12 years in SA, NW province, Potchefstroom from low SE environments aimed to determine the value of an integrated (Perseptual motor, sensory integration and task specific) mainly individual approach on children with DCD and reported that the intervention can be successful with slight adaptions and especially for hand skill (Ernst, 2003:56; Pienaar & Ernst, 2007:249). The balance showed the best results over long-term and only slight improvement was found in ball skill difficulties (Ernst, 2003:56).

Other intervention approaches that have also shown success included a goal-oriented approach on 7–12-year-old children who set their own motor goals that they wanted to achieve, and showed improved motor skills (Caçola et al., 2016:177). Furthermore, lifelong physical activity engagement can be achieved by conducting a holistic intervention approach and concentrating on physical literacy (St. John, Dudley & Cairney, 2020:11). Future intervention research should focus on categorising children with DCD into different aetiological groups to identify suitable interventions for each group (Davidson & Williamson, 2000:498). Furthermore, it is important to evaluate whether an intervention can work in a specific country or culture (Armstrong, 2012:536) and the availability of therapists' in these countries to conduct the intervention.

2.8.3 Role players for interventions for developmental coordination disorder

Intervention approaches are usually implemented by health professionals, such as occupational therapists and physiotherapists (Blank et al., 2012:75). Occupational therapists evaluate the abilities and performance of the child and assist the child with interventions focused on self-care difficulties, organisational problems, handwriting difficulties, challenges in play activities, and participation in daily activities, by including close co-operation with the child and parents (Adams et al., 2016:2; Cermak et al., 2015:171; Missiuna, Gaines, Souchie & McLean, 2006:510). In addition, physiotherapists are more involved when a child experiences severe motor impairments, such as balance, strength and delays in developing gross motor skills, and assists the child to increase their mobility and movement functions (Adams et al., 2016:2; Missiuna et al., 2006:510). According to Blank et al. (2012:75), occupational therapists develop interventions and solutions regarding problems around the child's performance and participation, while physiotherapists help children to optimise their mobility and improve movement. Both occupational and physiotherapists play an essential yet distinct role in rehabilitating children with DCD (Smits-Engelsman, Blank, Van der Kaay, Mosterd-van der Meijs, Vlugt-van den Brand, Polatajko & Wilson, 2012:230).

Another group of professionals specifically available in SA and known for addressing motor skill difficulties in children, are Kinderkineticists. An early study conducted in 1994 with one of the hypothesis focusing on the meaningful assistance to learners with gross motor skill difficulties by conducting remedial programmes for two months, have reported that the experimental group (15 children) with movement difficulties improved on their movements after receiving the remedial programme (Pienaar, 1994:203). The author recommended that people should be trained to conduct the tasks of movement specialists outside of the school environment with specific knowledge (neurological aspects) to assist children with motor difficutlies (Pienaar, 1994:205) and therefore Kinderkinetics were developed. Kinderkinetics is a specialised field in movement and physical activity developed in SA (Coetzee & Pienaar, 2015:380). The *kinder* part of the term refers to 0–13-year-old children, which is the focus area of this profession, and the *kinesis* part is focused on improving and increasing these children's movement (Pienaar & Coetzee, 2015:380). Kinderkineticists use scientifically-based movement programmes to help children with problems such as DCD. Part of the scope of practice of a Kinderkineticist is to provide remedial programmes and adapted programmes for children with motor deficits, including DCD (South African Professional Institute for Kinderkinetics, [SAPIK] 2020). The intervention provided by the Kinderkineticist aims to improve gross motor skills, skill acquisition and physical fitness, with the indirect improvement of daily living (SAPIK, 2020). The programmes focus on the psychomotor, physical and neuromotor development of the child with DCD (Coetzee & Pienaar, 2015:380). Movement development programmes include perceptual-motor activities and improve children's motor abilities (Pienaar, Van Rensburg & Smit, 2011:126). Research regarding motor intervention programmes provided by Kinderkineticists in SA for children with DCD and other motor difficulties have been reported and some are highlighted next. More SA studies focusing on the combined approach are further discussed under combined approaches of the literature review.

A study conducted in KwaZulu Natal in SA on 24 children 6–8 years of age has found that a Kinderkinetics movement intervention programme has improved the children's gross motor skills and motor proficiency (Gouws, 2015:1362). However, this study did not provide information on what the intervention entailed, but did emphasise the importance of conducting future studies on Kinderkinetics intervention (Gouws, 2015:1362). Van Biljon & Longhurst (2011:448) have pointed out in their study that the ten children (4.5–6 years) receiving Kinderkinetic training showed significant improvement in their motor skills, and emphasised that a specially developed intervention programme for Kinderkinetics to improve motor abilities in preschool children is necessary. Another study in the NW Province on a group of 13 children 4–6 years old found that a perceptual-motor development programme developed and presented by Kinderkineticists has improved the children's overall motor abilities (Pienaar et al., 2011:115, 126). However, these studies were not explicitly conducted on children identified with possible DCD or a confirmed diagnosis of DCD.

In addition, a study in the FS province on 5–8-year-old children identified with possible DCD, received a perceptual-motor intervention conducted by Kinderkineticists, and found that the intervention did not improve the motor proficiency of the children (De Milander et al., 2015:25). Furthermore, a study in the NW province on 32 children (7–8 years) who participated in this study with the aim to determine the effect of visual therapy on ocular motor control problems with DCD, found that the intervention improved ocular motor control (Coetzee & Pienaar, 2013:4074, 4082). In the NW province (farms in Klipdrift and Potchefstroom) 55 children between 5–8 years participated in the study with the aim to determine if a motor intervention programme based on an integrated approach (combined approach) can improve the motor performance of children with DCD (Pienaar & Lennox, 2006:70). The study found a slight positive effect on addressing the underlying difficulties experienced by children with DCD and specifically improved the kwalitative performance of their fundamental skills (Pienaar & Lennox, 2006:70).

Considering the results of the studies on Kinderkinetics intervention, it is clear that the majority reported an improvement. From the literature review it is clear that studies explicitly focusing on the success of motor interventions in children with possible DCD and diagnosed with DCD within the context of Kinderkinetics, have been conducted. Furthermore, the Kinderkineticist in training receive best practice guidelines for DCD intervention during their training to conduct with a child with DCD (Pienaar, 2020:219). However, in the textbook, Pienaar (2019:220) does however mention that the evidence for practice are conducted from a Canadian perspective and that it is still a work in progress for multidisciplinary cooperation in SA working with children with DCD. Therefore, a standard motor intervention framework in SA provided by input from Kinderkineticists with practical experience of five years and more in motor development is not currently available to use as a guideline within this profession and scope to address children with DCD. A previous study conducted in the NW Province of SA concluded that it is important to appoint Kinderkineticists at schools to assist with intervention programmes for children with motor proficiency problems (Pienaar & Kemp, 2014:178). Therefore, the development of specific guidelines for application in this context will be of value.

Not only Kinderkinetics play an important role, but other role players may also assist in the successful implementation of motor intervention programmes for children with DCD. According to Missiuna et al. (2006:510), other health professionals, parents, educational professionals and relevant others play an essential role in the treatment of and intervention for children with DCD. A speech therapist can assist in receptive and expressive language delays in children with DCD; a psychologist can help with comorbid conditions such as attention deficits, hyperactivity and learning disabilities (Missiuna et al. (2006:510), as well as self-concept issues (Peens & Pienaar, 2007:118). Role players such as parents, teachers and coaches should be included and made a priority to improve the effectiveness of the motor intervention programme and increase training opportunities (Ernst, 2003:57; Lee et al., 2016:27; Yu et al., 2018:2095). These role players' viewpoints and their supportive role are essential in an intervention programme for children with DCD (Blank et al., 2019:272; Coussens et al., 2020:241).

The supportive role of the different role players includes creating opportunities by improving various secondary problems associated with DCD during the child's intervention (Caçola, 2014:103; Schoemaker, Lingam, Jongmans, Van Heuvelen & Emond, 2013:3090). Teachers, for example, do not only have to play a role in the motor intervention programme itself, but can further assist by identifying emotional and behavioural problems, which can then be addressed by making the right recommendations and referrals (Van den Heuvel et al., 2016:47). Parents, on the other hand, can assist with providing regular opportunities to practice movements at home by making use of play activities and fun games to enhance motor skill development (Hardy et al., 2012:e397). Parents' contribution is further important to identify progress in their child, considering that a therapist is not with a child throughout the day (Adams et al., 2017:6).

Another role player that has been suggested is the child self. Children's views of their own motor abilities can significantly influence their motivation to participate in a motor intervention programme (Adams et al., 2017:6). The family's viewpoint should also be considered, especially when setting goals for the intervention (Blank et al., 2012:74). These role players should receive the necessary information from the therapist on how to assist the child, know what adaptions should be made in the home and school environment, and understand the child's difficulties and abilities (Blank et al., 2019:272, 273). It is, however, important to consider that this support will depend on the family situation of the child (Blank et al., 2019:272). The therapists' responsibility is to provide the correct advice to these role players and inform them of the child's shortcomings and abilities (Blank et al., 2019:273). The role players should further understand the physical and emotional strain it puts on a child with DCD to participate in daily activities (Zwicker et al., 2018:72), which should be a factor to keep in mind when deciding if a group or individual intervention approach would yield better results.

2.8.4 Individual and group interventions for developmental coordination disorder

Individual-based intervention approaches have been recommended due to its advantages. These advantages include numerous opportunities to practice the motor skills, less time waiting for the child's turn, sufficient active training time and fewer distractions and (Hung & Pang, 2010:126) and addressing serious individual problems and goals (Ernst, 2003:88). Pienaar and Lennox (2006:80) and Ernst (2003:56) are of the opinion that the best results will be received when conducting one on one intervention and can focus on the problems experienced by each individual. Despite the advantages of individual intervention, Preston et al. (2017:864) suggested that a group-based intervention could also be effective if the intervention focuses on addressing the children's unique needs within the group. Addressing individual needs is particularly important if the motor difficulties present in the children with DCD varies drastically (Hung & Pang, 2010:126). It is therefore important to ensure that the therapist can observe the individual progress the child is making and also understand the group dynamics within the group (Smits-Engelsman et al., 2018:97).

A group-based intervention has its advantages, including more social bonds and peer interaction (Caçola et al., 2016:178), and increased performance due to competitiveness and the need to perform better (Hung & Pang, 2010:126). The mental health difficulties of children with DCD can be addressed using group-based motor intervention (Caçola et al., 2016:176) and increase competence (Hung & Pang, 2010:126). Group interventions have been recommended to limit the waiting lists that are becoming a significant problem with therapy and could also be a good alternative if individual treatment is too expensive for parents (Blank et al., 2019:273; Smits-Engelsman et al., 2018:98). It has also been found that some parents preferred group-based rather than individual training (Au et al., 2014:998; Preston et al., 2017:864). In a research study in the NW province (Potchefstroom) improvement in motor proficiency when an integrated motor intervention programme was conducted in a group of 20 children with DCD (Peens & Pienaar, 2007:115) indicating that groups could work.

Despite the advantages of group-based intervention, some challenges have also been identified. It can be demanding to solve all the problems of each child in the group (Caçola et al., 2016:177). The different ages of the children, type of problems and levels of difficulties experienced might make it difficult to reach success, as it is not easy to keep up with the progress of each child in the group (Martini, Mandich & Green, 2014:218; Pienaar & Lennox, 2006:80). Pienaar and Ernst (2007:250) recommended from the results in their study that a large individualized approach should be conducted with DCD children and would be the best to address the indivicual shortcomings of each child as well as insure better treatability of the difficulties each individual experience. Anxiety levels of children with DCD in a group-based intervention might increase due to not being able to carry out the activities in the same way as the rest of the group (Caçola et al., 2016:177).

In a Hong Kong study, no difference was observed in the effectiveness of individual versus group-based intervention in children (6–10 years) diagnosed with DCD (Hung & Pang, 2010:126). Similar findings were reported by Smits-Engelsman et al. (2018:92), who confirmed that motor performance improvements occurred in both individual and group-based interventions. However, Dunford (2011:298) observed motor skill improvement when group-based interventions were conducted. The study in Hong Kong further determined that children with severe motor problems showed more significant improvements in the group-based setting than children with moderate motor difficulties (Hung & Pang, 2010:126). Conversely, an earlier study on younger children (5–6 years) reported significant improvement in children with moderate motor problems, but not in children experiencing severe motor difficulties when a group-based intervention was provided (Pless, Carlsson, Sundelin & Persson, 2000:188). In another study by Peens, Pienaar and Nienaber (2008:320) on children (7–9 years), improvement in children's motor performance was reported when using a group motor-based intervention programme. Lastly, in a study on children 7–12 years of age who received a group-based intervention, the children were encouraged to complement each other's achievements, resulting in increased self-esteem (Caçola et al., 2016:176). Pienaar & Lennox (2006:80) have however reported in their group intervention (11 children) that not enough individual attention could be provided to teach for example the cutting out skill and individual intervention would have been beneficial. Further considerations have been reported on the size of a group-based intervention.

The recommended size of a group has been inconsistent in the literature. Pless et al. (2000:185) and Ferguson et al. (2013:2453) have successfully used group sizes of 5–8 children, and Pless et al. (2000:185) put the benchmark on not more than ten children per group. Similarly, Hung and Pang (2010:126), as well as Caçola et al. (2016:177), worked with groups of 4–6 children in a group and reported success with these sizes. Lastly, Hung and Pang (2010:126) recommended that children with severe motor difficulties should be accommodated in small groups. Pienaar (2020:222) also recommend small groups of 4-6 children if the child does not have severe DCD. Blank et al. (2019:272) agreed with Hung and Pang (2010:126) and further pointed out that small groups should be used to ensure effectiveness, reduce anxiety levels and address the severity of the problems.

Research where group-based interventions were compared with individual-based interventions is limited, and emphasis has been put on investigating these two approaches (Blank et al., 2019:271; Smits-Engelsman et al., 2018:98). Although the reported studies in SA mostly conducted group interventions (Pienaar & Lennox, 2006:80; Peens et al., 2008:320) it is important to make mention of Kinderkineticists that make use of 1 on 1 sessions although it is not reported in research studies. Some studies, however, used group and individual intervention, for example in the study by Pienaar & Ernst (2007:250) the intervention comprised of 15 minutes’ group activities and 30 minutes individualized activities. Although the study by Peens et al (2008:319) were conducted in a group setting, the eye control activities were done on individual basis. Lastly the study by Coetzee and Pienaar (2013:4076) conducted their visual therapy intervention to improve ocular motor control in children with DCD in an individualized manner. Other factors to consider as part of the intervention is the duration, frequency and number of sessions of a motor intervention programme.

2.8.5 Frequency, duration and number of sessions of intervention for developmental coordination disorder

It has become evident that the success and level of effectiveness of a motor intervention programme depend on the intervention's intensity, frequency and duration (Lee et al., 2016:27; Lucas et al., 2016:14). However, limited findings have been reported on the recommended frequency, duration and number of sessions suitable for a child with DCD (Blank et al., 2019:269; Lucas et al., 2016:13). The results vary substantially and no single standard is available (Lee et al., 2016:27; Smits-Engelsman et al., 2018:97). It has been argued that more extended and more frequent motor intervention programmes present better and more successful improvement of the motor abilities of a child with DCD (Smits-Engelsman et al., 2018:99; Yu et al., 2018:2095). Relatively short interventions have also been reported to be successful (Blank et al., 2019:267). Successful interventions have been reported when the duration of the intervention was nine weeks (Yu et al., 2018:2095), ten weeks (Davidson & Williamson, 2000:498) and twelve weeks (Lucas et al., 2016:13). The recent systematic review of DCD motor intervention programmes has pointed out successful interventions ranging from four weeks up to eighteen weeks (Smits-Engelsman et al., 2018:93).

Reports have been published on the frequency of sessions ranging from one to five sessions per week, while a minimum of five to a maximum of 48 sessions have been conducted (Smits-Engelsman et al., 2018:93). The question could be raised, however, if it would be feasible to have five sessions per week. Amador-Ruiz et al. (2018:543) stated that three sessions per week should be adequate to achieve success and be carried over to home and school environments. In contrast, Yu et al. (2018:2095) were of the opinion that the more frequent practice sessions occur (four to five times a week), the more effective the programme will be. These numbers were similar to those reported by Lee et al. (2016:27).

Motor intervention studies for children with DCD in SA with specific frequencies and durations have been reported. Pienaar and Lennox (2006:72) conducted their intervention two times a week for eight weeks and each session was 45 minutes long. The researchers have however reported that the eight weeks were too short to get a real effect or improvement (Pienaar & Lennox, 2006:80). The findings of Ernst (2003:56) also conducted an eight week programme for 45 minutes twice as week and correlated with the findings of Pienaar and

Lennox (2006:80) indicating that the intervention programme could have provided better results if the intervention took place for a longer time. In contrast, another study in SA (NW province) also conducted an eight-week motor intervention for 30 minutes and twice a week and indicated improvement in the motor proficiency of boys and girls with DCD (Peens & Pienaar, 2007:116. 125). The training guide for Kinderkineticists on best practice for DCD intervention highlighted that most of the effective internventions are longer than 10 weeks with once a week treatment and then more frequent practice sessions (Pienaar, 2020:222).

In addition to the number of sessions and the duration of a motor intervention programme, it should be determined when these interventions should occur during the day. Information in the literature on this matter is limited. It is clear that if a school setting is used, the intervention will depend on the school's timetable, and suggestions have been made that the intervention should take place during recess, before school or after school (Amador-Ruiz et al., 2018:544). However, this could be a problem in South African schools, as many children cannot stay after school because they depend on transport that leaves for home directly after school (De Milander et al., 2016a:1001).

Clear information to follow should be provided to the therapists when conducting intervention trails. This will provide insight on whether an intervention could be the gold standard to address a problem, and to follow the guidelines as set out in the research regarding the duration and frequency of the intervention (Schulz, Altman & Moher, 2010:1). However, this does not occur in research on motor intervention programmes for children with DCD (Smits-Engelsman et al., 2018:97). More research on the frequency and duration of DCD motor intervention programmes is required, and the effects should be determined (Blank et al., 2019:272; Smits-Engelsman et al., 2018:98).

Many opportunities should be provided to the child to practice motor skills, and the child should then be encouraged to continuously use and practice these skills within different environments. Learnt skills should be carried over to the home and school when participating in sports and in the child's community-based activities, to ensure a successful outcome to an intervention (Blank et al., 2019:272).

2.8.6 Settings of intervention for developmental coordination disorder

Settings such as the home and school have been identified as most likely the best options to present a motor intervention programme for children with DCD in SA. Schools are an excellent place to offer motor intervention programmes, because children spend most of their days at school (Amador-Ruiz et al., 2018:543), the sustainability of keeping up with a motor intervention programme, the support received at school (Blank et al., 2019:273) and the cost-effectiveness (Yu et al., 2018:2095). Although the school setting is a good option for motor intervention for children with DCD, the intervention tasks provided to these children must vary and not merely include school-oriented activities (Lee et al., 2016:27). Another factor to consider is that school systems vary in different countries, and therefore, it is important to consider what will be effective in schools in a specific country (Blank et al., 2019:273).

Home settings should be considered carefully due to children's home situations that differ, which might cause the intervention to become more time-consuming (Lee et al., 2016:27). Instead, it is recommended that a home setting is added to the motor intervention programme to improve motor abilities (Lucas et al., 2016:14). A home setting is cost-effective because the child can practise tasks at home more frequently without paying for expensive therapy sessions, which will help the child take more responsibility for their well-being (Ashkenazi et al., 2013:472; Hung & Pang, 2010:127). If a home-based intervention approach is considered, it is the therapist's responsibility to provide efficient guidelines to the parents and the child (Ashkenazi et al., 2013:472). Furthermore, with regard to school and home settings, it is essential to note that the outcomes of motor intervention programmes in these settings have not been investigated and need to be considered for research (Blank et al., 2019:273).

It should be considered to use a school and home setting to provide intervention as it is more cost-effective. Research on the cost-effectiveness of intervention programmes has not been conducted yet and should be considered when planning interventions (Blank et al., 2019:274). One of the challenges concerning motor intervention programmes is identifying a cost-effective intervention (Smits-Engelsman et al., 2018:99; Yu et al., 2018:2095). Cost-effective interventions are important to ensure that children with DCD from all environments and circumstances have access to and receive the necessary support to improve their motor abilities (Lucas et al., 2016:13). Additional aspects to consider for intervention include equipment selection, sustainability, retention, and other important factors highlighted next.

2.8.7 Other aspects to consider for intervention

Equipment selection for an intervention programme will depend on the intervention provided. For example, a physio ball has been used in a core stability programme intervention (Au et al. 2014:994), visual apparatus for a visual therapy intervention programme (Coetzee & Pienaar, 2013:4083), virtual gaming equipment (PlayStation and Wii Fit) in virtual gaming interventions (Ferguson et al., 2013:2453) and a trampoline for balance training (Giagazoglou et al., 2015:15). Equipment such as hoops, ropes, ladders and outdoor games have been included in motor intervention programmes for children with DCD (Preston et al., 2017:864). As well as balance beams, balls and beanbags (Peens & Pienaar, 2007:118). Remedial equipment such as scooter boards and hammock- and bolster swings have also been included (Davidson & Williams, 2000:497). Research and recommendations pertaining to specific equipment for motor intervention programmes in children with DCD is however limited. However, considering the South African context, innovative plans and ideas may be required to make use of what is available at the child's home or school.

Limited information on the sustainability of a motor intervention programme for children with DCD has been published (Lee et al., 2016:23; Smits-Engelsman al., 2018:99). An early study conducted by Peens et al. (2008:320) identified no significant increase in motor abilities after a retention period of two months. Furthermore, Blank et al. (2019:269) reported that no results could be located in the literature that had determined whether a child who received sufficient intervention, would reach the level of a typically developing child. Finally, Blank et al. (2019:275) have designed a flow chart (Figure 2.3) to summarise the European Academy of Childhood Disability (EACD) recommendations for the treatment plan, intervention and evaluation of DCD, as presented in this literature review. However, the recommendations should be adapted to the environmental context, cultural-specific needs, and country-specific considerations (Blank et al., 2019:275).

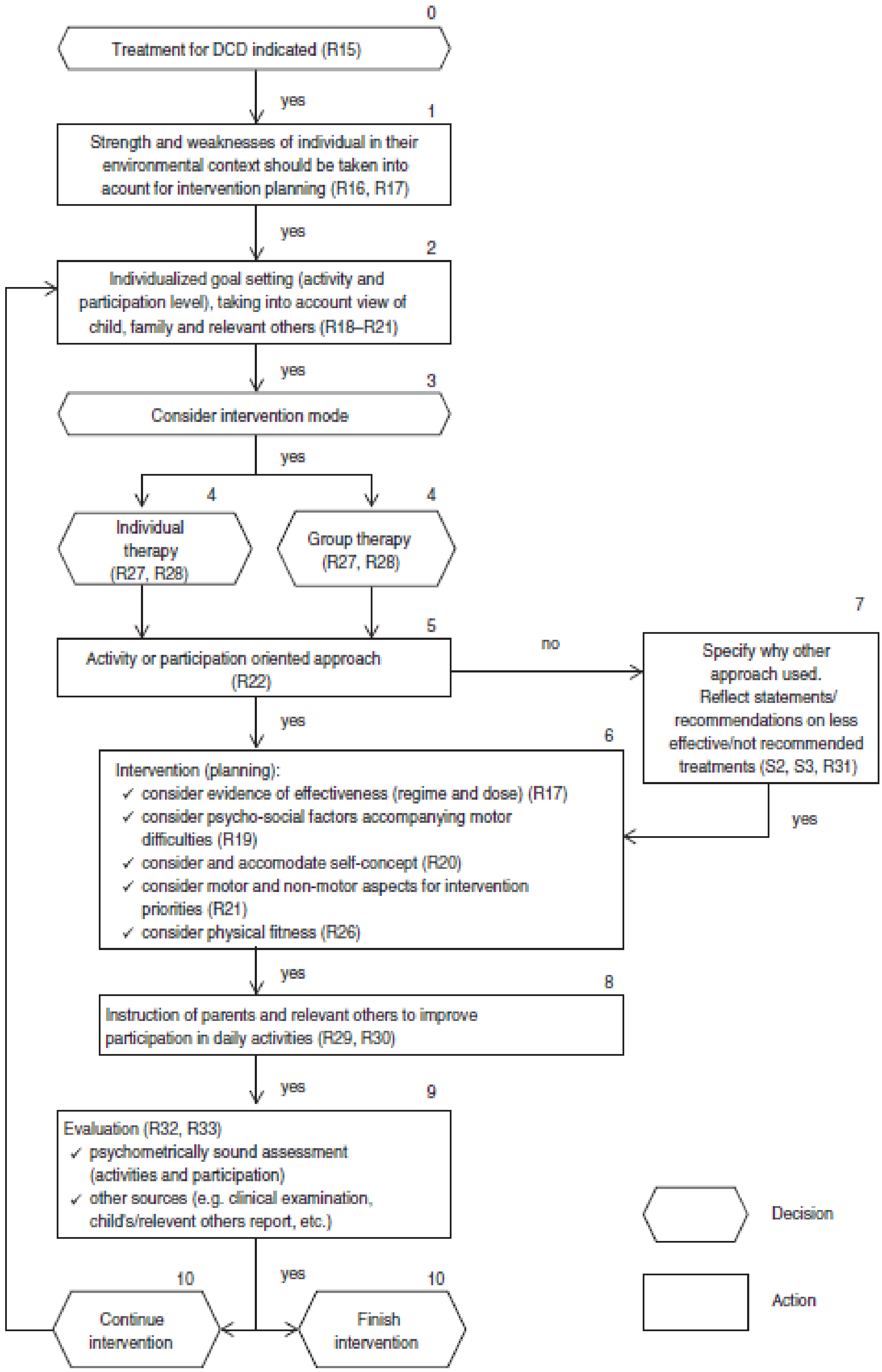

Figure 2.3. Flow chart for treatment, intervention, and evaluation of DCD (Blank et al., 2019:273)

After considering all the diverse literature findings regarding the results of interventions, it is clearly not easy to provide recommendations that can be applied to DCD intervention (Lee et al., 2016:27). However, it is important to develop recommendations that will provide the best options.

2.9 Conclusion

The literature review aimed to determine the prevalence rates of DCD in children living in different countries and SE environments, and the assessment methods used to identify DCD. It was further essential to highlight the intervention approaches used to support and help children with DCD. The literature review has determined that prevalence rates range from very low to very high in different countries and pointed out that boys tend to have a higher prevalence of DCD than girls. Furthermore, limited prevalence results have been reported in SA, and those that are available, are relatively high.

Diverse SE environments are characteristic of SA. Children from low SE environments who attend quintile one to three schools have restricted access to resources, receive lesser individual attention, and participate in physical activities to a limited extent. These limitations tend to cause developmental problems, learning impairments and motor coordination difficulties. The Motheo District in the FS Province, which includes the Mangaung Municipality where the research was conducted, has numerous quintile one to three schools. Several studies confirmed the negative influence of low SE environments on children's motor abilities and reported possible DCD in these children. However, controversy does exist where some studies have reported a higher prevalence of DCD in high SE environments. Furthermore, SE status has been considered as a possible contributing factor to the development of DCD.

Consequently, the lack of a definitive cause of DCD was highlighted in the literature. It has become evident that many factors can contribute to the aetiology of DCD. The cause cannot be ascribed to one single factor because children with DCD have been identified as a heterogeneous group that experience a variety of problems. Problems range from academic challenges, physical well-being problems, emotional and social difficulties, visual-perceptual difficulties, and the co-occurrence of DCD with other disorders.

The literature review summarised that the DSM-5 diagnostic criteria are the recommended method in terms of DCD assessment. Further observations were that the MABC-2 Performance Test and BOT-2 had been used most frequently to evaluate criterion A, and the DCDQ'07 to assess criterion B of the DSM-5. However, the literature has pointed out that only parents can complete the DCDQ'07, making it difficult in low SE environments where parents are often relatively uneducated or not involved in providing valuable feedback on their child's motor performances. Additionally, the MABC-2 Checklist has been highlighted as an option to use and can be completed by teachers. The second objective of this research study was to investigate teachers' ability to identify possible DCD in children using the MABC-2 Checklist. Therefore, the agreement between the MABC-2 Performance Test and the MABC-2 Checklist has been established.

Information on the completion of the MABC-2 Checklist by teachers in SA is limited, and the reports that are available, are applicable to research conducted in a high SE environment. Findings in the literature only reported on one other upper income country (Brazil) like SA, however the Checklist was completed by parents and not the teachers. Some developed countries reported high levels of agreement between the MABC-2 Performance Test and the Checklist, while some countries found a relatively low agreement. The literature also pointed out that teachers are important role players in identifying possible DCD due to the various environments in which they can observe the child. Others are, however, of the opinion that teachers are not trained to evaluate motor difficulties. Therefore, it is still unclear if teachers could be valuable role players in identifying DCD. Another important place where teachers should be considered as role players, is during intervention for children with DCD.

The literature review has found that two main intervention approaches are mostly used (process-oriented and task-oriented). A motor intervention programme is important to conduct to address the motor difficulties experienced by children with DCD. Various guidelines, recommendations and views have been pointed out in the literature to determine which intervention approach should be used and provide information regarding the duration, frequency and number of sessions that should be conducted. It has been concluded that task-oriented (activity- and participation-oriented), process-oriented (body-function-oriented) and combined approaches should be considered as intervention possibilities. Furthermore, various role players could be included in the intervention, although the preferred duration, frequency and number of sessions to conduct for an intervention programme are unclear.

Lastly, the interventions can have advantages when providing individual interventions, and group-based interventions and settings, such as at school or home, could be considered with regard to the location where the intervention takes place. It is clear that studies explicitly focusing on the success of motor interventions in children with possible DCD and diagnosed with DCD within the context of Kinderkinetics, have been conducted. Furthermore, the Kinderkineticist in training receive best practice guidelines for DCD intervention during their training to conduct with a child with DCD (Pienaar, 2020:219). However, in the textbook, Pienaar (2020:220) does mention that the evidence for best practice are conducted from a Canadian perspective and that it is still a work in progress for multidisciplinary cooperation in SA working with children with DCD. Therefore, a standard motor intervention framework in SA from as practical experience point of view from Kinderkineticists with practical experience of five years and more in motor development is not currently available. The proposed CPR-DCD recommendations have pointed out that it is important to adapt recommendations and guidelines applicable to a DCD intervention to specific cultural and environmental requirements.

In summary, diverse and widely varying prevalence rates have been reported, and it is possible that the prevalence of DCD may be high in low SE environments in SA. However, supporting research is limited. Despite the devastating secondary problems experienced by children with DCD, children may not be identified due to the lack of professionals and assessment opportunities in low SE environments. The literature further emphasised that the correct assessment tool should be used to identify possible DCD and that the possibility of teachers identifying DCD in low SE environments should be established. What makes SA unique, is the availability, although limited and inaccessible in some areas, of Kinderkinetics as a professional, specialist service. It is essential to have an intervention framework that can be applied to develop an effective motor intervention programme for children identified with DCD.

The findings of the three objectives outlined for this research study are presented in the next chapters in the format of three interrelated, yet independent articles.

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CHAPTER 3 (ARTICLE 1):

PREVALENCE OF POSSIBLE DEVELOPMENTAL COORDINATION DISORDER AMONG GRADE 1 LEARNERS IN LOW SOCIO-ECONOMIC ENVIRONMENTS IN MANGAUNG, SOUTH AFRICA

This article's objective was to determine the prevalence of possible developmental coordination disorder in Grade one learners in a low socio-economic environment in Mangaung, South Africa. The article was published in the South African Journal of Childhood Education (Appendix I). The article is cited as follows: Du Plessis, A.M., De Milander, M., Coetzee, F.F. & Nel, M., 2020, 'Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa', *South African Journal of Childhood Education* 10(1), a836. https://doi.org/10.4102/sajce.v10i1.836

Title

Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa

Authors

Alretha du Plessis[1], Monique de Milander[1], Derik Coetzee[1], Riëtte Nel[2]
[1]Department of Exercise and Sport Sciences, School for Allied Health Professions;
[2]Department of Biostatistics, School of Biomedical Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa

Corresponding author

Alretha du Plessis
P.O. Box 212
Glenvista
Johannesburg
2058

Telephone: +27 82 941 8194
Email address: 20268319@nwu.ac.za

Title

Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa

Abstract

Background: Developmental coordination disorder (DCD) affects motor skills and consequently has an impact on the performance in daily living activities of learners with this impairment.

Aim: The aim of this study was to determine the prevalence of possible DCD in Grade 1 (Gr. 1) learners in a low socio-economic environment in Mangaung, South Africa.

Setting: The study was conducted in the Mangaung Metro, Motheo District, Free State Province. Gr. 1 learners, 6–8 years old (n = 242), from a low socio-economic environment attending Quintile 1–3 schools were randomly selected for assessment.

Methods: The Movement Assessment Battery for Children-2nd edition (MABC-2) was used to identify learners with possible DCD. Furthermore, results were compared with regard to gender.

Results: Of the 242 learners, 9.9% were identified with possible DCD. With regard to gender, 10.5% of boys and 9.3% of girls showed signs of possible DCD. No significant difference (p = 0.9439) has been found between boys and girls.

Conclusion: The prevalence of possible DCD among Gr. 1 learners in this setting was lower than that in previously reported studies in other low and high socio-economic environments of South Africa. Further research is required to establish the full extent of possible DCD within learners living in low socio-economic environments.

Keywords: developmental coordination disorder (DCD); Movement Assessment Battery for Children-2nd edition (MABC-2); motor skills; children; learners; socio-economic environment; prevalence.

3.1 Introduction

Developmental coordination disorder (DCD) can be defined as motor performances that are substantially below the expected levels of the child's ability, considering the child's chronological age and previous opportunities for gaining skills (American Psychiatric Association [APA] 2013). Furthermore, DCD is defined as a neuro-motor developmental disorder, which includes a 'significant delay in the learning acquisition and execution of coordinated motor skills as expected for the child's chronological age and opportunities for learning' (APA 2013; Blank et al. 2012). The definition clearly states that DCD is a motor skill disorder, which influences a child's activities during daily routines, learning performance and coordinated skill development.

The diagnosis of DCD is based on its description in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) (APA 2013). Learners may only be diagnosed with DCD if the learner meets the four diagnostic criteria determined by the APA (APA 2013). The following criteria are used:

A Achievement and execution of coordinated motor skills are significantly below the expected performance according to the individual's chronological age and measured intelligence.

B The deficits in criteria A interfere with the individual's activities of daily living, for example, self-care and self-maintenance, including academic performance.

C The difficulties are not because of a general medical condition (such as cerebral palsy, hemiplegia or muscular dystrophy) and do not meet the criteria for pervasive developmental disorder.

D If mental retardation is present; the motor difficulties are in excess of those usually associated with it (APA 2013; De Souza 2015).

However, the literature clearly states that the prevalence of DCD will be referred to as possible DCD, suspected DCD or at risk for DCD if all four DSM-5 criteria have not been used (Alesi, Pecoraro & Pepi 2019; Delgado-Lobete et al. 2019; Lingam et al. 2009; Valentini, Clark & Whitall 2015). For this reason, the term possible DCD was used in this study. De Souza (2015) conducted a systematic review regarding the four criteria to diagnose DCD and identified the Movement Assessment Battery for Children-2nd edition

(MABC-2) as the most frequently used tool to assess criterion A, the Developmental Coordination Disorder Questionnaire (DCDQ) for criterion B and no specific instrument for criteria C and D. However, according to Blank et al. (2012), the European Academy of Childhood Disability (EACD) recommends that a medical practitioner should rule out criteria C before a diagnosis can be made and criteria D should be kept in mind if mental retardation is present.

The DSM-5 and previous researchers identified DCD in 5%– 6% of school-aged learners worldwide (APA 2013; Cairney & Streiner 2011; Goyen & Lui 2009; Rivard et al. 2014) between 6 and 12 years of age (Barnhart et al. 2003). It can therefore be ranked as one of the most common neuro-motor developmental disorders among school-aged learners (Lingam et al. 2010). The prevalence of DCD is well documented and varies within different countries and according to the diagnostic criteria used to identify this condition (Cardoso, Magalhães & Rezende 2014; De Milander, Coetzee & Venter 2014; Tsiotra et al. 2006; Valentini et al. 2012). In some countries, the incidence of DCD is high. In southern Brazil, 19.9% of learners between 4 and 12 years of age were identified with possible DCD (≤5th percentile) using the Movement Assessment Battery for Children (MABC) (Valentini et al. 2012). These findings were similar to those in earlier research reporting that 16.6% of learners aged 7–11 years in a high socio-economic environment in Japan had DCD (≤5th percentile and ICD criteria) using the the Movement Assessment Battery for Children (MABC) (Miyahara et al. 1998). Tsiotra et al. (2006) reported that in Greece, 19% of learners with a mean age of 11.3 years were identified with possible DCD (12th percentile) with the Bruininks-Oseretsky Test of Motor Proficiency Short Form. On the contrary, a low prevalence of DCD ranging between 0.8% and 4.3% was also reported among 7–8-year-old learners in Brazil (Cardoso et al. 2014) and 0.8% of Indian learners between 6 and 15 years of age using the DSM-5 (Girish, Raja & Kamath 2016) living in different socio-economic environments.

With regard to previous research in South Africa, De Milander et al. (2014) found a prevalence of 15% of possible DCD (≤15th percentile) among 6–8-year-old learners from a high socio-economic environment in Bloemfontein, South Africa using the MABC-2. Similar results were reported by Venter, Pienaar and Coetzee (2015), who found that DCD (≤5th percentile) occurred in 11.3% of learners aged 3–5 years from low and high socio-economic environments in the North West Province, South Africa using the MABC-2.

However, another study in the North West Province on learners aged 8–10 in different socio-economic environments identified 1.6% of children in the well below average category and 49.63% in the below average category using the Bruininks Oseretsky Test of Motor Proficiency second edition short form (Pienaar & Kemp 2014). In addition, a more recent study in the North West Province of South Africa on learners from quintile 1 to 5 schools (low to high socio-economic environments) with a mean age of 10.05 years reported that 21.3% of the learners in the sample were identified with DCD ($\leq 15^{th}$ percentile) using the MABC-2 (De Waal, Pienaar & Coetzee 2018).

Different results regarding the prevalence of DCD in gender have also been found. According to Lingam et al. (2009) and Pienaar and Lennox (2006), the prevalence of DCD is higher in boys than in girls. The DSM-5 (APA 2013) and Lingam et al. (2009) further suggested boy–girl ratios ranging from 2:1 to 7:1. Table 3.1 shows the comparison of the prevalence of DCD among boys and girls as reported previously from different studies. It is clear that contradicting results regarding the prevalence of DCD among boys and girls have been found. In addition, limited data on the prevalence of DCD in various socio-economic environments are available (Valentini et al. 2015).

Low socio-economic environments in South Africa are found in townships, inner cities and peri-urban areas (Ndebele 2015). These areas are identified on the basis of poverty, income, education, environmental factors, working conditions and health conditions (Isaacs-Martin 2015; Narsai et al. 2013; Pappin et al. 2015; Pienaar & McKay 2014). According to Senekal et al. (2015), learners and educators living in these environments have fewer opportunities and activities such as sport, playground spaces, equipment and extramural physical activities. Learners living in low socio-economic environments experience motor difficulties and developmental deficits in comparison with learners of the same age from more privileged environments (Pienaar 2004; Pienaar, Labuschagne & Peens 2007). Research conducted in South Africa by Cloete, Pienaar and Coetzee (2006) on 10–12-year-old learners and De Waal et al. (2018) on 10-year-old learners found that learners from low socio-economic environments had a high tendency to have DCD and showed motor skill difficulties. Even though motor skill difficulties are apparent in learners with DCD, no two learners with this disorder are the same and therefore experience different secondary problems.

TABLE 3.1: Published findings of the difference between boys and girls regarding the prevalence of developmental coordination disorder.

Authors	Year published	Participants' age (years)	% per gender or boys:girls ratio	Indication	Setting/location
Cardoso et al.	2014	6–15	54.1:45.9	Boys > girls	Brazil
De Milander et al.	2014	6–8	10:5	Boys > girls	Bloemfontein, South Africa; high socio-economic environment
De Waal et al.	2018	8–10	24.49:18.70	Boys < girls	Zeerust, South Africa
Girish et al.	2016	6–15	0.5:1.1	Girls > boys	India
Kadesjö and Gillberg	1998	7	2:1	Boys > girls	Karlstad, Sweden; different socio-economic environments
Pienaar and Lennox	2006	5–8	2–3:1	Boys > girls	North West Province, South Africa; low socio-economic environment
Valentini et al.	2012	4–12	16.9:23.2	Girls > boys	South Brazil
Venter et al.	2015	3–5	28.6:46.9	Girls > boys	North West Province, South Africa
Wessels et al.	2008	6–7	2–3:1	Boys > girls	Potchefstroom, South Africa

Secondary problems associated with DCD are physical performance, such as impaired strength and flexibility (Batey et al. 2014; Rihtman, Wilson & Parush 2011; Wuang, Su & Su 2012) and increased obesity (Rihtman et al. 2011; Tsiotra et al. 2006). Learners may show difficulty in academic performance (Cantell, Smyth & Ahonen 2003) and completing activities of daily living (Cairney et al. 2012; Zhu et al. 2010), which include activities such as dressing themselves (home activities), writing and reading (school activities) and play activities, for example, ball skills and balance (Asonitou et al. 2012; Edwards et al. 2011; Schoemaker, Smits-Engelsman & Jongmans 2003). These secondary problems may result in emotional and social problems, such as low self-esteem and poor social acceptance (Missiuna et al. 2006). Other problems related to DCD are difficulties with fine motor skills (Zwicker, Missiuna & Boyd 2009), visual impairments (Gomez & Sirigu 2015), attention deficit hyperactivity disorder (ADD/ADHD) and speech or language impairments (Gaines & Missiuna 2007; Missiuna 2003). Because of these difficulties (fine motor, visual and speech impairment), it is important to identify learners with DCD at an early stage.

According to our knowledge, limited research on the prevalence of DCD in different socio-economic environments in South Africa has been conducted. The aim of the study was to determine the prevalence of possible DCD among Grade 1 (Gr. 1) learners living in low socio-economic environments in Mangaung, Motheo District, Free State Province, South Africa, and to establish whether a significant difference between boys and girls could be observed.

3.2 Methodology

3.2.1 Study design

Grade 1 learners between 6 and 8 years of age, living in low socio-economic environments in Mangaung, Motheo District, South Africa, were the target population for this study. This research was an empirical study that focused on a quantitative approach to collect data. The cross-sectional design included one testing procedure to determine the prevalence of possible DCD and differences between boys and girls. The sample for the study was established by obtaining a list of schools in the Motheo District from the Department of Education in the Free State Province.

The sample size was further determined by considering: (1) the duration of administering the measuring instrument MABC-2; (2) the number of trained postgraduate students in Human Movement Science at the University of the Free State in Bloemfontein, specialising in Kinderkinetics (further referred to as movement specialists), with sufficient training and experience to administer the test battery; (3) the school hours; and (4) the budget. A poverty classification from the National Census data was used to determine the classification of schools in different quintiles (Pauw 2005). For example, Quintile 1 schools in each province cater for the poorest 20% of learners, compared with Quintile 4 and 5 schools representing high socio-economic populations (Van Den Berg 2015). From the list of schools in the province, the Motheo District represented approximately 378 schools. There were 33 Quintile 1–3 schools and 3940 Gr. 1 learners in these schools. Ten schools were randomly selected on the criteria that included: representation of Quintile 1–3 public schools and being within a 30 km radius from Bloemfontein, to ensure that the researcher and movement specialists could reach the schools.

3.2.2 Participants

Participants included Gr. 1 learners, 6–8 years of age, who were representative of the population living in low socio-economic environments in Mangaung. These learners were classified into Quintile 1–3 schools that are no-fee schools to make education affordable for poor learners, based on low income, unemployment and parents' level of literacy (Collinridge 2013). Ten schools were selected to take part in the study, of which two schools were Quintile 1 and 2 schools, respectively, and eight were Quintile 3 schools. Using proportional sampling, 400 learners were included in the study. The sample size per school was determined by using random sampling.

Consent forms were sent to the parents of the 400 learners, of which 242 (response rate 60.5%) learners' parents consented to their children's participation in the study. The consent forms included questions regarding the child's health. Parents were asked to indicate according to a tick box if their child suffered from any medical condition or illness and/or severe neurological problem that has been diagnosed by a medical practitioner.

The DSM-5 criteria proposed by the APA (2013) for DCD were partially met concerning criteria A, C and D. The EACD recommended using the MABC-2 as an assessment tool to determine criterion A (Blank et al. 2012) and was therefore used in this study. The EACD further indicated that the Developmental Coordination Disorder Questionnaire'07 (DCDQ'07) is recommended to be used as the assessment tool to determine criterion B (Blank et al. 2012). However, the DCDQ'07 has not been translated, adapted and validated in the home language (Sesotho) of this population in South Africa and could not be used as a valid instrument in this study; therefore, criterion B was excluded. To conduct criteria C and D, the exclusion criteria comprised learners who had serious neurological or intellectual disabilities or conditions such as epilepsy, ADD/ADHD, autism spectrum disorder, visual problems, hearing problems, cancer and/or physical disability.

Using information obtained from the parents, none of the participants met these exclusion criteria. However, the researcher was not able to involve a medical doctor to diagnose general medical conditions (criterion C) in the participating learners in this study. As criteria B and C were not fully met, it could not be alluded that the learner had DCD (Barba et al. 2017), and therefore the learners were referred to as having possible DCD if they fell below the 16th percentile in the MABC-2 performance test. Further exclusion criteria comprised (1) learners falling outside the age range of 6–8 years and (2) parents indicating that they were relocating. The principle researcher (AdP) captured data from the MABC-2 electronically on a Microsoft Excel spreadsheet.

3.2.3 Measuring instrument

Learners were identified with possible DCD using the MABC-2. The MABC-2 is a standardised performance test used to identify learners with motor difficulties. The chosen items of the performance test are aimed to be relevant to all cultural backgrounds. Although previous research has reported differences between learners from different cultures on particular items, no radical changes have been reported (Henderson, Sugden & Barnett 2007). Furthermore, the performance test's psychometric properties have not been established for the South African population, and a revised MABC-2 Performance Test for South Africa is not available. Therefore, no adjustment of the MABC-2 Performance Test was made for this study. Lastly, no assessment tool for South African children exists, and therefore the MABC-2 Performance Test was used. Both the original MABC performance test and the revised MABC-2 have been used successfully in research conducted in South Africa (De Milander, Coetzee & Venter 2016; Wessels, Pienaar & Peens 2008).

To use the MABC-2 for learners of various ages, the test consists of age band 1 (3–6 years), age band 2 (7–10 years) and age band 3 (11–16 years). For the purpose of this study, age bands 1 and 2 were used. The age bands consist of eight age-specific test items, grouped under three components, namely (1) manual dexterity (three test items), (2) aiming and catching (two test items) and (3) balance (three test items) (Henderson et al. 2007). Each test item was clearly demonstrated by a movement specialist, followed by a practice trial and two official test trials. The second trial was administered only if the first trial had not been completed in the correct way, or if the learner had not completed the test within the correct amount of time for his or her age group. Administration of the test battery lasted approximately 30 minutes per learner.

The best trial of each item is used and known as the raw score. The raw score of each item is converted to an item standard score. An item standard score is available for each age group between 3 and 16 years. The standard score is provided every 6 months for learners between 3 and 4 years (3 years 0 months, 3 years 6 months, etc.) and every year for learners between 5 and 16 years (5 years 0 months, 6 years 0 months, etc.). Standard scores and percentiles were further calculated for manual dexterity, aiming and catching as well as balance (Henderson et al. 2007). The standard score demonstrates that the higher the standard score, the better the Gr.1 learner performed, whereas the percentile indicated the percentage that the learner scored less than or equal to the raw score. Furthermore, the percentile was classified according to specific cut-off scores and interpreted through a traffic light system. The green zone (> 15th percentile) indicated performance in a normal range and was classified as no motor difficulty (non-DCD category), the amber zone (6th–15th percentile) indicated that a learner was at risk and should be monitored carefully, with the classification of moderate motor difficulty (risk for DCD category). The red zone (≤ 5th percentile) was an indication of definite motor difficulty (serious DCD category). Possible DCD was identified in the Gr. 1 learners if they fell below the 16th percentile.

The MABC-2 is a valid and reliable test with reliabilities of $r = 0.77$ for manual dexterity, $r = 0.84$ for aiming and catching and $r = 0.73$ for balance when the test was conducted in the United Kingdom on learners between the age of 3–16 years (Henderson et al. 2007). The total test score indicated a reliability of $r = 0.80$ according to Henderson et al. (2007), and an even higher reliability ($r = 0.97$) in a more recent study on 6–12-year-old learners in Taiwan (Wuang et al. 2012).

3.3 Statistical analysis

Data from the MABC-2 performance test was recorded electronically on a Microsoft Excel Spreadsheet by the principal researcher (A.d.P.). A statistician conducted the statistical analysis. The data were analysed using a statistical analysis software package, SAS version 9.4 (SAS Institute Inc., Cary, NC, United States). Descriptive statistics, namely frequencies and percentages, were calculated for categorical data, and medians and ranges for numerical data. The prevalence of Gr. 1 learners with possible DCD was determined and described by means of 95% confidence interval (CI). The total number of learners identified either with or without DCD, further separated into boys and girls in both groups, was determined. The learners were compared per gender by means of the chi-square test, or when necessary the Fisher's exact test for small samples, for categorical data. A probability level of 0.05 or less ($p \leq 0.05$) was accepted to indicate statistical significance.

3.4 Ethical consideration

Learners were recruited after approval from the provincial Department of Basic Education and the Health Sciences Research Ethics Committee (UFS-HSD2017/1363) at the University of the Free State was obtained. The headmasters of each school and the parents or legal guardians of the learners completed an informed consent form and gave permission for their child to participate in the study. The learners agreed to take part by completing an assent form.

The MABC-2 Performance Test was conducted by 11 trained movement specialists. All movement specialists underwent extensive training that included a minimum of 8 hours preparatory training and at least 6 hours of in-field training. To guarantee consistency within the study, each movement specialist conducted one subtest item. Testing took place during school hours in the second term and was conducted over a period of one month. The parents of the learners were provided with a feedback report regarding their child's motor proficiency results as well as exercises to address the problem, if necessary. The hard copies of each learner's data sheets were stored in a locked safety cabinet by the principal investigator. The electronic data on the computer were stored by using a protective password, which can only be accessed by the principal investigator.

3.5 Results

Table 3.2 displays the frequency distribution of the total sample in terms of gender and age. In total, 242 Gr. 1 learners participated in the study, with the group being composed of an approximately equal number of boys and girls. The majority of the learners were 6 years of age (*n* = 174; 71.9%). The median age was 6.66 years (range 6.0–8.75 years).

TABLE 3.2: Characterisation of participants (*n* = 242) in terms of gender and age.

Variable	*n*	%
Gender		
Boys	124	51.2
Girls	118	48.8
Age		
6 years	174	71.9
7 years	64	26.4
8 years	4	1.7

Table 3.3 displays the results according to the percentile cut-off values of the MABC-2. In total, 90.1% of the learners (*n* = 218) fell in the group above the 15th percentile, which identified them within the non-DCD group, whereas 9.9% of the learners (*n* = 24) scored equal or below the 15th percentile, indicating possible DCD. With regard to gender, the percentage of boys with possible DCD was similar to the girls (10.5% and 9.3%, respectively). The 95% CI for the prevalence of DCD is further illustrated in Table 3.3.

Table 3.4 shows the distribution of the total group of learners within the three MABC-2 subtests, with 27.7% of learners' scores for manual dexterity indicating possible DCD, opposed to their scores for aiming and catching (5.0% of learners) and balance (8.7% of learners). Of the total group, 72.3% fell in the non-DCD group for manual dexterity, 95.0% for aiming and catching and 91.3% for balance. The results indicated that the learners struggled more with the fine motor component of the MABC-2 performance test.

In Table 3.5, the differences between boys and girls with possible DCD are shown for the total test score and the individual MABC-2 subtests. No statistically significant differences between the boys' and girls' scores on the total test score (p = 0.9439) and the different subtests were observed (manual dexterity, p = 0.26; aiming and catching, p = 0.16; balance, p = 1.0).

TABLE 3.3: Percentage of learners without or with possible developmental coordination disorder.

DCD category	Percentile†	Total group (n = 242)			Gender					
					Boys (n = 124)			Girls (n = 118)		
		n	%	95% CI	n	%	95% CI	n	%	95% CI
Non-DCD	> 15	218	90.1	-	111	89.5	-	107	90.7	-
Possible DCD	≤ 15	24	9.9	4.1–10.5	13	10.5	6.2–17.1	11	9.3	5.3–15.9

Note: 95% CI = 95% confidence interval for possible developmental coordination disorder.

DCD, developmental coordination disorder; CI, confidence interval.

†, Percentile achieved on the Movement Assessment Battery for Children-2nd edition (MABC-2).

TABLE 3.4: Distribution of the total group of learners (n = 242) without and with possible developmental coordination disorder within the three Movement Assessment Battery for Children-2nd edition subtests.

MABC-2 subtest	Possible DCD		Non-DCD	
	n	%	n	%
Manual dexterity	67	27.7	175	72.3
Aiming and catching	12	5.0	230	95.0
Balance	21	8.7	221	91.3

DCD, developmental coordination disorder; MABC-2, Movement Assessment Battery for Children-2nd edition.

TABLE 3.5: Differences between boys and girls on the Movement Assessment Battery for Children-2nd edition total test score and subtests.

MABC-2 subtest	**Percentile†**	**Boys (*n* = 124)**		**Girls (*n* = 118)**	***p***
		n	**%**	***n***	**%**
Manual dexterity					0.26 (Chi-square)
Non-DCD	> 15	85	68.5	90	76.3
Possible DCD	≤ 15	39	31.5	28	23.7
Aiming and catching					0.16 (Fisher's exact)
Non-DCD	> 15	120	96.8	110	93.2
Possible DCD	≤ 15	4	3.2	8	6.8
Balance					1.0 (Fisher's exact)
Non-DCD	> 15	113	91.1	108	91.5
Possible DCD	≤ 15	11	8.9	10	8.5
Total test score					0.9439 (Fisher's exact)
Non-DCD	> 15	111	89.5	107	90.7
Possible DCD	≤ 15	13	10.5	11	9.3

DCD, developmental coordination disorder; MABC-2, Movement Assessment Battery for Children-2nd edition.

†, Percentile achieved on the Movement Assessment Battery for Children-2nd edition (MABC-2).

3.6 Discussion

The aim of this study was to determine the prevalence of possible DCD in Gr.1 learners between the age of 6 and 8 years, living in low socio-economic environments in the Motheo District of Mangaung, South Africa, and compare the findings of boys and girls participating in the study. To the authors' knowledge, this is the first study to assess the prevalence of possible DCD in the low socio-economic environment in Mangaung, which adds to the limited information on the prevalence of possible DCD in South Africa as a whole, especially with regard to low socio-economic environments. Consequently, comparison of this study with previous research on the prevalence of DCD in low socio-economic environments was restricted.

In this study, 9.9% of Gr. 1 learners were identified with possible DCD, and according to the parents, there was no medical DCD diagnosis before. Research in different countries, such as Israel (Engel-Yeger, Rosenblum & Josman 2010) and Brazil (Valentini et al. 2015), found a high prevalence (15%) of possible DCD in low-income families and socio-economic environments. Research conducted by Prinsloo and Pienaar (2003) in the North West Province of South Africa in a low socio-economic environment, supported these findings and indicated a high occurrence (20%) of DCD in 7- to 8-year-old learners. Furthermore, a more recent study in the same province indicated that the prevalence of possible DCD in a low (38.7%) and high (40.9%) socio-economic environment was high (Venter et al. 2015).

However, when using the 5th percentile as cut-off score for severe DCD with the MABC-2 performance test, it was noted that the high socio-economic environment had a higher incidence (22.7%) than the low socio-economic environment (3.2%) (Venter et al. 2015). Furthermore, another study in the North West Province identified 429 of 645 learners (10–12 years) with possible DCD when using the MABC-2. In addition to Venter et al. (2015), Cloete et al. (2006) reported that the lower the socio-economic environment, the lower the MABC scores, indicating higher rates of possible DCD. Furthermore, De Waal et al. (2018) determined that all the children who fell in the DCD group in their study were form low socio-economic environments. Therefore, it is clear that conflicting results regarding possible DCD in socio-economic environments may be found.

Delgado-Lobete et al. (2019) were of the opinion that the difference in the prevalence rates of DCD depended on the assessment used to identify and/or diagnose DCD. Previous research found results that were similar to those in this study by making use of the DSM-4 and/or DSM-5 and considering only one of the criteria (Amador Ruiz et al. 2018; Tsiotra et al. 2006). These findings are summarised in Table 3.6, and a comparison of the findings of this study with previously reported findings on studies where the socio-economic status of the participants had not been indicated is shown.

Hua et al. (2014) used all four criteria of the DSM-4 with 3–6-year-old learners from China and reported similar results (8.9%) compared with those in this study (9.9%). However, Lingam et al. (2009) indicated a very low prevalence of 1.8% when conducting a large cohort study of learners between 7 and 8 years of age in the United Kingdom. From the literature it is clear that findings vary extensively, even when the full DSM-5 criteria have been applied. It is furthermore important to note the discrepancies in the literature with regard to research conducted in South Africa where no socio-economic environment has been stated. Although De Milander et al. (2014) indicated that 12–15% of 6–8-year-old learners in Bloemfontein could have possible DCD, 1.6% of children were reported in the well below average category for motor proficiency and 49.63% in the below average category by Pienaar and Kemp (2014) in the North West Province, South Africa when the Bruininks Oseretsky Test of Motor Proficiency short form is used.

With regard to gender, the prevalence of DCD in this study indicated no statistically significant differences (p = 0.9439) between boys (10.5%) and girls (9.3%), showing a boy-to-girl ratio of 1:1. Similar results were reported by Cairney et al. (2005) and Dewey et al. (2002), where no differences between 12- and 14-year-old boys and girls were reported. Comparable findings of a study on Italian learners were reported (Alesi et al. 2019). On the contrary, Delgado-Lobete et al. (2019) indicated that the prevalence of DCD among boys was higher than in girls (16.2% and 8.6%, respectively). Similar to Delgado-Lobete et al. (2019), Gillberg (2003) reported a boy-to-girl ratio of 3–5:1, although Carslaw (2011) found an even higher boy–girl ratio of 9:1. These studies provided evidence of a higher prevalence of DCD in boys than in girls. Research conducted in South Africa showed results that were contrary to this study. Pienaar and Lennox (2006) found a boy–girl ratio of 2–6:1 in a North West Province study, and De Milander et al. (2014) found a boy–girl ratio of 1.6:1 in

Bloemfontein. In addition, another study in the North West Province found that mostly girls were identified with possible DCD (Venter et al. 2015) as well as in the Zeerust district (De Waal et al. 2018).

It has been reported that boys were at greater risk for DCD than girls (Wade & Kazeck 2018), and girls outperformed boys with regard to their overall motor proficiency (Pienaar & Kemp 2014). Amador-Ruiz et al. (2018), however, argued that the occurrence of DCD could be influenced by the tool used to evaluate the learners. Boys tend to be more skillful with ball activities, which increases their aiming and catching performance, whereas girls perform better on fine motor skills (Cardoso & Magalhães 2009). Furthermore, it has been suggested that factors such as cultural differences might have an impact on motor skill abilities (Blank et al. 2012), and also socio-demographic variables (Delgado-Lobete et al. 2019), and should be considered before evaluating a learner for possible DCD.

Disadvantaged educational, social and family circumstances are one of the main reasons for low socio-economic conditions in South Africa and could contribute to a lack of motor skill proficiencies and experience (Isaacs-Martin 2015; Narsai et al. 2013; Pappin et al. 2015; Pienaar & McKay 2014). Tsiotra et al. (2006) concluded that lifestyle differences, such as neighbourhood, environment and culture, should be taken into account when identifying motor skill difficulties or possible DCD. Barba et al. (2017) and Valentini et al. (2015) supported the argument of Tsiotra et al. (2006), confirming that a low socio-economic environment and family status are risk factors for DCD and increase the risk for motor skill difficulties.

TABLE 3.6: Comparison of this study with previously reported findings on the prevalence of developmental coordination disorder in different countries, with socio-economic environment not taken into account.

Authors	Year published	Participants' age (years)	Prevalence of possible DCD (%)	Assessment tool	Setting/location
This study	2019	6–8	9.9	MABC-2 Performance Test	Mangaung, South Africa
Ali, El-Tohamy and Mousa	2015	5–15	5.9	DCDQ'07	Egypt
Amador-Ruiz et al.	2018	4–6	9.9	MABC-2 Performance Test	Castilla-La Mancha, Spain
Barba et al.	2017	-	30.0	DCDQ-Brazil	São-Carlos, Brazil
Delgado-Lobete et al.	2019	6–12	12.2	DCDQ	Coruna, North West Spain
Dhote, Tushar and Ganvir	2017	5–15	3.2	BOT-2	Pimpri Chinchwad, India
Kokštejn et al.	2017	6	13.2	MABC-2 Performance Test	Prague, Czech Republic
Tsiotra et al.	2006	10.2–13.2	8.0	BOTMP-SF	Canada
Tsiotra et al.	2006	11.4–12.2	19.0	BOTMP-SF	Greece

BOT-2, Bruininks Oseretsky Test of Motor Proficiency-2nd edition; BOTMP-SF, Bruininks Oseretsky Test of Motor Proficiency; DCD, developmental coordination disorder; DCDQ'07, developmental coordination disorder questionnaire DCDQ 7th edition; MABC-2, Movement Assessment Battery for Children-2nd edition.

3.7 Conclusion

The prevalence of DCD (≤15th percentile) among Gr. 1 learners in low socio-economic environments in the Motheo District of the Free State Province is lower in comparison with previously reported South African findings. This finding highlights the need to identify learners as early as possible and enhance motor competencies to prevent further motor skill difficulties. Screening tools for the identification of possible DCD, such as the MABC-2 Checklist and the DCDQ'07, should be investigated in low socio-economic environments to increase early identification to assist these learners. Although it has been found that the prevalence of DCD may be higher among boys, the difference in gender ratio has been reported in recent studies to be decreasing. Although socio-economic status might be a reason for a higher prevalence of DCD, limited research has been conducted in South Africa. Given the contradicting prevalence of DCD in this study and other studies in South Africa, it is clear that the prevalence of DCD in South Africa, especially with regard to low socio-economic status, vary and made use of different measuring insturments to determine DCD, warranting further research in this area. Furthermore, it is important to make use of all four criteria of the DSM-5 when identifying DCD and ensure early identification to establish timely intervention. Finally, it is important to evaluate the role that socio-economic situations play on the development of characteristics associated with DCD in learners.

This study increased our knowledge of the importance to establish the prevalence of DCD in all provinces of South Africa to ensure a thorough knowledge of the occurrence of this disorder. Furthermore, increased awareness of prevalence of DCD in South Africa can assist in treating this disorder at an earlier stage by means of appropriate interventions. These interventions will contribute to improved motor proficiency levels in learners necessary for activities of daily living in addition to the school environment. Lastly, increasing the awareness of DCD in South Africa, especially in low socio-economic environments, increases our ability to attend to this disorder in future by means of implementing strategies for teachers to improve learners' motor abilities.

3.8 Limitations

Although the research was performed on a randomly selected sample, only one province and one district in South Africa were included in the study. Therefore, the findings could not provide a comprehensive reflection of the actual prevalence of possible DCD in all the low socio-economic environments of South Africa. It is therefore recommended that a larger sample group should be used in other parts of low socio-economic environments in South Africa to further investigate the prevalence of possible DCD.

It has to be noted further that DCD studies within various socio-economic environments are limited, and therefore, the results of this study could not be used to make comparisons or evaluate differences. Furthermore, it should be kept in mind that the daily living activities of the learners in this study could not be established and was therefore a limitation. It is probable that several learners with possible DCD in this study might have a functionality challenge at home, but because of the language challenge parents were not able to complete a standardised questionnaire such as the DCDQ'07 and the MABC-2 checklist. It will therefore be recommended to adapt the DCDQ’07 or MABC-2 for the SA population.

Lastly, criteria C and D of the DSM-5 were assessed by using feedback from parents and did not follow the recommendations of the EACD by making use of a medical doctor to ensure that physical and neurological disorders were not present, as well as a psychological evaluation to confirm that cognitive and intellectual problems were absent. Although limitations were recognised in the present study, the opportunity was created to evaluate more learners and establish the extent of DCD in learners living in low socio-economic environments.

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3.10 Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

3.11 Authors' contributions

A.M.d.P. was the main researcher reporting on her PhD study and the primary author of the article. M.d.M was the supervisor of the study and contributed to the article by providing guidance regarding structure and content. F.F.C. was the co-supervisor of the study and provided guidance on writing of the manuscript. M.N. was the biostatistician involved in the study and gave input during the planning and analysis of the study. All the authors approved the final version of the article.

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3.13 Data availability statement

Data are available from the corresponding author on request.

3.14 Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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CHAPTER 4 (ARTICLE 2):

THE ABILITY OF TEACHERS TO IDENTIFY GRADE 1 LEARNERS IN LOW SOCIO-ECONOMIC ENVIRONMENTS WITH POSSIBLE DEVELOPMENTAL COORDINATION DISORDER

This chapter's objective was to establish teachers' ability to identify Grade 1 (Gr. 1) learners in low socio-economic environments with possible DCD. The article was submitted for possible publication to the South African Journal of Childhood Education. Feedback has been received from the reviewers and the article has been provisionally accepted, pending minor revisions requested by the reviewers.

Authors

Aletta Margaretha du Plessis[1], Monique de Milander[1], Frederik Francois Coetzee[1], Mariette Nel[2]

[1]Department Exercise and Sport Sciences, [2]Department of Biostatistics, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa

Corresponding author

Aletta Margaretha du Plessis
P.O. Box 212
Glenvista
Johannesburg
2058

Telephone: +27 82 941 8194
Email address: 20268319@nwu.ac.za

Title

The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder

Abstract

Background: Early identification of learners in low socio-economic environments with possible developmental coordination disorder (DCD) is important. Although various screening tools are available, it is unclear whether teachers can use the movement assessment battery for children – second edition (MABC-2) Checklist to identify learners with possible DCD.

Aim: To establish teachers' ability to identify Grade 1 learners in low socio-economic environments with possible DCD.

Setting: The study was conducted in the Mangaung Metro, Motheo District of the Free State Province, South Africa. Grade 1 learners 6–8 years old (n = 200) from a low socio-economic environment attending quintile one to three schools were randomly selected for assessment. Twenty-nine teachers participated in the study.

Methods: Kinderkineticists identified learners with possible DCD (displaying motor skills far below the child's age) by means of the MABC-2 performance test. The teachers used the MABC-2 checklist to identify possible DCD. The convergent validity of the MABC-2 performance test and checklist was compared.

Results: The convergent validity between the MABC-2 performance test and the MABC-2 checklist indicated a kappa (κ) coefficient of 0.17, indicating a slight agreement between the performance test and the checklist. Overall, the specificity was 58% (105/180) and the sensitivity was 85% (17/20).

Conclusion: Teachers could effectively identify learners with possible DCD. However, they demonstrated a low ability to identify learners without possible DCD when using the MABC-2 checklist. It is therefore recommended that the performance test should be used in conjunction with the checklist to obtain the most reliable results.

Keywords: developmental coordination disorder (DCD); movement assessment battery for children – second edition (MABC-2); checklist; teachers; motor skills; children; learners; low socio-economic environment; prevalence

4.1 Introduction

Developmental coordination disorder (DCD) in children has become a constant concern in the last two decades (Blank et al. 2012; Geuze & Börger 1993; Schoemaker et al. 2006). When children are diagnosed with DCD, they experience low motor skill abilities without the evidence of a neurological disorder and the condition cannot be related to a general medical difficulty such as cerebral palsy or a pervasive development disorder (American Psychiatric Association [APA] 2013; Kadesjö & Gillberg 1998; Visser 2003). The low motor skill abilities of these children are significant to the extent that these interferes with their social competence, academic performance, and physical development, leading to problems with completing activities of daily living (Blank et al. 2012; Lingam et al. 2009). Therefore, DCD involves motor skill difficulties that have a negative influence on children's performances during daily activities.

Difficulties in performing daily activities include home activities (dressing themselves), play activities (ball skills and balance), and academic skills, such as writing and reading (Asonitou et al. 2012; Edwards et al. 2011). Secondary effects associated with DCD include social problems such as psychosocial challenges (Karras et al. 2019; Pratt & Hill 2011; Sylvestre et al. 2013) and low self-esteem (Missiuna et al. 2006; Missiuna et al. 2014; Zwicker et al. 2012), whilst physical challenges include lower cardiorespiratory fitness (Aertssen et al. 2018; Cairney et al. 2017), low strength and flexibility (Batey et al. 2014; Smits-Engelsman, Jelsma & Ferguson 2017) and increased obesity (Philips et al. 2016; Rihtman, Wilson & Parush 2011). A significant matter of concern is that DCD has been described as one of the most common motor neurological developmental disorders in school-aged children (Zwicker et al. 2018) and is present in 5–6% of school-aged children worldwide (APA 2013). The reported incidence of DCD could be influenced by the assessment tool used to identify motor skill difficulties and possible DCD (Amador-Ruiz et al. 2018).

Terms such as possible DCD, suspected DCD, or at risk for DCD have been used in research studies where a complete diagnostic assessment of DCD has not been conducted (Alesi, Pecoraro & Pepi 2019; Delgado et al. 2019; Lingam et al. 2009; Valentini et al. 2015). The APA (2013) proposed that the Diagnostic Statistical Manual of Mental Disorders fifth edition (DSM-5) should be taken into consideration before the diagnosis of DCD can be made. In order to determine Criterion A (execution of coordinated motor skills significantly lower than the child’s chronological age) and criterion B (deficits in criterion A interferes with the child’s daily activities) of the DSM-5, an evaluation of motor proficiency abilities of the child and how this have an influence on daily living activities should be conducted (APA 2013; Blank et al. 2019; van Waelvelde et al. 2007). Criterion C states that the onset of the motor difficulties should occur in the child's early developmental period and Criterion D states that the motor difficulties experienced are not because of intellectual, visual, or other neurological impairments (APA, 2013). Criteria C should be ruled out by a medical practitioner and criteria D should be kept in mind if a neurological impairment exists (Blank et al. 2012).

Using norm-referenced tests, such as the movement assessment battery for children – second edition performance test (MABC-2 performance test) (Henderson, Sugden & Barnett 2007) and the Bruininks-Oseretsky test of motor proficiency - second edition (BOT-2) (Missiuna et al. 2011), to measure a child's motor proficiency is required for accurate assessment of motor skills. However, these tests have been labelled as time-consuming, having long waiting lists for children to be evaluated, and being financially out of reach for children living in low socio-economic environments (Junaid et al. 2000; Schoemaker et al. 2006; Van der Walt, Plastow & Unger 2020). An alternative approach is to make use of questionnaire-based assessments (Dimitropoulou et al. 2019).

The Motor Observation Questionnaire for Teachers (van Dellen, Vaessen & Schoemaker 1990), the MABC original and the second edition checklist (MABC-2 checklist) (Henderson et al. 2007), and the Developmental Coordination Disorder Questionnaire'07 (DCDQ'07) (Wilson et al. 2009) have previously been used as questionnaire-based assessments. Faught et al. (2008) were of the opinion that screening children's motor skill abilities by making use of questionnaires was more useful and put emphasis on the important role that teachers play in identifying difficulties with motor skills. The importance of more research regarding the input from schools with the main focus on teachers to identify children with motor difficulties has been emphasised (Barnett, 2008:114; Missiuna et al. 2011). Teachers have the ability to observe learners in various situations, for example, during academic learning activities and play time (Faught et al. 2008; Larkin & Rose 2005). Asunta et al. (2017) elaborated on the importance of a suitable screening tool for teachers for early identification of learners with motor skill difficulties.

Although the MABC-2 Checklist can be used by teachers, uncertainties have been raised regarding the suitability of the screening tool for identification of motor skill difficulties (Barnett 2008; Peters & Henderson 2008), and disagreement continues whether teachers and therapists can identify the same children with motor skill difficulties and possible DCD when this screening tool is used (Missiuna et al. 2011; Schoemaker et al. 2008). Table 4.1 shows the total percentages of motor skill difficulties identified in children by teachers (using the MABC original and second edition checklist) which were also identified with the performance test. For example, in Table 4.1, Schoemaker et al. (2012) reported that class teachers identified 26 (41%) of the 64 children identified by the performance test with motor skill difficulties. Only two studies were found in South Africa in the Free State province. The class teachers were able to identify 46.5% of the children with motor difficulties who were also identified with motor difficulties using the MABC-2 performance test performance test in the one study (De Milander, Coetzee & Venter 2016), whereas another study by the same authors indicated an ability of 35.6% (De Milander, Coetzee & Venter 2019). Both of these studies were conducted in a high socio-economic environment. The only other study to the authors' knowledge on the MABC checklist in South Africa was the earlier study on 94 children (9–12 years) in the North West province with the aim to determine whether class teachers are reliable to use the MABC checklist as a screening tool for DCD; however, the teachers only completed two of the sections of the checklist and the focus was on the reliability of the teachers and the convergent validity was not provided (Lombard & Pienaar 2003).

Table 4.1 demonstrates a variation in the results where some results show a meagre ability of class teachers to correctly identify children with motor difficulties using the MABC original and second edition checklist and some show a very high ability ranging from 14.3% (Junaid et al. 2000) to 85% (Schoemaker et al. 2003). Therefore, controversy exists regarding the efficacy of using the checklist as a screening tool for motor difficulties. Furthermore, Table 4.1 emphasises the limited availability of studies regarding the second edition of the MABC, studies in low socio-economic environments, studies in low-to-middle-income countries and research findings in South Africa. Therefore, more research should be conducted.

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TABLE 4.1: Findings on the percentage of children with motor skill difficulties identified by teachers using the movement assessment battery for children original and second edition checklist.

Authors (year)	**Country**	**Number of participants**	**Age (years)**	**Completed by**	**% children identified with motor skill difficulties with the performance test**	**% children identified with motor skill difficulties with the checklist that was also identified with the performance test**	**MABC checklist used**
Piek & Edwards (1997)	Australia	171	9–10	Class teachers; Physical educators	19% (*n* = 32/171)	25% (*n* = 8/32) 49% (*n* = 15/32)	MABC; 15th percentile cut-off point
Junaid et al. (2000)	Canadian	103	7–8	Class teachers	14% (*n* = 14/103)	14% (*n* = 2/14)	MABC; 15th percentile cut-off point
Schoemaker et al. (2003)	Netherlands	184	6–11	Class teachers	–	79%	MABC; 15th percentile cut-off point
Green et al. (2005)	–	98	5.4–15.6	Class teachers	72% (*n* = 71/98)	44% (*n* = 31/71)	MABC; with DCD and at risk for DCD
Ellinoudis et al. (2009)	Greece	330	7–12	Physical educators	18% (*n* = 59/330)	27.1% (16/59)	MABC; 15th percentile cut-off point
Schoemaker et al. (2012)	Belgium	383	5–8	Class teachers	17% (*n* = 64/383)	41% (*n* = 26/64)	MABC-2; 15th percentile cut-off point

De Milander et al. (2016)	South Africa FS Province	545	6–8	Class teachers	13% (*n* = 71/545)	46.5% (*n* = 33/71)	MABC-2; 15th percentile cut-off point
De Milander et al. (2019)	South Africa FS Province	323	5–8	Class teachers	15% (*n* = 49/323)	35.6%% (16/45)	MABC-2; 15th percentile cut-off point
Dimitropoulou et al. (2019)	Greece	584	5–12	Class teachers; Physical educators	–	52.7% 43.2%	MABC-2; 15th percentile cut-off point

DCD: Developmental Coordination Disorder; FS: Free State Province; MABC: Movement Assessment Battery for Children (original version); MABC-2: movement assessment battery for children - second edition; -: no information

South Africa has incongruent socio-economic classes that can influence assessment tools and therapists' availability to conduct these assessments in different populations (Pienaar 2004). Low socio-economic environments are found in townships, the inner city and peri-urban areas of South Africa (Ndebele 2015) and are identified when observing poverty, income, education, environmental factors, working conditions and health conditions in these areas (Isaacs-Martin 2015; Narsai et al. 2013; Pappin et al. 2015; Pienaar & McKay 2014). The considerable diversity of socio-economic classes in South Africa has led to unequal educational opportunities for learners (Graven 2013). Consequently, the South African government has categorised public schools into five quintiles ranging from non-fee paying schools to fee-paying schools to allocate financial resources to specific schools (Graven 2013; Hall & Giese 2008; Ogbonnaya & Awuah 2019).

In South Africa, many children living in low socio-economic environments experience low motor skill abilities (Pienaar & Kemp 2014) because of limited opportunities to practice fundamental motor skills (Ferguson et al. 2015; Gallahue & Ozmun, 2006) and may therefore be identified with possible DCD (Hardy et al. 2012; Uys & Pienaar 2010; Valentini et al. 2015). Furthermore, the children living in low socio-economic environments are not adequately motivated to develop fundament motor skills and in many cases insufficient instructions and limited physical education opportunities for the development of these skills are provided (Barnett et al. 2016; Gallahue & Ozmun 2006; Pienaar & Kemp 2014). Pienaar, Barhorst and Twisk (2013) found in their study on 812 children living in the North West Province of South Africa that learners in quintile one to three schools performed poorly in perceptual-motor development skills and required additional help with these skills. Research in low socio-economic environments of the Western Cape found that fewer opportunities and activities are available for children and educators living in these environments (Senekal et al. 2015). Motor proficiency challenges could have a negative influence on young children's academic skills and their interest in sport participation (Pienaar & Kemp 2014).

Although the literature is available regarding children's motor skill abilities, research in low socio-economic environments in South Africa is still limited (Uys & Pienaar, 2010; De Waal et al. 2018; Pienaar & Kemp 2014). Uys and Pienaar (2010) reported in their study on 69 children between 4 to 71 months that the children from lower socio-economic environments had lower motor development abilities than children from the higher socio-economic environment. In accordance, De Waal et al. (2018) and Pienaar and Kemp (2014) reported higher tendencies of possible DCD in children (8-10 years old & 6-7 years old) from low socio-economic environments in the Zeerust District of South Africa and the North West Province.

Consequently, it is vital to investigate the motor skill abilities of learners living in low socio-economic environments in South Africa and to ensure appropriate identification methods of possible DCD for these children. The priority is to determine if teachers can be used in the school community to identify physical features in children that can indicate possible DCD using a screening tool (De Milander et al. 2016). If teachers can identify motor difficulties, they will be able to support children who experience motor difficulties. Teachers can refer children with motor difficulties to formal neurodevelopmental evaluation by a multidisciplinary team, if necessary (Blank et al. 2019). To determine if teachers can play a valuable role, it was essential to determine if the MABC-2 checklist could be used effectively by teachers to identify learners with possible DCD and whether teachers were competent when using the checklist, which constituted the aim of this study. Therefore, the completed MABC-2 checklist (teachers) will be compared with the MABC-2 performance test results (Kinderkineticists in training) of the children.

4.2 Methodology

4.2.1 Study design

An empirical study with a cross-sectional design was conducted and focused on a quantitative research method to collect data. Participants of this study included learners and class teachers. The target population was Grade 1 learners between 6 and 8 years of age and the class teachers of these learners. The Grade 1 learners lived in low socio-economic environments in Mangaung, Motheo District, in the Free State Province of South Africa. The cross-sectional design included one assessment tool consisting of two parts. The one part included a standardised testing procedure to identify the prevalence of possible DCD, and the second part comprised a screening checklist to identify the prevalence of possible DCD. The standardised test was completed by trained postgraduate students in Exercise and Sport Sciences at the University of the Free State in Bloemfontein, specialising in Kinderkinetics (further referred to as movement specialists) and the checklist was completed by the class teachers of the participating learners.

The sample size was determined by including quintile one to three public primary schools within a 30 km radius from Bloemfontein in the Motheo District, Free State Province. A 30 km radius was selected to ensure that the principal investigator and the movement specialists could reach the schools. Quintile one schools are in the most economically disadvantaged geographical areas, whereas quintile five schools are in the most affluent geographical areas (Graven 2013; Hall & Giese 2008). Quintiles one to three schools are the non-fee-paying schools, and according to Ogbonnaya and Awuah (2019), the learners in these schools demonstrate low levels of achievement. The sample size was further determined by considering (i) the duration of administering the MABC-2 performance test and checklist; (ii) the number of movement specialists to administer the test; (iii) the physical education periods; and (iv) the budget. A list of schools was obtained from the provincial Department of Basic Education in the Motheo District, from which a random selection was made to finalise the study population. There were 33 quintile one to three schools in the Motheo District within a 30 km radius from Bloemfontein; a total of 3940 Grade 1 learners attended the schools. Using proportional sampling, a total of 10 primary schools were randomly selected, of which two were quintile one and two schools, respectively, and eight were quintile three schools. Within the 10 schools, there were a total of 1179 Grade 1 learners. Using proportional sampling, a total of 400 learners were invited. The sample size per school was determined using random sampling. Limited schools in quintile one and two categories were available within a 30 km radius from Bloemfontein, which formed part of the study's inclusion criteria. Therefore, more quintile three schools were identified.

4.2.2 Participants

The principals of the 10 primary schools were invited to participate in the research study and asked to consider providing permission for the Grade 1 learners in the school and their teachers to participate in the study, to which all the principals agreed. After the principals provided permission, information about the study was sent to the children's parents/legal guardians. Proportional sampling was used to determine the number of learners that should be included, and random sampling was used to determine the sample size per school (Etikan & Bala 2017). The sample consisted of 400 learners.

Of the 400 children in the sample, 242 parental consent forms were returned to the different schools, giving a response rate of 60.5%. These learners also provided assent to participate in the study. Of the 242 learners, 124 (51.2%) were boys and all the children were living in low socio-economic environments in Mangaung. Most learners were 6 years of age (n = 174; 71.9%) with a mean age of 6.66 years (range 6.0–8.75 years). A total of 29 teachers agreed to participate in the study.

The following exclusion criteria were applied for the learners: if learners fell outside the age range of 6–8 years, if their parents indicated that they were relocating and if parents indicated that a medical practitioner diagnosed learners with conditions that included epilepsy, attention deficit and/or hyperactivity disorder (ADD/ADHD), autism spectrum disorder, visual problems, hearing problems, cancer and/or physical disability. The following exclusion criteria applied for the teachers: Teachers were only excluded if they did not want to participate in the study anymore and if they were a relative of one of the learners who participated in the study or if the researcher felt it is in the teacher's best interest not to participate.

4.2.3 Procedure

Two hundred and forty-two Grade 1 learners were tested using the MABC-2 performance test. The lower the score obtained on the MABC-2 performance test, the lower the child's motor coordination skills. Learners were identified with possible DCD when their results fell at or below the 15th percentile on the MABC-2 performance test and within the amber and red zone. For the purpose of this study, the criteria of the DSM-5 were partially met. Learners were categorised as having possible DCD if their motor coordination skills were far below their chronological age when using the MABC-2 performance test (Criterion A of the DSM-5). The MABC-2 checklist was used to determine if performance of activities during daily living was influenced if the child experienced motor skill difficulties (Criterion B or the DSM-5). The MABC-2 checklist was completed by the teachers as language barriers could have limited the opportunity for parents to complete the checklist. The influence of motor coordination difficulties on academic performance was not evaluated in this study. The parents indicated on the consent form if the child had any general medical condition and/or neurological impairment, although a confirmatory diagnosis by a medical doctor could not be obtained due to time constraints and expenses.

The 29 class teachers were requested to complete the MABC-2 checklist. Instructions and demonstrations on the completion of the MABC-2 checklist were provided by the principal investigator to each schools' head of department (HOD) of the Grade 1 learners. The HOD provided the class teachers with instructions, as received from the principal investigator, on how to complete the MABC-2 checklist. The HOD received the instructions because the teachers themselves had teaching responsibilities and were not available for the principal investigator's information session. The information to the HOD included (i) the observation of the learner in the classroom, during physical education classes and on the playground; (ii) what to do when the teacher was unable to answer one of the questions; and (iii) the content and rating of the checklist with regard to sections A, B and C. The teachers had 1 month to complete the checklists. No information was provided to the teachers about the learners' level of motor skills and the findings of the MABC-2 performance test.

The interpretation of the scores of the MABC-2 checklist differs from the performance test. The higher the scores obtained with the MABC-2 checklist, the lower the motor coordination skills of the learners. Learners were identified with possible DCD when they performed at or above the 85th percentile and fell within the amber and red zone. The final sample was determined after the teachers completed the MABC-2 checklist of each participating learner. Learners' checklists were excluded if more than one value was missing. Out of the 242 checklists completed by the teachers, 200 were used in the final analysis. Of the 242 checklists completed, 42 was excluded because teachers did not complete all the values and more than one value was missing.

4.2.4 Measuring instruments

The MABC-2 is composed of three components, (i) a standardised performance test that directly involves the child and can be completed by professionals such as research psychologists, occupational therapists, movement specialists and physiotherapists; (ii) a checklist that can be completed by an adult such as parents, teachers and professionals (psychologists, occupational therapists, movement specialists, physiotherapists); and (iii) an ecological approach manual to guide intervention for children experiencing motor skill difficulties (Henderson et al. 2007). For the purpose of this study, the standardised performance test and the checklist were used according to the developers' prescriptions and guidelines (Henderson et al 2007). Previous research has proven the successful use of the MABC-2 in the South African setting (De Milander et al. 2019; De Waal et al. 2018).

4.2.4.1 Movement Assessment Battery for children - second edition performance test

The MABC-2 performance test provides for the testing of three age groups, each with their own individual assessment form and activities, and are called age bands (Henderson et al. 2007). The age bands are divided into, 3–6 years (age band one), 7–10 years (age band two) and 11–16 years (age band three) (Henderson et al. 2007). For this study, age bands one and two were used. The learners were required to complete eight motor tasks grouped within three subtests: manual dexterity, balance, and aiming and catching (Henderson et al. 2007). Each task was demonstrated to the learner by the movement specialist, where the learner had one practice trial, followed by two trials that were formally evaluated. If the learner was not able to correctly complete the first formal trail or complete the trial within the time frame allocated for the age band, the learner was required to conduct the second formal trial. The learner's performance was evaluated by making use of seconds or number of correct catches. The scores were recorded as raw scores and converted to an item standard score. The sum of the item standard scores provided the general standard score and percentile for each subtest and for the total score. A percentile equal to or lower than five identifies the learner with definite motor skill difficulties (red zone), a percentile score of 6–15 puts the learner in the at-risk or moderate motor skill difficulty category (amber zone) and a percentile score above 15 classifies the learner with no motor skill difficulties (green zone).

The MABC-2 is a valid and reliable test. Manual dexterity shows a reliability of $r = 0.77$, aiming and catching has a reliability of $r = 0.84$ and the reliability for balance is $r = 0.73$ (Henderson et al. 2007). The total test score indicates the reliability of $r = 0.80$, according to Henderson et al. (2007), and even higher reliability ($r = 0.97$) has been reported (Wuang, Su & Su 2012).

4.2.4.2 Movement Assessment Battery for children - second edition checklist

The MABC-2 checklist consists of three sections of which sections A and B (30 items) focus more on motor and movement aspects, whereas section C (13 items) includes other aspects that might influence a child's motor movements (Henderson et al. 2007). Section A measures 'movement in a static and predictable environment' and is divided into three subsections, namely 'self-care skills, classroom skills, and physical exercise (PE)/recreational skills'. Section B measures 'movement in a dynamic and unpredictable environment' and is divided into 'self-care/classroom skills, ball skills, and PE/recreational skills'. The class teacher rated each learner's performance regarding each item listed in the individual sections. The teacher used a four-point scale to indicate how well the learner performed in the different skills. The scale includes 0 – very well, 1 – just OK, 2 – almost and 3 – not close (Henderson et al. 2007). If the teacher did not complete one item in a specific section, the four completed items in the section determined what the score for the empty item would be. If the scores were consistently positive, the learner was allocated a one; if it is consistently negative, the learner was allocated a two. The score results were then added up and a total motor score was interpreted by the red, amber and green of the traffic light system. The higher the total motor score, the weaker the performance, which is in contrast with the MABC-2 performance test. The green zone indicates 'no motor difficulty' with a cut-off point of < 85th percentile; amber indicates 'at risk or moderate motor difficulty', indicating percentiles between 85 and 94 and red shows 'definite motor difficulty' with a percentile indication of ≥ 95th percentile. The checklist took approximately 15 minutes per learner to complete.

According to Schoemaker et al. (2003) and Schoemaker et al. (2012), the discriminative validity of the original MABC checklist has been established. Research regarding the reliability of the second edition of the MABC checklist is limited (Brown & Lalor 2009). In addition, the reliability of the original MABC checklist was found to be useful (Shoemaker et al. 2003). Research on the MABC-2 checklist confirmed that the internal consistency was strong (Shoemaker et al. 2012).

To determine if teachers had the competence to identify Grade 1 learners in low socio-economic environments with possible DCD, the results of the MABC-2 checklist were compared to the results of the MABC-2 performance test and the convergent validity was determined. Learners with a score on the 15th percentile and lower (red and amber zone) with the MABC-2 performance test and on the 85th or higher percentile (red and amber zone) for the MABC-2 checklist, were referred to as the possible DCD group, which included learners with severe and moderate motor difficulties. The moderate and severe motor difficulties are grouped together to categorise children in a possible DCD group and a without DCD group (De Waal et al. 2018). Children below the 15th percentile are categorised as possible DCD because their motor coordination skills are below average (Alesi et al. 2019).

4.3 Statistical analysis

Data from the results of the MABC-2 performance test and the checklist were recorded electronically on a Microsoft Excel spreadsheet by the principal researcher (AdP). A statistician was consulted and conducted the statistical analysis. The data were analysed using a statistical analysis software package, SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics, namely frequencies and percentages, were calculated for categorical data, and medians and percentiles for numerical data. The Bowker's test for symmetry was calculated for paired categorical data as more than two discrete outcomes were measured. The difference in the total score was calculated and compared using the signed rank test.

The agreement between the results of the MABC-2 performance test and the MABC-2 checklist was determined by means of the kappa (κ) coefficient and 95% confidence interval (CI) for kappa. Values lower than 0 indicated no agreement, 0–0.20 slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement, and 0.81–1 as an almost perfect agreement (Landis & Koch 1977). Diagnostic test statistics were calculated where amber and red were combined as one discrete outcome. Sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios, were calculated.

4.4 Ethical considerations

Learners were recruited after permission for the study had been obtained from the provincial Department of Basic Education. The Health Sciences Research Ethics Committee (HSREC; reference number UFS-HSD2017/1363) at the University of the Free State provided ethical approval to conduct this study. The principal of each school, teachers of the participating learners, and the parents or legal guardians of the learners provided consent for the children to participate in the study by completing an informed consent form. The learners provided assent. The information letters and consent forms were provided in the languages most commonly spoken in the region, namely English and Sesotho. The information letters and explanation to the participants stipulated that participation was not compulsory and should a participant wish to withdraw, they were allowed to do so at any time during the study. The learners and teachers were treated according to the ethics guidelines of the Faculty of Health Sciences, University of the Free State. Data collection took place during the second term of the school year. The principal investigator stored all the data sheets in a locked safety cabinet and the data on the computer were stored by using a protective password.

4.5 Results

Table 4.2 presents the frequency distribution of the total sample in terms of gender and age. Two hundred (*N* = 200) Grade 1 learners between the age of 6 and 8 years participated in the study, with an equal distribution of boys and girls (*n* = 101, 50.5%; *n* = 99, 49.5%, respectively). The median age was 6.7 years, ranging between 6.0 and 8.1 years.

TABLE 4.2: Distribution of participants (*N* = 200) in terms of gender and age.

Variables	n (%)
Gender	
Boys	101 (50.5)
Girls	99 (49.5)
Age	
6 years	142 (71)
7 years	56 (28)
8 years	2 (1)

Table 4.3 shows the number of learners identified with and without possible DCD as determined by the movement specialists using the MABC-2 performance test and the teachers completing the MABC-2 checklist. In order to categorise the learners into a possible DCD group, the cut-off scores of the amber and red zones were combined. Therefore, the non-DCD group comprised learners with a percentile score of above the 15th percentile (> 15), and the possible DCD group are learners with a percentile score of lower or equal to the 15th percentile (≤ 15) for the MABC-2 performance test. In addition, the checklist's non-DCD group represented a percentile score of below 85, and the possible DCD groups score was at or above the 85th percentile. The movement specialist identified more learners (*n* = 180; 90.0%) in the non-DCD group than the teachers, who identified 108 (54.0%) learners.

The teachers miss-identified learners with possible DCD by identifying 92 (46.0%) learners with possible DCD. However, only 20 (10.0%) learners were identified by the movement specialist with possible DCD.

TABLE 4.3: Percentage of learners (*N* = 200) without or with possible developmental coordination disorder (DCD).

DCD category	Movement specialist (MABC-2 performance test)		Teacher (MABC-2 checklist)	
	Percentile*	**n (%)**	**Percentile***	**n (%)**
Non-DCD	> 15	180 (90.0)	≤ 85	108 (54.0)
Possible DCD	≤ 15	20 (10.0)	> 85	92 (46.0)

*Percentile achieved on the movement assessment battery for children - second edition (MABC-2).

Table 4.3 shows the inter-rater agreement between the MABC-2 performance test and the MABC-2 checklist with cut-off scores for each category of the MABC-2, namely definite motor skill difficulties (≤ 5th percentile), moderate motor skill difficulties (6th–15th percentile) and no motor skill difficulties (> 15th percentile). A slight agreement was found (κ = 0.1362). Of the seven learners identified by the movement specialist with moderate motor difficulties, none were identified by the teachers using the checklist. Eleven of the 13 learners identified with severe motor difficulties were similarly identified by the teachers by means of the MABC-2 checklist.

TABLE 4.4: Inter-rater agreement between the MABC-2 performance test and the MABC-2 checklist with the three cut-off scores.

MABC-2 checklist	MABC-2 performance test			
	No motor difficulties	Moderate motor difficulties	Severe motor difficulties	Total
No motor difficulties	105	2	1	108
Moderate motor difficulties	13	0 (0%)	1	14
Severe motor difficulties	62	5	11 (85)%	78
Total	180	7	13	200
	κ coefficient = 0.1362; $p < 0.0001$ Slight agreement			

*MABC-2 = movement assessment battery for children – second edition

Table 4.5 illustrates the agreement with cut-off scores divided into a non-DCD group (> 15th percentile) and possible DCD group (≤ 15th percentile). The k coefficient used to determine the convergent validity of the MABC-2 performance test and the MABC-2 checklist indicated a slight agreement, with k = 0.1667. The low agreement between the two tests demonstrated that the movement specialist and the teacher did not identify the same learners with and without motor difficulties.

TABLE 4.5: Inter-rater agreement between the MABC-2 performance test and the MABC-2 checklist with the non-DCD group and possible DCD group

MABC-2 checklist	**MABC-2 performance test**		
	Non-DCD	Possible DCD	Total
Non-DCD	105 (58.3%)	3	108
Possible DCD	75	17 (85.0%)	92
Total	180	20	200
	κ coefficient = 0.1667; $p < .0001$ Slight agreement		

*MABC-2 = movement assessment battery for children - second edition

In Table 4.6, the MABC-2 performance test and MABC-2 checklist are presented: sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio and the negative likelihood ratio. The predicted standards when using the 15th percentile as cut-off scores with the MABC-2 are 80% sensitivity and 90% specificity (APA 1985). In this study, the sensitivity was 85%, indicating a high ability of the class teachers to correctly identify learners in Grade 1 with possible DCD. The specificity was 58%, indicating that the teachers found it difficult to identify the absence of motor skill difficulties when using the MABC-2 checklist.

The positive predictive value indicated the probability that the learners who were identified with possible DCD, truly had possible DCD. The probability of possible DCD in this study was 18%, indicating a low probability that the learners who were identified with possible DCD, truly had possible DCD. The negative predictive value is the probability that the learners in the non-DCD category, certainly did not have possible DCD. The probability of non-DCD was 97%, indicating that these learners certainly did not have possible DCD.

TABLE 4.6: Sensitivity, specificity, positive- and negative predictive values and likelihood ratios of positive and negative test of the MABC-2 performance test and the MABC-2 checklist

	Value	95% CI range
Sensitivity	85%	62% – 97%
Specificity	58%	51% – 66%
Positive predictive value	18%	11% – 28%
Negative predictive value	97%	92% – 99%
Positive test likelihood ratio	2.04	1.58 – 2.63
Negative test likelihood ratio	0.26	0.09 – 0.74

CI: confidence interval

4.6 Discussion

This study aimed to determine whether class teachers of Grade 1 learners living in low socio-economic environments were able to identify these learners with possible DCD by completing the MABC-2 checklist. The convergent validity (agreement of the MABC-2 performance test and checklist) was determined in order to establish the ability of the teachers.

A sensitivity of 85% was found in this study, showing that of the 20 learners identified with possible DCD with the MABC-2 performance test, 17 learners were also identified by means of the teacher-completed MABC-2 checklist. These results demonstrated a high ability of the teachers to identify learners with possible DCD and correlated with the findings of Schoemaker et al. (2003). Schoemaker et al. (2003) reported that a study in the Netherlands on 184 children 6–11 years of age found a sensitivity of 85% when using the original MABC performance test conducted by physiotherapists and the checklist completed by classroom teachers.

Our findings on sensitivity were contrary to other research on the original MABC that found lower sensitivities. A sensitivity of 44% on 98 children (mean age 107.4 months) were reported in a study when the MABC performance test was executed by occupational therapists and the checklists completed by the physical education teachers (Green et al. 2005). Ellinoudis et al. (2009) established a sensitivity of 27.1% in a study on 330 Greek children when evaluated with the original MABC checklist completed by the physical education teachers and the performance test by professionals trained in the assessment of children. Junaid et al. (2000) reported an even lower sensitivity of 14.3% in a study on 103 Canadian children (mean age 8 years) when evaluated with the MABC performance test by physical therapists and the checklist completed by the teachers. Junaid et al. (2000) further explained that of the 14 learners identified with DCD by means of the original MABC performance test, only two learners were identified by using the MABC checklist. Piek and Edwards (1997), as well as Ellinoudis et al. (2009), concluded that teachers had a low ability to identify motor skill difficulties in learners, when using the original MABC checklist and were therefore unable to identify learners with possible DCD. The opinion of Piek and Edwards (1997) and Ellinoudis et al. (2009) was in contrast with the findings of the current study, where the indication of teachers to have the ability to identify learners with possible DCD when using the second edition MABC-2 checklist, was high (85%).

Schoemaker et al. (2012) put emphasis on the contradicting findings of this study (current study) when using the MABC-2, and reported a sensitivity of 41% in a study on 383 Belgium children 5–8 years of age, where teachers completed the MABC-2 checklist and therapists the MABC-2 performance test. They further reported that of the 64 learners with possible DCD with the MABC-2 performance test, only 26 (40.6%) were identified by means of the checklist (Schoemaker et al. 2012). Dimitropoulou et al. (2019) recently determined 52.7% sensitivity in a study on 584 Greek children when evaluated with the MABC-2 checklist completed by teachers. Comparing the research findings of Dimitropoulou et al. (2019) with the current study, the greater ability of the teachers to identify possible DCD by means of the MABC-2 checklist (85.0%) was evident. In another study conducted in the Free State Province in South Africa by De Milander et al. (2016), a sensitivity of 46.5% when the checklist was completed by teachers was reported. Their study included 323 children (5–8 years), where Kinderkineticists conducted the performance test.

In this study, we determined a specificity of 58%, which indicated the following: of the 180 learners identified by the MABC-2 performance test without DCD, only 105 were identified without possible DCD with the MABC-2 checklist completed by the teachers. This finding demonstrated that the teachers had a low ability to identify learners without DCD. The results are supported by Schoemaker et al. (2003). Their findings reported a specificity of 66% with the original MABC performance test and checklist. In addition, several authors reported higher specificities when using the original MABC and the MABC-2 performance test and checklist, ranging from 70% to 88% (De Milander et al. 2016; Dimitropoulou et al. 2019; Green et al. 2005; Shoemaker et al. 2012). Their findings suggested that teachers and/or parents who completed the checklist, had a high ability to identify individuals without possible DCD (De Milander et al. 2016; Dimitropoulou et al. 2019; Green et al. 2005; Shoemaker et al. 2012), and were in contrast with the findings of the current study. Junaid et al. (2000) found an even higher specificity when using the original MABC. They reported that out of the 89 learners identified without DCD with the performance test, 87 (97.8%) were also evaluated without DCD with the checklist (Junaid et al. 2000). Their results contradict the current study's findings. One of the reasons for the low specificity in this study might be that class teachers have not been formally trained to identify and observe motor skills, and might therefore observe more children with motor difficulties instead of realising that it was part of their normal motor development. Furthermore, it would be more ideal to make use of physical education teachers with more in-depth knowledge of motor skills to determine if motor skills are on par or absent.

The convergent validity of this study between the MABC-2 performance test and the MABC-2 checklist completed by the class teachers was indicated by a k coefficient of 0.17. The convergent validity, therefore, demonstrated a slight agreement and the results correlated well with research conducted in a high socio-economic environment in Bloemfontein, Free State Province, with a k coefficient of 0.11 (De Milander et al. 2016). Similar results were reported by Ellinoudis et al. (2009) and Green et al. (2005) when using the original MABC performance test and checklist, with a k coefficient of 0.14 (14%). The agreement found in the current study was lower than that by Schoemaker et al. (2012) and Dimitropoulou et al. (2019) with the MABC-2 performance test and checklist, who reported an agreement of 0.28. In addition, more moderate agreements were found when using the original MABC, with k coefficients of 0.44 (Schoemaker et al. 2003) and 0.51 (Junaid et al. 2000), respectively.

Schoemaker et al. (2003) were of the opinion that both the MABC performance test and the MABC checklist should be used, and if the learner failed both the evaluations, they could be identified with possible DCD. The authors further mentioned that the MABC checklist should identify all children with possible DCD, after which the MABC performance test should be conducted to confirm the diagnosis (Schoemaker et al. 2003). This argument was later supported by Ellinoudis et al. (2009), putting emphasis on the statement that if the MABC checklist is used, the MABC performance test must further be conducted to confirm the diagnosis. Considering the results of the current study, the views of Schoemaker et al. (2003) and Ellinoudis et al. (2009) could be seen as meaningful to determine possible DCD, and the problem of incorrectly identifying learners with possible DCD might then be eliminated. The current study, therefore, supports the view that the MABC-2 checklist should not be used independently.

A possible reason for the low agreement between the MABC-2 performance test and the MABC-2 checklist, could be that the class teachers indicated that they do not present structured physical education classes because of unavailable space or limited time. Teachers indicated to the principal investigator that they are not qualifie, physical educators. They therefore did not have the experience of observing learners performing movement activities outside the classroom. Piek and Edwards (1997) and Schoemaker et al. (2008) supported this point of view, as they were of the opinion that class teachers did not experience children in a changing environment and were not part of physical education classes, which could cause a disadvantage on how to evaluate motor skills in children. Another reason could be that teachers do not have sufficient knowledge about DCD (Dimitropoulou et al. 2019) and this could have an effect on how they evaluate motor behaviours and motor proficiency executions. Netelenbos (2005) further explained that a screening tool specifically observes the motor skill abilities of a child in daily living activities, whereas a motor test conducted by a movement specialist evaluates underlying motor skill abilities, and could therefore be an explanation for the low agreement observed in the current study. Further reasons might be the socio-economic environment. The learners were from a low socio-economic environment attending quintile one to three schools. The MABC-2 checklist might therefore not be suitable for this population because of the lack of apparatus, opportunities and facilities. Although the MABC-2 checklist completed by teachers of Grade 1 learners living in a low-socioeconomic environment could be used to identify learners with possible DCD, it should not be the only assessment tool used and teachers might wrongfully identify learners with possible DCD, who might not have this problem.

4.7 Conclusion

We found a slight agreement (0.17) of convergent validity between the MABC-2 performance test and the MABC-2 checklist completed by teachers. Although we showed that the teachers were able to use the MABC-2 checklist to identify possible DCD in learners (sensitivity), the study further established that the ability of the teachers to accurately identify learners without possible DCD (specificity) was low. Teachers have therefore identified learners who do not have possible DCD, confirmed by the movement specialist, as having possible DCD when using the MABC-2 checklist. Based on the results and findings, it would therefore not be recommended to only use the MABC-2 checklist by teachers to identify possible DCD. Furthermore, other assessment tools should be considered.

The prevalence of possible DCD as determined by the MABC-2 performance test has been reported to be high in low socio-economic environments. Some children living in these low socio-economic environments in SA have more developmental delays and limited opportunity to develop motor skills (Kahts et al. 2017; Pienaar & Kemp 2014). It was further evident that teachers could not identify learners living in low socio-economic environments with possible DCD, and it is therefore important to raise awareness of limited or unfitting screening tools available for teachers in a low socio-economic environment to identify learners with possible DCD. Venter, Pienaar and Coetzee (2015) emphasised the importance of early screenings for motor difficulties to identify possible DCD. They further explained that the results of a child's motor skills are important for teachers, day care personnel, and other professionals who work with children with motor skill problems (Venter et al. 2015). According to Pienaar and Kemp (2014), more strategies should be developed to create more awareness of motor skill problems. If an assessment is not provided, early intervention cannot take place.

This study has the potential to raise awareness of possible DCD and to motivate the public school services to raise awareness of children having limited access and experience to participation in motor activities, as well as the lack of assessment services for DCD. The motor difficulties experienced by these learners highlight the importance of early identification to prevent further problems and provide adequate interventions or support. It is essential for the Department of Basic Education to put more emphasis on the importance of screening and execution of motor skills, as motor development plays very important part in the complete development of a child.

4.8 Limitations

The sample size of this research study was small and further research on a larger sample is recommended. Furthermore, the study was conducted in only one province and one district and should be expanded to other provinces for a broader view and improved results on the national prevalence of possible DCD among Grade 1 learners. A larger sample group of different quintile schools and teachers in other parts of South Africa within low socio-economic and high socio-economic communities should be investigated. The MABC-2 is based on a UK population, which should be taken into account when evaluating South African children for possible motor skill deficits. The method of providing the instructions of the MABC-2 Checklist might have influenced the ability of the teachers to complete the MABC-2 Checklist accurately. More in-depth training with various examples before conducting the MABC-2 Checklist is recommended to ensure that teachers understand different aspects of the Checklist correctly, and errors can be avoided. The movement specialist should present this training. Consequently, in future studies, more of the MABC-2 Checklist results can be included in the data. Despite the limitations, awareness of evaluating teachers' role in identifying possible DCD, especially in low socio-economic environments, has been created. The research can motivate more in-depth studies to assist children with low motor skill abilities earlier. Suppose all the children wrongfully identified with possible DCD by the Teachers should be referred for further assessment by therapists. In that case, an overload of the therapist' capacity can occur or be costly for the parents from these low socio-economic environments. Therefore, more research strategies are required for assessment options.

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4.10 Competing interests

The authors declare that they have no financial or personal relationships, which may have inappropriately influenced them in writing this article.

4.11 Authors' contributions

A.M.d.P. was the main researcher reporting on her PhD study and the primary author of the article. M.d.M was the supervisor of the study and contributed to the article by providing guidance regarding structure and content. F.F.C. was the co-supervisor of the study and provided guidance on writing of the manuscript. M.N. was the biostatistician involved in the study and gave input during the planning and analysis of the study. All the authors approved the final version of the article.

4.12 Disclaimer

The authors declare that the views expressed in this article are their own and do not reflect the institution's official position.

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CHAPTER 5 (ARTICLE 3):

KINDERKINETICS MOTOR INTERVENTION FRAMEWORK FOR CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER: AN E-DELPHI PERSPECTIVE

This chapter aims to use an e-Delphi survey as a unique approach to develop a motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African context. The article was prepared for possible publication in the South African Journal for Research in Sport, Physical education and Recreation.

Title

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective

Short title

Intervention framework for children with DCD

Authors

Aletta M. du Plessis, Monique de Milander, Frederik F. Coetzee

Department of Exercise and Sport Sciences, School of Exercise and Rehabilitation Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, South Africa

Full author details

Mrs. Aletta M. du Plessis (corresponding author)

Email address:	20268319@nwu.ac.za
Telephone (work):	+27 18 299 1799
Cellular number:	+27 82 941 8194
Field of study:	Human Movement Sciences, Kinderkinetics
Postal address:	P.O. Box 212
	Glenvista
	Johannesburg 2058
	South Africa

Dr. Monique de Milander

Email address:	demilanderm@ufs.ac.za
Telephone (work):	+27 51 401 9342
Cellular number:	+27 82 979 1040
Field of study:	Human Movement Sciences, Kinderkinetics

Prof. Frederik F. Coetzee

Email address:	coetzeef@ufs.ac.za
Telephone (work):	+27 51 401 2944
Cellular number:	+27 82 820 5979
Field of study:	Exercise and Sport Sciences

TITLE

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective

ABSTRACT

Developmental coordination disorder (DCD) is a motor coordination disorder that continues if motor intervention is not provided. Although national guidelines are available for motor intervention in children with DCD, this study aimed to develop a motor intervention framework based on experts' information to be applied as a guideline in Kinderkinetics for children with DCD or possible DCD. Twenty-nine Kinderkinetics experts from South Africa participated in a three-round e-Delphi method. Round one obtained consensus and opinions from the experts by reviewing findings on intervention for children with DCD, as stipulated in the literature. Rounds two and three were based on answers and opinions provided in round one to determine an 80% agreement to accept the statement. Consensus was reached on various motor intervention aspects and identified ten main elements to form the foundation for motor intervention framework. The main focus areas to develop the framework are intervention planning, goal-setting, intervention approaches; intervention apparatus; intervention delivery mode, additional role players, settings, dosage (time; duration, frequency and number of sessions), and evaluation. Understanding that the causes of DCD is heterogeneous was an essential factor to consider when choosing the final motor intervention framework. The research provided unique and collated feedback from Kinderkinetics experts to develop a motor intervention framework for children with DCD or possible DCD.

Keywords: developmental coordination disorder; DCD; e-Delphi survey; Kinderkinetics; motor intervention; framework

Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective

5.1 INTRODUCTION

Developmental coordination disorder (DCD) refers to a motor coordination disorder influencing daily activities and academic performance (American Psychiatric Association [APA], 2013). The causes of the disorder are heterogeneous with secondary problems, such as low physical fitness causing overweight and obesity (Cermak *et al.,* 2015), psychological and psychosocial problems (Biotteau *et al.,* 2017) and decreased participation in physical activity (Caçola, 2014). Physical activity participation is essential for motor development and low levels of participation in physical activity increase the possibility of DCD (Ferguson et al., 2015). DCD is diagnosed on the characteristics proposed in the Diagnostic Statistical Manual of Mental Disorders, fifth edition (DSM-5) (APA, 2013). Considering that DCD is usually diagnosed during childhood, it has become evident that children do not outgrow the disorder (Blank *et al.*, 2019). Those who do not receive intervention continue to experience low motor abilities, and many children do not receive the necessary intervention (Blank *et al.*, 2019). Various intervention approaches for DCD have been reported in the literature. Published reports in the literature mostly refer to task-oriented approaches, process-oriented approaches and combined approaches (Blank *et al.,* 2019; Smits-Engelsman *et al.,* 2018; Pienaar, 2020).

The task-oriented approach involves an intervention where the task that should be learned is addressed (Smits-Engelsman *et al.,* 2012). It has recently been referred to as the activity-oriented and participation-oriented approach (Smits-Engelsman *et al.*, 2018). The activity-oriented approach improves the task and the participation-oriented approach improves participation (Smits-Engelsman *et al.*, 2018). In contrast, the process-oriented approach refers to improve the underlying processes involved in executing a task and improving body functions such as strength and core stability (Smits-Engelsman *et al.*, 2012). The process-oriented approach has recently been called the body-function oriented approach and enhances the child's body functions and structure during the intervention (Blank *et al.*, 2019; Smits-Engelsman *et al.*, 2018).

A motor intervention has been recommended for children with DCD, considering that the main problem of DCD is motor difficulties (Smits-Engelsman *et al.,* 2018). The motor intervention aims to strengthen motor difficulties, increase motor skills, promote healthy lifestyles and increase fitness levels (Amador-Ruiz *et al.,* 2018; Cermak *et al.,* 2015; Yu *et al.,* 2018). Despite the physical improvements, motor intervention enhances social abilities, cognitive factors and emotional well-being (Yu *et al.,* 2018). The advantages of motor intervention emphasise the importance of choosing the correct intervention approach, plan correctly, identify goals and determine the frequencies and durations of this intervention for children with DCD (Blank *et al.,* 2019). According to the recent international clinical practice recommendations on the definition, diagnosis, assessment, intervention and psychosocial aspects of DCD (CPR-DCD), various guidelines have been identified to follow during the intervention (Blank *et al.*, 2019). Those applicable to this study are briefly pointed out in Table 5.1.

Considering these recommendations, one of the drawbacks is that limited information is available regarding the durations and frequencies to apply (Preston *et al.,* 2017; Pienaar, 2020; Smits-Engelsman *et al.,* 2018). Further questions have been raised whether group interventions are practical and acceptable to use in environments where unaffordability or limited resources are available (Ferguson *et al.,* 2013; Smits-Engelsman *et al.,* 2018). Various suggestions have further been made in the literature on whether activity-oriented interventions and body-oriented interventions should not be combined with functional tasks (Smits-Engelsman *et al.,* 2018). In contrast, only activity-oriented and task-oriented interventions have been considered for best results (Ferguson waarom *et al.,* 2013; Smits-Engelsman *et al.,* 2018). The CPR-DCD recommendations further aimed to determine the importance of various professionals from different disciplines to work together in an interdisciplinary approach (Blank *et al.,*2019); however, no recommendation was made regarding the role of a Kinderkineticist. Kinderkinetics is however a profession only known by this name in SA, however other names in other countries similar to this profession such as Adapted Physical Education Teachers, Special Needs Teachers, Pediatric Exercise Specialist, Motor Therapist, Motor Remedial Teacher, Pediatric Physical Therapist, Developmental Movement Therapist and are known to be similar to Kinderkinetics. Therefore, the profession will not be listed in the CPR-DCD recommendations.

Table 5.1. International clinical practice recommendations on the intervention of DCD (Blank *et al.*, 2019).

Recommendation description
A child diagnosed with DCD must receive an intervention (15).
During the planning of the intervention: the strengths and weaknesses in the child's environment must be considered to improve motor performance, activity, and participation; the evidence of effective dose should be considered, and priorities should be set according to the severity if a co-occurring disorder is present. Priorities should further be established using motor and non-motor factors in functioning (16, 17 & 21).
The focus should be on individual goals during planning, and the goals should address activities and participation. The viewpoints of the child, the family and relevant others should be considered (18).
Psycho-social factors should be considered during planning and self-concept should be accommodated (19 & 20).
Activity- and participation oriented approaches should be used for improving general, fundamental and specific motor skills (22).
Active video games can be useful in supervised settings and physical fitness should be considered in the intervention (25 & 26).
Small group intervention should be considered carefully if and when a group setting is appropriate (27 & 28).
Children should be provided with sufficient opportunity to practice movement skills (29).
Professionals should provide parents and relevant other advice on abilities and problems the child with DCD experience and how they can assist at home, school, leisure and sport (30).
Formal standardized assessment should be repeated at the end of the intervention and at least every three months if intervention is longer to determine the effectiveness, if goals are met and if more extended intervention is required (33).

Kinderkinetics is a professional field in South Africa that provides scientifically based motor developmental programs with specialised knowledge in movement and physical activity for children 0–13 years of age (South African Professional Institute of Kinderkinetics, 2020). The Kinderkineticist focuses on improving psychomotor, physical and neuromotor difficulties for children with motor impairments (Coetzee & Pienaar, 2015). South Africa is an upper middle-income country with various socio-economic environments and cultural differences (Fantom & Serajuddin, 2014). Furthermore, relatively high prevalence rates of possible DCD (moderate to severe motor difficulties) have been reported in South Africa by De Milander *et al.* (2014) and Wessels *et al.* (2008), namely 23.0% and 13.2%, respectively. Therefore, these high incidences emphasise that intervention for children with possible DCD in South Africa is crucial to help these children. According to Blank *et al.* (2019), the CPR-

DCD recommendations should be adapted to national guidelines according to the country's specific needs, environments and professionals available.

Best practice principles for Kinderkineticists are provided during their training, however in the training textbook, Pienaar (2019:220) does however mention that the evidence for best practice are conducted from a Canadian perspective and that it is still a work in progress for multidisciplinary cooperation in SA working with children with DCD. Therefore, a standard motor intervention framework in SA provided by input from Kinderkineticists with practical experience of five years and more in motor development is not currently available. It is essential to develop a motor intervention framework provided by practical Kinderkinetics experts to provide further guidelines for Kinderkineticists working with children with DCD or possible DCD, and further research is necessary. Therefore, the aim of this study was to develop a motor intervention framework for children with DCD or possible DCD derived from Kinderkinetics experts within the South African context.

5.2 METHODOLOGY

5.2.1 Ethical clearance

Ethical clearance to conduct the research was obtained from the Human Research Ethics Committee (HSREC) of the Faculty of Health Sciences, University of the Free State (UFS-HSD2017/1363). Written informed consent was obtained from all the experts participating in the e-Delphi before data collection commenced.

5.2.2 Research design

An e-Delphi survey was conducted to obtain quantitative opinions. Therefore, this study provided the researchers with feedback and input on motor intervention for children with DCD or possible DCD in Kinderkinetics to develop a motor intervention framework. The e-Delphi survey consisted of three rounds. Participants' opinions were requested in round one, and their responses were obtained and analysed to reach consensus. Statements and questions that did not reach consensus were added to the next round for review and consideration by the participants (Figure 5.1). If consensus could not be achieved in round three due to participants' opinions stipulating reasons, this outcome was considered in the final framework.

5.2.3 Participants

An appropriate panel of experts was required to form the e-Delphi method's requirements, including ensuring quality responses, less potential bias, and credibility (Nworie, 2011). There is no current standard for the sample size of an e-Delphi; however, it should not be too small. The larger the group size, the greater the quality of feedback (Giannarou & Zervas, 2014). All of these factors were met when selecting the participants.

Twenty-nine (N=29) qualified Kinderkineticists were recruited for this e-Delphi survey and selected based on their professional Kinderkinetics qualification with prerequisite experience, knowledge and insights related to motor intervention for children with DCD. Their level of expertise consisted of five years or more experience practicing as a Kinderkineticist, and they were registered with the South African Professional Institute of Kinderkinetics (SAPIK). The Kinderkineticist was required to fulfill at least one of the following criteria: academic position in Kinderkinetics with five years or more experience, an employer or employee of a Kinderkinetics practice with five years or more experience. Lastly, they were based in SA in various provinces from various practices and universities. The participants were informed about the study via email.

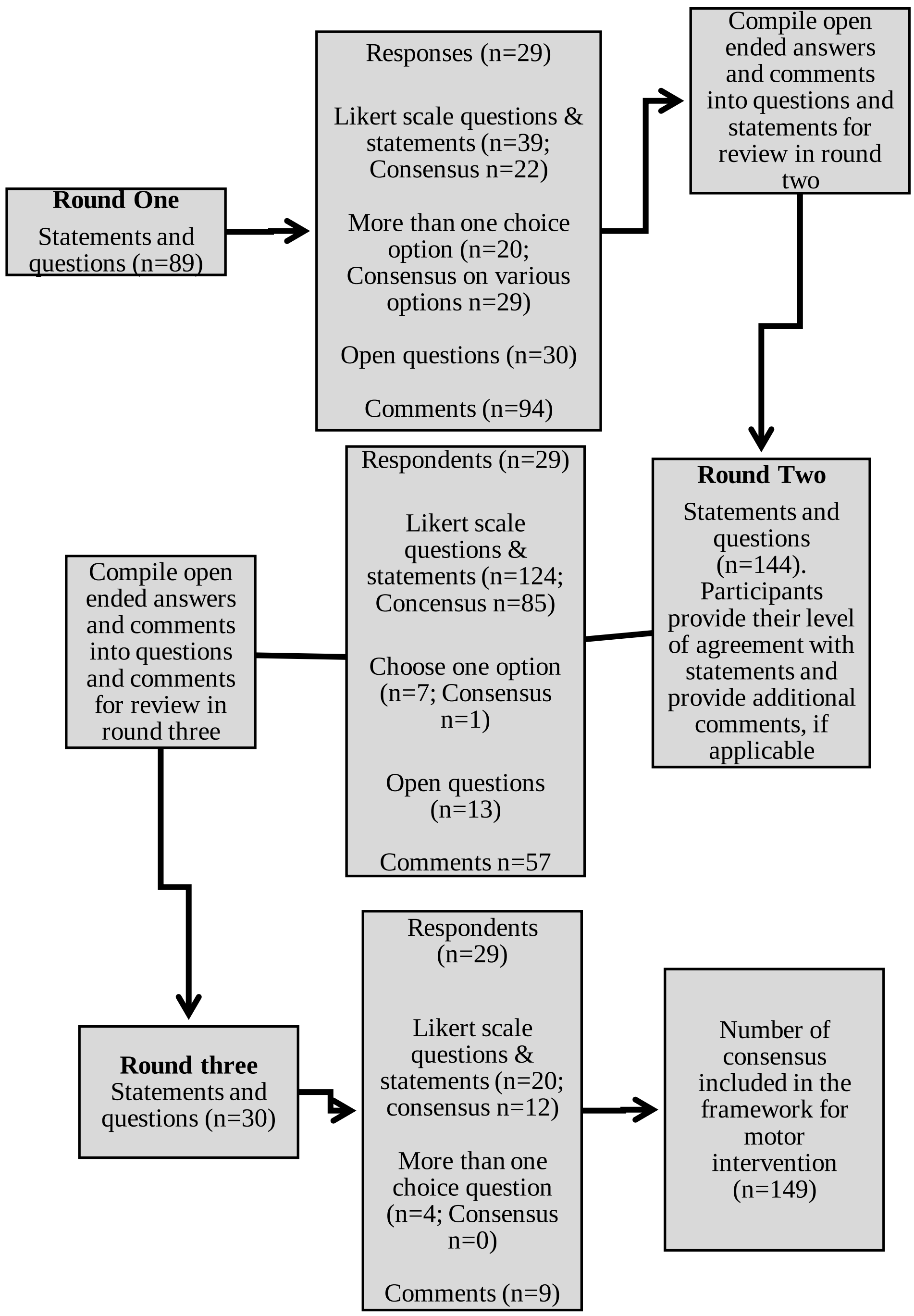

Figure 5.1. Flow diagram of the e-Delphi process followed.

5.2.4 *Procedure*

Participants were invited by email to take part in this study. The information letter provided information on the aim of the study, ethical clearance, e-Delphi and follow-up process. A consent form was available at the end of the letter. The participants were asked to provide consent to participate, which was applicable to all the rounds of the e-Delphi. After the agreement was received, the first round of the e-Delphi questionnaire was sent by email with clear information on how to complete the survey by clicking on the link provided. A glossary addendum was added with clarification on intervention approaches and types. Participants had two weeks for each round to complete the survey and a reminder was sent every four days. After setting up round one, the questionnaire was piloted with two experts, not taking part in the study, for feedback on the duration, clarity and structure of the questions to ensure that it was linguistically accurate.

The e-Delphi technique consists of several rounds until a consensus of 80% is reached between participants (Nworie, 2011). The participants' expression is anonymous to each other. It provides the opportunity for participants to give their opinions and reconsider and refine their views as the rounds continue (Giannariou & Zervas, 2014). The e-Delphi survey consisted of three rounds. Each round focused on collecting information and opinions from the participants to draft a motor intervention framework for children with DCD or possible DCD in Kinderkinetics.

5.2.5 *Data collection*

The e-Delphi survey focused on collecting the participants' consensus regarding motor intervention suggestions and recommendations in the literature through a semi-structured questionnaire available online. The sections included in the questions for round one were based on the information obtained from the in-depth literature review of the authors' doctoral study. The UFS EvaSys Survey System was used. Only participants who responded to the first round of the e-Delphi survey were included in the next rounds to limit attrition bias.

The e-Delphi consisted of ten sections: additional role players; assessment tools; goal-setting; types of motor intervention programs; additional inclusions in the motor intervention; group and individual delivery mode; motor intervention setting; time of motor intervention; dosage (duration, frequencies and number of sessions); and lastly, evaluating the motor intervention program. The questionnaire took approximately 20 minutes to complete in each round.

Round one included 89 questions consisting of closed questions such as dichotomous questions (yes/no), multiple choice questions and Likert scale (agree/disagree) questions, as well as open-ended responses. The closed questions were evaluated for consensus by the EvaSys program and the primary researcher. The open-ended responses and comments from participants were compiled into questions and statements to use in round two. The experts' answers and opinions in round one were used to formulate the statements and questions in round two. Round two consisted of 144 questions and included mostly Likert scale (agree, disagree) questions and multiple choice questions, with some open-ended questions. Participants were allowed to comment further if desired. Round three included 30 questions and consisted of Likert scale and multiple choice questions and three open response questions to reach further input regarding intervention. A table was provided in round three with a summary of the findings drafted from rounds one and two. The main sections of the questions remained the same in all the rounds. If consensus (80%) was reached, it was indicated in the next round. If consensus was not reached, the question would be repeated in the next round. In some cases, questions had been modified slightly or added, based on the participants' opinions in the previous round. Where consensus was not reached in round three, it was reported in the results.

After information was collected from round three, a motor intervention framework was developed.

5.2.6 Validity and reliability of the e-Delphi

Thorough information was received from SAPIK and from the participants themselves to ensure the validity of the e-Delphi survey. The information received from SAPIK and further information obtained from the participants confirmed that they adhered to the required competence and knowledge in the field of Kinderkinetics and motor intervention for children with DCD or possible DCD. Questions were further thoroughly planned and evaluated in order to ensure the validity of the captured data.

5.2.7 *Analysis of data*

The UFS EvaSys Survey System quantitatively analysed the responses from the participants provided during all three rounds. Descriptive statistics of the participants were further recorded and analysed by the EvaSys program. A consensus agreement of 80% and more was an indication of agreement. The researcher recorded and analysed the open questions for each participant and incorporated it in the next round of questions and final motor intervention framework where applicable.

5.3 RESULTS

Twenty-nine Kinderkineticists participated in the e-Delphi survey, with a 100% response rate for all three rounds. Table 5.2 summarises the demographic variables of the participants. Overall, 93.1% (n=27) of the participants were female and 6.9% (n=2) were male. The mean age of the group was 33.5 years, with a standard deviation (SD) of 6.67 years and range of 28–62 years. On average, the participants had 11.3 years of experience with children aged 0–13 years (SD 6.54, range 5–40 years). Most of the participants' highest qualification was an honours degree (n=20; 69.0%). Five (17.2%) were holding a Master's degree and four (13.8) had a Ph.D.

In round one, consensus (80%) was reached on 51 of the 89 questions (Table 5.3). Ninety-four comments from the open questions (n=30) were reviewed and compiled into questions and statements for round two. A total of 144 statements and questions were identified for review in round two.

Participants reached consensus of 89 of the 144 statements provided in round two. The 15 open questions and 57 comments were compiled into statements and questions for round three. The last round included 30 statements, of which 12 reached consensuses. The results are shown in Table 5.4.

Table 5.2. Demographic information of the e-Delphi participants.

Variable	n (%)
Gender	
Male	2 (6.9)
Female	27 (93.1)
Highest qualification	
Honours degree	20 (69.0)
Master's degree	5 (17.2)
PhD	4 (13.8)
Additional qualification(s) related to motor development	
Yes	13 (44.8)
No	16 (55.2)
Author/co-authors of article(s) published in a peer-reviewed journal	
Yes	8 (27.6)
No	21 (72.4)
Province where employed [a]	
Eastern Cape	1 (3.4)
Free State	5 (17.2)
Gauteng	13 (44.8)
Kwa-Zulu Natal	0 (0)
Limpopo	0 (0)
Mpumalanga	2 (6.9)
North West	5 (17.2)
Northern Cape	1 (3.4)
Western Cape	5 (17.2)
Setting of employment [b]	
Gymnasium of health club	3 (10.3)
Multidisciplinary practice	6 (20.7)
Permanently at one school	8 (27.6)
Private practice	18 (62.1)
University	5 (17.2)
Various schools	16 (55.2)
Socioeconomic environment of employment [c]	
Low socio-economic	7 (24.1)
Middle socio-economic	26 (89.7)
High socio-economic	17 (58.6)
Years of experience with DCD intervention	
No experience	3 (10.3)
Less than one year	1 (3.4)
1 – 3 years	6 (20.7)

4 – 5 years	6 (20.6)
More than 5 years	13 (44.8%)

[a] Some participants work in more than one province.
[b] Some participants work in more than one setting.
[c] Some participants work in more than one socioeconomic environment.

Table 5.3. Statements and questions reaching consensus in round one of the e-Delphi survey.

Section	Statement or question	Level of consensus
Additional role players	• Other role-players should be involved and play an essential role in the success of a motor intervention program.	97%
	• Role players that should be included are:	
	○ Class teachers.	97%
	○ Physical education teacher.	100%
	○ Parents.	100%
	• Kinderkineticist should provide advice to the role players on the abilities of a child with DCD.	83%
	• Kinderkineticist should provide advice to the role players on the difficulties of a child with DCD.	90%
	• Kinderkineticist should provide advice to the role players on how to assist the child with DCD.	93%
Assessment tools for the identification of a motor intervention program	• The following suggestions of assessment options to identify possible DCD and assist in goal-setting have been identified:	
	○ Motor proficiency tests.	100%
	○ Parent and/or teacher-reported questionnaire.	100%
	• The test items and subcomponents in a motor proficiency test help identify the child's motor skill difficulties level.	90%
	• Information resources to determine the environmental context and psychosocial factors of the child:	
	○ Medical history.	83%
	○ Parents reports and/or feedback.	97%
	○ Teacher reports and/or feedback.	97%
Goal-setting	• Individual goals should be considered for a motor intervention program	97%
	• The following factors and/or viewpoints should be considered when planning goal-setting:	
	○ The health of the child.	97%
	○ Strength and weakness of the child.	86%
	○ Physical factors.	93%
	○ Self-concept.	83%
	○ Activities of daily living.	86%
	• At the end of the motor intervention program, the child should have increased/improved:	
	○ Participation in physical activity.	97%
	○ Well-being.	97%
	○ Body functioning.	90%
	○ Motor skills.	86%
	○ Motivation.	86%
	○ Functional tasks.	93%
	○ Activities of daily living.	97%
	○ Execution of challenging activities.	93%

Table 5.3. continued

Section	Statement or question	Level of consensus
Types of a motor intervention program	• A combination intervention approach is the best approach for a motor intervention program for DCD children.	83%
	• Body function-oriented intervention options to use:	
	○ Perceptual motor intervention.	100%
	○ Fundamental motor skill intervention.	86%
	○ Motor skill training.	83%
	• Apparatus/Equipment to use in a motor intervention:	
	○ Playground apparatus.	90%
	○ Basic physical education apparatus.	100%
	○ Therapeutic equipment.	100%
Group and/or individual mode	• Factors to consider for group intervention:	
	○ Size of the group.	100%
	○ Manageability.	100%
	○ Instructions.	100%
	○ Effectiveness of motor intervention.	100%
	○ Professionals available.	90%
	○ Motor skill ability of the child.	96%
	○ Ability to monitor individual progress.	100%
	○ Age of the child.	83%
	○ Psychosocial factors of the child.	93%
	○ Goals of the motor intervention program.	100%
Setting	• Therapy-based intervention is the most beneficial.	90%
Duration, frequency and number of sessions	• Consider the child's age.	100%
	• A session should be between 30 to 45 minutes.	88%
Evaluating the motor intervention program	• MABC-2 to evaluate the effectiveness of intervention.	93%
	• Aspects to evaluate the effectiveness of a motor intervention program:	
	○ Evaluate the effects of the intervention program.	100%
	○ Evaluate if goals are reached.	90%
	○ Determine if further intervention is required.	93%

Table 5.4. Statement and questions reaching consensus (≥ 80%) in rounds two and three of the e-Delphi survey.

Section	Statement or question	Level of consensus
Additional role players	• Provide clear instructions on when to stop assisting.	97%
	• Role players that should be included are:	
	○ Additional caregivers	83%
	○ Other therapists, currently working with the child.	90%
	○ Occupational therapist.	90%
	• Provide general guidelines to the role players on daily living participation.	83%
Assessment tools for the identification of a motor intervention program	• The child's age determines assessment tools to use in goal-setting.	100%
	• Screening/testing options should be used depending on the child's problems.	93%
	• Assessments and/or checklist should be used to determine underlying problems that cause movement difficulty.	100%
	• Tests evaluating underlying neuromotor components should be used in setting goals for motor intervention.	86%
	• MABC-2 is the gold standard and should be used.	100%
	• BOT-2 can be used as an additional test.	100%
	• TGMD-3 can be used as an additional test.	86%
	• DCD Q'07 can be used as an additional screening.	100%
	• MABC-2 Checklist can be used as additional screening.	100%
	• PDMS-2 can assist if a young child shows DCD's characteristics features and determine the need for ongoing monitoring.	86%
	• The START checklist can be used as an additional test to evaluate the impact of motor difficulties on the child's daily performance.	90%
	• Factors that will determine which information to use to determine the environmental context and psychosocial factors for the child with DCD:	
	○ Age of the child.	97%
	○ Where the problem occurs (school or home).	100%
	○ Living conditions of the child.	97%
	○ Resources available to use.	100%
	• The following information resources should be used to identify the child's environmental and psychosocial factors associated with DCD:	
	○ Clinical examination, if available.	93%
	○ Child self-report if the child is old enough.	90%
	○ The results of a motor proficiency test.	90%
	○ A family lifestyle report.	90%

Table 5.4. continued

Section	Statement or question	Level of consensus
Goal-setting	• Individual or group-based intervention will help determine the goals of the motor intervention program.	90%
	• The child's baseline ability level will determine what the goals for the motor intervention program will be.	100%
	• If group intervention is used, each child's problems should be used independently to determine goals.	86%
	• Emotional goals to boost the child's self-esteem through movement should be considered if emotional problems are experienced.	100%
	• Functional goals for each individual should be used to determine the goals of the motor intervention program	97%
	• Sport-specific goals should be considered if the child is old enough and want to participate in a specific sport or struggle with a sport.	93%
	• The child should experience joy while moving.	100%
	• The following factors and/or viewpoints should be considered when planning goal-setting for a motor intervention program:	
	○ Childs' viewpoint if the child is old enough.	97%
	○ The child's family's viewpoint is if they play an active role in the child's life.	86%
	○ Emotional factors.	93%
	○ Psychosocial factors.	93%
	○ If a child experience problems with general fitness.	93%
	○ Environmental factors.	83%
	○ Peer interaction.	83%
	○ Self-care of the child.	83%
	○ If the child struggles with specific skills used to participate in free play activities.	97%
	○ Academic performance if it is a problem within the child.	83%
	○ General problems.	93%
	○ Social support.	86%
	○ The social ability of the child.	83%
	• If sport-specific goals are considered for the motor intervention program, the Kinderkineticist should first start with fundamental movement skills that are the building blocks of sport-specific skills.	100%
	• Long-term health, well-being, body functioning, motor skills, general fitness, psychosocial factors, motivation, functional tasks, daily living activities, emotional skills, social skills, and participation in play activities, sports activities, physical activities are all interlinked with each other. If one link is not working, it will affect the rest of the factors	90%
	• In order to determine if improvement has occurred, improvement should be measurable.	86%
	• Improvement, even if it is just 1%, can be celebrated.	100%

Table 5.4. continued

Section	Statement or question	Level of consensus
Types of a motor intervention program	• The selection of intervention approaches types will depend on the problems experienced.	97%
	• The most appropriate intervention approach should first be selected and combined with interventions from other approaches to address specific problems.	100%
	• The choice of additional body function and/or activity and/or participation oriented intervention will depend on:	
	○ Outcomes the Kinderkineticist wants to achieve.	97%
	○ Problems the child experience.	100%
	○ Functional problems the child experience	100%
	• Apparatus and/or resources to use in intervention:	
	○ Age-appropriate sport-related equipment.	100%
	○ Visual apparatus.	97%
	○ Apparatus used for daily living.	90%
	○ Academic apparatus if academic problems occur.	90%
	○ Fine motor apparatus	83%
	• The situation/s in which the child with DCD finds himself/herself should be considered a factor before choosing the type/s of interventions to use.	86%
	• Part of the motor intervention program should be child-centered, setting their own goals if they are old enough.	93%
Group and/or individual mode	• A combination of individual-based intervention with group sessions is the best option to use for motor intervention.	83%
	• The size of the group would depend on:	
	○ Age of the child.	100%
	○ Skill level of the child.	100%
	○ The cognitive capacity of the child.	97%
	○ The ability of the child to follow instructions.	97%
	○ Sensory profile of the child.	86%
	○ The attention span of the child.	100%
	• Children who experience severe problems should be 2–3 in a group.	93%
Time of motor intervention program	• The time of the day a motor intervention program will be presented will depend on a child's:	
	○ Age.	90%
	○ Energy levels.	83%
	○ Concentration level.	93%
	○ When the child eats.	86%
	○ When the child sleeps.	93%
	○ The availability of the venue or location.	93%
	○ The availability of transport.	93%
	○ Blood sugar levels of the child.	93%
	○ Self-regulation of the child.	86%
	○ School schedule of the child.	100%

Table 5.4. continued

Section	Statement or question	Level of consensus
Durations, frequencies, and sessions	• The duration, frequency and amount of sessions will depend on the _______________ of the child.	
	○ Prognosis.	100%
	○ Progress rate.	97%
	○ Needs.	93%
	○ Extend of the difficulties/severity of the problems.	100%
	○ The financial status of the parents/caregivers.	97%
	○ Cognitive ability.	90%
	○ Number of functional areas that require attention.	93%
	○ Integration of skills and how to sustain these skills.	97%
	○ Goals that need to be achieved by the child.	97%
	○ The willingness of the child to participate.	97%
	○ Whether the child is committed to the home programs provided.	97%
	○ If the child experiences regression after a while without intervention.	97%
	○ How many sessions per week the child receives.	100%
	• Parents/caregivers should exercise with the child daily when the child does not receive the intervention.	93%
	• The length of a session will depend on the ____________ of the child with DCD:	
	○ Concentration level.	97%
	○ Age.	100%
	○ Endurance capacity.	100%
	• If the motor intervention program is presented three times a week, the therapist conducts the therapy twice a week, and the parents conduct the therapy once a week at home.	97%
Evaluating the motor intervention program	• The same test was used as the child's initial assessment to identify DCD before the motor intervention program should be used to determine if real progress was made.	100%
	• Various assessment tools should be used to determine the progress on different aspects of the child with DCD.	90%
	• It is important to evaluate whether there were any aspects of the motor intervention program that was unsuccessful.	93%

5.4 DISCUSSION

Despite the CPR-DCD recommendations for intervention in a clinical setting (Blank *et al.*, 2019) and the best practice guidelines for DCD intervention provided during training for Kinderkineticists (Pienaar, 2020), the research aimed to develop a motor intervention framework for children with DCD or possible DCD derived from Kinderkinetics experts within the South African context. The experts identified ten main aspects (intervention planning; goal-setting; intervention approaches; intervention apparatus; intervention delivery mode; additional role players; settings; dosage (time; duration, frequency and number of sessions); and evaluation) to form the foundation of the motor intervention framework. The statements reaching agreement and forming part of the final framework as stipulated in Table 5.3, Table 5.4 and Figure 5.2, are highlighted in this discussion. The percentages in brackets demonstrate the agreement.

The participants (28/29) stated that before choosing the resources to obtain information regarding the child's environmental context and psychosocial factors, their age (97%) should be determined. This was supported by the literature that the child's age is an indication of the development level and should be used for planning intervention (Blank *et al.,* 2019). In order to plan the motor intervention, the setting where the problem occurs (100%), the child's living conditions (97%) and the resources available (100%) should further be established, as emphasised in Table 5.4. These results correlated with Blank *et al.* (2019) and further pointed out that the child's personality should also be considered. Various resources to collect the information mentioned above (Tables 5.3 & 5.4) include a medical history report (83%), parent and teacher questionnaire (97%), age-appropriate child self-report (90%), family lifestyle report (90%), clinical examination (if available) (93%) and the results of a motor proficiency test (90%) to determine environmental and psychosocial factors. This information will assist with goal-setting.

The participants agreed (100%) that the child's baseline ability level should be considered for goal-setting. Furthermore, the child's health (97%), strength and weaknesses (86%), physical, environmental (93%), psychosocial factors (93%), own viewpoint (97%), general fitness (93%), peer interaction (83%), self-care (83%) and academic performance (83%) should be considered when setting the goals. The results correlate with the literature that highlighted the importance of considering the environmental strengths and weaknesses that the child experiences (Blank *et al.,* 2019), and the importance of considering all factors that can relate to the different problems present in the child to assist in planning and goal-setting (Biotteau *et al.,*2017; Lucas *et al.,* 2016; Smits-Engelsman *et al.,* 2018). The psychosocial and emotional factors of the child assist with goal-setting (Blank et al., 2019) and can provide the therapist with information to determine if the emotional aspects identified in the child should be incorporated into the intervention program (Draghi et al., 2020). Lastly, 27 of the 29 participants highlighted general fitness (93%) as essential to consider for goal-setting and agreed with the literature that physical fitness is recommended during goal-setting, due to many children with DCD who experience overweight and obesity (Blank *et al.* 2019).

The results further demonstrated that the family's viewpoint (86%) should be considered if the family plays an active role in the child's life. The results were supported by the literature indicating that the family and the child's viewpoint should be considered for setting goals (Blank *et al.*, 2012; Blank *et al.*,2019). Setting goals will further be established by environmental factors (83%) recommended by the e-Delphi results (Table 5.4) and is in agreement with the recommendations by Blank *et al.* (2019). The APA (2013) has determined that environmental factors can increase DCD risk and should be considered during motor intervention. DCD is further known to impact daily living activities, and therefore the e-Delphi emphasised consideration of these activities for goal-setting. Blank *et al.* (2012) have pointed out that the goals should be to increase daily living activities comfortably. All the participants (100%) further had a strong feeling toward ensuring that intervention should be joyful and set as one of the motor intervention goals. The reason for a joyful intervention could be to invest the importance of movement throughout life and enhance physical activity and sport participation, which improves motor skills and lowers possible DCD as well as improve better cooperation during therapy (Ferguson *et al.*, 2015). The results further pointed out that if sport-specific goals were considered for the motor intervention program, the Kinderkineticist should start with fundamental movement skills required as the building blocks of sport-specific skills (100%).

This study's results have found that the goals should be determined by using motor proficiency tests. The Movement Assessment Battery for Children-2 (MABC-2) (100%), with additional tests such as the Bruininks Oseretsky Test of Motor Proficiency-2 (BOT-2) (100%), the Test of Gross Motor Development-3 (TGMD-3) (86%) and the Peabody Developmental Motor Scales-2 (PDMS-2) (86%) for younger children, were recommended. The MABC-2 has been identified as the gold standard to identify motor difficulties (Blank *et al.*, 2019; Schoemaker *et al.*, 2012), whereas the BOT-2 has also been pointed out in the literature to use as a possible assessment for possible DCD (Blank *et al.*, 2019). All the participants further agreed (100%) that parent and teacher questionnaires could help with goal-setting. It has been recommended that the Developmental Coordination Disorder Questionnaire '07 (Blank *et al.*, 2019) and the MABC-2 Checklist (Schoemaker *et al.*, 2012) be used by parents and teachers. Another example highlighted by the results is the Short-Term Assessment of Risk and Treatability (START) tool (90%) that can be used to evaluate the impact of motor difficulties on the child's daily activities. The tests results should give an indication of the child's level of motor difficulties and specific motor skills the child struggles with, that should be used for goal-setting, as stipulated by the e-Delphi survey. The findings correlated with reports in the literature giving prominence to the importance of considering the child's activity level for setting goals in an intervention program (Blank *et al.*, 2019).

The results of the e-Delphi further confirmed that the physical activities and play activities (97%) of the child should show improvement by the end of the motor intervention. The findings are supported by Smits-Engelsman *et al.* (2018), who stated that if specific skills were improved during the intervention, play activities will improve. The researchers specified that fundamental movement skills should be a goal for the intervention and improve general skills and specific skills (Smits-Engelsman *et al.* 2018). Improved specific skills will increase sports activities in children (Smits-Engelsman *et al.*, 2018). Other aspects identified by the participants that should improve after the motor intervention has been conducted, are motor skills (86%), functional tasks (93%), daily living activities (97%) and challenging activities (93%). It has been documented that children with DCD struggle with participation in activities and have lower functional abilities, which should be addressed during the intervention and show improvement by the end of the intervention (Delgado-Lobete *et al.*, 2020).

Improvement in the skills mentioned above will increase motivation (86%), which was another aspect highlighted in the e-Delphi survey that should be reached. Ashkenazi *et al.* (2013) has established that focusing on the correct goals could increase the child's motivation. The overall independent participation in meaningful life areas should be improved after the motor intervention and is therefore important for goal-setting. The results are in accordance with Blank *et al.* (2019), who stated that interventions should be transferred to daily participation in real-life activities.

The results of the e-Delphi (Table 5.3) determined that individual goals (97%) should be used in planning and were in agreement with Blank *et al.* (2019). They stated that the child's individual goals should be the primary focus when planning the intervention program. One of the additional goals to use during the planning of the motor intervention, on which the participants reached consensus, was that goals should be set by the child itself. However, the child's selection of goals should only be conducted if the child is old enough. It has previously been questioned in the literature if it would be beneficial for children to choose their own goals, as increasing anxiety levels and task engagement were reported (Caçola *et al.,* 2016; Zwicker *et al.,* 2015). Furthermore, it will not improve self-efficacy participation in physical activity (Zwicker *et al.,* 2015). The results included functional goals (97%), emotional goals (100%) and sport-specific goals (93%) as other types of goals to consider. Emotional goals should be set only if emotional problems are experienced (100%) and sport-specific goals (93%) should be age-appropriate. It has been reported that sport-specific skill training can effectively improve motor abilities (Caçola *et al.,* 2016).

The goals will further influence the type of intervention that will be chosen. Even though various intervention approaches are available, all the participants agreed that a combined motor intervention approach (100%) should be used by selecting the most appropriate approach and combining it with some of the other approaches. These results were in contrast to findings in the literature that stipulated using a task-oriented approach, more recently known as the activity-oriented approach (Blank *et al.,* 2019; Yu *et al.,* 2018). However, one reason for choosing the combined approach is that it addresses the various problems related to DCD (Biotteau *et al.*,2017) and it is part of the Kinderkineticist training during the degree course (Pienaar, 2016:232). The participants agreed (97%) that the different approaches should be selected according to problems the child experiences. The combined approach has pointed out that many of the approaches described in the literature include aspects or characteristics of other approaches (Lucas *et al.,* 2016). The participants' recommendation was in agreement with the statement by Wilson (2005:819), who said that a combination approach is an effective strategy to reach success with children suffering from DCD. More recently, it has been reported that body function-oriented approaches are combined with activity-oriented intervention approaches (Smits-Engelsman *et al.,* 2018). However, some participants (5/29; 17%) have suggested that there might be specific cases where only one approach should be used, as indicated in Figure 5.2.

The results from the e-Delphi identified various apparatus that should be included in the motor intervention, such as playgroup (90%) and basic physical education (100%) apparatus, therapeutic equipment (100%) and age-appropriate sports equipment (100%). The results further indicated that visual (97%), academic (90%) and fine motor (83%) apparatus should be included when the child experiences problems in those areas due to DCD. Further comments suggested that the child's age should be a determining factor for choosing apparatus and that daily living apparatus could be included, but should not be the main focus.

Literature regarding the type of apparatus used for motor intervention programs in DCD have not been identified. The choice of apparatus will depend on the intervention type. However, it has been mentioned that hoops, ropes, ladders and outdoor equipment, which could be part of various apparatus specified by the participants, have been used in motor intervention programs (Preston *et al.*, 2017).

With regard to the mode of delivery of the intervention, participants (24/29) indicated that individual-based intervention is recommended, but could include group sessions. The results are supported by Hung and Pang (2010), who stated that individual-based intervention provides more opportunities to practice motor skills. Children do not have to wait a turn and there are fewer distractions that can influence them. Also, a group-based intervention should be used if individual-based is not possible. In a group-based intervention, the size of the group (100%), instructions (100%), manageability (100%), the effectiveness of the intervention (100%), number of professionals available (90%), motor skill ability of the child (96%), ability to monitor individual progress (100%) and the child's age (83%) should be considered. The results are supported by the available literature. Smits-Engelsman *et al.* (2018) specified the importance to manage the group in order to evaluate individual progress, and Martini *et al.* (2014) identified that the children's age levels, degree of difficulties experienced by each child and the type of problems for a group-oriented approach should be taken into consideration. The results further showed that the group's size would depend on the child's age (100%), skill levels (100%), cognitive capacity (97%), ability to follow instructions (97%), sensory profile (86%) and attention span (100%). The group sizes recommended by the participants varied, as shown in Figure 5.2, and the literature reported inconsistencies, such as groups of 5–8 children recommended by Ferguson *et al.* (2013) and groups of 4–6 children recommended by Hung and Pang (2010) and Caçola *et al.* (2016). Suggestions from the e-Delphi survey (Table 5.4) have further advised that children with severe motor difficulties should be in small groups (2–3 per group) (93%), which correlated with the literature (Hung & Pang, 2010).

Class teachers (97%), physical education teachers (100%), occupational therapists (90%), parents, additional caregivers (83%) and other therapists working with the child (90%) were a point of consensus to include in the motor intervention. This related to the literature specifying that other health professionals, parents, educational professionals, coaches and relevant others play an essential role in the intervention of children with DCD and increase the effectiveness and training opportunities (Lee *et al.,* 2016; Yu *et al.,* 2018). A small number of participants (5/29) commented that the role players will differ depending on the child's problems, to address particular problems. The literature supported this comment and specified that supportive role players create opportunities by improving various secondary problems in children with DCD (Caçola, 2014). The role players should also understand their role, as shown in Figure 5.2.

The recommended setting for the motor intervention has been identified as a therapy based setting (90%) with considering school-based and home-based settings if therapy-based is too expensive. The results agreed with previous findings that school-based settings and home-based settings are cost-effective (Ashkenazi *et al.,* 2013; Yu *et al.*, 2018:). Schools have further been identified as sustainable to keep up with the motor intervention (Blank *et al.*, 2019). Home settings provide opportunities to practice activities more frequently (Ashkenazi *et al.*, 2013). One of the participants' comments suggested that a home-based setting will depend on the child's living conditions, which was also highlighted in the literature and indicated that the home situation would be a determining factor (Lee *et al.,* 2016). The e-Delphi have further determined that a once-off therapy-based session should be conducted with continuous school- and home-based after that. This result correlates with the literature that the therapist will have to provide efficient guidelines to follow (Ashkenazi *et al.*, 2013). Some commented that parents and teachers should be motivated; otherwise, these settings will not work.

Consensus was reached regarding the time (07h00–12h00) of the day to conduct the motor intervention. The finding is important as no information is available in the literature regarding the best time to present a motor intervention. The participants agreed (ranging between 83% and 100% agreement) that various factors (presented in Figure 5.2) should be considered to determine the time of day. Another limited aspect reported in the literature is the recommended dosage (frequency, duration and number of sessions) of a motor intervention (Blank *et al.,* 2019; Lucas *et al.,* 2016). The e-Delphi survey has found it challenging to provide consensus on specific dosage indications. However, the results pointed out that the motor intervention should not be less than eight weeks. The intervention could be between 1–3 sessions per week, with sessions lasting between 30 and 45 minutes, depending on various factors (Figure 5.2). These factors will cause variation in the duration, frequency and number of sessions required for each child, and are supported by the literature stating that more than one standard exists (Lee *et al.*, 2016; Smits-Engelsman *et al.*, 2018). Smits-Engelsman *et al.* (2018), however, pointed out that interventions could be successful, ranging between 4 and 18 weeks, while Amador-Ruiz *et al.* (2018) suggested that adequate intervention could be ensured by providing three sessions a week. Lastly, the participants commented that several practice sessions per week should be provided, and agreed with the literature stating that several practice opportunities are required for a successful outcome (Blank *et al.*, 2019).

The e-Delphi survey recommended evaluation of the motor intervention's success informally (on or before 3 months) and formally (after 3–6 months), and again after a break of 8 to 12 weeks to determine if retention occurred. Informal evaluation can include feedback from parents/teachers and the child, whereas formal feedback will be determined using a motor proficiency test, the same as before starting the intervention. These results are similar to the CPR-DCD recommendations indicating that formal standardised assessment should be repeated at the end of the intervention, and at least every three months afterwards when intervention has been conducted for a longer period of time, to determine the effectiveness (Blank *et al.*, 2019). The results should be used to determine if goals were met and whether more extended intervention is required (Blank *et al.*, 2019). Based on the e-Delphi survey results and findings reported in the literature, the motor intervention framework in Kinderkinetics for children with DCD or possible DCD was developed and is presented in Figure 5.2. The framework presents the Kinderkineticist with a guideline to use when conducting a motor intervention program for children with DCD or possible DCD.

Collecting data from participants using an online medium was a cost-effective way of collecting information anonymously between participants. The online survey provided an opportunity for the participants to provide input on motor intervention for children with DCD or possible DCD. The survey was of great value due to the 100% response rate and the number of experts who participated in the study. The researcher's continuous communication with the participants has ensured the success of receiving feedback. Another advantage was that the participants were experts in Kinderkinetics, contributing to the significance of the results. A limitation identified was that the software used did not have a save option, which required the participants to complete the survey in one session, which could have been strenuous. Another aspect to consider was that some participants felt that they required a longer time to complete the questionnaire. An indication of 20 minutes might not have been the correct estimate. The participants provided different opinions because their scope (environments, schools, multidisciplinary approach) varied which had an effect on obtaining consensus for all factors. Lastly, although the participants were experts in Kinderkinetics a limitation of the study was that the number of years the participants have experience with DCD children was not considered as a prerequisite for the e-Delphi which might be a reason for the various opinions from the participants, therefore it should be considered for future e-Delphi survey's where experts' opinions are required.

5.5 PRACTICAL APPLICATION

This research has significant value. It provided incisive and unique feedback and input from experts in Kinderkinetics to develop a motor intervention framework for children with DCD or possible DCD in South Africa. This framework can be used as a guideline by Kinderkineticists when working with children with DCD or possible DCD. Future research can focus on refining the framework to a more specific motor intervention program with recommended specific intervention types, elements of the intervention program, physical and informational materials required, mode of delivery, location and infrastructure requirements, exercise prescriptions (frequency, intensity, timing) and dosage (duration, number of sessions). Apart from the South African context, it could be promoted internationally, especially in developing countries, to determine its efficacy and the outcomes of its application in different cultural and socio-economic settings.

5.6 CONCLUSION

The outcomes of this research led to the proposal of a motor intervention framework for Kinderkineticists to use in children with DCD or possible DCD. The results identified ten aspects that should be considered and form the foundation of the framework. It has further been established that children with DCD are heterogeneous and that problems in each child with DCD differ according to type and severity. The heterogeneity will directly impact planning of the intervention, setting the intervention goals, choosing the intervention approaches, deciding if an intervention should be individual or group-oriented, and determining the duration, frequency, and number of motor intervention sessions. A few aspects were hightlighted in the feedback from the experts that was not presented in previous literature and add to the uniqueness of the motor intervention framework.

An aspect that was only identified in this framework that differ from the literature is the importance of considering the child's personality when planning the motor intervention. The findings further agreed with the literature that the family's viewpoint of the child with DCD for motor intervention planning should be considered, however the experts emphasized that this will only be applicable where the family plays an active role, as many children do not experience involvement of their family, especially in low SE environments of SA. Sport specific skills were highlighted as important in the framework and emphasis was put to first start with fundamental movement skills that is the building blocks of the sport-specific skills. Furthermore, the experts identified the same assessment tools pointed out in the literature to assist with determining goals but have also added the START tool to evaluate the impact of motor difficulties on the chidl's daily activities as an additional tool that should be used.

Controversies exists in the literature whether the child should be allowed to set their own goals for the motor intervention. The experts provided the guideline that children should be allowed only if they are old enough and under the supervision of the therapist. An aspect that is clearly unique is that a combined approach is recommended to use according to the framework of this study and not the recommended task-oriented approach as indicated in the literature. The experts are of the opinion that various problems can be addressed and it is also part of their training as a Kinderkineticist. Another unique aspect is that the therapist should choose the apparatus according to the child's age and that daily living apparatus that is included should not be the main focus, which has not been reported in the literature findings. Although agreement with the literature was also reported by the experts that teachers and parents should be included in the intervention, the experts further emphasized that these role players should be motivated otherwise intervention will not be successful at home and at the school. Lastly an indication of time of intervention was made that has not been provided in the literature and the guideline to follow will be in the morning between 7am and 12pm. Even though the literature findings could not provide clear indications of dosage of the motor intervention, the guidelines recommended by the experts to follow are that the motor intervention should not be less than eight weeks, with one to three sessions per week and each session being between 30 to 45 minutes. This is a great contribution to the guidelines of the motor intervention programme.

The research provides a valuable framework developed for Kinderkineticists in South Africa and will play a valuable role in assisting children with DCD or possible DCD.

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Intervention planning
- Consider child's age, living conditions, problems experienced; resources available.
- Collect environmental and psychosocial factors by using specific information resources.

Goal-setting
- Assessment methods, various factors, aspects and viewpoints; outcomes of intervention should be used and considered for goal-setting.
- Individualised goals (main focus); additional functional-, emotional-, sport-specific (age appropriate) and child-centered goals.

Intervention approaches
- Combined (preferred)
- Choice of motor intervention depend on: outcomes to achieve, severity and type of problems, situation of the child.
- Body function-oriented = independently if a child does not like a specific activity and improvement can occur using similar activities.
- Activity-oriented = used independently when a child struggles to reach the goal of a few activities with the same outcome.
- Participation-oriented = independently if a skill causes negative emotions in everyday routine and in older children 11–12 years.

Intervention apparatus
- Playground, physical education, sport (age appropriate), visual (if problem is present), daily activity, academic (if problem is present), fine motor equipment.

Intervention delivery mode
- Depend on level of motor ability, nature and extent of problems, availability of resources.
- Individual – recommended
- Size of group depends on age, skill level, cognitive capacity, ability to follow instructions, social profile, and attention span of the child.
- Group sizes: severe problems = 2–3; low-moderate problems = ≤9; short attention span = ≤7; 5–6 years = ≤9; 7–10 years = 3–9; 11–13 years = 3–11.

Additional role players
- Class and physical education teachers, occupational therapists, parents, caregivers, others working with the child.
- Role players should understand their role, the abilities and difficulties of the child, and instructions and general guidelines to participate in daily activities.

Settings
- Therapy-based (preferred)
- School-based
- Home-based (if parents are involved)
- Once-off therapy-based, with continuous school- and home-based thereafter.

Time of intervention
- Consider various factors before determining time of day: child's age, energy levels, concentration levels, eating times, sleeping times, blood sugar levels, self-regulation, school schedule, availability of the venue and transport.
- Best time between 07h00 and 12h00.

Duration, frequency & sessions
- Depend on various factors: child's age, prognosis, progress rate, needs, severity of problems, willingness to participate, financial status, commitment of home programs, if regression occurs, amount of sessions per week.
- ≥ 8 weeks
- 1–3 times per week
- Length of a session depend on age, attention span and endurance of child
- ± 30–45 minutes

Evaluation of motor intervention

Informally every 4–8 weeks.
Formally every 3–6 months.
Evaluate the effect of intervention, goals reached, is further intervention required, what was unsuccessful in the intervention.
8–12 week break before evaluating if retention occurred.
Test only once after the break.

Figure 5.2: Kinderkinetics motor intervention framework for children with DCD or possible DCD.

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CHAPTER 6

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

6.1 Summary

The three objectives set for the research study were: (i) firstly, to determine the prevalence of possible developmental coordination disorder (DCD) in Grade 1 (Gr.1) learners in a low socio-economic (SE) environment in Mangaung, South Africa (SA), using the Movement Assessment Battery for Children 2nd edition (MABC-2) Performance Test; (ii) secondly, to establish teachers' ability to identify Gr. 1 learners with possible DCD in low SE environments using the MABC-2 Checklist; and (iii) finally, to use an e-Delphi survey to develop a motor intervention framework for children with DCD in the field of Kinderkinetics within the South African context. Chapter one provided the introduction, background, problem statement, research questions and study objectives. The thesis is submitted in article format and includes a literature review (Chapter two), three articles (Chapters 3–5) and a concluding chapter (Chapter six). The articles were submitted to accredited journals for peer-review, and article one (Chapter three) has already been published. Article two (Chapter four) has been provisionally accepted, pending minor revisions requested by the reviewers, and article three (Chapters five) has been submitted for possible publication and is under peer review at the time of completion of this thesis.

Chapter two provides an in-depth literature review addressing the scope of the current study and the set objectives. The chapter presents literature findings related to the assessment and identification of DCD and interventions proposed to manage DCD in the global and local context, as well as motor abilities in children being raised in low SE environments related explicitly to SA. First, the relevant terminology and definitions of DCD have been provided. Secondly, the prevalence of DCD or possible DCD in various countries, determined by means of different assessment methods, was investigated, as well as the prevalence of possible DCD in low SE environments. In terms of SE environments, the components used to determine a person's SE status were described with detailed information on low SE environments in SA and its impact on motor performance and DCD. The characteristics and symptoms experienced by children with DCD and the aetiology of this disorder have been described. Subsequently, an investigation of the diagnosis and different assessment methods used to identify DCD were described with detailed information on the MABC-2 Performance Test and Checklist. Next, a description of the teacher's role in using the MABC-2 Checklist as a screening tool was provided. Lastly, DCD intervention approaches with specific relevance to planning, goal setting, delivery mode and dosage relevant to the aims of this study were highlighted.

The literature review confirmed that various prevalence rates of DCD, ranging from very low to very high, have been reported in different countries. Furthermore, a considerably high prevalence was reported in the limited number of studies that had been conducted in SA. Many children live in low SE environments in SA with resource constraints (such as educational resources and access to physical education experts and sports facilities) and factors that negatively influence their motor ability (for example, the lack of parental involvement, living in an emotional and physically demanding environment and poverty). Although studies published in the literature mainly determined a higher prevalence of motor difficulties in low SE environments, the opposite has also been reported. It has been established that motor performances in specific tasks, such as balance and gross motor skills, might be more advanced in children living in low SE environments. However, it has become evident that information on the prevalence of DCD in SA is insufficient, especially regarding the situation in low SE environments.

Taking into consideration that motor difficulties are the main problem experienced in DCD, various other characteristics have been highlighted in the literature review. Therefore, it is evident that children with DCD are a heterogeneous group and children's daily performance tasks are affected, resulting in reduced physical, emotional, and social well-being. The literature review confirmed that DCD can co-exist with other disorders such as attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder (AS). The co-existing conditions can be one of the factors that contributes to the cause of DCD. Despite the co-existence, the cause of DCD described in the literature review specified that no definitive aetiology for DCD has been identified. Factors that may contribute to the condition include neonatal causes, neurological reasons, genetics and environmental factors. Further important aspects have been highlighted regarding the identification of DCD.

The literature review has confirmed that the criteria proposed in the Diagnostic Statistical Manual of Mental Disorders 5th edition (DSM-5) are the preferred resource for evaluating

DCD. The MABC-2 Performance Test was identified as the primary objective standardised assessment tool to determine the first part of Criterion A ('acquiring and executing coordinated motor skills are far below the expected level for age') of the DSM-5 (American Psychiatric Association [APA], 2013:74). The Developmental Coordination Disorder Questionnaire '07 (DCDQ'07) completed by parents was identified as one of the preferred screening methods to address Criterion B of the DSM-5 in the literature (APA, 2013:74). It has been asserted in the literature that parents are not always available to complete this questionnaire in low SE environments, a tendency that was also observed in this study's population. Some parents have also been found to have inadequate understanding to complete the questionnaire due to language and literacy barriers (Engel-Yeger, Rosenblum & Josman, 2010:93).

Consequently, it can be suggested to administer a structured interview with the parents. However, parents' work responsibilities (extended hours) cause fewer interactions with their children during the day. The parents might find it challenging to observe motor difficulties in their children (Kalam, Francke, Jainodien, Petersen, Silo & Turnbull, 2016:61). Teachers can therefore be used to identify children with motor difficulties, and then refer them for further diagnostic assessment where more insight into the functioning at home and in the community can be obtained. However, class teachers vary with regard to their level of experience that might influence how they evaluate children's motor abilities. The experience referred to can be explained as follows: (i) some teachers have substantially more years of teaching experience than others; (ii) some teachers have a qualification to teach physical education, whereas others do not have this specialised qualification; and (iii) some teachers' lack of experience might cause them to miss a child with motor difficulties, or teachers might over-identify them as having motor difficulties even when it is not the case. The MABC-2 Checklist has been proposed in the literature as one of various screening tools to be completed by teachers to facilitate the identification of motor difficulties. However, limited research has been conducted regarding the practicality, suitability and feasibility of the MABC-2 Checklist to be used by teachers in low SE environments in SA.

In addition to the numerous screening tools and methods to evaluate possible DCD in children, various intervention approaches have also been described in the literature. Published research findings emphasise the importance of motor intervention for children with DCD. The international clinical practice recommendations on the definition, diagnosis, assessment, intervention and psychosocial aspects of DCD (CPR-DCD) (Blank et al., 2019:244) have provided guidelines for intervention in children with DCD. However, these guidelines and its feasibility have not been adapted to national standards that take culture- and country-specific policies and different environments into account. Furthermore, although various therapists, such as occupational and physiotherapists, have been referred to in these guidelines, reports on intervention strategies and guidelines for Kinderkineticists are not provided. A further shortcoming was identified regarding population-based motor intervention guidelines. A Kinderkineticist in SA can provide a motor intervention programme for children with DCD. Since motor difficulties are the main problem experienced by children with DCD, the Kinderkineticist's motor intervention role should be considered essential. The literature pointed out that specific recommendations and guidelines were not provided regarding the duration, frequency and number of intervention sessions, with specific variations also occurring in settings, role players and delivery mode.

The literature review highlighted several shortcomings regarding the objectives of this study, which include the limited availability of prevalence rates in SA, specifically in low SE environments, with the Mangaung district noted as one of the areas with many children living in low SE environments. Furthermore, teachers' ability to complete the MABC-2 Checklist in low SE environments has not been established in low SE environments of the Mangaung district in SA. It has become an important point of focus to identify feasible methods for screening motor abilities in these environments in the school setting. The findings that are available regarding the MABC-2 Checklist when completed by teachers are limited and outdated. Lastly, it has become evident that motor intervention programmes are essential to help children with DCD, although recommendations and guidelines pertaining to motor intervention specific to Kinderkinetics in SA are unavailable.

Chapter three was completed in article format with the article titled 'Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa'. The article was accepted by the *South African Journal of Childhood Education* following peer review and published in the September 2020 issue of the journal (Du Plessis, De Milander, Coetzee & Nel, 2020). The article reported on the prevalence of possible DCD in Gr. 1 learners 6–8 years of age living in low SE environments in Mangaung, SA, using the MABC-2 Performance Test. A total of 400 children were targeted in the study, of which 242 children's parents consented for their children to participate. A cross-sectional design was used and included a single testing procedure to determine the prevalence of possible DCD. All the children meeting the inclusion criteria, whose parents provided informed consent, and assented themselves to participate, were included in the study. The parents were requested to indicate on the informed consent form whether their child had any health problems, and whether the child had formally been diagnosed with a medical condition. Motor abilities were evaluated by means of the MABC-2 Performance Test to identify possible DCD. The prevalence was also compared by gender.

Results were reported using frequencies and percentages for categorical data and medians for numerical data. The prevalence was described using the 95% confidence interval (95% CI). The children were compared by gender by means of the chi-square test and Fisher's exact test. A probability level ($p \leq 0.05$) was accepted for statistical significance.

The median age of the 242 children was 6.7 years. A total of 9.9% (n=24) of the learners scored at or below the 15th percentile, indicating severe and moderate motor difficulties (possible DCD). The prevalence of possible DCD was comparable between boys (n=13; 10.5%) and girls (n=11; 9.3%) (p=0.94). Children meeting the criteria for possible DCD on the various subtests of the MABC-2 Performance Test included manual dexterity (n=67; 27.7%); balance (n=21; 8.7%) and aiming and catching (n=5; 5%). The results pointed out that children found fine motor tasks more challenging. It was found that these children's motor difficulties were higher than the reported DCD prevalence norm of 5–6% in school-aged children (APA, 2013). However, it is important to note that the reported norm of 5–6% had met the DSM-5 criteria for DCD, whereas this study only determined the prevalence of possible DCD prevalence. It could be anticipated that the prevalence of possible DCD in the current study could be higher than when a complete DSM-5 diagnosis have been conducted due to only meeting one of the criteria and challenging motor performance in low SE environments. Furthermore, the findings emphasise the need to identify children with motor difficulties as early as possible to determine which children require referral for a more definite diagnosis and treatment of DCD. Further research is necessary to establish the full extent of possible DCD in children from low SE environments using an interdisciplinary approach, identifying motor difficulties, and making a full DCD diagnosis.

Chapter four is also presented in article format. titled 'The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder'. The article was submitted to the *South African Journal for Childhood Education* and has provisionally been accepted for publication with minor revisions requested by the reviewers. This article focussed on objective two of the study and described teachers' ability to complete the MABC-2 Checklist in order to identify children with possible DCD in the school environment. A cross-sectional design was used. All the Gr. 1 class teachers of the children selected for participation in the study at the different schools were included. Out of the 242 MABC-2 Checklists completed by the teachers, 200 were used in the final analysis. The final sample included 200 children 6–8 years of age and 29 class teachers. The children were tested by the movement specialist with the MABC-2 Performance Test to determine their motor abilities. After receiving appropriate instructions, the teachers were asked to complete the self-administered MABC-2 Checklist for each child. The results determined if the children identified as having motor difficulties (possible DCD) with the Performance Test were also identified by the teachers when using the MABC-2 Checklist. The data were captured and statistically analysed using SAS version 9.4 (SAS Inc.; Cary, NJ, USA). Descriptive statistics were calculated and afterwards the Bowker's test for symmetry was calculated for paired categorical data. The signed-rank test was used to compare the total scores of the MABC-2 Performance Test and the Checklist, and the agreement was determined using the kappa (κ) coefficient and 95% confidence interval.

The results showed an inter-rater agreement of $\kappa=0.13$, indicating a slight agreement between the MABC-2 Performance Test and Checklist when all three cut-off scores ($\leq$ 5th, 6th–15th and > 15th percentile) were used. Of the seven learners identified by the movement specialist as having moderate motor difficulties, none were identified by the teachers using the Checklist. Eleven of the 13 learners identified with severe motor difficulties were similarly identified by the teachers with the MABC-2 Checklist. The results established a slight agreement ($\kappa=0.17$) between the total score of the MABC-2 Performance Test and the MABC-2 Checklist. Furthermore, a sensitivity of 85% was reported. From these results, it is clear that a teacher was less likely to identify 'less obvious' motor difficulties. The findings further indicated that of the 20 learners identified with possible DCD ($\leq$ 15th percentile) with the MABC-2 Performance Test, 17 were also identified by the teachers using the MABC-2 Checklist. The results reflected a high ability of the teachers to identify motor difficulties in children. The specificity found in the results was indicated at 58% and specified that of the 180 learners identified with the MABC-2 Performance Test without motor difficulties, the teachers only identified 105 of them without motor difficulties. Therefore, the results pointed out that children were wrongly identified with possible DCD when they had typical motor abilities according to their age. To summarise, the teachers could identify possible DCD in the low SE environment when using the MABC-2 Checklist but could not accurately identify learners without possible DCD.

From the results, it could be concluded that if teachers used the MABC-2 Checklist, the children who were identified by them with motor difficulties should be referred for a more formal evaluation to exclude those children not presenting significant motor problems. Therefore, it would not be recommended to use the MABC-2 Checklist independently, and more research on other assessment options should also be conducted. Furthermore, considering the challenges related to limited therapists in the community and school setting, it is suggested that professionals train teachers to complete the MABC-2 Checklist for children in their Gr. 1 class and then refer the child in consultation with the parents to a professional for further more detailed assessment. Another aspect to consider is that even though many children were wrongly identified with motor difficulties, it was encouraging to note that most children with actual motor problems had not been missed. Considering that it is not feasible to complete the MABC-2 Performance Test for each child by a movement specialist, the MABC-2 Checklist can be used as a starting point for identification of motor difficulties. Lastly, it would be recommended to obtain multiple perspectives, for example, from parents, the child and the teacher, to enhance the screening.

Chapter five is also presented in article format with the article titled: 'Kinderkinetics motor intervention framework for children with developmental coordination disorder: an e-Delphi perspective'. The article has been submitted to the *South African Journal for Research in Sport, Physical Education and Recreation (SAJRSPER)*, and the authors are currently awaiting reviewers' comments and feedback from the journal's editor. This article reports on the results related to objective three of the study, where a motor intervention framework for children with DCD or possible DCD was drafted as a guideline to use in Kinderkinetics. The motor intervention framework that falls within the scope of Kinderkinetics was designed on the basis of specific input from Kinderkineticists with expert experience in motor development. Their input provided a broad perspective with no specification on guidelines for age and a specific environment, but rather was the first step to refining this motor intervention framework to later include more specific requirements, such as SE environments and children of different ages. Participants included 29 qualified Kinderkineticists with an age range of 28–62 years and an average of 11.3 years' experience with children 0–13 years of age. Their contributions were based on their experience in motor intervention for children with motor difficulties and DCD. Participants completed a three-round e-Delphi survey, combined with quantitative methods, to reach consensus (80%) on statements derived from the literature review regarding motor intervention. Data were collected using the University of the Free State (UFS) EvaSys survey system. Descriptive statistics were also generated by EvaSys. If an agreement had not been reached, the statements were repeated in the next round.

A 100% response rate was obtained for all three rounds of the survey. Consensus (80% agreement) was reached for 57% (51/89) of round one questions. Furthermore, 94 comments from the open-ended questions (n=30) were reviewed and compiled into round two statements. A total of 144 statements and questions were identified and reviewed in round two. Consensus (80%) was reached on 89/144 (62%) statements, and 57 comments were compiled into statements and questions for round three, if applicable to the study. Lastly, round three consisted of 30 statements, and with consensus reached on 12 statements. The statements and consensus in all three rounds were used to develop a motor intervention framework as a guideline to use for Kinderkineticists. Ten main aspects were identified. The foundation for the framework includes generic intervention principles with specific relevance to the expert input of Kinderkineticists regarding intervention planning, goal-setting, intervention approaches, intervention apparatus, delivery mode, addition role players, settings, dosage and evaluation of the intervention. The research provided unique and collated feedback from the participants in the field of Kinderkinetics. The framework and the input from the Kinderkineticists focused on a motor intervention approach within the South African context. Apart from the South African context in the field of Kinderkinetics, this motor intervention framework could be promoted to other developing countries to determine its efficacy and the outcomes of its application in different cultural and SE settings. It is noteworthy that many similarities to the findings and guidelines proposed by Blank et al. (2019:244) were observed, despite their proposition to adjust the CPR-DCD recommendations to national guidelines.

In summary, a motor intervention framework for Kinderkineticists working with children with DCD has been developed, considering the input and consensus of experts in the field. Furthermore, the research provided a guideline for Kinderkineticists to pilot in SA as the next step in establishing the efficacy of this motor intervention framework. Consequently, if the motor intervention framework's efficacy could be established, it could be used as a guideline to set up specific motor intervention programmes when working with children with DCD. Furthermore, the motor intervention framework could be refined in future studies. The refinement should include recommended specific intervention types, elements of the intervention programme, physical and informational materials required, mode of delivery, location and infrastructure requirements, exercise prescriptions (frequency, intensity and timing) and dosage (duration and number of sessions).

6.2 Conclusions

The conclusions have been drawn from this study's results and explain how the objectives stated in Chapter one have been achieved.

6.2.1 Objective one

Chapter three aimed to determine the prevalence of possible DCD in Gr. 1 learners in a low SE environment in Mangaung, SA, using the MABC-2 Performance Test.

The conclusion drawn from the results is indicative of a possible DCD prevalence of 9.9% for the whole group, with a gender-specific prevalence of 10.5% for boys and 9.3% for girls. The results reflected a higher possible prevalence than the reported norm of 5–6%, as estimated by the American Psychiatric Association (APA, 2013:74). However, a comprehensive diagnosis has not been established. It should further be noted that the limited resources and opportunity to acquire motor skills could have affected the prevalence of DCD or possible DCD observed in this study.

6.2.2 Objective two

Objective two aimed to establish the ability of teachers to identify Gr. 1 learners with possible DCD in low SE environments by means of the MABC-2 Checklist.

With regard to the agreement between the MABC-2 Performance Tests completed by the movement specialist and the MABC-2 Checklist completed by the class teachers, only a slight agreement (κ=0.17) was found. The teachers were able to identify 17 of the children with possible DCD displaying moderate and severe motor difficulties, compared to the 20 children identified by the movement specialists (85% sensitivity); however, they incorrectly identified children with possible DCD who did not have motor difficulties (58% specificity). Of the 180 children identified without motor difficulties by the movement specialists, the teachers could identify only 105 of the children as showing no motor difficulties. These results suggest that teachers could identify Gr. 1 learners in low SE environments with possible DCD, but not those without motor difficulties. Teachers were further less likely to identify children with moderate motor difficulties and might overestimate the presence of motor difficulties. However, they were able to identify motor challenges in children and could therefore be used to recognise motor difficulties.

6.2.3 Objective three

Objective three aimed to use an e-Delphi survey to develop a motor intervention framework as a guideline in the field of Kinderkinetics for children with DCD within the South African context.

An e-Delphi with a 100% response rate over three rounds was conducted successfully, reaching consensus of 80%. From the feedback provided by the participants, the foundation for the framework was developed and categorised into ten aspects: intervention planning, goal setting, intervention approaches, intervention apparatus, delivery mode, additional role players, settings, time of intervention, dosage (duration, frequency and number of sessions) and evaluation. In summary, a motor intervention framework focusing on the ten intervention aspects to provide a guideline for Kinderkineticists in planning a motor intervention programme for children with DCD, has been developed, taking into consideration the feedback from and consensus among experts in the field.

A few aspects were highlighted in the feedback from the experts that was not presented in previous literature and add to the uniqueness of the motor intervention framework.

An aspect that was only identified in this framework that differ from the literature is the importance of considering the child's personality when planning the motor intervention. The findings further agreed with the literature that the family's viewpoint of the child with DCD for motor intervention planning should be considered, however the experts emphasized that this will only be applicable where the family plays an active role, as many children do not experience involvement of their family, especially in low SE environments of SA. Sport specific skills were highlighted as important in the framework and emphasis was put to first start with fundamental movement skills that is the building blocks of the sport-specific skills. Furthermore, the experts identified the same assessment tools pointed out in the literature to assist with determining goals but have also added the START tool to evaluate the impact of motor difficulties on the chidl's daily activities as an additional tool that should be used.

Controversies exists in the literature whether the child should be allowed to set their own goals for the motor intervention. The experts provided the guideline that children should be allowed only if they are old enough and under the supervision of the therapist. An aspect that is clearly unique is that a combined approach is recommended to use according to the framework of this study and not the recommended task-oriented approach as indicated in the literature. The experts are of the opinion that various problems can be addressed and it is also part of their training as a Kinderkineticist. Another unique aspect is that the therapist should choose the apparatus according to the child's age and that daily living apparatus that is included should not be the main focus, which has not been reported in the literature findings. Although agreement with the literature was also reported by the experts that teachers and parents should be included in the intervention, the experts further emphasized that these role players should be motivated otherwise intervention will not be successful at home and at the school. Lastly an indication of time of intervention was made that has not been provided in the literature and the guideline to follow will be in the morning between 7am and 12pm. Even though the literature findings could not provide clear indications of dosage of the motor intervention, the guidelines recommended by the experts to follow are that the motor intervention should not be less than eight weeks, with one to three sessions per week and each session being between 30 to 45 minutes. This is a great contribution to the guidelines of the motor intervention programme.

Furthermore, the guideline for Kinderkineticists should be piloted and refined as a next step in determining the framework's efficacy when applied to children with DCD in SA.

6.3 Limitations and Recommendations

The researcher strived to optimise the validity and reliability of the study. However, limitations of the study that might have possibly affected the results should be pointed out and taken into consideration when planning future research studies. The limitations include the following:

- The results of articles one and two (Chapter three & four) were obtained from one district within one province of SA. The results can therefore not be generalised to the whole province or the country and it is therefore recommended to conduct similar studies in all areas of SA with children representative of various quintile schools. A larger sample group should be used in future studies.

- The study focused on Gr. 1 learners between 6–8 years of age, which could be considered as a limited age range. More studies should be conducted with a broader age group ranging between five and 13 years to more reliably determine the prevalence of DCD or possible DCD in low SE environments in SA. Furthermore, the inclusion of a representative sample with regard to gender, SE environments and school types (both private and public schools) would be beneficial.

- A total of 400 children were recruited for objective one and two of the study. However, only 242 children took part due to only 242 parents providing consent. Strategies should be implemented in future studies to recruit more parents in providing consent for their children to participate.

- The study could only determine moderate to severe motor difficulties (possible DCD) in the participating children, and insight into the prevalence of DCD was not possible due to compliance with the DSM-5 criteria that was not established. Therefore, it is recommended for future studies to incorporate the DSM-5 criteria to diagnose DCD and provide a true reflection of the prevalence of DCD in low SE environments of SA.

- Part of Criterion A of the DSM-5 is to determine if a child receives adequate opportunity to acquire motor skills. In this study, the opportunity for adequate skill acquisition was not determined. Therefore, it will be recommended to use a SE demographic analysis survey to determine the opportunities and resources available to children in low SE environments to determine the extent of possibilities for skill development.

- The children's academic performance that is part of Criterion B of the DSM-5 was not determined and should be considered in future research by obtaining information on their academic performance (school rapport card) in the school environment.

- Part of Criterion B is that the child’s functional challenges in an environmental context and at home should be considered. This could however not be established due to language barriers experienced by parents in low SE environments. The MABC-2 Checklist is not available in the different languages of the communities. Therefore, a translator or interpreter should be used for future research, or the screening tool should be translated and then validated according to the specific measuring instructions of the checklist.

- Due to a population-based sample. It was not possible to complete a clinical examination for each child to determine compliance with Criteria C and D of the DSM-5. However, the parents did indicate whether their child suffered from a general medical condition and if intellectual impairment was present. The accuracy of the information provided by the parents could not be determined. Taking the understanding of the literature review into account, some parents in poor communities tend to have lower education levels. Therefore, the accuracy of their children's health-related information might be questioned. It is recommended to involve a physician to exclude an alternative diagnosis.

- The children's class teachers only completed the MABC-2 Checklist. It is recommended that the physical education teachers (if available) and the parents also complete the MABC-2 Checklist. If the parents could complete the MABC-2 Checklist, it could be determined whether they, as the caregivers, might be better predictors of motor difficulties in children. Another aspect that should be considered is the child's viewpoints. Therefore, interviews with parents, the teacher and the child can probably provide a holistic view on the child's motor difficulties.

- Information regarding the class teachers' level of experience and interaction with children during the day were not established and considered for the purpose of this study. Therefore, it is recommended to determine the teachers' level of experience to ascertain whether they would be able to provide valuable input when completing the MABC-2 Checklist and give an accurate indication of their observations of children's motor abilities.

- Instructions and demonstrations on completing the MABC-2 Checklist were provided to each school's Head of Department of the Gr.1 learners. The departmental head gave instructions to the teachers due to the teachers themselves not being available for the information sessions. The method of providing the instructions might have influenced the ability of the teachers to complete the MABC-2 Checklist accurately. More in-depth training with various examples before conducting the MABC-2 Checklist is recommended to ensure that teachers understand different aspects of the Checklist correctly, and errors can be avoided. The movement specialist should present this training. Consequently, in future studies, more of the MABC-2 Checklist results can be included in the data. Additionally, another recommendation would be to adapt the Checklist for SA conditions.

- Another limitation of the study was that the children were categorised as coming from low SE environments when they attended quintile one to quintile three schools. A socio-demographic analysis by means of a survey should be conducted in future studies. The survey should focus on education, cultural restrictions, poverty, resources and healthcare facilities to determine the child's SE status and consider other SE components or aspects that could directly affect a child's motor abilities.

- The study used a specific automated software programme provided by the University to conduct the e-Delphi survey. Although the software functioned well, a limitation was that it had no save option, which required the participants to complete the questionnaire in one session, resulting in challenges regarding time or input. Therefore, a save function should be available in the software options, giving the participant the choice to return and continue with the survey at a more convenient time. The save option will also increase validity and reliability, and the participants will have more time to provide thorough feedback.

- An estimated ± 20 minutes per questionnaire was provided to the participants to complete the e-Delphi survey. This specific amount of time was based on feedback provided by the two experts who piloted the questionnaire before making it available to the study participants. However, some of the participants were of the opinion that it had taken them substantially longer. Therefore, more experts should be involved in the pilot study of the e-Delphi before estimating the amount of time required to complete the questionnaire, in order to provide the participants with a more unambiguous indication of the time required for their participation. Being more prepared regarding the time required will help the participants select a time when they have sufficient time to complete the questionnaire. The results may be more reliable because adequate time will be spent to consider and answer the questions thoroughly with expert insight, and not attempting to finish the questionnaire quickly due to time constraints and other responsibilities.

- Opinions obtained from participants taking part in the e-Delphi varied mostly regarding the scope within which they work (such as socio-economic environment, school, multidisciplinary teams, ages of children, Universities, practical experience). Therefore, they have diverse experiences regarding intervention for children with DCD, which could have affected obtaining consensus. Future studies should consider using different approaches within the areas of expertise to collect information and establish sub-sections for different situations in which participants work with children with DCD. More valuable insights into each expert's individual experience and work situation should be obtained, which may provide a valuable contribution to refining the motor intervention framework developed in this study. Part of the inclusion criteria should include the number of years the participants have experience with DCD children as a prerequisite for the e-Delphi where experts' opinions are required.

- The participants did not evaluate the motor intervention framework that was developed from the opinions of the experts of the e-Delphi survey. It is recommended to let participants evaluate the final motor intervention framework through a second e-Delphi survey or by means of the nominal group technique (NGT). The NGT can be used by asking a small group of Kinderkinetics experts with many years of experience working with children with DCD to evaluate the motor intervention programme. The experts will be asked to prioritize ideas or suggestions of the group after assessing the motor intervention programme framework. The whole group participate and provide recommendations preferences to reach consensus. Final feedback can then be provided and increase the reliability and validity before piloting the motor intervention framework in a practice environment, which is proposed to be conducted in a future research study. The future research should further explore the value and effectiveness of a Kinderkinetics intervention for children with DCD.

- The motor intervention framework has been developed and is still relatively broad in its scope due to the diversity of the participants' viewpoints on motor intervention in Kinderkinetics for children with DCD. Therefore, the motor intervention framework might require more refinement and development. The refinement and development will improve the guidelines and create programmes with specific activities in the particular field of Kinderkinetics to manage children with DCD. For future studies, it is proposed to specify the motor intervention programme's content, such as the recommended specific intervention types, elements of the intervention programme, physical and informational materials required, mode of delivery, location and infrastructure requirements, exercise prescriptions (frequency, intensity, timing) and dosage (duration and number of sessions). Once consensus on the content of the framework's guidelines has been achieved, the intervention should be piloted to test its efficacy. It is further recommended that the guidelines should consider the heterogeneous nature of DCD and provide steps to adapt the guidelines to various situations.

- Although the motor intervention framework identified the importance of incorporating parents and teachers during a motor intervention, it is essential to further refine their roles in the South African context when conducting a motor intervention programme for children with DCD.

- The framework has not been tested in practice. Therefore, a substantial number of Kinderkineticists should be approached to evaluate this motor intervention framework and determine whether it could be used successfully in practice. The Kinderkineticists should have experience to remediate DCD.

6.4 General recommendations

General recommendations for practice and future research are provided in the following section.

- The term DCD confuses what is being reported when the four criteria of the DSM-5 (APA, 2013:74) are not met. The preferred term should be motor skill impairments, motor skill difficulties, or motor difficulties. Preferably no reference to DCD should be made in the case of this study, as there may be other explanations for the motor difficulties experienced by children. If the word possible DCD are used, a very good description should be used or provided on how the DSM-5 criteria has been used.

- The prevalence of possible DCD in Gr. 1 learners from a low SE environment, determined in this study by using the MABC-2 Performance Test, was found to be slightly higher than many of the other countries referred to in the literature review. However, it is essential to remember that the MABC-2 Performance Test norms are based on the validation sample representative of a United Kingdom population of children. A validated sample representative of the SA population pertaining to norms of the MABC-2 Performance Test does not exist. Due to the United Kingdom being a developed country and SA a developing country, the prevalence of possible DCD cannot be compared accurately, and inevitably, differences will occur. It is therefore proposed to establish norms specifically for children in SA. Establishing norms for the SA context will require a stratified sampling plan to represent children from each province, district, demographic group, different age groups, gender, ethnicity and educational level. Furthermore, the sample should be of a sufficient size to identify and validate norms for SA.

- Various standardised motor assessment tools are available to be used by therapists, parents, teachers and children in different countries to identify motor difficulties in children. However, these motor assessment tools are expensive, especially in developing countries where financial constraints have to be kept in mind. The available motor assessment tools have not been developed in SA and did not take SA demographics, resource availability, cost-effectiveness and cultural factors into consideration. Therefore, a motor assessment tool should be developed and standardised for therapists, teachers and parents to use within the SA population. A local motor test tool will determine motor difficulties in children as the first step. Thereafter, children with motor difficulties can be referred for further diagnostic evaluations to determine the presence of DCD. The child will then receive the necessary support. A South African developed screening tool will ensure that developing countries' restrictions are taken into consideration and must incorporate different sports and opportunities applicable to SA, in addition to the cultural and SE diversity of SA. This motor assessment tool, however, should be standardised and validated prior to use in practice. It should also be kept in mind that developing such a motor assessment tool will be time-consuming.

  In the meantime, investigating the most relevant screening tools available to identify possible DCD in low SE environments is recommended to ensure earlier detection of children presenting with difficulties at school and home. Children should be screened for possible DCD at an early stage from five years of age to facilitate motor intervention without delay and prevent secondary challenges throughout childhood, adolescence and adulthood.

- The results presented in this thesis provided insight into teachers living in low SE environments' ability to identify possible DCD when using the MABC-2 Checklist. The results showed that teachers could identify children with DCD (85% sensitivity). Schools are a suitable environment for early detection of motor difficulties that may impact scholastic performance and development of strategies to improve the abilities of children with DCD. Although teachers could identify motor difficulties, they over-identified children with motor problems who did not exhibit difficulties on the professional, detailed, standardised assessment. It can be anticipated that over-identifying of children with possible DCD could be attributed to teachers' lack of exposure to the assessment tool and their lack of training to identify less evident motor difficulties. Therefore, the MABC-2 Checklist may be suitable to identify motor difficulties, but should not be applied as a single screening option. It is important to note that norms and standards for children in SA do not exist for the MABC-2 Checklist. Developing SA norms for the MABC-2 Checklist is recommended. The SE circumstances of various countries and culture-specific needs should be considered when adapting the MABC-2 Checklist for the SA context. Lastly, because of the limited or unsuitable screening tools available for teachers in low SE environments in SA, it is essential to conduct research on more screening instruments to use.

- There is a need to focus on screening school-aged children in a community setting (home and school) in South Africa. It is recommended that the escalating universal system of surveillance, screening and evaluation to ultimately identify and diagnose children with DCD be followed (Lipkin, Faap, Macias & Faap, 2020:12). The American Academy of Pediatrics reported that there is a shortage of paediatric healthcare professionals, including physicians and therapists, to meet children's developmental needs, even in high-income countries (Lipkin et al., 2020:10). The limited number of professionals is an even more significant challenge in low- to middle-income countries such as SA. Therefore, attention should be paid to feasible means of screening children in the community (by parents, local clinic sisters) and at school (by teachers) to identify children at risk of developmental challenges. Children with these problems need to be channelled to healthcare professionals for comprehensive evaluation and diagnostic testing where indicated.

- In SA the environment may affect motor performance through increased risk of inadequate opportunity for practice and medical conditions (malnutrition). The high burden of environmental risk for children from low SE environments will in effect make it difficult to assign formal diagnosis of DCD to a child presenting motor difficulties. Therefore, it should be recommended to address aspects such as undernutrition and opportunity before completing a formal diagnosis. The focus in SA should rather shift away from DCD and more on motor skill impairments whilst addressing the underlying impairments of body structure and function (nutritional status, muscle strength, decreased balance, etc). If impairments, then persist, further investigation into the possibility of DCD can be pursued.

- The public school services should be made more aware of children having limited access to and experience of participation in motor activities and the lack of assessment services for DCD. Therefore, it is recommended that this research be communicated to the Department of Basic Education and the health sector. The researcher will endeavour to raise awareness and provide guidelines on how these children can be assisted in the school environment and the role that a Kinderkineticist can play. Furthermore, additional information can be communicated to the Department of Basic education regarding screening tools. Early identification to prevent further problems and provide adequate interventions or support is crucial. Solutions for intervention and therapists that can assist without expensive treatments can be proposed to the Department of Basic Education. School readiness assessments can be used as a first screening for referral to evaluate motor abilities. The role of a Kinderkineticist to improve motor difficulties should be explained to the Department of Basic Education, and the importance of appointing more Kinderkineticists at schools needs to be emphasised.

- The awareness of motor difficulties experienced by children should be raised to assist parents, teachers and therapists in identifying and supporting these children. This can be conducted by encouraging more research in this field, making professional bodies in the healthcare sector aware of this disorder, and collaborating with the educational and early childhood development sectors.

- The Department of Basic Education should be aware of the need to emphasise the importance of screening for and executing motor skills, as motor development plays an integral part in the child's holistic development. Even though teachers are aware of the importance of motor skills for academic performance, daily living activities, and participation in sport, they are unsure how to determine the normal motor execution for a child's age and what should be considered a difficulty experienced by the child. Teachers should be empowered by means of workshops and seminars on children's motor difficulties, and receive the necessary guidance to understand what characteristics and symptoms to look for as possible DCD indicators.

- Considering the strict criteria for a diagnosis for DCD, many children may not be formally diagnosed with DCD, or it may even take a considerable amount of time to make a diagnosis, especially in low SE environments. Kinderkineticists treat the limitations and motor impairments of a child with DCD through therapy or activity-based interventions. Therefore, it is recommended that if a child is identified with motor difficulties, intervention should be provided as soon as possible to address the deficits and not to wait for a formal diagnostic confirmation.

- The e-Delphi survey has determined that experts can provide valuable insight by using a questionnaire and, through the questionnaire, contribute to the development of a motor intervention framework for children with DCD in Kinderkinetics. It has become evident when conducting this e-Delphi survey that DCD is heterogeneous and will be a determining factor in the intervention approach and type of intervention that will be implemented. It was further highlighted that various aspects and viewpoints from parents, teachers, therapists and the child should be considered for planning and goal-setting for the motor intervention programme. Furthermore, the uncertainties of the best settings, the dosage, and whether group or individual interventions should be conducted, have been emphasised in the experts' feedback. Various factors, such as the level of motor difficulties, age of the child and the availability of resources, will play a role when conducting the intervention programme. Considering the experts' input into developing the framework, it is essential to test the framework in various environments, settings and situations with children with DCD in SA, to determine if the framework could successfully assist and support children with DCD, especially in a population-based sample. Further refinement of the framework is required to develop a more specific motor intervention programme framework for Kinderkineticists to use.

- Taking into account that the SE environment can impact the development of motor abilities in children living in low SE environments, it is recommended that more attention should be paid to these children's circumstances. More opportunities and resources should be provided to them without requiring them to pay for it. Teachers and parents should be educated and trained on improving their children's motor abilities by applying basic principles and performing activities with the resources available to them. Children from low SE environments should receive more attention from the government and Department of Basic Education to improve their motor development, which should be addressed as early as possible. The lack of physical education in SA schools should further be addressed. The Kinderkineticist can play an essential part in working with all the stakeholders to raise awareness and provide their expert skills to assist these children. Parents should be aware of their children's motor difficulties and be guided to assist their motor development.

- More awareness should be raised about the importance of Kinderkineticists in schools. Limited evidence regarding the value of Kinderkinetics in the South African school setting is available, especially during the pre-primary and primary school years when the child's development occurs at a rapid pace. Therefore, studies to prove the value of motor intervention programmes at school is required. The Kinderkineticist appointed at a school will evaluate whether motor difficulties are present and address the problems early to prevent further difficulties and improve those impairments that the child is struggling with. Based on their training the Kinderkineticist can refer the child if necessary and as soon as possible. The Kinderkineticist can further support other professionals in the child's academic performance and sport participation skills by providing motor intervention programmes. Therefore, it is essential to appoint a Kinderkineticist or movement specialists at pre-primary and primary schools.

- Further exploration is required on the value and effectiveness of the input provided by a Kinderkinetics in the intervention for children with DCD.

- A final recommendation is to raise awareness of DCD. There is a lack of understanding of and attention to the disorder among the general population, parents and teachers, as concluded from this study's findings and the expert opinions obtained from professional Kinderkineticist who participated in the research.

This chapter concludes the research study.

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APPENDIX A

ETHICS DOCUMENTS OF THE STUDY

1. Ethics approval
2. Amendment approval 1
3. Extention of ethical clearance 1
4. Amendment approval 2
5. Extention of ethical clearance 2

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Health Sciences Research Ethics Committee

05-Mar-2018

Dear **Mrs Aletta Du Plessis**

Ethics Clearance: **Developmental Coordination Disorder in children: Assessment, Identification and Intervention**

Principal Investigator: **Mrs Aletta Du Plessis**

Department: **Exercise and Sport Sciences (Bloemfontein Campus)H**

APPLICATION APPROVED

Please ensure that you read the whole document.

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2017/1363**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

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Health Sciences Research Ethics Committee

04-Sep-2019

Dear **Miss Aletta Du Plessis**

Ethics Number: UFS-HSD2017/1363

Ethics Clearance: **Developmental Coordination Disorder in children: Assessment, Identification and Intervention** Principal Investigator: **Miss Aletta Du Plessis**

Department: **Exercise and Sport Sciences Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

Minor amendment: Exclusion of Article 3 (Aim 3)

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

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IRB 00006240; REC 230408-011; IORG0005187; FWA00012784

Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
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Health Sciences Research Ethics Committee

04-Sep-2019

Dear Miss **Aletta Du Plessis**

Ethics Number: UFS-HSD2017/1363
Ethics Clearance: **Developmental Coordination Disorder in children: Assessment, Identification and Intervention**
Principal Investigator: **Miss Aletta Du Plessis**
Department: **Exercise and Sport Sciences Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

Minor amendment: Extension request on ethics clearance

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

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T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
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Health Sciences Research Ethics Committee

29-Jun-2020

Dear **Miss Aletta Du Plessis**

Ethics Number: UFS-HSD2017/1363

Ethics Clearance: **Developmental Coordination Disorder in children: Assessment, Identification and Intervention** Principal Investigator: **Miss Aletta Du Plessis**

Department: **Exercise and Sport Sciences Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

Minor Amendment:

Change the wording of the last objective:

- Original objective: To use an e-Delphi survey as a unique approach to develop a motor intervention programme for children with DCD.

  Change objective to: To use an e-Delphi survey as a unique approach to develop a motor intervention programme framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African majority world context.

Due to the focus being on Kinderkinetics, which is a South African based occupation, the aim is to reach the input of experts in Kinderkinetics in South Africa. The focus is, therefore, within a national context. The following two selection criterion's of participants, as explained in the proposal for completing the e-Delphi, is requested to change, the rest of the selection criterion's will stay the same as approved and is not mentioned here:

- Kinderkineticists, if any, who's publications were used in the systematic review, will be recruited to participate in the e-Delphi survey, as well as other experts in South Africa within the field of Kinderkinetics who have published at least two articles in this field. - This criterion will be removed because a systematic review was not conducted as previously approved by the evaluation committee and the Health Sciences Ethics committee.
- International members in the field of Adapted Physical Education Teachers, Special Needs Teachers, Pediatric ExerciseSpecialist, Motor Therapist, Motor Remedial Teacher, Pediatric Physical Therapist, Kinderfysiotherapeute, Developmental Movement Therapist and Pediatric Occupational Therapist who published articles with regard to motor intervention programmes for children with DCD and are known to be similar to Kinderkinetics. - This criterion must be removed since the focus of the research will be within the national context and only include Kinderkineticists. Kinderkinetics is further not known by international experts.

The consent form for participants have been adapted according to these requested changes and is attached.

Delphi questions submitted for evaluation as soon as it has been compiled for evaluation:

- The principal investigator has set the questions. The questions have been evaluated and approved by the study leaders and an expert in the field.
- Please note, the questions will be set up in survey monkey, and participants will have tick boxes as well as text box spaces available to answer the questions. Each section will be on a new page on survey monkey.
- I have added a PDF document to provide an idea of how participants will answer the questions.
- I have also added a word document with all the questions.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00011992; REC 230408-011; IORG 0010096; FWA 00027947

Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

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YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

29-Jun-2020

Dear **Miss Aletta Du Plessis**

Ethics Number: UFS-HSD2017/1363

Ethics Clearance: **Developmental Coordination Disorder in children: Assessment, Identification and Intervention** Principal Investigator: **Miss Aletta Du Plessis**

Department: **Exercise and Sport Sciences Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

- Continuation report and annual re-approval until 04/03/2021.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act.

No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

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Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
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APPENDIX B

CONSENT DEPARTMENT OF EDUCATION

education
Department of Education
FREE STATE PROVINCE

Enquiries: BM Kitching
Ref: Research Permission: AM du Plessis
Tel. 051 404 9283 / 9221 / 082 454 1519
Email: berthakitching@gmail.com and B.Kitching@edu.fs.gov.za

AM du Plessis
26 Aranos Complex
1 Strutt Street
Radiokop Extention 23
JOHANNESBURG, 1724

082 941 8194

Dear Mrs du Plessis

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

   Research Topic: Developmental Coordination Disorder in Children: Assessment, Identification and Intervention.

   Schools: [redacted]

   Target Population: 400 Grade 1 learners and 30 Grade 1 Teachers.

   Period of research: From the date of signature of this letter until 30 September 2018. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours.

2. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.
3. The approval is subject to the following conditions:

   3.1 The collection of data should not interfere with the normal tuition time or teaching process.

   3.2 A bound copy of the research document or a CD, should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.

   3.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

   3.4 The attached ethics documents must be adheared to in the discourse of your study in our department.

4. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

JEM Sekolanyane
DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 09/02/2018

RESEARCH APPLICATION AM DU PLESSIS PERMISSION EDITED FEB 2018
Strategic Planning, Policy & Research Directorate
Private Bag X20565, Bloemfontein, 9300 - Room 318, Old CNA Building, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 **Fax:** (086) 6678 678

APPENDIX C

CONSENT FORMS

1. Consent form – Principals
2. Consent form – Parents
3. Consent form – Teachers
4. Assent form – Children
5. Consent form – e-Delphi

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein

APPLICATION: RESEARCH PROJECT AT YOUR SCHOOL

The Principal of the School

TITLE: Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Hereby I (Alretha du Plessis) would like permission to conduct research at your school. The purpose of the research project will be to determine how many grade 1 learners in low socio-economic environments in Mangaung have Developmental Coordination Disorder (DCD). Furthermore, to investigate the role that teachers may play in the early identification of possible motor skill difficulties.

Data will be collected through the help of Kinderkineticist, Kinderkineticists in training and teachers. Kinderkineticists will determine grade 1 learners' motor skill abilities using a standardized measuring instrument. The test will take approxamitly 30 minutes per child. Complete feedback will be provided to parents regarding their children's motor proficiency skills. There is no cost associated with testing or feedback of the results. Teachers will complete a motor proficiency checklist about their perceptions of the child's motor skill abilities in order to identify children with potential symptoms of Developmental Coordination Disorder. The questionnaire will take teachers approximately 15 minutes to complete.

Procedure of the research:

Parents:
As soon as permission is given from the school the parents and children need to give their informed consent. There will be two forms namely the informed consent form and child assent form which will be sent home.

1. The informed consent includes information with regard to the research project.

2. The child assent form explains the research project to the learner and requires the learners consent.

Teachers:

We also need the assistance of the teachers; this includes:

1. The completion of a Motor Proficiency Checklist for each child participating in the study.
2. The teachers will be given one month to complete the checklist and a full explanation on how to complete it will be provided.

Performance Test:

Each class will be tested with the motor proficiency test during the physical education periods. Testing include, fine motor activities, aiming and catching as well as balance activities. Kinderkineticists will conduct this test. Children will not lose any academic time and a complete roster will be provided to explain when each child will be evaluated.

The School involved will in turn be rewarded with the following:

1. All the children who are allowed to take part in the research will undergo a motor proficiency assessment.
2. All the children who are allowed to take part in the research will receive an individual report with the results of their child's performance.

Kind regards

Alretha du Plessis

Kinderkineticist (M.A. HMS)

0829418194

alretha.buys@gmail.com

CONSENT FORM FOR RESEARCH PROJECT

Developmental Coordination Disorder: Assessment, identification and intervention for children in a low socio-economic environment

I, ____, principal of _________________________________ (School name), give permission that the research may be conducted at the school. I am aware that the information gathered at the school, will be analysed to determine DCD. As well as teachers' perceptions of the children's motor skills and the role teachers' play in the early identification of motor skill difficulties. The researcher will take precautions to ensure that the identities of participants remain anonymous and that all information is kept confidential. The results of this research study will be used for presentations at national and international conferences and for publication of articles in medical journals.

Contact details of REC Secretariat and Chair – for reporting of complaints/problems.

Contact details of the ethics committee: ethicsFHS@ufs.ac.za

(051) 4052812

We trust that our request will meet your approval.

__________________________ __________________________

Principal **Date**

__________________________ __________________________

Mrs. A. du Plessis **Date**

Researcher

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

The teacher of participating school and learners

<u>TITLE:</u> Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Introduction:

I, Alretha du Plessis (Masters Degree in Human Movement Science, Kinderkinetics) are doing research for my PhD degree in Kinderkinetics. I am doing my research on Developmental Coordination Disorder in grade 1 learners. Within this research I will be looking at the motor skill abilities of the learners as well as how you, as the child's teacher experience their motor abilities.

Invitation to participants:

I am asking/inviting you to be part of this research project.

What does your responsibility consist of:

Teachers will be asked to complete a motor proficiency checklist. The Checklist will take teachers approximately 15 minutes to complete. This checklist can assist in identifying motor skill difficulties. A complete explanation will be provided to the teacher on how to complete the checklist. Questions may be asked if uncertainty occurs. Teachers will be given a month to complete the checklist for each child during their own time.

Risk of being involved in the study:

No risks are involved in this research study. It will just be expected from the teacher to complete the checklist.

Benefits of being in the study:

This information is important to determine whether teachers have a role to play in the early identification of motor skill difficulties. Kinderkineticists involved in the development of the young child will be able to evaluate the results to help make the correct recommendations regarding intervention and the awareness of this disorder among parents and teachers.

Participation is voluntary:

Participation is voluntary, and your may discontinue your participation at any time without penalty or loss of benefits to which the subject is otherwise entitled to. Refusal to participate will involve no penalty.

Reimbursements:

Your participation in this research project is greatly appreciated, but remains voluntary and please note that no compensation is granted for the participation. There is no costs associated with the testing procedures and feedback of results.

Confidentiality:

All efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law. If results are published, this may lead to individual/cohort identification. The results of this research project will be used for presentations at national- and international conferences and for publication of articles in medical journals.

Kind regards

____

Alretha du Plessis

Kinderkineticist (M.A. HMS)

0829418194

alretha.buys@gmail.com

CONSENT FORM FOR TEACHERS

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

I, ____, teacher at ________________________________ (School name), give consent to take part in this research study. I am aware that the information gathered at the school, will be analysed to determine DCD. As well as teachers' perceptions of the children's motor skills and the role teachers' play in the early identification of motor skill difficulties. The researcher will take precautions to ensure that the identities of participants remain anonymous and that all information is kept confidential. The results of this research study will be used for presentations at national and international conferences and for publication of articles in medical journals.

Contact details of REC Secretariat and Chair – for reporting of complaints/problems.
Contact details of the ethics committee: ethicsFHS@ufs.ac.za
(051) 4052812

We trust that our request will meet your approval.

__________________________	______________________
Teacher	**Date**
__________________________	______________________
Mrs. A. du Plessis	**Date**
Researcher	

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

Die onderwyser/es van deelnemende skool en leerders

TITEL: Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Inleiding:

Ek, Alretha du Plessis (Meesters Graad in Menslike Bewegingskunde, Kinderkinetika) doen navorsing vir my PhD grad in Kinderkinetika. Ek doen my navorsing op “Developmental Coordination Disorder in grade 1 learners”. Met hierdie navorsing sal ek kyk na die motoriese vaardigheidsvermoë van die leerders sowel as hoe die leerder se onderwyser sy/haar motoriese vaardighede ervaar.

Uitnodiging aan deelnemers:

Ek nooi jou uit om deel te wees van die navorsingsprojek.

Wat behels jou verantwoordelikheid:

Onderwysers sal gevra word om die motoriese vaardigheidskontrolelys te voltooi. Die kontrolelys sal onderwysers plus minus 15-minute neem om te voltooi. Die kontrolelys kan help om motoriese vaardigheidsprobleme te identifiseer. ‘n Volledige verduideliking sal aan die juffrou voorsien word om te verduidelik hoe die kontrolelys voltooi moet word. Vrae mag gevra word indien jy onseker is. Onderwysers sal ‘n maand gegee word om die kontrolelys te voltooi vir elke kind gedurende hulle eie tyd.

Risikos vir betrokkenheid aan die studie:

Geen risikos is betrokke vir deelname aan die studie nie. Daar word net van jou verwag om die kontrolelys te voltooi.

Voordele van die studie:

Hierdie inligting is belangrik om te bepaal of onderwysers ‘n rol speel in vroeë identifiser van motoriese vaardigheidsprobleme. Kinderkinetici betrokke by die ontwikkeling van die jong kind sal kan evalueer or die resultate help om die korekte aanbevelings the maak ten opsigte van intervensies en die bewustheid van die uitdaging by ouers en onderwysers.

Deelname is vrywillig:

Deelname is vrywillig en jy kan ophou om deel te neem sonder enige penalisering of verlies van voordelde. Indien jy weier om deel te neem sal jy nie gepenaliseer word nie.

Vergoedings:

U deelname in die navorsingsprojek word opreg waardeer, maar bly vrywillig en neem kennis dat geen vergoeding gegee word vir deelname nie. Daar is geen kostes geassosieer met die toetsings prosedure of terugvoering nie.

Konfidentialiteit:

Alle pogings word gemaak om persoonlike inligting konfidentieel te hou. Absolute konfidentialiteit kan nie gewaarborg word nie. Persoonlike inligting sal beskikbaar gestel word indien vereis word van die wet. As resultate gepubliseer word, sal individuele/groep indentifikasie moontlik plaasvind. Die resultate van die navorsingsprojek sal gebruik word vir aanbiedinge by nationale en internationale konferensies sowel as publikasies van artikels in mediese joernale.

Vriendelike groete

Alretha du Plessis

Kinderkineticist (M.A. HMS)

0829418194

alretha.buys@gmail.com

TOESTEMMINGSVORM VIR ONDERWYSERS

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Ek, ____, onderwyser/es van ______________________________ (Skool naam), gee toestemming om deel te neem aan die navorsingsstudie. Ek is bewus dat die inligting wat by die skool ingesamel word geanaliseer word om DCD te bepaal. Sowel as die onderwysers se persepsie van kinders se motorise vaardighede en die rol wat onderwysers speel in die vroeë identifikasie van motorise vaardigheidsprobleme. Die navorser sal voorsorg tref om te verseker dat die identiteit van die deelnemers anonym bly en dat alle inligting konfidentieel is. Die resultate van die navorsingsstudie sal vir aanbiedinge by nationale en internationale kongresse gebruik word sowel as vir publikasies van artikels in mediese joernale.

Kontak besonderhede van REC Secretariat en Hoof – vir raportering van klagtes/probleme.
Kontak besonderhede van die etiese kommitee: ethicsFHS@ufs.ac.za
(051) 4052812

Ons vertrou dat ons versoek jou goedkeuring sal wegdra.

_________________________ _____________________

Onderwyser **Datum**

_________________________ _____________________

Me. A. du Plessis **Datum**
Navorser

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UFS UV

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

STUDY TITLE

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Dear parent/guardian

Introduction:

I, Alretha du Plessis (Masters Degree in Human Movement Science, Kinderkinetics) are doing research for my PhD degree in Kinderkinetics. Research is just the process to learn the answer to a question. I am doing my research on Developmental Coordination Disorder in grade 1 learners. Within this research I will be looking at the motor skill abilities of your child as well as how the teachers see your child's motor abilities. Motor skill abilities are learned activities performed by your child and this learned activities results in a specific movement.

Invitation to participants:

I am asking/inviting you to include your child in this research project.

What does the study consist of:

Data will be collected through the help of Kinderkineticists in training, qualified Kinderkineticists and teachers. The first test, the Movement Assessment Battery for Children-2 Performance Test (MABC-2) for 3-16 year old children is a standardized test to determine your child's motor skill abilities. The test requires learners to complete motor skill activities which include manual dexterity (coordinated hand and finger movements such as stringing blocks), balance (such as standing on one leg or walking on a line) as well as aiming and catching (such as throwing a ball to a target). The study will be executed over an four week period and it will take at least 30 minutes to complete. In addition it will be asked from each child to sign an assent form. The second test is a checklist. Teachers will complete a motor proficiency checklist. Motor proficiency refers to the level of movement and activity your child can perform. The Checklist will take teachers approximately 15 minutes to complete. This checklist can assist in identifying motor skill difficulties. Finally, the results of the MABC-2 will be compared with the results of the teachers. Feedback will be provided to parents regarding their children's motor skill abilities.

Risk of being involved in the study:

No risks are involved in this research study. It will just be expected from each child to perform a set of motor skill activities.

Benefits of being in the study:

This information is important to determine whether teachers have a role to play in the early identification of motor skill difficulties. Kinderkineticists involved in the development of the young child will be able to evaluate the results to help make the correct recommendations regarding intervention and the awareness of this disorder among parents and teachers.

Participation is voluntary:

Participation is voluntary, and your child may discontinue his or her participation at any time without penalty or loss of benefits to which the subject is otherwise entitled to. Refusal to participate will involve no penalty.

Reimbursements:

Your participation in this research project is greatly appreciated, but remains voluntary and please note that no compensation is granted for the participation. There are no costs associated with the testing procedures and feedback of results.

Confidentiality:

All efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law. If results are published, this may lead to individual/cohort identification. The results of this research project will be used for presentations at national- and international conferences and for publication of articles in medical journals.

Contact details of the researcher - : for further information / reporting of study- related adverse events.

____

Alretha du Plessis
Kinderkineticist (M.A. HMS)
0829418194
alretha.buys@gmail.com

Contact details of REC Secretariat and Chair – for reporting of complaints/problems.
Contact details of the ethics committee: ethicsFHS@ufs.ac.za or 051 405 2812

CONSENT FORM TO PARTICIPATE IN RESEARCH PROJECT

Please return all relevant forms back to school no later than ...., whether completed or not.

- You have been asked to give permission for your child to participate in a research study.
- You have been informed about the study by Alretha du Plessis and may contact her at 0829418194 during work hours if you have questions about the research.
- You may contact the Secretariat of the Health Sciences Research Ethics Committee, UFS at telephone number (051) 4052812 if you have questions about the rights as a research subject.
- If you agree to participate, you will be given a signed copy of this document as well as the written summary of the research.
- The researcher will take precautions to ensure that the identities of participants remain anonymous and that all information is kept confidential.

The research study, including the above information has been communicated to me via a letter. I understand that the participation of my child in this research is voluntary, and he/she will not be penalized if he/she refuse to participate or if I decide to terminate participation.

I, ____, parent / guardian of ____________________________________ (child's full name and surname) __________________________ (date of birth), give permission that he / she may participate in the research project.

Tick the relevant boxes below **if** your child suffers from the following medical condition or illness and/or severe neurological problem that has been diagnosed by a medical practitioner.

☐ Epilepsy	☐ Physical disability
☐ Attention Deficit Hyperactive Disorder / Attention Deficit Disorder	☐ Visual problems
☐ Autism Spectrum Disorder	☐ Hearing problems
☐ Asperger Syndrome	☐ Cancer

________________________	___________________
Signature (Parent / Guardian)	**Date**
____________________	_________________
Signature of Witness *(Where applicable)*	**Date**
________________________	___________________
Signature of Translator *(Where applicable)*	**Date**

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Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

STUDIE TITEL:

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Geagte ouer/voog

Inleiding:

Ek, Alretha du Plessis (Meesters Graad in Menslike Bewegingskunde, Kinderkinetika) doen 'n navorsingsstudie vir my PhD graad in Kinderkinetika. Die navorsing gaan oor "**Developmental Coordination Disorder" in graad 1 leerders.** Navorsing is die proses om 'n antwoord tot 'n vraag te kry. Binne hierdie navorsing sal ek na die motoriese vaardigheidsvermoë van jou kind kyk sowel as die vermoë van onderwysers om jou kind se motoriese vaardigheidsvermoë raak te sien. Motoriese vaardigheidsvermoëns is geleerde aktiwiteite wat deur jou kind uitgevoer word en hierdie geleerde aktiwiteite vorm dan 'n spesifieke beweging.

Uitnodiging aan deelnemers:

Graag vra/nooi ek jou om jou kind in te sluit by die navorsingsprojek.

Wat behels die studie:

Data sal deur Kinderkinetici in opleiding, gekwalifiseerde Kinderkinetici en onderwysers ingesamel word. Die eerste toets, die "Movement Assessment Battery for Children-2 Performance Test (MABC-2)" vir 3-16 jarige kinders is 'n gestandaardiseerde toets om kinders se motorise vermoëns te bepaal. Die toets vereis van die leerders om motoriese vaardigheidsaktiwiteite uit te voer wat "manual dexterity"(koördinasie van hand en vinger bewegings soos ryg van blokkies); balans (bv staan op een been of loop op 'n lyn) sowel as mik en vang (bv gooi die bal na die teiken), insluit. Die studie sal oor 'n vier week periode strek en sal ten minste 30 minute neem om te voltooi. Elke leerder sal gevra word om 'n kind toestemmingsvorm te teken. Die tweede toets is 'n stiplys. Onderwysers sal die motoriese vaardigheidsstiplis voltooi. Motoriese vaardigheid verwys na die vlak van beweging en aktiwiteite waarop jou kind kan presteer. Die stiplys sal die juffrou plus minus 15 minute neem om te voltooi. Die stiplys kan help om motoriese uitdagings te identifiseer. Laastens sal die MABC-2 met die resultate van die onderwysers vergelyk word. Terugvoering sal aan die ouers voorsien word ten opsigte van hulle kind se motoriese vermoëns.

Risiko van betrokkenheid:

Geen risiko is betrokke vir hierdie navorsing nie. Daar word net van jou kind verwag om 'n stel motoriese aktiwiteite uit te voer.

Voordele om deel te wees van die studie:

Die inligting is belangrik om te bepaal of die onderwysers ‘n rol kan speel in vroeë identifisering van motoriese vaardigheidsuitdagings. Kinderkinetici betrokke in die ontwikkeling van die jong kind sal die resultate kan evalueer om te help met die korrekte aanbevelings ten opsigte van intervensie en die bewustheid van die uitdagings by ouers en onderwysers.

Deelname is vrywillig:

Deelname is vrywillig en jou kind kan enige tyd deelname staak sonder enige penalisering of verlies van voordele. As jou kind weier om deel te neem sal geen penalisering plaasvind nie.

Vergoedings:

U deelname aan die navorsingsprojek word baie waardeer, maar dit bly vrywillig en neem kennis dat geen vergoeding gegee word vir deelname nie. Daar is geen kostes geassosieer met die toetsprosedure of terugvoering van resultate nie.

Konfidentialiteit:

Alle pogings sal gemaak word om persoonlike inligting konfidensieël te hou. Absolute konfidentialiteit kan nie gewaarborg word nie. Persoonlike inligting kan geopenbaar word as dit vereis word deur die wet. Indien resultate gepubliseer word, mag dit lei tot individuele/groep identifikasie. Die resultate van die navorsingsprojek sal vir aanbiedinge by nasionale en internasionale konferensies gebruik word sowel as publikasies van artikels in mediese joernale.

Kontak besonderhede van die navorser - : vir meer inligting / raportering van die studie- relevant to nadelige gebeure.

____

Alretha du Plessis

Kinderkineticist (M.A. HMS)

0829418194

alretha.buys@gmail.com

Kontakbesonderhede van die REC Secretariat en Hoof – vir raportering van probleme/klagtes.

Kontakbesonderhede van die etiese kommitee: ethicsFHS@ufs.ac.za of 051 405 2812

TOESTEMMINGSVORM OM DEEL TE NEEM AAN DIE NAVORSINGSPROJEK

Stuur asseblief al die relevante forms terug na die skool nie later as… voltooi of nie

- Jy is gevra om permissie te gee vir jou kind om deel te neem aan die navorsingsstudie.
- Jy is in kennis gestel van die studie deur Alretha du Plessis en mag haar kontak by 0829418194 gedurende werksure indien jy enige vrae het oor die navorsing.
- Jy mag die Secretariat van die "Health Sciences Research Ethics Committee" kontak, UFS by telefoon nommer (051) 4052812 indien jy enige vrae het oor die regte as 'n navorsingsonderwerp.
- As jy instem om deel te neem, sal jy 'n getekende kopie van die dokument ontvang wat as geskrewe opsomming dien van die navorsing.
- Die navorser sal voorsorg tref om te verseker dat die identiteit van die deelnemers anoniem bly en dat alle inligting konfidensieël gehou sal word.

Die navorsingsstudie, insluitend die bogenoemde inligting is na u gekommunikeer per brief. Ek verstaan dat die deelname van my kind aan die navorsing vrywillig is en hy/sy sal nie gepenaliseer word indien hy/sy weier om deel te neem of besluit om deelname te staak nie.

Ek, ____, ouer / voog van ____ (kind se volle name en van) _____________________________ (geboortedatum), gee hiermee toestemming dat hy/sy mag deelneem aan die navorsingsprojek.

Merk die relevante boksies hier onder **as** jou kind aan een van die volgende mediese kondisies of siektes en/of ernstige neurologiese probleme ly wat deur 'n mediese dokter gediagnoseer is.

☐ Epilepsie	☐ Fisiese gestremdheid
☐ Aandag afleibare hiperaktiwiteitssindroom / Aandag afleibare sindroom	☐ Visuele probleme
☐ Outisme	☐ Gehoorprobleme
☐ Aspergers Sindroom	☐ Kanker

__________________________ __________________________

Handtekening (ouer/voog) **Datum**

______________________ ___________________

Handtekening van getuie **Datum**

(Indien van toepassing)

__________________________ __________________________

Handtekening van vertaler **Datum**

(Indien van toepassing)

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

SEHLOOHO SA THUTO:

Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Motswadi/ mohlokomedi ya retehang

Sehlooho:

Nna, Alretha du Plessis (Masters Degree in Human Movement Science, Kinderkinetics) ke etsa dipatlisiso ho lengolo la ka la thuto e phahameng e leng PhD Kinderkinetics. Dipatlisiso tsena ke mokgwa feela wa ho ithuta kapa hona ho fumana dikarabo ho dopotso tseo basibolle ba nang le tsona ka Developmental coordination ho bana/baithuti ba balang sehlopha sa pele (1). Basibolle ba tlo shebana le bokgoni ba ngwana wa hao, hape le hore mosuwe /titjere e bona jwang bokgoni ba ngwana wa hao.

Memo ya ho nka karolo:

Ke mema le ho kopa hore o dumelle ngwana wa hao dipatlisisong tsena.

Thuto ena e kenyelleditse eng:

Lesedi le tla bokellwa ka thuso ya Kinderkineticists e leng baithuti ba ntseng ba ikwetlisa, le barupelle ba kinderkinetics. Teko ya pele ke Movement Assessment Battery ya bana ba dilemong di 3-16, ke teko e lekantsweng ho lekola bokgoni ba ngwana wa hao. Teko ena e hloka baithuti ba phethe bokgoni ba mesebetsi e kenyelleditseng Manual dexterity, ho leka-lekanya, ho akanya le ho tshwara. Thuto ena e tla etswa nakong ya beke tse nne(4) mme e tla nka metsotswana e mashome a mararo (30 minutes) ho phethelwa. Hodima moo ngwana ka mong o tla tlameha ho saena foromo ya hlahlobo. Teko ya bobedi ke e lekolang hore tsohle di entswe. Barupelle ba tla phetha motor proficiency e lekolang hore ebe ntho tsohle di entswe, mme ba tla nka metsotso e leshome le metso e mehlano (15 minutes) hore ba qetele. Lethathamo lena le tla thusa ka ho kgethaa (kgetholla) moo mohlomong ho na le bothata ka bokgoni. Qetellong diphetho tsa MABC-2 di tla bapitswa le dipheto tsa ba rupelle. Hot la fanwa ka tlhahiso (dipheto) ho batswadi mabapi le bokgoni ba bana ba bona.

Kotsi ya ho nka karolo thutong ena:

Ha ho kotsi e teng thutong ena. Tebello ke hore ngwana ka mong a bapatse bokgoni ha hae ka dipapadi tse tla be di bapalwa.

Molemo wa ho nka karolo thutong ena:

Tlhahisoleseding ena e bohlokwa bakeng sa hore ho etswe qeto yah ore na ebe titjere e na le karolo eo e e bapalang pele ho bothata ba bokgoni. Kinderkineticits (ditsibi) tse nkang karolo ya ntshetsopele ya ngwana a dilemong tse tlase o tla kgona ho hlalosa diphetho hore a thuse ho etsa tlhahiso mabapi le ho kenella, le tlhokomediso ya bofokodi ho batswadi le ho matitjere.

Ho nka karolo ke kgetho ya motho/ho ithaopa

Ho nka karolo ke ka ho rata ha motho (ke ho ithaopa), le ngwana a ka tlohela ho nka karolo nako enngwe le enngwe mme ha hona kotlo kapa ho lahlehelwa ke melemo eo motho a ka e fumana. Ho se dumle ho nka karolo ha hona kotlo.

Ho tsosolotswa/ho palalwa:

Ho nka karolo ha motho dipatlisisong tsena ho amohelwa ka thabo e kgolo, empa ke ka ho rata ha motho mme ha ho lefwe batho kapa ha ho tjelete ya teboho/matshidiso eo motho a tlo e fumanang. Ha hon a ditjeo bakeng sa diteko le tlhahiso ya diphetho.

Sephiri:

Boiteko bohle botla ba ho boloka dintlha tsa bohlokwa tsa batho ele sephiri, empa sephiri se fetelletseng ha sena tiisetso. Dintlha tsa sephiri tsa motho di ka ntshwa ha molao o di batla. Ha diphetho di ka phatlalatswa, ena e ka etsa hore motho/sehlopha sa batho se tsebitswe. Diphetho tsa dipatlisiso tsena di tla sebediswa ditlhahisong tsa naha kapa ho seboka sa machaba le kgatiso ya dihlooho dikorantengtsaa bongaka.

Ikopanye le mofuputsi: bakeng sa tlhahisoleseding

____

Alretha du Plessis

Kinderkineticist (M.A. HMS)

0829418194

alretha.buys@gmail.com

Lintlha tsa puisano tsa **REC Secretariat le Chair –** bakeng sa ho tlaleha litletlebo kapa mathata

Contact details of the ethics committee: ethicsFHS@ufs.ac.za or 051 405 2812

Foromo ya tumellano ya ho nka karolo ho projeke ya dipatlisiso

Ka kopo kgutlisa diforomo tsohle tse bohlokwa sekolong pele ho ………. O qetile ho ditlatsa kapa o sa qeta.

- O kopilwe hore ngwana wa hao a nke karolo dipatlisisong tsa thuto ena.
- O tsibisitswe ka thuto ya Alrerha du Plessis ebile o ka mo letsetsa nomorong ta 082 941 8194 ka dihora tsa mosebetsi ha ebe o na le dipotso ka dipatlisiso.
- O ka letsetsa mothusi wa komiti ya lefapha la Health Sciene, Univesiting ya Foreisitata nomorong ya 051 405 2812 ha ebe ona le dipotso ka ditokelo ka projeke ya dipatlisiso.
- Ha o dumela ho nka karolo, o tla fuwa tokomane e tswanang le ena e sainilweng le foromo ya dipatlisiso e kgutsufaditsweng.
- Mofuputsi o tla sireletsa boitsibiso ba barupellwa mme tlhahisoleseding yohle ke sephiri.

Thuto ya dipatlisiso le tlhahisoleseding e hlahellang hodimo ke ntlha tse fetiseditsweng honna ka lengolo. Ke a utlwisisa hore ho nka karolo ya ngwana wa ka ke hoithaopa mme ngwana a ke ke a otlwa ha ebe a sa kgahlwe ke ho nka karolo kapa ha nka mo hanela.

Nna, ____, motswadi/mohlokomedi wa ___________________________________ (lebitso la ngwana le sefane) ____________________________ (letsatsi la tswalo), ke fana ka tumellano ya hore ngwana a ka nka karolo projekeng ena.

Tšoaea lebokoseng le ka tlaase haeba ngoana oa hao a utloa bohloko ka lebaka la boemo bo latelang ba bongaka kapa bokuli le / kapa bothata bo matla ba meriana bo fumanoeng ke ngaka.

☐ Sefuba	☐ Bokooa ba mele
☐ Hlokomoloha ho ba le bothata ba ho se sebetse hantle (ADHD/ADD)	☐ Mathata a Bonang
☐ Mathata a Autism Spectrum	☐ Mathata a Ho utloa
☐ Lefu la Asperger	☐ Kankere

__________________________ __________________

Saena (motswadi/mohlokomedi) **mohla**

__________________________ __________________

Saena paki
(moo ho hlokahalang)

Saena mofetoledi
(moo ho hlokahalang)

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

CHILD ASSENT FORM (6- to 8-year-olds)

TITLE: Developmental Coordination Disorder in children: Assessment, Identification and Intervention

You are being asked to take part in a research study done by Alretha du Plessis (Kinderkineticist). In this study, we are interested to know more about your moving talent by using your body and muscles during different play activities. We have asked your parents or caregiver whether it is OK for you to participate, but now we want to see if it is OK with you.

If you decide to take part in this study, you will be asked to do different activities using your body and muscles. You will complete activities such as catching a ball, jumping and throwing as well as balancing. This will all together take about 30 minutes to do. Also, we would like to ask your teachers about your moving talent when you are using your body and muscles. All the information we collect will be kept secret and you don't have to share any of your information with anybody else. We will not use your name so everything will remain private.

If you want to do these activities, you must write your name to say it is OK. Any time you feel that you don't want to go on, you just stop and nothing will happen to you.

______________________________ ______________________

Child's signature **Date**

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

KIND TOESTEMMINGSVORM (6- to 8-jaar-oud)

TITEL: Developmental Coordination Disorder in children: Assessment, Identification and Intervention

Jy word gevra om deel te neem aan ‘n navorsingsstudie wat deur Alretha du Plessis (Kinderkinetikus) gedoen word. In die studie stel ons belang om meer te weet oor wat jou beweeg talent is deur jou lyf en spiere tydens speelaktiwiteite te gebruik. Ons het jou ouers of oppasser gevra of dit reg sal wees vir jou om deel te neem, maar nou wil ons weet of dit reg is met jou.

As jy besluit om deel te neem aan die studie sal jy gevra word om verskillende aktiwiteite te doen deur jou lyf en spiere te gebruik. Jy sal aktiwiteite soos vang van ‘n bal, spring en gooi sowel as balans uitvoer. Dit sal alles saam omtrent 30-minute neem. Ons wil ook jou juffrou vra oor jou beweging talent wanneer jy jou lyfie en spiere gebruik. Al die inligting wat ons insamel sal geheim gehou word en jy hoef nie enige van jou inligting met iemand anders te deel nie. Ons sal nie jou naam gebruik nie.

As jy hierdie aktiwiteite wil doen, skryf jou naam op die lyn om te sê dit is reg. As jy voel jy wil nie meer deelneem nie, kan jy stop en niks sal met jou gebeur nie.

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____________________________ ____________________

Kind se handtekening **Datum**

Skool vir Aanvullende Gesondheidsberoepe (SAGB)/School for Allied Health Professions (SAHP), UV/UFS, Bloemfontein 9300

<u>Foromo ya ho dumella ngwana (6-8 dilemo)</u>

<u>Sehlooho</u>: Developmental Coordination Disorder in children: Assessment, Identification and Intervention.

Re o kopa hore o nke karolo dipatlisisong tse etswang ke Alretha du Plessis (kinderkineticist). Thutong ena, rena le kgahleho ya ho tseba haholo ka bokgoni ba hao ba ho tseba ho sebedisa karolo tse ding tsa mmele wa hao. Re se re kopile batswadi/ bahlokomedi ba lona hore le nke karolo, empa jwale re botsa wena ha ebe ona le kgahleho.

Ha o dumela ho nka karolo thutong ena, re tla o kopa hore o ikwetlise ka ho tswara bolo, ho tlola, ho lahlela le ho leka-lekanya. Tsena tsohle di tla nka metsotso e leshome le metso e meraro (30 minutes). Hape re thabelo ho botsa matitjere a lona ka bokgoni ba lona. Tlhahisoleseding yohle eo re tlo e fumanang ke sephiri ebile ha o a tshwanela ho arolelana yona le mang kapa mang. Ha rena ho sebedisa lebitso la hao hore ntho tsohle ebe sephiri.

Ka ho saena foromo ena o bontsha hore o botsitse dipotso ka dipatlisiso tsena. O ka tswela pele ka ho botsa dipotso ha morao ha ebe ha o na tsona ha jwale. Ho saena foromo ena ha ho bolele hore o tlamehile ho qeta thuto ena, o ka tlohela nako enngwe le enngwe o sa fane ka lebaka.

______________________________ ______________________________

Ngoana ho saena **Letsatsi**

UNIVERSITY OF THE **FREE STATE**
UNIVERSITEIT VAN DIE **VRYSTAAT**
YUNIVESITHI YA **FREISTATA**

UFS
HEALTH SCIENCES
SCHOOL OF HEALTH AND REHABILITATION SCIENCES
EXERCISE AND SPORT SCIENCES

Dear Participant

I am a qualified Kinderkineticist and a lecturer at the North-West University, South Africa. I have a Master's degree in Human Movement Sciences (Specializing in Kinderkinetics) and currently busy completing my Doctoral degree in the Faculty of Health Sciences at the University of the Free State, South Africa (Student number: 2009087301). The title of the research is **Developmental Coordination Disorder in children: Assessment, Identification, and Intervention.**

Supervisors:	
Supervisor: Doctor M. de Milander Lecturer: Exercise and Sport Sciences Faculty: Health Sciences University of the Free State Email: demilanderm@ufs.ac.za Contact number: 051 401 9342	Co-supervisor: Professor. F.F. Coetzee Adjunct Professor and Head of Department: Exercise and Sport Sciences Faculty: Health Sciences University of the Free State Email: coetzeef@ufs.ac.za Contact number: 051 401 2323

Aim of the study:

The objective of this research study is as follow:

1. To determine the prevalence of possible developmental coordination disorder (DCD) amongst grade 1 learners in low socio-economic environments in Mangaung.
2. To establish the ability of teachers to identify grade 1 learners in low socio-economic environments with possible developmental coordination disorder (DCD).
3. To use the e-Delphi survey as a unique approach to develop a motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African majority world context.

Reason for letter

You are selected according to a predetermined criterion as having expert knowledge and experience to take part in this study. Your expertise and knowledge is of high value and required to reach aim 3 of this research study. I, therefore, invite you to take part in this research study by consenting to be included in the panel of experts and completing a questionnaire/s by making use of the e-Delphi method.

Information and background

The e-Delphi methodology is an interactive and iterative process that can continue for several rounds (Donohoe *et al.*, 2012). Its foundation is based on anonymity and the free expression of participants' opinions by allowing reconsideration and refined views through controlled feedback (Giannarou & Zervas, 2014), and it is frequently used in the health sciences environment (Donohoe *et al.*, 2012). In this study, we aim to use the e-Delphi survey as a unique approach to develop a motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African majority world context. Using the knowledge and insights gained from the literature review of my Ph.D., specific questions were formulated. The finalised online questionnaire/s will be administered to you via an email which will include a link to access the questionnaire.

Blank *et al.* (2019) emphasize the importance of an interdisciplinary approach of intervention with physicians and therapists from a variety of different disciplines. However, limited research is available regarding the role of a Kinderkineticist. One of the essential goals of Kinderkinetics is to promote proper motor development of young children and to provide intervention programmes for children with developmental disorders to maintain an active, healthy lifestyle. Kinderkinetics is one of the valuable services for children in South Africa who is diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). High prevalence (15%; 11.3%) of DCD (de Milander *et al.*, 2014; Venter *et al.*, 2015) are present in South Africa and it is therefore vital to identify the best motor intervention framework to use for children with DCD or possible DCD. Blank *et al.* (2019) indicated that due to country-specific and culture-specific service provision for individuals with DCD in different countries, international standards of intervention for children with DCD should be adapted for national conditions. Therefore, this research study will focus on identifying a motor-intervention framework for children with DCD or possible DCD in the field of Kinderkinetics within the South African majority world context.

Process

You will be asked to complete an online questionnaire in each round. An explanation will be provided on how the questionnaire should be completed within each round. You will have two weeks to complete each round as soon as you receive the questions for the round. One round will take approximately 20 minutes to complete. Responses to the e-Delphi questionnaire will then be analysed and commented on by the researcher and supervisors to determine if they are in line with the data required for this study (three to four rounds aiming at 80% consensus). Names and identities of the participants are anonymous to each other and do not form part of the data that will be presented. The researcher is the only one who knows the names and identities of the participants and will use it in confidentiality. Please take note that the outcomes of this study will be published. Participation in the survey is voluntary, and the participants may withdraw from the study at any time. Participants will not be remunerated for their participation, and no expenses will be payable to participants. This research has been approved by the Health Sciences Research Ethics Committee: UFS-HSD2017/1363.

Value of the research

This research is important as it presents a unique and collated perspective of experts in the field of Kinderkinetics regarding motor intervention for DCD and possible DCD in children. The e-Delphi is a vital method to use as various opinions concerning intervention programmes' for DCD exists. The aim is to identify a motor intervention framework to help children with DCD or possible DCD in the field of Kinderkinetics.

Having explained these processes and identifying you as an essential role player within this field, I would respectfully request your cooperation in completing this study. Should you be able to participate in this research study, please fill in the consent form on the next page and return it to me via email on or before Tuesday, 21 July 2020. If you have any questions regarding the study, please feel free to contact me, or if you have complaints or problems, contact the REC Secretariat and Chair. Contact details of the ethics committee: ethicsFHS@ufs.ac.za or 051 405 2812

Kind regards

Mrs. Alretha du Plessis
Kinderkineticist (M.A. HMS)
0829418194
alrethaduplessisdelphi@gmail.com

CONSENT FORM FOR PARTICIPATION IN THE e-DELPHI

Dear Expert

You are cordially invited to take part in the research study concerning the e-Delphi process to assist in developing a motor intervention framework for children with DCD or possible DCD in the field of Kinderkinetics. You have been informed about the research study by the researcher in the written letter above.

You may contact the researcher at any time if you have any concerns or questions. Additionally, you may contact the Secretary of the Ethics Committee of the Health Science Faculty at the University of the Free State (ethicsFHS@ufs.ac.za or 051 405 2812) for any concerns or questions regarding your rights as a study participant. Contact information of the researcher and the ethics committee is available, as stipulated above.

I, as a study participant, hereby understand that information will always be kept confidential. I am aware that participation is voluntary, and I can withdraw from the research study at any time without penalties. I understand that no financial reward will be received for participating in the research study. Lastly, I understand my involvement in this study and voluntarily give my consent to participate. Please return the completed form via email **on or before Tuesday, 21 July 2020** to alrethaduplessisdelphi@gmail.com

Title:		**Surname:**		**Name:**	
E-mail address:		**Contact number:**			

If you agree to take part in this study, please answer the three questions below in order to further determine if you qualify to take part in the first round according to the inclusion criteria for this study. Please sign at the bottom of the next page to give consent for participation.

Please go to the next page

1. Identify the setting/s that you work in. Mark all settings applicable to your work environment:

Private practice environment		Various schools	
Multidisciplinary practice environment		Health environments such as hospitals, clinics etc.	
Permanently at one School		Gym or health clubs	
Other		University	
If you selected other, please specify:			

2. What is your job description of where you work? (For example: Kinderkineticist, teacher, physical education teacher, lecturer, etc.) If it is more than one, please elaborate.

3. If your job description is a Kinderkineticist, please indicate all the programmes that you are presenting (for example, remedial lessons, wellness programmes, movement development programmes, vision programmes etc).

Signature of participant

Date

APPENDIX D

MOVEMENT ASSESSMENT BATTERY FOR CHILDREN-2 PERFORMANCE TEST

OBJECTIVE 1

The steps followed according to the manual to conduct the Performance Test are as follow (Henderson et al., 2007:79-83):

Step 1: Demographic data

The demographic data (name of the child, gender, address, school, year group, examiner name and reason for referral and the date of testing) should be indicated on the first page of the record form before testing starts. After that, the chronological age of the child should be calculated. It is important to check that the correct age band is used.

Step 2: Score of individual items

Each activity should be demonstrated to the child and the examiner should record the correct raw data in the correct boxes. Scores will differ according to the number of seconds, steps, or catches.

Step 3: Completing qualitative data on each motor task

For intervention planning, this is an optional section. If the examiner uses this option, observe the child during a task and how he or she reacts during success and failure.

Step 4: Scoring the drawing trial

The number of errors the child makes is recorded. Instructions on the various ways a child draws and how to score is available in the manual and should be followed.

Step 5: Transfer raw scores to the front page.

The score of the child's best effort in each task should be transferred to the relevant box on the front page of the record form.

Step 6: Convert the raw scores to standard scores

The standard scores for every age group are available in Appendix B of the manual and are based on the child’s age. The child's age in years and months will determine which table in Appendix B will be used to transfer the raw score to a standard score. Each item's standard score should be entered in the block on the front page for standard scores.

Step 7: Determine standard scores and percentiles for the three components

The standard scores and percentile ranks for the three components are available in Appendix B, Table 2 of the manual. The standard scores of the three items of manual dexterity should be summed and the two items of aiming and catching and the three items of balance. The sum of each component standard scores should be used to transfer the sum to standard scores and percentiles using Table 2.

Step 8: Determine the standard score and percentile for the total test score

The standard scores and percentile ranks for the total test score is in Appendix B, Table 3 of the manual. Sum the standard scores of the eight items, use the sum to read from Appendix B, Table 3 and obtain the standard score and percentile rank. Enter the numbers in the boxes provided.

Step 9: Summarise the qualitative observations

If qualitative observations were made, summarise them on page 7 of the record form.

Step 10: Complete the assessment summary and intervention plan

APPENDIX E

MOVEMENT ASSESSMENT BATTERY FOR CHILDREN-2 CHECKLIST OBJECTIVE 2

The steps followed according to the manual to score the Checklist is as follows (Henderson et al., 2007:93-94):

Step 1: Start with Section A, then Section B and then Section C

Section C was not used for this research study.

Step 2: Rating sections A and B

A score of 0 (very well), 1 (just ok), 2 (almost) and 3 (not close) are the options to choose from when completing the 15 statements in the sections. The guidelines to the person completing the checklist should be to decide whether the child can or cannot do a task. If they can do it, the decision will be between very well or just ok and if the child cannot do it, is it almost or not close. The person writes the decision that best describes the child on the score sheet of the Checklist.

Step 3: Obtaining a total score for sections A and B

Add the scores for each section and enter the sum into the box below each section. If a person left a block open or indicated not observed, further scoring guidelines are available in the manual. Once Section A and Section B have been finalized, transfer the totals to the front page and sum them, which will then be the total motor score.

Step 5: Interpreting the total motor score

The front cover includes a table that provides the cut-off points for each zone (green, amber, or red). First, the child's age should be established and then their total motor score should be looked up in the table. The red zone indicates highly likely movement difficulty, amber zone shows at risk for movement difficulty, and the green zone has not detected any movement difficulty.

APPENDIX F

E-DELPHI QUESTIONS

OBJECTIVE 3

1. Round 1
2. Addendum of interventions with round 1
3. Round 2
4. Round 3

Please note: The questionnaires for all three rounds were developed on the UFS EvaSys Software program. On the software program the questions are in large type format and easy readable. When downloading the question to display the format from the EvaSys program the view is quite small. Please enlarge with pdf if it is difficult to read.

ROUND 1

Dear participant

Please complete all the questions as thoroughly as possible. The questions are formulated from research findings in the literature and your opinion about these findings and additional knowledge that you can add as a qualified Kinderkineticist is required.

You will be required to provide your Name and Surname on the next page. Please be reminded that names and identities are anonymous to each other and do not form part of the data that will be presented. The researcher is the only one who knows the participants' names and identities and will use them in confidentiality.

Each section of the questionnaire is on a separate page. Complete each question on each page and click on next. <u>Do not</u> click on next if you have <u>not completed</u> all the questions as you will not be able to continue to the next page.

Unfortunately, a save option is not available for this questionnaire, therefore make sure you complete all the questions and click on submit before you close the link (browser page).

<u>Important to know:</u>
There is a difference between children diagnosed with DCD and children identified with DCD (possible DCD).

A child **<u>diagnosed</u>** with DCD = meets all four criteria of the Diagnostic Statistical Manual of mental disorders-5th edition for DCD or are diagnosed with the International Statistical Classification of Diseases and Related Health Problems, 10th revision.

A child **<u>identified</u>** with DCD = A child with motor skill abilities (motor proficiency) far below their age group. Motor skill abilities can be determined by using a standardized motor proficiency test battery and the results of the tests indicate motor proficiency levels far below the child's age group. For example, if a child falls at or below the 15th percentile when the MABC-2 is used, the child is identified with moderate to severe motor skill difficulties (possible DCD).

Click on next.

1 <u>General Information</u>

1.1 **What is your Name and Surname?**

1.2 **How old are you?**

1.3 **What is your gender?**
- ○ Female
- ○ Male
- ○ Prefer not to say

1.4 **Indicate your highest qualification.**
- ○ Degree
- ○ Honours degree
- ○ Masters degree
- ○ Ph.D.
- ○ Associate Professor
- ○ Professor
- ○ Other

1.5 **If you selected other at question 1.4, please indicate your highest qualification below.**

1.6 **Do you have any additional certificates specializing in a child's development, motor proficiency and other important aspects of a child between the age of 0-13 years?**
- ○ Yes
- ○ No

1.7 **If you selected yes at question 1.6, please specify additional qualifications below.**

1.8 **Have you been an author or co-author of an article published in a peer-reviewed journal?**
- ○ Yes
- ○ No

1.9 **If you selected yes at question 1.8, please specify the field/s in which you have published.**

1.10 **In which province/s are you currently working in? Please select all provinces you are working in.**
- ☐ Eastern Cape
- ☐ Free State
- ☐ Gauteng
- ☐ KwaZulu-Natal
- ☐ Limpopo
- ☐ Mpumalanga
- ☐ Northern Cape
- ☐ North West
- ☐ Western Cape

1.11 **Identify the setting/s that you work in. Select all settings applicable to your work environment.**
- ☐ Gym or health clubs
- ☐ Health environment such as hospitals, clinics, etc.
- ☐ Multidisciplinary Practice Environment (involves a range of health professionals and other professionals, from one or more organisations, working together)
- ☐ Permanently at one School
- ☐ Private Practice Environment
- ☐ University
- ☐ Various Schools
- ☐ Other

1.12 If you selected other at question 1.11, please specify the setting/s that you work in, below.

1.13 In which socio-economic environment/s do you work? Please select all options you work in.
- ☐ Low socio-economic environment (households and environments with little income)
- ☐ Middle socio-economic environment (households and environments with medium income)
- ☐ High socio-economic environment (households and environments with high income)
- ☐ Other

1.14 If you selected other in question 1.13, please specify in which socio-economic environment/s you work in, below.

1.15 How many years of experience do you have working with children between 0-13 years of age?

1.16 Identify the following conditions that you have worked with in children. Please choose all relevant options.
- ☐ Children diagnosed with DCD by a medical doctor or other professionals
- ☐ Children identified with possible DCD (motor skills far below the child's age) by using a motor proficiency test (such as the MABC-2, BOT-2, etc).
- ☐ Children experiencing motor skill problems that is not due to any other general medical condition such as cerebral palsy, ADHD, hemiplegia, autism, etc.
- ☐ Other (related to low motor skill abilities)
- ☐ None of the above

1.17 If you selected other in question 1.16, please provide the conditions that you have worked with, below.

1.18 If you selected children diagnosed with DCD, by a medical doctor or other professionals at question 1.16, please indicate which professional person/s have referred the child/children to you.
- ☐ General practitioner
- ☐ Pediatrician
- ☐ Pediatric physiotherapist
- ☐ Other
- ☐ Occupational Therapist
- ☐ Pediatric neurologist
- ☐ Psychologist
- ☐ N/A

1.19 If you selected other at question 1.18, provide the professional person/s who referred the child/children to you.

1.20 How many years of experience you have working with children diagnosed with DCD and/or identified with possible DCD (motor skills far below the child's age).
Please select...

1.21 If you have any other relevant information that you think is important to know regarding section 1 (general information), please provide it below.

2 Additional role players in a motor intervention programme for children diagnosed with DCD or identified with possible DCD

	Do not agree	Partially agree	Agree
2.1 Research indicates that although you as the therapist (Kinderkineticist) plays the most important role during a motor intervention programme, various other people such as teachers, psychologists, parents, etc, should be involved and play an important role to ensure the success of a motor intervention programme. In your opinion, do you agree with this statement?	○	○	○

2.2 Select all the role players that you think should be involved to ensure the success of a motor intervention programme and add additional ones by selecting other.
- ☐ Class Teacher
- ☐ Physical education teacher
- ☐ Parents
- ☐ Dietitian
- ☐ Psychologist
- ☐ Other

2.3 If you selected other in question 2.2, please name any other role players that you think should be involved to ensure the success of a motor intervention programme.

		Do not agree	Partially agree	Agree
2.4	According to research, the therapist (Kinderkineticist) should give the parents, teachers and relevant others advice on the abilities the child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) experience. In your opinion, do you agree with this statement?	○	○	○
2.5	According to research, the therapist (Kinderkineticist) should give the parents, teachers and relevant others advice on the difficulties the child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) experience. In your opinion, do you agree with this statement?	○	○	○
2.6	According to research, the therapist (Kinderkineticist) should give the parents, teachers and relevant others advice on how to assist the child with challenges when diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, do you agree with this statement?	○	○	○
2.7	According to research, the therapist (Kinderkineticist) should give the parents, teachers and relevant others advice on how to assist the child with participation in daily activities when diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, do you agree with this statement?	○	○	○

2.8 If you have any other relevant information that you think is important to know regarding section 2 (Role players), please provide it below.

3 Assessment tools for the identification of a motor intervention programme for children with DCD or possible DCD

3.1 Research has identified various assessment options to use to identify motor skills far below the child's age (possible DCD) and to assist in setting goals for a motor intervention programme. In your opinion, which of the following assessment options would you suggest to use? Only select the options that you will suggest to use.

- ☐ Motor proficiency test (motor tests such as the MABC-2 Performance Test, the BOT-2, etc.)
- ☐ A parent and/or teacher reported questionnaire (motor questionnaire such as the MABC-2 Checklist, Developmental Coordination Disorder Questionnaire, etc)
- ☐ Motor proficiency screening test (Short screening of motor proficiency such as the BOT-2 Short form, MABC-2 Checklist, etc)
- ☐ A child self-report (questionnaire and/or checklist where children reflect on their own motor skill abilities)
- ☐ Physical fitness test (Such as the FitnessGram)
- ☐ Other

3.2 If you selected other in question 3.1, please specify the assessment option/s below to use in the identification of possible DCD and to assist with goal setting for a motor intervention programme.

3.3 Do you have specific suggestions and/or names of motor tests, test-batteries, screening tools, questionnaires, etc, that should be used to identify motor skills far below the child's age (possible DCD) and to assist with goal setting for a motor intervention programme in children?

○ Yes ○ No

3.4 If you have suggestions, please name them below.

		Do not agree	Partially agree	Agree
3.5	According to research, the scores of test items and sub components in a motor proficiency test can help to identify the level of motor skill difficulties experienced by the child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, do you agree with this statement?	○	○	○
3.6	According to research, the scores of test items and sub components in a motor proficiency test can help to indicate specific motor skills the child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) struggles with. In your opinion, do you agree with this statement?	○	○	○
3.7	A motor proficiency test should be used to identify the skills that should be focused on during a motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, do you agree with this statement?	○	○	○

3.8 Research indicates various information resources that can be used to determine the environmental context and psycho-social factors a child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) finds him- or herself in. In your opinion, which of the following information resources should be used to determine the environmental context and psycho-social factors of the child which would specifically help with planning a motor intervention programme? Choose all relevant options.

- ☐ Clinical examination
- ☐ Child self-report
- ☐ Medical History
- ☐ Motor test results
- ☐ Parent reports and/or feedback
- ☐ Reports of relevant others
- ☐ Teacher reports and/or feedback
- ☐ Validated questionnaires
- ☐ Other

3.9 If you selected other at question 3.12, please specify the information resource/s below.

3.10 If you have any other relevant information that you think is important to know regarding section 3 (Assessment tools), please provide it below.

4 Goal-setting of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

4.1 Research has identified various aims/goals to consider for determining what the motor intervention programme should focus on when presented to children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age group). Select the goals that you think should be considered to determine the motor intervention programme that will be presented.

- ☐ Individual goals - Focus on and consider the motor skill problems or delays identified for each individual diagnosed with DCD or identified with possible DCD when planning the motor intervention programme
- ☐ Group goals - Focus on and consider the motor skill problems or delays identified for all members in the intervention group diagnosed with DCD or identified with possible DCD when planning the motor intervention programme
- ☐ General goals - Focus on and consider general motor skill problems or delays experienced by children diagnosed with DCD or identified with possible DCD when planning the motor intervention programme
- ☐ Other

4.2 If you selected other in question 4.1, please specify below.

4.3 Research indicates that it is important to consider a few factors and/or viewpoints when planning your goal-setting for your motor intervention programme. Select the factors that you think is important for goal-setting for the motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). Select all relevant factors.

- ☐ The child's viewpoint
- ☐ The viewpoint of the child's family
- ☐ The viewpoint of relevant others
- ☐ The health of the child
- ☐ Environmental factors
- ☐ Strength and weakness of the child in an environmental context
- ☐ Psycho-social factors
- ☐ Emotional factors
- ☐ Physical factors
- ☐ Self-concept
- ☐ Peer interaction
- ☐ Social support and/or ability
- ☐ Anxiety
- ☐ Depression
- ☐ Self-esteem
- ☐ Activities of daily living
- ☐ Participation levels
- ☐ Leisure play
- ☐ Self-care
- ☐ Academic/school productivity
- ☐ Academic achievement
- ☐ Other

4.4 If you selected other in question 4.3, please specify below.

Research indicates that the motor intervention programme should aim to improve various aspects of the child diagnosed with DCD or identified with possible DCD. In your opinion, indicate if you agree with the following aspects to be achieved after the motor intervention programme has been conducted and if it is important to take into consideration when setting your goals for the intervention programme.

		Disagree	Partially agree	Agree
4.5	At the end of the motor intervention programme the child should have improvement in long term health.	○	○	○
4.6	At the end of the motor intervention programme the child should have improved skills required for play participation.	○	○	○
4.7	At the end of the motor intervention programme the child should have improved skills required for sport participation.	○	○	○
4.8	At the end of the motor intervention programme the child should have an increased participation in physical activity.	○	○	○
4.9	At the end of the motor intervention programme the child should have an increase in his/her well-being.	○	○	○
4.10	At the end of the motor intervention programme the child should have an increase in body functioning.	○	○	○
4.11	At the end of the motor intervention programme the child should have improved motor skills.	○	○	○
4.12	At the end of the motor intervention programme the child should have improved general fitness.	○	○	○
4.13	At the end of the motor intervention programme the child should have improved psycho-social factors.	○	○	○
4.14	At the end of the motor intervention programme the child should have increased motivation.	○	○	○
4.15	At the end of the motor intervention programme the child should have improved functional tasks.	○	○	○
4.16	At the end of the motor intervention programme the child should have improved activities of daily living.	○	○	○
4.17	The child should be able to participate in important life areas as independently as possible and with high quality of life at the end of the motor intervention programme.	○	○	○
4.18	At the end of the motor intervention programme the child should have improved emotional skills.	○	○	○
4.19	At the end of the intervention the child should be able to have learned ways of doing activities they find difficult, such as breaking down difficult movements into smaller parts and practicing them regularly.	○	○	○
4.20	At the end of the motor intervention programme the child should have improved social skills.	○	○	○

4.21 If you have any other relevant information that you think is important to know regarding section 4 (Goal-Setting), please provide it below.

5 Types of motor intervention programmes for children diagnosed with DCD or identified with possible DCD

A clear explanation of the types of intervention approaches and interventions are available in the email send to you (Addendum A). Please refer to the attached intervention document if you are unsure about any of the approaches or interventions mentioned below.

5.1 **In your opinion, which approach/es will you more likely suggest to make use of in a motor intervention programme for a child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). Select all approaches you will suggest to use.**

- ☐ **Body function- and structure-oriented approach** (The activity is developed to improve specific body functions to address the functional motor problem).
- ☐ **Activity-oriented approach** (The activity is designed to improve performance in that specific activity).
- ☐ **Participation-oriented approach** (The activity is developed so that it will improve participation in that activity within an everyday situation).
- ☐ **Combination**
- ☐ **Other**

5.2 **If you have selected other in question 5.1, please specify below.**

5.3 A list of body-function-oriented intervention approaches identified in the literature to use for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) is presented here. In your opinion, which intervention/s will you suggest to use when developing a motor intervention programme for children diagnosed with DCD or identified with possible DCD? Choose all the interventions that you will suggest to use.

- ☐ Perceptual-motor intervention
- ☐ Sport-oriented motor intervention by making use of a specific sport and combining it with fundamental movements
- ☐ Strength training intervention
- ☐ Core stability training
- ☐ Aquatic intervention
- ☐ Endurance training intervention
- ☐ Visual-perceptual motor intervention
- ☐ Visual motor intervention
- ☐ Fundamental motor skill intervention
- ☐ Basic exercise programmes focusing on improving balance, ball skills and gross motor skills
- ☐ Motor skill training
- ☐ General skill training
- ☐ Other

5.4 If you selected other at question 5.3, please specify below.

5.5 Here is a list of various activity-oriented and participation oriented intervention approaches identified in the literature to use for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, which intervention/s will you suggest to use when developing a motor intervention programme for children diagnosed with DCD or identified with possible DCD? Choose all the interventions that you will suggest to use.

- ☐ Neuromotor Task Training (NTT)
- ☐ Cognitive orientation to daily occupational performance intervention
- ☐ Task-specific brain gym activities, fine motor activities, balance activities, and gross motor activities
- ☐ Motor imagery training
- ☐ Sport/play related skill training
- ☐ Virtual reality training (Active video games)
- ☐ Health promotion programme
- ☐ Task-specific balance training programme
- ☐ Task-specific motor skill training
- ☐ Task-oriented motor training and perceived motor competence training
- ☐ Goal-directed training
- ☐ Other

5.6 If you selected other at question 5.5, please specify what you will suggest to use below.

5.7 Research indicates that various apparatus and/or resources are used in motor intervention programmes for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, identify the apparatus and/or resources that you think should be included in the motor intervention programme. Select all the relevant options.

- ☐ Sport related equipment such as soccer balls, rugby balls etc.
- ☐ Academic apparatus such as worksheets, stationary, fine motor games, etc.
- ☐ Playground apparatus such as jungle gyms, swings, etc.
- ☐ Basic physical education apparatus such as skipping ropes, parachutes, hula hoops, etc.
- ☐ Therapeutic equipment such as vestibular scooter, therapy balls, etc.
- ☐ Virtual gaming such as Xbox, Wii, etc.
- ☐ Visual apparatus
- ☐ Other

5.8 If you selected other at question 5.7, please specify below.

5.9 If you have any other relevant information that you think is important to know regarding section 5 (Interventions), please provide it below.

6 Additional inclusions in the motor intervention programme for children diagnosed with DCD or identified with possible DCD

Research suggests that other aspects should also be considered or included when planning and/or implementing a motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age). In your opinion, indicate whether you agree with the following statements:

		Disagree	Partially agree	Agree
6.1	The motor intervention programme for children diagnosed with DCD or identified with possible DCD should be relevant to daily living activities. Therefore, the activities included in the intervention should include performing the activities during daily living.	○	○	○
6.2	The motor-intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) should be child-centered (the child identifies and take responsibility for making choices about what they want to improve on or do in the intervention programme).	○	○	○
6.3	The most severe motor problem experienced by the child diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) must be addressed in the motor intervention programme.	○	○	○

6.4 If you have any other relevant information that you think is important to know regarding section 6 (Additional inclusions), please provide it below.

7 Group and/or Individual delivery mode of intervention

		Disagree	Partially agree	Agree
7.1	According to research the level of motor skill abilities of the child diagnosed with DCD or identified with possible DCD will assist in determining if you will present your motor intervention programme in a group-based setting or an individual-based setting. In your opinion, do you agree with this statement?	○	○	○
7.2	The availability of resources is an aspect that will determine if a motor intervention programme will be presented in a group-based setting or an individual setting. In your opinion, do you agree with this statement?	○	○	○

7.3 Research indicates that group-based and individual-based intervention for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) has been successfully used. In your opinion what is the best option to use?

- ○ Only group-based intervention
- ○ Only individual-based intervention
- ○ A combination of group-based intervention with individual sessions
- ○ A combination of individual-based intervention with group sessions
- ○ Other

7.4 If you selected other at question 7.3, please specify below.

If you need to make use of a group-based motor intervention, in your opinion, identify the level of importance of the following aspects to consider with a group intervention.

		Not important	Slightly important	Important	Very important
7.5	Size of the group	○	○	○	○
7.6	Instructions	○	○	○	○
7.7	Manageability	○	○	○	○
7.8	Effectiveness of motor-intervention	○	○	○	○
7.9	Professionals available	○	○	○	○
7.10	Motor skill ability of the child	○	○	○	○
7.11	The ability to monitor individual progress	○	○	○	○
7.12	Psycho-social factors of the child	○	○	○	○
7.13	Age of the children	○	○	○	○
7.14	Goals of the motor intervention programme	○	○	○	○

7.15 The research indicates various sizes of intervention groups ranging from between two to 10 children in a group. In your opinion, what should the size of the group be to ensure effective and manageable intervention for children diagnosed with DCD or identified with possible DCD? Please select...

7.16 If you selected other in question 7.15, please specify.

7.17 If you have any other relevant information that you think is important to know regarding section 7 (Group/Individual interventions), please provide it below.

8 The setting of the motor intervention programme for children diagnosed with DCD or identified with possible DCD

8.1 In your opinion, which intervention setting would you suggest will be more beneficial to present the motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age)?

- ☐ Home-based setting
- ☐ School-based setting
- ☐ Therapy-based center setting
- ☐ Other

8.2 If you selected other in question 8.1, please specify below.

8.3 If parents or caregivers of children diagnosed with DCD or identified with possible DCD cannot afford treatment, in your opinion, what type of intervention setting will you recommend in order to assist these children?

- ☐ Group-based intervention setting
- ☐ Small group-based intervention setting
- ☐ School based intervention setting
- ☐ Therapy center based intervention setting
- ☐ Home-based intervention setting
- ☐ Other

8.4 If you selected other at question 8.3, please specify below.

8.5 If you have any other relevant information that you think is important to know regarding section 8 (Setting), please provide it below.

9 Time of motor intervention programme for children diagnosed with DCD or identified with possible DCD

9.1 In you opinion when is the best time of the day to present the motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age)?

- Early morning (between 7am and 10am)
- Late morning (between 10am and 12pm)
- Early afternoon (between 12pm and 3pm)
- Late afternoon (between 3pm, and 6pm)
- Early evening (between 6pm and 8pm)

9.2 If you have a reason for your choice at question 9.1, please provide it below.

9.3 If you have any other relevant information that you think is important to know regarding section 9 (Time), please provide it below.

10 Durations, frequencies and sessions of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

Research identifies various duration, frequencies, and sessions of motor intervention programmes for children diagnosed with DCD or identified with possible DCD. The next questions below will require you to provide your opinion regarding the duration, frequency, and sessions to use for a successful motor intervention programme.

10.1 Research indicates various results regarding how long a motor intervention programme for children diagnosed with DCD or identified with possible DCD should be. Variations as short as 4 weeks up until as long as 24 weeks have been found. In your opinion, how many weeks should a motor intervention programme be for children diagnosed with DCD or identified with possible DCD?

Please select...

10.2 If you selected other in question 10.1, please specify below.

10.3 According to research, successful motor interventions for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) include frequencies of once a week, twice a week and three times a week. In your opinion, how many sessions per week would you suggest should a child diagnosed with DCD or identified with possible DCD, receive?

- Once a week
- Twice a week
- Three times a week
- More than three times a week

10.4 In your opinion, how long (duration) in minutes should a session during a motor intervention programme be?

Please select...

10.5 If you selected other at question 10.4, please specify below.

10.6 Do you think the age of a child should be considered when planning the duration, frequency and sessions of the motor intervention programme?

- Yes
- No

10.7 If you have any other relevant information that you think is important to know regarding section 10 (Duration, frequencies), please provide it below.

11 Evaluating the motor intervention programme for children diagnosed with DCD or identified with possible DCD

11.1 Various assessment tools can be used to evaluate the effectiveness of a motor intervention programme. In your opinion, which assessment tool/s should be used to evaluate if a motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) is successful? Select all relevant options.

- Movement Assessment Battery for Children
- Bruininks Oseretsky Test of Motor proficiency
- Test of Gross Motor Development
- Fitnessgram
- Beery Buktenica Developmental Test of Visual Motor Integration 6th Edition (Beery VMI)
- Other

11.2 If you selected other at 11.1, please specify below.

11.3	How often do you think should the effectiveness of a motor intervention programme, be evaluated?	◯ Once every four weeks ◯ Once every three months ◯ Once every six months ◯ Only when the motor intervention programme has been completed ◯ Other
11.4	If you selected other at question 11.3, please specify below.	
11.5	In your opinion, what aspects of a motor intervention programme for children diagnosed with DCD or identified with possible DCD (motor skills far below the child's age) is important to evaluate? Select all relevant options.	☐ Evaluate the effects of the intervention programme ☐ Evaluate if goals are reached ☐ Determine if further intervention is required ☐ Other
11.6	If you selected other in question 11.5, please specify below.	
11.7	If you have any other comments and/or suggestions, please provide it here.	

Thank you for completing round 1 of this survey. You will receive round 2 as soon as the results of this questionnaire have been processed.

ADDENDUM A: Interventions and intervention approaches defined

Addendum A: Interventions and Intervention approaches defined:

According to the literature, there are two main approaches to intervention for DCD. The one approach is referred to as **process-oriented approach**, and the other is referred to **as task-oriented approach**.

1. **Process-oriented approach**
   Focus on using activities to target the underlying performance problems (Smits-Engelsman *et al.,* 2012).

2. **Task-oriented approach**
   Focus on using activities to address the performance issue itself (Smits-Engelsman *et al.,* 2012).

   Recent literature made use of the level of International Classification of Functioning, Disability, and Health (ICF) that is the primary target of the intervention and identified interventions as follows: Body-function- and structure-oriented approach, activity-oriented approach, and participation-oriented approach.

1. **Body-function- and structure-oriented approach (Process oriented approaches)**
   The activity that the child performs is developed to improve specific body functions to address the functional motor problem (Smits-Engelsman *et al.,* 2018). For example, if stringing beads is used as an activity in the intervention to improve eye-hand coordination in a child with handwriting difficulties.

2. **Activity-oriented approach (Task oriented approaches)**
   The activity is designed to improve performance in that activity (Smits-Engelsman *et al.,* 2018). For example, the goal is for the skill of stringing beads to improve, and therefore the child is stringing the beads.

3. **Participation-oriented approach (Task oriented approaches)**
   The activity is developed so that it will improve participation in that activity within in an everyday situation.

   Within activity-oriented and participation-oriented motor interventions, the main focus is to improve the performance skill of that activity or participation. The training, therefore, focuses on training the skill concerned (Smits-Engelsman *et al.* 2018). For example, if activity and participation oriented is used, the goal for the child is to become better in stringing beads in order to make decorations with his friends.

The interventions listed in the questionnaire are previously used for individuals diagnosed with DCD or identified with possible DCD. A short explanation of each intervention is provided.

1. **Perceptual-motor intervention.**

   Perceptual Motor Skills are the movement-related skills vital to children's development, learning, and growth. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- A perceptual-motor-intervention that targets components such as laterality (unilateral, bilateral, and cross-lateral activities), balance, body image, tracking, spatial relations (body, spatial, directional, and temporal awareness), locomotor and manipulative skills. These categories consist of spatial awareness, eye-hand coordination, eye-foot coordination; body awareness; gross motor coordination; motor planning; directionality, and dynamic balance. Provides a child with a broad range of experiences with sensory and motor tasks, with the opportunity to practice (Barnhart *et al.,* 2003; de Milander *et al.,* 2015; Gallahue & Ozmun, 2006; Johnstone & Ramon, 2011; *Mandich et al.,* 2001).

2. **Sport oriented motor-intervention**

   Making use of a specific sport and combining it with fundamental movements such as locomotor, manipulation, and stability skills (de Milander *et al.,* 2014).

3. **Strength training intervention**

   Strength training involves the performance of physical exercises that are designed to improve strength and endurance. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Strength training with Thera-bands – A moderate load training was implemented to strengthen the core muscles and lower limb muscles involved in static and dynamic balance. This includes leg abductors and adductors, knee flexor and extensors, abdominals, back extensors, and plantar flexors. Thera-bands are used, and body weight is in the supine or prone positions. The focus is on free weight training. (Kordi *et al.,* 2016).
- Strength training with a Universal Exercise Unit – Exercises include supine position unilateral leg press, unilateral and bilateral hip extension to neutral with a knee immobilizer, unilateral hip abduction and adduction with knee immobilizers, lateral trunk flexion to neutral

with knee immobilizers, unilateral and bilateral hip and knee flexion, bridging, unilateral shoulder extension with elbow immobilizers, unilateral shoulder horizontal abduction with elbow immobilizers, prone position unilateral knee flexion, seated unilateral knee extension, standing bilateral heel raises with upper extremity support for balance (Menz *et al.,* 2013).

4. Core stability training

Core stability training exercises for the trunk muscles not only to stabilize but also to assist as facilitators of trunk movement. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Exercises are performed with a physioball and executed in the supine, prone, sitting, and standing positions and the aim is to increase core stability, balance, strength, and motor control (Au *et al.,* 2014).

5. Aquatic intervention

Refers to treatments and exercises performed in water for physical rehabilitation and therapeutic benefit (Hillier *et al.,* 2010).

6. Endurance training intervention

Endurance training is the act of exercising to increase endurance. The term endurance training generally refers to training the aerobic system as opposed to the anaerobic system. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Interval training (repeat work-recovery bouts over short distance: 5x 100m, 3 x 200m, 2x 600m) and one continuous long-distance running session and one session with another aerobic activity (cycling, step aerobics, rope jumping). Distance, speed, and the number of repetitions are gradually increased throughout the training period according to each child's ability (Tsia *et al.,* 2014).

7. Visual-perceptual motor intervention

A combination of visual-perceptual skills and motor skills. Example interventions used in children with DCD or possible DCD:

- This therapy focuses on perceptual and motor activities such as balance, hand-eye coordination, bilateral integration, and vestibular integration combined with visual exercises that focus on the improvement of ocular motor control. Attention is focused on near (at a desk) and far (visual and gross motor activities) visual activities (Coetzee and Pienaar 2013).

8. Visual-motor intervention

The ability to observe, recognize, and use visual information about forms, shapes, figures, and objects makes up our visual-motor abilities. Visual-motor skills include coordination of visual information that is perceived and processed with motor skills, including fine motor, gross motor, and sensory-motor. These aspects are all used in the visual-motor intervention.

9. Fundamental motor skill intervention

Necessary fundamental motor skills such as running, jumping, catching, kicking, and throwing are executed. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- The tasks are initially elementary, with difficulty progressively increasing over time. Increase in difficulty is controlled by gradually increasing distance in four skills: jumping (horizontal distance between the takeoff and landing points), catching (distance between the thrower and the child), kicking (distance between the stationary ball and the target goal), and throwing (distance between the participant and the target wall). Task difficulty is further controlled by adjusting the size or weight of objects: jumping (height of barriers), catching (size and weight of the balls), kicking (width of the goals), and throwing (size of the target areas). If participants had completed> 50% of the target skills required in each session, they would progress to the next level of difficulty (Hui-Ping Sit et al., 2019).

10. Basic exercise programmes

A range of physical exercises. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Physical activities on improving balance, ball skills, and gross motor skills.

11. Motor skill training intervention

Motor skills are something most of us do without even thinking about them. Motor skills are divided into gross and fine motor skills. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Children are trained in the essential fundamental gross motor skills (hopping, jumping, throwing, and catching) and the primary motor abilities that are thought to be prerequisites for skills in sports teams such as games with a handball against age norms. Children can be trained in outdoor games such as soccer, netball, and variations of tagging games. *(*Ferguson *et al.*, 2013; Peens *et al.,* 2008).

12. General skill training

General training required to gain the knowledge and abilities necessary to fulfill a specific skill in daily living activities.

13. Neuromotor Task Training (NTT)

Neuromotor Task Training is a principled approach to intervention based on an understanding of the deep connections between the child, the task and the environment, and in-depth analysis of the factors affecting task performance and the application of evidence principles of motor learning. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- It is based upon a cognitive neuroscience approach to motor control, which implies that several cognitive and motor control processes can be distinguished during the preparation and execution of functional motor tasks, such as the processing of motor task-related information, action planning, and initiation. Before starting the intervention, the therapist talks with the parent(s) to get insight into the problems experienced in daily life. In addition, they perform a standard protocol to assess a child's functional performance's strengths and weaknesses. The aim of this assessment is twofold. First, the therapists determine the extent to which motor tasks are performed below the expected level, such as handwriting or ball skill tasks. Second, they will analyse which cognitive or motor control processes might be involved in deficient motor performance. Thus the standard assessment of NTT includes assessing the child's impairments within a particular functional motor activity. During the intervention, therapists implement functional exercises that tap the specific motor control processes that are considered involved" (Ferguson *et al.,* 2013; Niemeijer *et al.,* 2007*)*.

14. Cognitive orientation to daily occupational performance (CO-OP)

A performance-based treatment approach for children and adults who experience difficulties performing the skills they want to, need to or are expected to perform. CO-OP is a specifically tailored, active client-centered approach that engages the individual at the meta-cognitive level to solve performance problems. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- In CO-OP, it is believed that the child would solve movement problems through explicit and implicit learning. The therapists or parents only act as an essential role to assist the child in solving the problematic problem using cognitive strategies, e.g., changing the body position in a right way to catch a ball, calibration of the force of the hands when cutting sandwiches, organizing the table when stuck on the homework or packing a school bag. The child learns the strategies by repetitive practice of tasks of similar cognitive demands, which are then reinforced by the therapists or parents (Adams *et al.,* 2016; Thornton *et al.,* 2016; Zwicker *et al.,* 2015).

- Cognitive orientation to daily occupational performance during a summer camp programme (Zwicker *et al.,* 2015).

15. Task-specific brain gym activities, fine motor activities, balance activities, and gross motor activities.

Example interventions used in children diagnosed with DCD or identified with possible DCD:

- The programme includes 10 min Brain Gym followed by fine motor movement activities, balance exercises, and gross motor coordination activities. Each activity begins with a simple movement and then progresses to more complex variations. A feature of the intervention is that all activities start with the easiest variation, and more challenging variations are introduced only once the whole group successfully achieves the task (Alloway and Warner, 2008).

16. Motor Imagery training

It uses internal modeling of movements, which facilitates the child to predict consequences for actions in the absence of overt movement. In time and with practice, children use the knowledge of the relationship between vision and internal feeling. Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Exercises are displayed on a monitor. Six components are addressed visual imagery exercises, relaxation protocol, and mental preparation, visual modeling of fundamental motor skills, mental rehearsal of skills, an overt practice involving several repetitions of the skills. Six fundamental motor skills are the focus of imagery training: catching a tennis ball, throwing a tennis ball, striking a softball, jumping to a target using a two-leg takeoff, balancing a ball on a bat while walking, and placing objects using a form board. These exercises are presented as digital video, modeled by male and female peers who are considered well-coordinated for their age (Wilson *et al.,* 2016).

17. Sport/Play related skill training

Example interventions used in children diagnosed with DCD or identified with possible DCD:

- An intensive ten-week soccer training programme (Tsai *et al.,* 2009) or Ball-oriented intervention by training children in table tennis (Tsai *et al.,* 2009).
- Children participate in typical taekwondo training syllabus for beginners (Fong *et al.,* 2012; Fong *et al.,* 2013).

- Balance trampoline training – The intervention consists of balance training in a circuit and includes a trampoline station. Training consists of walking exercises, jump on one foot, jumps and landings on one or both legs, landings from heights (eyes open and closed), rotations in different directions. Trampoline exercises include standstill with eyes closed, hopping with rotation or with legs opening and closing, alternate front and back leg movements, one foot jumps, kicking a ball while hopping and association of different jump patterns with ball throwing, hooping and playing with a balloon with the hands (Giagazoglou *et al.,* 2015).

18. Virtual reality training (Active video games)

The interactive and immersive teaching method employs technology to provide virtual scenarios to simulate situations that might occur in actual settings.

Example interventions used in children diagnosed with DCD or identified with possible DCD:

- Children manipulate virtual objects in a way that evokes behaviours similar to real life. For example, the Sony PlayStation two is used with an Eye Toy to play volleyball. The volleyball is on the TV screen, and the child's body movements are picked up by the eye toy too, for example, hit the ball. The game tasks require the user to make accurate, target-based upper extremity movements, which include motor planning, standing balance, eye-hand coordination, and multitasking at a high level of intensity.
- Another way is with the Sony PlayStation 3 and Move and Eye motion input devices or a Microsoft xbox360 with kinetic motion input. Games such as Sports championship, start the party, TV superstars, Eye Pet, your-shape fitness evolved, motion sports, kinetic adventures, dance central, body and brain exercises, racket sports, cross-board 7 is provided. These games include tasks requiring fine and gross motor skills and upper and lower limb movements (Ashkenazi *et al.,* 2013; Straker *et al.,* 2015).
- Activities are performed on the Nintendo Wii Fit balance board. Learners are required to mimic sports such as cycling, soccer, skateboarding, skiing, etc., by shifting their weight from side to side, shifting their weight back and forth on the balance board, stepping and jumping over virtual objects. Games, including arm movements, are also used. (Ferguson *et al.,* 2013; Hammond *et al.,* 2013; Jelsma *et al.,* 2014; Lee *et al.,* 2016; Smits-Engelsman *et al.,* 2017).

19. Health promotion programme

Include a set of principles to follow within a school-setting over some time. Principles included aspects such as informing classes regarding the importance of physical activity, providing games on the school playground by providing essential equipment and drawing chalk outlines for games, design and implement physical education lessons and select appropriate activities for teaching movement skills, etc. (Ferguson *et al.,* 2015).

20. A Task-Specific balance training programme

The focus is on exposing the child repeatedly to specific balance training and include electromyography biofeedback (Fong *et al.,* 2016).

21. Task-oriented Motor skill training

A collaboration of task-oriented and motor skill training and discovering new strategies to perform motor skills (Cacola *et al.,* 2016). Example interventions used in children diagnosed with DCD or identified with possible DCD:

- This intervention consists of skill and agility training. Skills include aerobic power, agility, strength, balance, flexibility, balance-ball skill, reaction speed, aerobic power ball-skill, strength-coordination. Activities such as walking, running, climbing, and jumping is included. Skills are made difficult by progressively changing constraints of the task and combining tasks. The intervention aims to address common motor difficulties experienced by children with DCD, such as poor agility, balance, core stability, and movement coordination (Farhat *et al.,* 2015).
- The focus is on training functional tasks such as body stability (standing) and body transport (walking, running, jumping, hopping, skipping, and galloping). The difficulty level is increased during the intervention by changing the surface, width and/or base of support; removing visual input and changing demands regarding direction, speed, and movement pattern; lateral/bilateral upper limb or lower limb task is added to teach the person to do tasks at the same time, for example, picking up an object while walking, etc.; children need to perform the tasks in an environment that is continuously changing as well as in a stationary environment (Au *et al.,* 2014).

22. Task-oriented motor training and perceived motor competence training

This intervention focuses on each child's treatment goals and is based on the clinical problems and assessment of the child's motor performance. Treatment focus on the intersection of motor activity and the underlying motor skill problems (tailor-made and reproducible intervention). For example, if a child experiences difficulty in ball activities, the underlining motor skill problems are first investigated. This includes timing, bouncing, and throwing. During the treatment, different kinds of ball activities are practiced whereby specific attention is focused on improving timing, bouncing, and throwing. As soon as they are performed adequately, they are linked to the practice of motor activity, such as basketball (Noordstar *et al.,* 2017).

23. Goal-directed training

Children have the opportunity to identify what they want to accomplish before the programme starts. A set of goals is then addressed during the sessions. In the end, the group can see what they have accomplished. For example, a goal could be to be able to gallop (Cacola *et al.,* 2016 & Dunford, 2011).

ROUND 2

Dear participant

Please provide your level of agreement (agree/disagree) regarding the questions provided.

The results of round 1 was used to formulate the questions for this round (2). If consensus was not reached for a question in round 1, the question was included in this round for further consideration. In some cases, slight adaptations were made to the questions, and additional questions have been added based on the feedback and comments received from the participants in round 1.

You will be required to provide your Name and Surname on the next page. Please be reminded that names and identities are anonymous to each other.

Each section of the questionnaire is on a separate page. Complete each question on each page and click on next. Do not click on next if you have not completed all the questions as you will not be able to continue to the next page.

Unfortunately, a save option is not available for this questionnaire, therefore make sure you complete all the questions and click on submit before you close the link (browser page).

Click on next.

1 General Information

1.1 **What is your Name and Surname?**

2 Additional role players in a motor intervention programme for children diagnosed with DCD or identified with possible DCD

Participants agreed (96.6%) that various other people should be involved and play an important role in the success of a motor intervention programme.

The most important role players identified by the participants in round 1 to ensure the success of a motor intervention programme were:

Class teachers (96.6%),
Physical education teachers (100%) and
Parents (100%)

Please rate your agreement with the following statements:

The additional role players which are used in the motor intervention programme...

		Do not agree	Agree
2.1	should be provided with clear instructions on when to stop assisting a child.	○	○
2.2	should be informed on your role as the therapist and their role as the additional person playing a part in the intervention programme.	○	○
2.3	should not be encouraged to teach a new skill to the child, as the risk of teaching the skill in the wrong way may occur.	○	○

Research has indicated that children with DCD or possible DCD (motor skills far below the child's age) are heterogeneous and each child do not experience the same problems.

It is understandable that specific professional people will be included in the motor intervention programme if the child experience specific problems, for example if a child have depression due to low motor abilities, a psychologist will be beneficial.

However, when taking into consideration that you are providing a motor intervention programme to improve the motor skill difficulties experienced by children with DCD or possible DCD, would you include the following people as important role players in the motor intervention programme? Agree (yes I would include them to improve motor skill difficulties), Disagree (No I would not include them to improve motor skill difficulties).

		Disagree (Will not)	Agree (Will include)
2.4	Dietitian	○	○
2.5	Psychologist	○	○
2.6	Podiatrist	○	○
2.7	Rheumatologist	○	○
2.8	Behavioural Optometrist	○	○
2.9	Additional caregivers (such as an Au-pair)	○	○
2.10	Other therapists currently also working with the child	○	○
2.11	The person who diagnosed the child	○	○
2.12	Physiotherapist	○	○
2.13	Occupational Therapist	○	○
2.14	Sibling/s of the child	○	○

The participants agreed that the therapist should give the additional role players advice on the abilities (82.8%) and the difficulties (89.7%) experienced by the child with DCD and how to assist the child with these challenges (93.1%). Furthermore, provide advice on how to assist the child with participation in daily activities (100%).

One of the main problems associated with DCD or possible DCD is participation in activities of daily living such as getting dressed, eating with a knife and fork, sitting upright and walking up the stairs.

Please rate your agreement with the following statement.

		Disagree	Agree
2.15	Considering the scope of practice of a Kinderkineticist, the Kinderkineticist should assist the additional role players with general guidelines on daily activity participation.	○	○

2.16 If you have any comments regarding section 2 (Role players), please provide it below.

3 Assessment tools for the identification of a motor intervention programme for children with DCD or possible DCD

The participants agreed that Motor proficiency tests (100%) and Parents/Teacher reported questionnaires (100%) should be used to determine possible DCD and to assist in setting goals for a motor intervention programme.

Inconsistent feedback has however occur among the participants in round 1 regarding motor proficiency screening tests, child self-reports and physical fitness tests in identifying possible DCD.

Please rate your level of agreement with the following statements provided by the feedback and comments received in round 1:

		Disagree	Agree
3.1	The age of the child is a determined factor when choosing assessment tools to identify possible DCD and setting goals for the motor intervention programme.	○	○
3.2	Some of the participants were of the opinion that a child self-report should not be used, because in their opinion children of any age are not able to realize that they have problems with their motor skills. Do you agree?	○	○
3.3	A child self-report should be used to identify possible DCD and to assist in setting goals for a motor intervention programme if the child is old enough and able to reflect on his or her abilities.	○	○
3.4	Additionally to a motor proficiency test, other screening/testing options should be used depending on the problems associated with the child identified with possible DCD. For example, if the child is also obese, a fitness test will be required.	○	○
3.5	Assessments and/or checklists should be used to determine if difficulty of movement is not caused by other underlying problems, such as hyper-mobility or poor sensory processing, etc.	○	○
3.6	Tests evaluating underlying neuro-motor components such as reflex integration, sensory functioning and processing should be used to identify possible DCD and to assist in setting goals for a motor intervention programme.	○	○

Various motor tests, test-batteries, screening tools and questionnaires have been identified by the participants in round 1 to use to identify possible DCD and to assist with goal setting for a motor intervention programme in children.

It is important to remember that the child's age and the problems the child experience will determine what additional tests you will use, however, in order to determine motor skill difficulties in the child, specific testing instruments have been suggested.

Please rate your agreement with the following statements:

		Disagree	Agree
3.7	The Movement Assessment Battery for Children -2 Performance Test is identified as the gold standard to use in the identification of possible DCD and should be used.	○	○
3.8	The Bruininks-Oseretsky Test of Motor Proficiency-2 can be used as an additional test to provide information regarding the child's physical and motor abilities.	○	○
3.9	The Test of Gross Motor Development can be used as an additional test to provide information on the qualitative performance of the child with DCD or possible DCD.	○	○
3.10	The Developmental Coordination Disorder Questionnaire'7 completed by parents can be used as an additional screening tool to identify possible DCD in children.	○	○
3.11	The Movement Assessment Battery for Children Checklist completed by teachers and/or parents can be used as an additional screening tool to identify possible DCD.	○	○
3.12	The Peabody Developmental Motor Scales -2 can assist if a young child is showing the characteristic features of DCD, and to determine the need for ongoing monitoring.	○	○
3.13	The START Checklist can be used as an additional test to evaluate the impact of motor difficulties on the child's daily performance.	○	○

Participants agreed (89.7%) that the scores of test items and sub components in a motor proficiency test can help to identify the level of motor skill difficulties experienced by the child, indicate specific motor skills the child struggles with (100%) and assist in identifying the skills that should be focused on during a motor intervention programme (100%).

The participants agreed that the information resources to use to determine the environmental context and psychosocial factors a child diagnosed with DCD or identified with possible DCD, finds him- or herself in is:

Using a Medical history of the child (82.8%)
Using parents reports and/or feedback by using validated questionnaires (96.6%)
Using teacher reports and/or feedback by using validated questionnaires (96.6%)

According to the feedback of the participants in round 1, various factors will determine which resources you will use to determine the environmental context and psychosocial factors of the child with DCD or possible DCD.

Please rate your agreement with the following statements:

The following factors will determine which information you would use to determine the environmental context and psychosocial factors of the child with DCD or possible DCD:

		Disagree	Agree
3.14	Age of the child.	○	○
3.15	Where the problem occurs (at school or at home).	○	○
3.16	Where the child lives.	○	○
3.17	Who the child is living with.	○	○
3.18	Living conditions of the child.	○	○
3.19	Resources available to use.	○	○

Indicate whether you agree if the following information resources should be used to identify environmental factors and psychosocial factors of the child with DCD or possible DCD.

		Disagree	Agree
3.20	A clinical examination if this resource is available to the child.	○	○
3.21	A child self-report if the child is old enough to complete the report.	○	○
3.22	If the child was evaluated with a motor proficiency test, the results of the test should be used.	○	○
3.23	A family lifestyle report (screen time, sleeping time, etc).	○	○

3.24

If you have any comments regarding section 3 (Assessment tools), please provide it below.

4 Goal-setting of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

SETTING GOALS OF THE MOTOR INTERVENTION PROGRAMME

Provide your level of agreement regarding the following statements:

		Disagree	Agree
4.1	The type of intervention used: individual or group based intervention will be a determined factor on what the goals for the motor intervention programme will be.	○	○
4.2	The baseline ability level of the DCD child will be a determined factor on what the goals for the motor intervention programme will be (for example, if it is very low, your focus will be on first developing a base from where more difficult skills can be focused on).	○	○

The participants agreed that individual goals (96.6%) should be considered for determining what the motor intervention programme should focus on when presented to children diagnosed with DCD or identified with possible DCD to achieve anticipated results.

Provide your level of agreement with the following statements, considering that individual goals should be the focus point when planning your motor intervention programme, due to each child with DCD or possible DCD experiencing different problems. It is also important to remember that it is difficult to address all the problems experienced by the child, and therefore selective goal setting that can have an informal advantage on addressing another problem, is important to consider.

		Disagree	Agree
4.3	If group intervention is used, the motor skill problems experienced by each individual child in the group should be used to determine the goals of the motor intervention programme.	○	○
4.4	General problems that have been identified within children with DCD or possible DCD should be considered to set goals for the motor intervention programme.	○	○
4.5	If a child experience emotional problems such as a low self-esteem due to DCD or possible DCD, emotional goals to boost the child's self esteem through movement should be considered for the motor intervention programme.	○	○

		Disagree	Agree
4.6	Functional goals for each individual child should be used to determine the goals of the motor intervention programme (functional skills affecting daily living such as eating properly, fastening shoes, sitting upright etc.)	○	○
4.7	Sport specific goals – Taken into consideration that the child is old enough, if a child wants to take part in a specific sport and struggle with it, the specific sport will be a goal that you should consider to determine the motor intervention programme.	○	○
4.8	One of the goals that should be considered to determine the motor intervention programme for children with DCD or possible DCD should be to let the child experience joy while moving around in order to avoid hating movement at the end of the day.	○	○

The participants agreed that it is important to consider the following additional viewpoints/factors for goal-setting of a motor intervention programme for children with DCD or possible DCD: the health and long term health of the child (96.6%), the strengths and weaknesses of the child in an environmental context (86.2%), the physical factors of the child (93.1%), the self concept of the child (82.8%), activities of daily living (86.2%), improving skills to increase play participation (100%), improving participation in important life areas independently (100%).

Consensus has not been reached regarding the additional factors/viewpoints listed below.

In your opinion do you agree/disagree that the following viewpoints/factors are also important to consider for goal-setting of the motor intervention programme for children with DCD or possible DCD?

		Disagree	Agree
4.9	The child's viewpoint if the child is old enough to understand and provide a viewpoint.	○	○
4.10	The viewpoint of the child's family if they play an active role in the child's life.	○	○
4.11	The viewpoint of relevant others actively involved in his or her life.	○	○
4.12	Emotional factors (anxiety, depression, self-esteem) if the child experience emotional problems.	○	○
4.13	Psycho-social factors if these factors are present in the child.	○	○
4.14	If the child experienced problems with his or her general fitness.	○	○
4.15	Environmental factors.	○	○
4.16	Peer interaction.	○	○
4.17	Social support and social ability.	○	○
4.18	Self care of the child.	○	○
4.19	If the child struggles with specific skills used to participate in free play activities.	○	○
4.20	Academic performance if it is a problem within the child.	○	○

REACHING GOALS AT THE END OF A MOTOR INTERVENTION PROGRAMME

At the end of the motor intervention programme, participants agreed that the child should have increased participation in: physical- and play activities (96.6%), increased well-being (96.6%), increased body functioning (89.7%), improved motor skills (86.2%), increased motivation (86.2%), improved functional tasks (93.1%), improved activities of daily living (96.6%), have learned ways of doing activities they find difficult easier (93.1%), improved participation in important life areas independently (100%).

Further comments have been made by the participants in round 1:

The total well-being of a child with DCD or possible DCD is compromised.

Not all aspects mentioned above are directly addressed in a motor intervention programme or prioritized.

Therapists need to determine if the motor intervention programme will solve the problems experienced by the child in an informal manner by improving the child's motor proficiency. In order to do so the therapist needs to be experienced enough to address additional problems in his/her intervention of the child without specifically making it a goal.

		Disagree	Agree
4.21	Long term health, well-being, body functioning, motor skills, general fitness, psycho-social factors, motivation, functional tasks, daily living activities, emotional skills, social skills and participation in play activities, sport activities, physical activities are all interlinked with each other. If one link is not working it will have an effect on the rest of the factors.	○	○
4.22	In order to determine if improvement has occurred after the motor intervention programme, the improvement should be measurable with many opportunities to see the improvement.	○	○
4.23	Improvement should be recorded so that any improvement even if it is just 1% can be celebrated as improved skills.	○	○

4.24 If you have any comments regarding section 4 (Goal-Setting), please provide it below.

5 Types of motor intervention programmes for children diagnosed with DCD or identified with possible DCD

The participants agreed that a combination approach (82%) is the best option to make use of in a motor intervention programme. The participants provided the following comments:

Considering that each child with DCD or possible DCD experience different problems, the intervention selection will also differ.

Even though the combination approach has been selected as the best option, some suggestions by the participants were made that other approaches could be used individually, however consensus has not been reached. Taking into consideration that each child with DCD or possible DCD experience different problems, please answer the following questions.

5.1 If you do not agree with a combination approach, in which case/s will you only use a body function- and structure-oriented approach for children with DCD? If you will not use this approach alone please write n/a in the block below.

5.2 If you do not agree with a combination approach, in which case/s will you only use a activity-oriented approach for children with DCD? If you will not use this approach alone please write n/a in the block below.

5.3 If you do not agree with a combination approach, in which case/s will you only use a participation oriented approach for children with DCD? If you will not use this approach alone please write n/a in the block below.

		Disagree	Agree
5.4	The most effective intervention type identified by the recent research should be used in order to save time and effort in determining which one to use.	○	○
5.5	The selection of intervention approaches and types will differ for each child with DCD or possible DCD depending on the problems experienced by the child.	○	○
5.6	All three intervention approaches with all the different intervention types listed underneath them can be used but will depend on the problems the child with DCD or possible DCD experience.	○	○

The participants agreed that if a body-function-oriented intervention approach is used, the following interventions should be included in the programme for children with DCD or possible DCD:

Perceptual-motor intervention (100%)
Fundamental motor skill intervention (86.2%)
Motor skill training (82.8%)

Consensus was not reached on if: sport-oriented motor intervention by making use of a specific sport and combining it with fundamental movements, strength training intervention, core stability training, aquatic intervention, endurance training intervention, visual-perceptual motor intervention, visual motor intervention, basic exercise programmes focusing on improving balance, ball skills and gross motor skills and general skill training, should be used as intervention approaches.

Consensus was further not reached if the listed activity oriented and participation oriented approaches in brackets (Neuromotor Task Training (NTT), Cognitive orientation to daily occupational performance intervention, Task-specific brain gym activities, fine motor activities, balance activities, and gross motor activities, Motor imagery training, Sport/play related skill training, Virtual reality training (Active video games), Health promotion programme, Task-specific balance training programme, Task-specific motor skill training, Task-oriented motor training and perceived motor competence training, Goal-directed training) should be used as intervention approaches for children with DCD.

The participants provided further comments. Please rate your level of agreement with the following comments:

		Disagree	Agree
5.7	The most appropriate intervention approaches should be selected and then combined with some of the other listed body function-and/or, activity and/or- participation oriented intervention approaches that will address the specific problems experienced by the individual child with DCD or possible DCD.	○	○

The choice of additional body function- and/or, activity and/or participation oriented intervention (as listed above) will depend on the ___________________

		Disagree	Agree
5.8	outcomes you want to achieve with the child.	○	○
5.9	situation in which the child find himself.	○	○
5.10	problems the child experience.	○	○
5.11	functional problems the child experience.	○	○
5.12	The statement has been made that the motor intervention programme should start wide and general and later move towards more specific task skills in all children with DCD or possible DCD to make sure that the child feels comfortable in the intervention programme. Do you agree with this statement?	○	○

The participants agreed that playground apparatus (89.7%); basic physical education apparatus (100%) and therapeutic equipment (100%) should be used in the motor intervention programme for children with DCD or possible DCD.

Other suggestions of apparatus and/or resources have also been identified. Indicate if you agree/disagree whether the following apparatus should be used in the motor intervention programme:

		Disagree	Agree
5.13	Age appropriate sport related equipment such as soccer balls, rugby balls, etc.	○	○
5.14	If academic problems occur in the child with DCD or possible DCD. Do you agree that academic apparatus such a worksheets, stationary, fine motor games, etc, should be included in the motor intervention programme?	○	○
5.15	Virtual gaming such as Xbox, Wii, etc, should be used if this resources is available.	○	○
5.16	Visual apparatus.	○	○
5.17	Apparatus used for daily living such as knives, forks, stairs, shoes,etc.	○	○

5.18 If you have any comments regarding section 5 (Interventions), please provide it below.

6 Additional inclusions in the motor intervention programme for children diagnosed with DCD or identified with possible DCD

The participants agreed that the motor intervention programme should include a part where the activities is performed during daily living and agreed that the most severe motor problem experienced by the child should be addressed.

In your opinion, indicate whether you agree with the following statement:

		Disagree	Agree
6.1	Part of the motor-intervention programme should be child-centered (the child identifies and take responsibility for making choices about what they want to improve on or do in the intervention programme).	○	○

6.2 If you have any comments regarding section 6 (Additional inclusions), please provide it below.

7 Group and/or Individual delivery mode of intervention

Participants agreed that the level of motor skill abilities and the extend of the problems experienced by the child will assist in determining if the motor intervention programme will be presented in a group-based setting or an individual-based setting.

Provide your level of agreement with the following statement:

		Disagree	Agree
7.1	The availability of resources will determine if a motor intervention programme will be presented in a group-based setting or an individual-based setting.	○	○

Consensus have not been reached between the participants in round 1 on whether group-based intervention or individual-based intervention should be conducted.

According to comments from the participants it is important to consider the nature and extend of the problems the child diagnosed with DCD or identified with possible DCD experience. Furthermore suggestions have been made that you will initially start of with individual sessions and later when the improvement level of the child has increased, group sessions should be provided.

7.2 Considering the factors of question 7.1 and 7.2 and the comments by the participants. In your opinion what is the best option to use?

- ○ Only group-based intervention
- ○ Only individual-based intervention
- ○ A combination of group-based intervention with individual sessions
- ○ A combination of individual-based intervention with group sessions

The participants agreed in round 1 that the size of the group (100%); instructions (100%), manageability (100%), effectiveness of motor-intervention (100%), professionals available (89.6%), motor skill ability of the child (96.6%), the ability to monitor individual progress (100%), psycho-social factors (93.1%), age of the child (82.8%) and the goals of the motor intervention programme (100%) is important aspects to consider with a group intervention.

Consensus has not been reached by the participants in round 1 regarding the size or the group intervention.

Taking into consideration the comments of the participants, please provide your level of agreement below:

The size of the group will depend on the:

		Disagree	Agree
7.3	Age of the child.	○	○
7.4	Skill level of the child.	○	○
7.5	Cognitive capacity of the child.	○	○
7.6	Ability of the child to follow instructions.	○	○
7.7	Sensory profile of the child.	○	○
7.8	Attention span of the child.	○	○

In your opinion how many children should be in a group if the child with DCD or possible DCD ______________

		2-3 per group	3-5 per group	5-7 per group	7-9 per group	9-11 per group
7.9	experience severe problems.	○	○	○	○	○
7.10	experience low to mild problems.	○	○	○	○	○
7.11	have a low attention span.	○	○	○	○	○
7.12	is 5-6 years old.	○	○	○	○	○
7.13	is 7-10 years old.	○	○	○	○	○
7.14	is 11-13 years old.	○	○	○	○	○

7.15 If you have any comments regarding section 7 (Group/Individual interventions), please provide it below.

8 The setting of the motor intervention programme for children diagnosed with DCD or identified with possible DCD

The participants agreed that the therapy-based setting (89.7%) will be more beneficial to present the motor intervention programme for children diagnosed with DCD or identified with possible DCD.

A comment was further made that the therapist can work at the therapy-based setting whereas the parents can do certain activities at home and the teacher at the school with the therapists guidance.

A school-based setting can also be used as a therapy-based setting if the school has a venue and is well equipped.

8.1 If the parents/caregivers of a child diagnosed with DCD or identified with possible DCD cannot afford treatment and the therapist cannot assist for free. In your opinion, what type of intervention setting will you recommend in order to assist this child? It is important to consider, even if the child experience severe difficulties, individual therapy is not an option due to expenses.

- ○ Large group-based intervention setting
- ○ Small group-based intervention setting
- ○ School based intervention setting
- ○ Home-based intervention setting
- ○ Therapy-based intervention setting
- ○ Once of therapy based setting, with guidance to the school and parents (home) thereafter.

8.2 If you have any comments regarding section 8 (Setting), please provide it below.

9 Time of motor intervention programme for children diagnosed with DCD or identified with possible DCD

Various factors have been identified by participants in round 1 that can influence the decision on when a motor intervention programme should be presented to the child with DCD or possible DCD during the day.

Please provide your level of agreement regarding the following statements.

		Disagree	Agree
	The time of the day the motor intervention programme will be presented will depend on the child's:		
9.1	Age	○	○
9.2	Energy levels	○	○
9.3	Concentration level	○	○
9.4	Blood sugar levels	○	○
9.5	When the child eats	○	○
9.6	When the child sleeps	○	○
9.7	Self regulation	○	○
9.8	Natural, internal process that regulates the sleep-wake cycle (Circadian rhythms)	○	○
	The time of the day the motor intervention programme will be presented will depend on:		
9.9	The availability of the venue or location	○	○
9.10	The availability of transport	○	○

9.11 The participants agreed that late afternoon and early evenings are not a preferable option to use for motor intervention in a child with DCD or possible DCD. Taking into consideration the factors mentioned in question 9.1 to 9.10. In you opinion when is the best time of the day to present the motor intervention programme DCD?

- ○ Early morning (between 7am and 10am)
- ○ Late morning (between 10am and 12pm)
- ○ Early afternoon (between 12pm and 3pm)

9.12 If you have any comments regarding section 9 (Time), please provide it below.

10 Durations, frequencies and sessions of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

According to the feedback from the participants in round 1, many factors will influence the determination of the duration, frequency and amount of sessions of the motor intervention programme. The age of the child has been identified (100%) as one of these factors. The participants have further suggested that it is difficult to put a time frame on therapy.

Please provide your level of agreement with the following statements.

		Disagree	Agree
	The duration, frequency and amount of session will depend on the ____________ of the child with DCD or possible DCD.		
10.1	prognosis	○	○
10.2	progress rate	○	○
10.3	needs	○	○
10.4	extend of the difficulties/severity of the problems	○	○
10.5	financial status of the parents/caregivers (can they afford the sessions)	○	○
10.6	cognitive ability	○	○
10.7	number of functional areas that require attention	○	○
10.8	integration of skills and how to sustain these skills	○	○
10.9	goals that needs to be achieved by the child	○	○
10.10	willingness of the child to participate	○	○
10.11	on whether the child is committed to the home programmes provided	○	○
	The duration (weeks) of the motor intervention programme will further also depend on ____________		
10.12	the school terms of the school the child attends.	○	○
10.13	if the child experience regression after a period of time without intervention.	○	○
10.14	how many sessions per week the child receives.	○	○

10.15 Considering the above factors in question 10.1 to 10.13. What would you consider to be the minimum amount of weeks for a motor intervention programme for a child with DCD or possible DCD?

- ○ 8- 12 weeks
- ○ 12-16 weeks
- ○ 16-20 weeks
- ○ 20-24 weeks
- ○ Anything at or above 12 weeks
- ○ Intervention should continue for the rest of the child's childhood to prevent regression.

10.16 Considering the above factors in question 10.1 to 10.13. What would you consider to be the minimum amount of sessions per week for a motor intervention programme for a child with DCD or possible DCD?

- ○ Once a week
- ○ Twice a week
- ○ Three times a week

	Disagree	Agree
10.17 If the motor intervention programme is presented 3 times a week, it would be suggested that the therapist conduct the therapy once a week and the parents conduct the therapy twice a week at home.	○	○
10.18 Parents/caregivers should exercise with the child on a daily basis on the days that the child does not receive the intervention.	○	○

The participants agreed that a motor intervention session should be between 30 to 45 minutes (89.7%).

The participants identified various factors that will influence how long (minutes) a session of a motor intervention programme will be.

Provide your level of agreement regarding the following statements.

The length of a session (minutes) will depend on the ________________ of the child with DCD or possible DCD.	Disagree	Agree
10.19 concentration level	○	○
10.20 age	○	○
10.21 endurance capacity	○	○
10.22 skill level	○	○

10.23 If you have any comments regarding section 10 (Duration, frequencies), please provide it below.

11 Evaluating the motor intervention programme for children diagnosed with DCD or identified with possible DCD

The participants of round 1 agreed that the Movement Assessment Battery for Children-2 (93.1%) should be used to evaluate the effectiveness of the motor intervention programme.

Additional suggestions and comments have been made by the participants. Provide your level of agreement on the following statements:

	Disagree	Agree
11.1 The same test used as the initial assessment of the child to identify DCD before the motor intervention programme should be used in order to determine if real progress was made.	○	○
11.2 Various assessment tools should be used to determine the progress on different aspects of the child with DCD.	○	○

Consensus has not been reached between the participants regarding how often the effectiveness of the motor intervention programme should be evaluated.

The following comments from participants in round one was made:

How often the effectiveness of the motor intervention programme should be evaluated will depend on how many times a week the child participates in the programme.

A general observation should be conducted every 2 weeks to see if an assessment on progress is necessary.

If a standardized test battery is used the guidelines of the test battery should be used. Many test batteries suggest re-assessment only after 6 months to prevent the affect of transfer/memory of tasks done in the test setting.

Testing will also depend on the extend of the problems.

Taking the comments into consideration, please answer the following questions:

11.3 How often do you think should the effectiveness of a motor intervention programme, be evaluated in an informal manner without using a formal assessment tool?

- ○ Every 2 weeks
- ○ Every 4 weeks
- ○ Every 6 - 8 weeks
- ○ Every 3 months
- ○ Every 6 months
- ○ Only when the motor intervention programme has been completed

11.4 How often do you think should the effectiveness of the motor intervention programme be evaluated when using formal assessment tools?

- ○ Every 2 weeks
- ○ Every 4 weeks
- ○ Every 6 - 8 weeks
- ○ Every 3 months
- ○ Every 6 months
- ○ Only when the motor intervention programme has been completed
- ○ I will follow the guidelines of the assessment tool used

	Disagree	Agree
11.5 The total amount of times a week the child participates in the motor intervention programme will determine how often I will evaluate the effectiveness of the programme.	○	○

The participants agreed that the effects of the motor intervention programme (100%), if goals were reached after the motor intervention programme (89.7%) and to determine if further intervention is required (93.1%), are aspects of a motor intervention programme that should be evaluated.

Comments have been made by the participants. Provide your level of agreement with the following statements:

		Disagree	Agree
11.6	**It is important to evaluate whether there were any aspects of the motor intervention programme that was unsuccessful.**	○	○
11.7	**After the motor intervention has been conducted, a sufficient break needs to be provided to see how the child with DCD or possible DCD function on his/her own before an evaluation is conducted.**	○	○

11.8 **If you have any other comments and/or suggestions, please provide it here.**

Thank you for completing round 2 of this survey. Round 3 will be send to you if consensus has not been reached in round 2, after the results of this questionnaire have been processed.

ROUND 3

Dear participant

If consensus was not reached for a question in round 2, the question was included in this round for further consideration.

You will be required to provide your Name and Surname on the next page. Please be reminded that names and identities are anonymous to each other.

Each section of the questionnaire is on a separate page. Complete each question on each page and click on next. Do not click on next if you have not completed all the questions as you will not be able to continue to the next page.

Unfortunately, a save option is not available for this questionnaire, therefore make sure you complete all the questions and click on submit before you close the link (browser page).

Click on next.

1 General Information

1.1 What is your Name and Surname?

2 Additional role players in a motor intervention programme for children diagnosed with DCD or identified with possible DCD

Please rate your agreement with the following statement:

		Do not agree	Agree
2.1	The additional role players which are used in the motor intervention programme should be advised not to teach a new skill to the child. The reason for this is to prevent the risk of teaching the skill in the wrong way.	○	○

3 Goal-setting of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

SETTING GOALS OF THE MOTOR INTERVENTION PROGRAMME

Do you think it is important to consider the following viewpoints/factors for goal setting?

		Disagree (No)	Agree (Yes)
3.1	General problems that have been identified in the child (not necessarily identified in children with DCD or motor difficulties?)	○	○
3.2	Social support for the child.	○	○
3.3	Social ability of the child.	○	○
3.4	If sport-specific goals are considered for the motor intervention programme, the Kinderkineticist should first start with fundamental movement skills that are the building blocks of sport-specific skills.	○	○

3.5 How often should the motor intervention programme be evaluated in an informal manner (verbal feedback from parent, teacher and child on changes, improvements, etc)?
- ○ Every 2-4 weeks
- ○ Every 4-8 weeks
- ○ Every 8-12 weeks

3.6 How often should the effectiveness of a motor intervention programme be evaluated in a formal manner (Feedback using a motor proficiency test and additional assessment methods or tools)?
- ○ Every 2-4 weeks
- ○ Every 4-8 weeks
- ○ Every 8-12 weeks
- ○ Every 3-6 months
- ○ Only when the motor intervention has been completed

AFTER THE MOTOR INTERVENTION

3.7 When a formal evaluation was conducted after the completion of the motor intervention programme and the child has progressed to not receive any form of therapy anymore. How long break will you give the child before evaluating the child again to determine which skills have been retained or integrated, and which ones still require more attention.
- ○ 2-4 weeks break
- ○ 4-8 weeks break
- ○ 8-12 weeks break
- ○ Other

3.8 If you selected other at question 3.7, please specify.

3.9 For how long will you suggest should the evaluation of a child's performance continue after the break? For example, if you selected that the child should be evaluated at 8-12 weeks after the break in question 3.7, for how long will you suggest to evaluate the child every 8-12 weeks, before you decide it is enough due to performance not being a problem anymore?
- ○ Only test once after the break
- ○ Continue for 6 months
- ○ Continue for a year
- ○ Other

3.10 If you selected other at question 3.9, please specify

4 Types of motor intervention programmes for children diagnosed with DCD or identified with possible DCD

Even though the combination approach has been selected as the best option, some suggestions by the participants were made that other approaches could be used individually, however consensus has not been reached. Taking into consideration that each child with DCD or possible DCD experience different problems, please answer the following questions.

Body function oriented approach and structure oriented approach

Focus on developing activities that the child performs to improve specific body functions to address the functional motor problem.

For example:
If stringing beads is used as an activity to improve eye-hand coordination in a child with handwriting difficulties.

When climbing up the stairs is used as an activity to improve balance in a child with posture problems (strength and stability).

Suggestions have been made that this approach will be used individually if a child:
Is older than 10 years and has received occupational therapy for many years.
Experience obesity problems, cognitive problems or if a disability is present.

4.1 Is there any other cases or situations in which you will suggest to only use a body function- and structure-oriented approach for children with DCD and not a combination approach?
- ○ Yes
- ○ No, I will most likely always suggest a combination approach

4.2 If you selected yes, please provide an example below on when you will use the body function- and structure-oriented approach independently.

Activity oriented approach
The activity is designed to improve performance in that activity.

For example:
If the activity is stringing beads, the goal is for the skill of stringing beads to improve, and therefore the child is stringing the beads.

If the activity is walking up the stairs, the goal is for the skill of walking up the stairs to improve, and therefore the child is practicing walking up the stairs.

Suggestions have been made that this approach will be used individually if a child:

Is older than 10 years and has received occupational therapy for many years.
If a child does not show signs of DCD in various life/daily circumstances, but rather within specific circumstances.

4.3 Is there any other cases or situations in which you will suggest to only use a activity-oriented approach for children with DCD and not a combination approach?
- ○ Yes
- ○ No, I would most likely always suggest a combination approach

4.4 If you selected yes, please provide an example below on when you will use the activity oriented approach independently with a DCD child.

Participation oriented approach

The activity is developed to focus on improving participation in that activity within in an everyday situation.

For example:
The skill of stringing beads are practiced in order for the child to make decorations with his or her friends.

The skill of climbing stairs are practiced in order to climb the stairs to class at school.

Suggestions have been made that this approach will be used individually if :
The cases of DCD affects specific play-related, or sport-related skills and prevents children from participating in daily age-related physical activity.

4.5 Is there any other cases or situations in which you will suggest to only use a participation-oriented approach for children with DCD and not a combination approach?
- ○ Yes
- ○ No, I would most likely always suggest a combination

4.6 If you selected yes, please provide an example below on when you will use the participation oriented approach independently with a DCD child.

		Disagree	Agree
4.7	The most effective intervention type identified by the recent research should be used in order to save time and effort in determining which intervention type to use.	○	○
4.8	The situation/s in which the child with DCD find himself / herself in should be considered as a factor before choosing the type/s of interventions to use.	○	○
4.9	The statement has been made that the motor intervention programme should start wide and general and later move towards more specific task skills in all children with DCD or possible DCD to make sure that the child feels comfortable in the intervention programme. Do you agree?	○	○
4.10	Part of the motor-intervention programme should be child-centered (the child identifies and take responsibility for making choices about what they want to improve on or do in parts of the intervention programme). Only if the child is old enough and have a good level of understanding. This should also be guided by the therapist.	○	○

Selection of apparatus

The following comments were made by participants:
Academic apparatus should not be the main focus of the intervention programme but can add value regarding the specificity of the problem area and assist with cognitive stimulation throughout the intervention.
If you want to use virtual gaming, it is recommended to first start with natural movement without electronic apparatus.

		Disagree	Agree
4.11	If academic problems occur in the child with DCD or possible DCD. Do you agree that academic apparatus such a worksheets, stationary, fine motor games, etc, should be included in the motor intervention programme?	○	○
4.12	Virtual gaming such as Xbox, Wii, etc, should be used if this resources is available.	○	○
4.13	Fine motor apparatus should be included – to boost the child at the end of the session.	○	○

5 Time of motor intervention programme for children diagnosed with DCD or identified with possible DCD

Factors to consider when selecting the time of the day the motor intervention programme should be presented are:

		Disagree	Agree
5.1	Blood sugar levels of the child	○	○
5.2	Self regulation of the child	○	○
5.3	Natural, internal process that regulates the sleep-wake cycle (Circadian rhythms) of the child	○	○
5.4	The school schedule of the child	○	○

6 Durations, frequencies and sessions of a motor intervention programme for children diagnosed with DCD or identified with possible DCD

		Disagree	Agree
6.1	The decision on the duration (weeks) of the motor intervention programme will also depend on the school terms of the school the child attends.	○	○
6.2	If the motor intervention programme is presented 3 times a week, it would be suggested that the therapist conduct the therapy once a week and the parents conduct the therapy twice a week at home.	○	○
6.3	If the motor intervention programme is presented 3 times a week, it would be suggested that the therapist conduct the therapy twice a week and the parents conduct the therapy once a week at home.	○	○
6.4	The length of a session (minutes) will depend on the skill level of the child with DCD.	○	○

Thank you for completing round 3 of the e-Delphi questionnaire. Your input is of great value and highly appreciated.

APPENDIX G

JOURNAL GUIDELINES

SOUTH AFRICAN JOURNAL OF CHILDHOOD EDUCATION

CHAPTER 3 AND CHAPTER 4

Original Research Article full structure

Title: The article's full title should contain a maximum of 95 characters (including spaces).

Abstract: The abstract, written in English, should be no longer than 250 words and must be written in the past tense. The abstract should give a succinct account of the objectives, methods, results and significance of the matter. The structured abstract for an Original Research article should consist of six paragraphs labelled Background, Aim, Setting, Methods, Results and Conclusion.

- Background: Summarise the social value (importance, relevance) and scientific value (knowledge gap) that your study addresses.
- Aim: State the overall aim of the study.
- Setting: State the setting for the study.
- Methods: Clearly express the basic design of the study, and name or briefly describe the methods used without going into excessive detail.
- Results: State the main findings.
- Conclusion: State your conclusion and any key implications or recommendations.
- Do not cite references and do not use abbreviations excessively in the abstract.

Introduction: The introduction must contain your argument for the social and scientific value of the study, as well as the aim and objectives:

- Social value: The first part of the introduction should make a clear and logical argument for the importance or relevance of the study. Your argument should be supported by use of evidence from the literature.
- Scientific value: The second part of the introduction should make a clear and logical argument for the originality of the study. This should include a summary of what is already known about the research question or specific topic, and should clarify the knowledge gap that this study will address. Your argument should be supported by use of evidence from the literature.
- Conceptual framework: In some research articles it will also be important to describe the underlying theoretical basis for the research and how these theories are linked together in a conceptual framework. The theoretical evidence used to construct the conceptual framework should be referenced from the literature.
- Aim and objectives: The introduction should conclude with a clear summary of the aim and objectives of this study.
-

Research methods and design: This must address the following:

- Study design: An outline of the type of study design.

- Setting: A description of the setting for the study; for example, the type of community from which the participants came or the nature of the health system and services in which the study is conducted.
- Study population and sampling strategy: Describe the study population and any inclusion or exclusion criteria. Describe the intended sample size and your sample size calculation or justification. Describe the sampling strategy used. Describe in practical terms how this was implemented.
- Intervention (if appropriate): If there were intervention and comparison groups, describe the intervention in detail and what happened to the comparison groups.
- Data collection: Define the data collection tools that were used and their validity. Describe in practical terms how data were collected and any key issues involved, e.g. language barriers.
- Data analysis: Describe how data were captured, checked and cleaned. Describe the analysis process, for example, the statistical tests used orsteps followed in qualitative data analysis.
- Ethical considerations: Approval must have been obtained for all studies from the author's institution or other relevant ethics committee and the institution's name and permit numbers should be stated here.

Results: Present the results of your study in a logical sequence that addresses the aim and objectives of your study. Use tables and figures as required to present your findings. Use quotations as required to establish your interpretation of qualitative data. All units should conform to the **SI convention** and be abbreviated accordingly. Metric units and their international symbols are used throughout, as is the decimal point (not the decimal comma).

Discussion: The discussion section should address the following four elements:

- Key findings: Summarise the key findings without reiterating details of the results.
- Discussion of key findings: Explain how the key findings relate to previous research or to existing knowledge, practice or policy.
- Strengths and limitations: Describe the strengths and limitations of your methods and what the reader should take into account when interpreting your results.
- Implications or recommendations: State the implications of your study or recommendations for future research (questions that remain unanswered), policy or practice. Make sure that the recommendations flow directly from your findings.

Conclusion: Provide a brief conclusion that summarises the results and their meaning or significance in relation to each objective of the study.

Acknowledgements: Those who contributed to the work but do not meet our authorship criteria should be listed in the Acknowledgments with a description of the contribution. Authors are responsible for ensuring that anyone named in the Acknowledgments agrees to be named. Refer to the acknowledgement structure guide on our *Formatting Requirements* page.

Also provide the following, each under their own heading:

- Competing interests: This section should list specific competing interests associated with any of the authors. If authors declare that no competing interests exist, the article will include a statement to this effect: *The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.* Read our **policy on competing interests**.
- Author contributions: All authors must meet the criteria for authorship as outlined in the **authorship** policy and **author contribution** statement policies.
- Funding: Provide information on funding if relevant
- Data availability: All research articles are encouraged to have a data availability statement.
- Disclaimer: A statement that the views expressed in the submitted article are his or her own and not an official position of the institution or funder.

References: Authors should provide direct references to original research sources whenever possible. References should not be used by authors, editors, or peer reviewers to promote self-interests. Refer to the journal referencing style downloadable on our *Formatting Requirements* page.

Style and format

File format

- Manuscript files can be in the following formats: DOC, DOCX, or RTF. Microsoft Word documents should not be locked or protected.
- LaTeX documents (.tex) should be converted into Microsoft Word (.doc) before submission online.
- Rich Text Format (RTF): Users of other word processing packages should save or convert their files to RTF before uploading. Many free tools are available that will make this process easier.

Length

Manuscripts should adhere to the author guidelines of the journal. There are restrictions on word count, number of figures, or amount of supporting information.

Font

Use a standard font size and any standard font family.

Special characters

Do not use the font named ‘Symbol’. To add symbols to the manuscript, use the Insert → Symbol function in your word processor or paste in the appropriate Unicode character. Refer to our AOSIS house style guide on mathematical and Unicode font guidelines.

Headings

Ensure that formatting for headings is consistent in the manuscript. Limit manuscript sections and sub-sections to four heading levels. To avoid confusion during the review and production process, ensure that the different heading levels used in your work are visually distinct from one another. The simplest way to achieve this is to use different font sizes and/or a combination of bold/italics for different heading levels.

Keywords

Identify eight keywords that represent the content of your manuscript and are specific to your field or sub-field, ensure to separate each keyword with a semi-colon. Test your keywords: when you enter your keywords into the various journal and academic databases like Google Scholar, do the results include papers similar to your topic? If not, revise the terms until they do.

Layout and spacing

Manuscript text should have a 1.5 line spacing.

Page and line numbers

Include page numbers and line numbers in the manuscript file. Use continuous line numbers (do not restart the numbering on each page).

Footnotes

Footnotes are not ideal. If your manuscript contains footnotes, move the information into the main text or the reference list, depending on the content.

Language

Manuscripts must be written in British English, according to the Oxford English Dictionary (avoid Americanisms [e.g. use ‘s’ and not ‘z’ spellings], and set your version of Microsoft Word default language to UK English). Refer to the AOSIS house style guide for more information.

Abbreviations

Define abbreviations upon first appearance in the text. Do not use non-standard abbreviations unless they appear at least three times in the text. Keep abbreviations to a minimum.

Illustrations

Illustrations fall into two categories:

- Figures: Photographs, drawings, diagrams, graphs, flowcharts, maps, etc.
- Tables and/or Boxes: Text and/or numbers arranged in orderly columns and rows.

Every time a Figure, Table and/or Box is presented in your manuscript, it should be referred to three times:

- In a legend, which includes a number, a title, and its source. The legend is placed below a Figure and above a Table and/or Box. The source section should consist of the in-text citation, creator or owner and its year of creation, and any other attribution required as stipulated by the permission received (person and place) to reproduce.
- In the body of your written manuscript. You should include an in-text citation and a sentence or two about the image explaining what it illustrates and why it is there.

- As a reference entry within your reference list.

AOSIS house style

The manuscript must adhere to the **AOSIS house style guide**.

References

Referencing style guide

The manuscript must adhere to the **Harvard referencing style**.

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APPENDIX H

JOURNAL GUIDELINES

SOUTH AFRICAN JOURNAL FOR RESEARCH IN SPORT, PHYSICAL EDUCATION AND RECREATION

CHAPTER 5

The guidelines have been followed, note that the margins for the purpose of the thesis was changed in order to fit on the page and make it easier to read.

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The *South African Journal for Research in Sport, Physical Education and Recreation* is published by the North-West University, Potchefstroom. Contributions from the fields of Sport Science, Physical Education, Recreation/Leisure Studies, Exercise Science and Dance Studies will be considered for publication. The articles submitted will be administered by the appropriate Subject Review Editor and evaluated by two or more referees. The decision as to whether a particular article is to be published or not, rests with the Editorial Board.

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We discourage the practice of parts of the same study submitted for other issues of this Journal. Authors who submit a manuscript from a study of which some data have been or will be published elsewhere, must provide a strong justification in the accompanying letter to the Editor. The justification for not publishing all the data together in one paper must also be motivated in the covering letter.

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All studies testing the effect of an intervention have to be registered with a trials registry to be eligible for peer review. We STRONGLY recommend prospective registration but will consider retrospectively registered trials with appropriate justification.

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Book

WEINBERG, R.S. & GOULD, D. (2011). *Foundations of sport and exercise psychology* (5th ed.). Champaign, IL: Human Kinetics.

Chapter in book

SCHNECK, C.M. (2010). Visual perception. In J. Case-Smith & J.C. O'Brian (Eds.), *Occupational therapy for children* (6th ed.) (pp. 373-403). Maryland Heights, MO: Mosby.

Thesis/Dissertation

SURUJLAL, J. (2004). Human resources management of professional sports coaches in South Africa. Unpublished doctoral dissertation. Johannesburg, South Africa: Rand Afrikaans University.

Proceedings of a conference

HARDMAN, K. & MARSHALL, J. (2001). Worldwide survey on the state and status of physical education in schools. In G. Doll-Tepper & D. Scoretz (Eds.), *World summit on physical education* (pp. 15-37). Proceedings of the "World Summit on Physical Education", 3-5 November 1999. Berlin, Germany: International Council of Sport Science and Physical Education (ICSSPE).

Personal communication/correspondence/interview

BOUKES, P.B. (2015). Personal communication from the Acting Director of Sport at the Nelson Mandela Metropolitan University, Port Elizabeth on 27 February 2015.

JACOBS, L. (2015). Personal interview with the Spokesperson of UNICEF, 25 August, Pretoria.

Newspaper

CAPE ARGUS (*The*) (1997). 25 March, p. 5.

Electronic source

DINOFFER, J. (2011). "Activities to build balance". *Prevent child obesity 101.* Hyperlink: [http://www.preventchildobesity101.com/Activities/BalanceActivities.php]. Retrieved on 20 November 2012.

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APPENDIX I

ARTICLE ACCEPTED IN THE SOUTH AFRICAN JOURNAL OF CHILDHOOD EDUCATION

CHAPTER 3

South African Journal of Childhood Education
ISSN: (Online) 2223-7682, (Print) 2223-7674

AOSIS

Page 1 of 9 Original Research

Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa

Authors:
Alretha Margaretha du Plessis[1]
Monique de Milander[1]
Frederick Francois Coetzee[1]
Mariette Nel[2]

Affiliations:
[1]Department of Exercise and Sport Sciences, University of the Free State, Bloemfontein, South Africa

[2]Department of Biostatistics, University of the Free State, Bloemfontein, South Africa

Corresponding author:
Alretha du Plessis,
20268319@nwu.ac.za

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Background: Developmental coordination disorder (DCD) affects motor skills and consequently has an impact on the performance in daily living activities of learners with this impairment.

Aim: The aim of this study was to determine the prevalence of possible DCD in Grade 1 (Gr. 1) learners in a low socio-economic environment in Mangaung, South Africa.

Setting: The study was conducted in the Mangaung Metro, Motheo District, Free State Province. Gr. 1 learners, 6–8 years old (n = 242), from a low socio-economic environment attending Quintile 1–3 schools were randomly selected for assessment.

Methods: The Movement Assessment Battery for Children-2nd edition (MABC-2) was used to identify learners with possible DCD. Furthermore, results were compared with regard to gender.

Results: Of the 242 learners, 9.9% were identified with possible DCD. With regard to gender, 10.5% of boys and 9.3% of girls showed signs of possible DCD. No significant difference (p = 0.9439) has been found between boys and girls.

Conclusion: The prevalence of possible DCD among Gr. 1 learners in this setting was higher than that in previously reported studies in other low and high socio-economic environments of South Africa. Further research is required to establish the full extent of possible DCD within learners living in low socio-economic environments.

Keywords: developmental coordination disorder (DCD); Movement Assessment Battery for Children-2nd edition (MABC-2); motor skills; children; learners; socio-economic environment; prevalence.

Introduction

Developmental coordination disorder (DCD) can be defined as motor performances that are substantially below the expected levels of the child's ability, considering the child's chronological age and previous opportunities for gaining skills (American Psychiatric Association [APA] 2013). Furthermore, DCD is defined as a neuro-motor developmental disorder, which includes a 'significant delay in the acquisition and execution of coordinated motor skills as expected for the child's chronological age and opportunities for learning' (APA 2013; Blank et al. 2012). The definition clearly states that DCD is a motor skill disorder, which influences a child's activities during daily routines, learning performance and coordinated skill development.

The diagnosis of DCD is based on its description in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) (APA 2013). Learners may only be diagnosed with DCD if the learner meets the four diagnostic criteria determined by the APA (APA 2013). The following criteria are used:

- Achievement and execution of coordinated motor skills are significantly below the expected performance according to the individual's chronological age and measured intelligence.
- The deficits in criteria A interfere with the individual's activities of daily living, for example, self-care and self-maintenance, including academic performance.
- The difficulties are not because of a general medical condition (such as cerebral palsy, hemiplegia or muscular dystrophy) and do not meet the criteria for pervasive developmental disorder.
- If mental retardation is present, the motor difficulties are in excess of those usually associated with it (APA 2013; De Souza 2015).

However, the literature clearly states that the prevalence of DCD will be referred to as possible DCD, suspected DCD or at risk for DCD if all four DSM-5 criteria have not been used (Alesi, Pecoraro & Pepi 2019; Delgado-Lobete et al. 2019; Lingam et al. 2009; Valentini, Clark & Whitall 2015). For this reason, the term possible DCD was used in this study. De Souza (2015) conducted a systematic review regarding the four criteria to diagnose DCD and identified the Movement Assessment Battery for Children-2nd edition (MABC-2) as the most frequently used tool to assess criterion A, the Developmental Coordination Disorder Questionnaire (DCDQ) for criterion B and no specific instrument for criteria C and D. However, according to Blank et al. (2012), the European Academy of Childhood Disability (EACD) recommends that a medical practitioner should rule out criteria C before a diagnosis can be made and criteria D should be kept in mind if mental retardation is present.

The DSM-5 and previous researchers identified DCD in 5% – 6% of school-aged learners worldwide (APA 2013; Cairney & Streiner 2011; Goyen & Lui 2009; Rivard et al. 2014) between 6 and 12 years of age (Barnhart et al. 2003). It can therefore be ranked as one of the most common neuro-motor developmental disorders among school-aged learners (Lingam et al. 2010). The prevalence of DCD is well documented and varies within different countries and according to the diagnostic criteria used to identify this condition (Cardoso, Magalhães & Rezende 2014; De Milander, Coetzee & Venter 2014; Tsiotra et al. 2006; Valentini et al. 2012). In some countries, the incidence of DCD is high. In southern Brazil, 19.9% of learners between 4 and 12 years of age were identified with possible DCD (Valentini et al. 2012). These findings were similar to those in earlier research reporting that 16.6% of learners aged 7–11 years in a high socio-economic environment in Japan had DCD (Miyahara et al. 1998). Tsiotra et al. (2006) reported that in Greece, 19% of learners with a mean age of 11.3 years were identified with possible DCD. On the contrary, a low prevalence of DCD ranging between 0.8% and 4.3% was also reported among 7–8-year-old learners in Brazil (Cardoso et al. 2014) and 0.8% of Indian learners between 6 and 15 years of age (Girish, Raja & Kamath 2016) living in different socio-economic environments.

With regard to previous research in South Africa, De Milander et al. (2014) found a prevalence of 15% of possible DCD among 6–8-year-old learners in Bloemfontein, South Africa. Similar results were reported by Venter, Pienaar and Coetzee (2015), who found that DCD occurred in 11.3% of learners aged 3–5 years in the North West Province, South Africa. However, another study in the North West Province on learners aged 8–10 in different socio-economic environments identified a lower prevalence of possible DCD (6.3%) (Pienaar & Kemp 2014). In addition, a more recent study in the North West Province of South Africa on learners with a mean age of 10.05 years reported that 21.3% of the learners in the sample were identified with DCD. It is, however, important to note that this was a longitudinal study, and data were collected in 2013 (De Waal, Pienaar & Coetzee 2018).

Different results regarding the prevalence of DCD in gender have also been found. According to Lingam et al. (2009) and Pienaar and Lennox (2006), the prevalence of DCD is higher in boys than in girls. The DSM-5 (APA 2013) and Lingam et al. (2009) further suggested boy–girl ratios ranging from 2:1 to 7:1. Table 1 shows the comparison of the prevalence of DCD among boys and girls as reported previously from different studies. It is clear that contradicting results regarding the prevalence of DCD among boys and girls have been found. In addition, limited data on the prevalence of DCD in various socio-economic environments are available (Valentini et al. 2015).

Low socio-economic environments in South Africa are found in townships, inner cities and peri-urban areas (Ndebele 2015). These areas are identified on the basis of poverty, income, education, environmental factors, working conditions and health conditions (Isaacs-Martin 2015; Narsai et al. 2013; Pappin et al. 2015; Pienaar & McKay 2014). According to Senekal et al. (2015), learners and educators living in these environments have fewer opportunities and activities such as sport, playground spaces, equipment and extramural physical activities. Learners living in low socio-economic environments experience motor difficulties and developmental deficits in comparison with learners of the same age from more privileged environments (Pienaar 2004; Pienaar, Labuschagne & Peens 2007). Research conducted in South Africa by Cloete, Pienaar and Coetzee (2006) on 10–12-year-old learners and De Waal et al. (2018) on

TABLE 1: Published findings of the difference between boys and girls regarding the prevalence of developmental coordination disorder.

Authors	Year published	Participants' age (years)	% per gender or boys:girls ratio	Indication	Setting/location
Cardoso et al.	2014	6–15	54.1:45.9	Boys > girls	Brazil
De Milander et al.	2014	6–8	10:5	Boys > girls	Bloemfontein, South Africa; high socio-economic environment
Girish et al.	2016	6–15	0.5:1.1	Girls > boys	India
Kadesjö and Gillberg	1998	7	2:1	Boys > girls	Karlstad, Sweden; different socio-economic environments
Pienaar and Lennox	2006	5–8	2–3:1	Boys > girls	North West Province, South Africa; low socio-economic environment
Valentini et al.	2012	4–12	16.9:23.2	Girls > boys	South Brazil
Venter et al.	2015	3–5	28.6:46.9	Girls > boys	North West Province, South Africa
Wessels et al.	2008	6–7	2–3:1	Boys > girls	Potchefstroom, South Africa

10-year-old learners found that learners from low socio-economic environments had a high tendency to have DCD and showed motor skill difficulties. Even though motor skill difficulties are apparent in learners with DCD, no two learners with this disorder are the same and therefore experience different secondary problems.

Secondary problems associated with DCD are physical performance, such as impaired strength and flexibility (Batey et al. 2014; Rihtman, Wilson & Parush 2011; Wuang, Su & Su 2012) and increased obesity (Rihtman et al. 2011; Tsiotra et al. 2006). Learners may show difficulty in academic performance (Cantell, Smyth & Ahonen 2003) and completing activities of daily living (Cairney et al. 2012; Zhu et al. 2010), which include activities such as dressing themselves (home activities), writing and reading (school activities) and play activities, for example, ball skills and balance (Asonitou et al. 2012; Edwards et al. 2011; Schoemaker, Smits-Engelsman & Jongmans 2003). These secondary problems result in emotional and social problems, such as low self-esteem and poor social acceptance (Missiuna et al. 2006). Other problems related to DCD are difficulties with fine motor skills (Zwicker, Missiuna & Boyd 2009), visual impairments (Gomez & Sirigu 2015), attention deficit hyperactivity disorder (ADD/ADHD) and speech or language impairments (Gaines & Missiuna 2007; Missiuna 2003). Because of these difficulties (fine motor, visual and speech impairment), it is important to identify learners with DCD at an early stage.

According to our knowledge, limited research on the prevalence of DCD in different socio-economic environments in South Africa has been conducted. The aim of the study was to determine the prevalence of possible DCD among Grade 1 (Gr. 1) learners living in low socio-economic environments in Mangaung, Motheo District, Free State Province, South Africa, and to establish whether a significant difference between boys and girls could be observed.

Methodology

Study design

Grade 1 learners between 6 and 8 years of age, living in low socio-economic environments in Mangaung, Motheo District, South Africa, were the target population for this study. This research was an empirical study that focussed on a quantitative approach to collect data. The cross-sectional design included one testing procedure to determine the prevalence of possible DCD and differences between boys and girls. The sample for the study was established by obtaining a list of schools in the Motheo District from the Department of Education in the Free State Province.

The sample size was further determined by considering: (1) the duration of administering the measuring instrument MABC-2; (2) the number of trained postgraduate students in Human Movement Science at the University of the Free State in Bloemfontein, specialising in Kinderkinetics (further referred to as movement specialists), with sufficient training and experience to administer the test battery; (3) the school hours; and (4) the budget. A poverty classification from the National Census data was used to determine the classification of schools in different quintiles (Pauw 2005). For example, Quintile 1 schools in each province cater for the poorest 20% of learners, compared with Quintile 4 and 5 schools representing high socio-economic populations (Van Den Berg 2015). From the list of schools in the province, the Motheo District represented approximately 378 schools. There were 33 Quintile 1–3 schools and 3940 Gr. 1 learners in these schools. Ten schools were randomly selected on the criteria that included: representation of Quintile 1–3 public schools and being within a 30 km radius from Bloemfontein, to ensure that the researcher and movement specialists could reach the schools.

Participants

Participants included Gr. 1 learners, 6–8 years of age, who were representative of the population living in low socio-economic environments in Mangaung. These learners were classified into Quintile 1–3 schools that are no-fee schools to make education affordable for poor learners, based on low income, unemployment and parents' level of literacy (Collinridge 2013). Ten schools were selected to take part in the study, of which two schools were Quintile 1 and 2 schools, respectively, and eight were Quintile 3 schools. Using proportional sampling, 400 learners were included in the study. The sample size per school was determined by using random sampling.

Consent forms were sent to the parents of the 400 learners, of which 242 (response rate 60.5%) learners' parents consented to their children's participation in the study. The consent forms included questions regarding the child's health. Parents were asked to indicate according to a tick box if their child suffered from any medical condition or illness and/or severe neurological problem that has been diagnosed by a medical practitioner.

The DSM-5 criteria proposed by the APA (2013) for DCD were partially met concerning criteria A, C and D. The EACD recommended using the MABC-2 as an assessment tool to determine criterion A (Blank et al. 2012) and was therefore used in this study. The EACD further indicated that the Developmental Coordination Disorder Questionnaire'07 (DCDQ'07) is recommended to be used as the assessment tool to determine criterion B (Blank et al. 2012). However, the DCDQ'07 has not been translated, adapted and validated in the home language (Sesotho) of this population in South Africa and could not be used as a valid instrument in this study; therefore, criterion B was excluded. To conduct criteria C and D, the exclusion criteria comprised learners who had serious neurological or intellectual disabilities or conditions such as epilepsy, ADD/ADHD, autism spectrum disorder, visual problems, hearing problems, cancer and/or physical disability.

Using information obtained from the parents, none of the participants met these exclusion criteria. However, the researcher was not able to involve a medical doctor to diagnose general medical conditions (criterion C) in the participating learners in this study. As criteria B and C were not fully met, it could not be alluded that the learner had DCD (Barba et al. 2017), and therefore the learners were referred to as having possible DCD if they fell below the 16th percentile in the MABC-2 performance test. Further exclusion criteria comprised (1) learners falling outside the age range of 6–8 years and (2) parents indicating that they were relocating. The principle researcher (AdP) captured data from the MABC-2 electronically on a Microsoft Excel spreadsheet.

Measuring instrument

Learners were identified with possible DCD using the MABC-2. The MABC-2 is a standardised performance test used to identify learners with motor difficulties. The chosen items of the performance test are aimed to be relevant to all cultural backgrounds. Although previous research has reported differences between learners from different cultures on particular items, no radical changes have been reported (Henderson, Sugden & Barnett 2007). Furthermore, the performance test's psychometric properties have not been established for the South African population, and a revised MABC-2 Performance Test for South Africa is not available. Therefore, no adjustment of the MABC-2 Performance Test was made for this study. Lastly, no assessment tool for South African children exists, and therefore the MABC-2 Performance Test was used. Both the original MABC performance test and the revised MABC-2 have been used successfully in research conducted in South Africa (De Milander, Coetzee & Venter 2016; Wessels, Pienaar & Peens 2008).

To use the MABC-2 for learners of various ages, the test consists of age band 1 (3–6 years), age band 2 (7–10 years) and age band 3 (11–16 years). For the purpose of this study, age bands 1 and 2 were used. The age bands consist of eight age-specific test items, grouped under three components, namely (1) manual dexterity (three test items), (2) aiming and catching (two test items) and (3) balance (three test items) (Henderson et al. 2007). Each test item was clearly demonstrated by a movement specialist, followed by a practice trial and two official test trials. The second trial was administered only if the first trial had not been completed in the correct way, or if the learner had not completed the test within the correct amount of time for his or her age group. Administration of the test battery lasted approximately 30 minutes per learner.

The best trial of each item is used and known as the raw score. The raw score of each item is converted to an item standard score. An item standard score is available for each age group between 3 and 16 years. The standard score is provided every 6 months for learners between 3 and 4 years (3 years 0 months, 3 years 6 months, etc.) and every year for learners between 5 and 16 years (5 years 0 months, 6 years 0 months, etc.). Standard scores and percentiles were further calculated for manual dexterity, aiming and catching as well as balance (Henderson et al. 2007). The standard score demonstrates that the higher the standard score, the better the Gr.1 learner performed, whereas the percentile indicated the percentage that the learner scored less than or equal to the raw score. Furthermore, the percentile was classified according to specific cut-off scores and interpreted through a traffic light system. The green zone (> 15th percentile) indicated performance in a normal range and was classified as no motor difficulty (non-DCD category), the amber zone (6th–15th percentile) indicated that a learner was at risk and should be monitored carefully, with the classification of moderate motor difficulty (risk for DCD category). The red zone (≤ 5th percentile) was an indication of definite motor difficulty (serious DCD category). Possible DCD was identified in the Gr. 1 learners if they fell below the 16th percentile.

The MABC-2 is a valid and reliable test with reliabilities of $r = 0.77$ for manual dexterity, $r = 0.84$ for aiming and catching and $r = 0.73$ for balance when the test was conducted in the United Kingdom on learners between the age of 3–16 years (Henderson et al. 2007). The total test score indicated a reliability of $r = 0.80$ according to Henderson et al. (2007), and an even higher reliability ($r = 0.97$) in a more recent study on 6–12-year-old learners in Taiwan (Wuang et al. 2012).

Statistical analysis

Descriptive statistics, namely frequencies and percentages, were calculated for categorical data, and medians and ranges for numerical data. The prevalence of Gr. 1 learners with possible DCD was determined and described by means of 95% confidence interval (CI). The total number of learners identified either with or without DCD, further separated into boys and girls in both groups, was determined. The learners were compared per gender by means of the chi-square test, or when necessary the Fisher's exact test for small samples, for categorical data. A probability level of 0.05 or less ($p \leq 0.05$) was accepted to indicate statistical significance.

Ethical consideration

Learners were recruited after approval from the provincial Department of Basic Education and the Health Sciences Research Ethics Committee (UFS-HSD2017/1363) at the University of the Free State was obtained. The headmasters of each school and the parents or legal guardians of the learners completed an informed consent form and gave permission for their child to participate in the study. The learners agreed to take part by completing an assent form.

The learners agreed to take part by completing an assent form. The MABC-2 Performance Test was conducted by 11 trained movement specialists. All movement specialists underwent extensive training that included a minimum of 8 hours preparatory training and at least 6 hours of in-field training. To guarantee consistency within the study, each movement specialist conducted one subtest item. Testing took place during school hours in the second term and was conducted over a period of one month. The parents of the learners were provided with a feedback report regarding their child's motor proficiency results as well as exercises to address the problem, if necessary. The hard copies of each learner's data sheets were stored in a locked safety cabinet by the principal investigator. The electronic data on the computer were stored by using a protective password, which can only be accessed by the principal investigator.

Results

Table 2 displays the frequency distribution of the total sample in terms of gender and age. In total, 242 Gr. 1 learners participated in the study, with the group being composed of an approximately equal number of boys and girls. The majority of the learners were 6 years of age (n = 174; 71.9%). The median age was 6.66 years (range 6.0–8.75 years).

Table 3 displays the results according to the percentile cut-off values of the MABC-2. In total, 90.1% of the learners (n = 218) fell in the group above the 15th percentile, which identified them within the non-DCD group, whereas 9.9% of the learners (n = 24) scored equal or below the 15th percentile, indicating possible DCD. With regard to gender, the percentage of boys with possible DCD was similar to the girls (10.5% and 9.3%, respectively). The 95% CI for the prevalence of DCD is further illustrated in Table 3.

Table 4 shows the distribution of the total group of learners within the three MABC-2 subtests, with 27.7% of learners' scores for manual dexterity indicating possible DCD, opposed to their scores for aiming and catching (5.0% of learners) and balance (8.7% of learners). Of the total group, 72.3% fell in the non-DCD group for manual dexterity, 95.0% for aiming and catching and 91.3% for balance. The results indicated that the learners struggled more with the fine motor component of the MABC-2 performance test.

In Table 5, the differences between boys and girls with possible DCD are shown for the total test score and the individual MABC-2 subtests. No statistically significant differences between the boys' and girls' scores on the total test score (p = 0.9439) and the different subtests were observed (manual dexterity, p = 0.26; aiming and catching, p = 0.16; balance, p = 1.0).

Discussion

The aim of this study was to determine the prevalence of possible DCD in Gr.1 learners between the age of 6 and 8 years, living in low socio-economic environments in the Motheo District of Mangaung, South Africa, and compare the findings of boys and girls participating in the study. To the authors' knowledge, this is the first study to assess the prevalence of possible DCD in the low socio-economic environment in Mangaung, which adds to the limited information on the prevalence of possible DCD in South Africa as a whole, especially with regard to low socio-economic environments. Consequently, comparison of this study with previous research on the prevalence of DCD in low socio-economic environments was restricted.

In this study, 9.9% of Gr. 1 learners were identified with possible DCD, and according to the parents, there was no medical DCD diagnosis before. Research in different countries, such as Israel (Engel-Yeger, Rosenblum & Josman 2010) and Brazil (Valentini et al. 2015), found a high prevalence of possible DCD in low-income families and socio-economic environments. Research conducted by Prinsloo and Pienaar (2003) in the North West Province of South Africa in a low socio-economic environment, supported these findings and indicated a low occurrence of DCD in 7- to 8-year-old learners. In addition, a more recent study in the same province indicated that the prevalence of possible DCD in a low (38.7%) and high (40.9%) socio-economic environment was similar (Venter et al. 2015).

TABLE 2: Characterisation of participants (N = 242) in terms of gender and age.

Variable	*n*	%
Gender		
Boys	124	51.2
Girls	118	48.8
Age		
6 years	174	71.9
7 years	64	26.4
8 years	4	1.7

TABLE 4: Distribution of the total group of learners (N = 242) without and with possible developmental coordination disorder within the three Movement Assessment Battery for Children-2nd edition subtests.

MABC-2 subtest	Possible DCD		Non-DCD	
	n	%	*n*	%
Manual dexterity	67	27.7	175	72.3
Aiming and catching	12	5.0	230	95.0
Balance	21	8.7	221	91.3

DCD, developmental coordination disorder; MABC-2, Movement Assessment Battery for Children-2nd edition.

TABLE 3: Percentage of learners without or with possible developmental coordination disorder.

DCD category	Percentile†	Total group (N = 242)			Gender					
					Boys (N = 124)			Girls (N = 118)		
		n	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Non-DCD	> 15	218	90.1	-	111	89.5	-	107	90.7	-
Possible DCD	≤ 15	24	9.9	4.1–10.5	13	10.5	6.2–17.1	11	9.3	5.3–15.9

Note: 95% CI = 95% confidence interval for possible developmental coordination disorder.
DCD, developmental coordination disorder; CI, confidence interval.
†, Percentile achieved on the Movement Assessment Battery for Children-2nd edition (MABC-2).

TABLE 5: Differences between boys and girls on the Movement Assessment Battery for Children-2nd edition total test score and subtests.

MABC-2 subtest	Percentile†	Boys (N = 124)		Girls (N = 118)		p
		n	%	n	%	
Manual dexterity						0.26 (Chi-square)
Non-DCD	> 15	85	68.5	90	76.3	
Possible DCD	≤ 15	39	31.5	28	23.7	
Aiming and catching						0.16 (Fisher's exact)
Non-DCD	> 15	120	96.8	110	93.2	
Possible DCD	≤ 15	4	3.2	8	6.8	
Balance						1.0 (Fisher's exact)
Non-DCD	> 15	113	91.1	108	91.5	
Possible DCD	≤ 15	11	8.9	10	8.5	
Total test score						0.9439 (Fisher's exact)
Non-DCD	> 15	111	89.5	107	90.7	
Possible DCD	≤ 15	13	10.5	11	9.3	

DCD, developmental coordination disorder; MABC-2, Movement Assessment Battery for Children-2nd edition.
†, Percentile achieved on the Movement Assessment Battery for Children-2nd edition (MABC-2).

TABLE 6: Comparison of this study with previously reported findings on the prevalence of developmental coordination disorder in different countries, with socio-economic environment not taken into account.

Authors	Year published	Participants' age (years)	Prevalence of possible DCD (%)	Assessment tool	Setting/location
This study	2019	6–8	9.9	MABC-2 Performance Test	Mangaung, South Africa
Ali, El-Tohamy and Mousa	2015	5–15	5.9	DCDQ'07	Egypt
Amador-Ruiz et al.	2018	4–6	9.9	MABC-2 Performance Test	Castilla-La Mancha, Spain
Barba et al.	2017	-	30.0	DCDQ-Brazil	São-Carlos, Brazil
Delgado-Lobete et al.	2019	6–12	12.2	DCDQ	Coruna, north West Spain
Dhote, Tushar and Ganvir	2017	5–15	3.2	BOT-2	Pimpri Chinchwad, India
Kokštejn et al.	2017	6	13.2	MABC-2 Performance Test	Prague, Czech Republic
Tsiotra et al.	2006	10.2–13.2	8.0	BOTMP-SF	Canada
Tsiotra et al.	2006	11.4–12.2	19.0	BOTMP-SF	Greece

BOT-2, Bruininks Oseretsky Test of Motor Proficiency-2nd edition; BOTMP-SF, Bruininks Oseretsky Test of Motor Proficiency; DCD, developmental coordination disorder; DCDQ'07, developmental coordination disorder questionnaire DCDQ 7th edition; MABC-2, Movement Assessment Battery for Children-2nd edition.

However, when using the 5th percentile as cut-off score for severe DCD with the MABC-2 performance test, it was noted that the high socio-economic environment had a higher incidence (22.7%) than the low socio-economic environment (3.2%) (Venter et al. 2015). Furthermore, another study in the North West Province identified 429 of 645 learners (10–12 years) with possible DCD when using the MABC-2. In addition to Venter et al. (2015), Cloete et al. (2006) reported that the lower the socio-economic environment, the lower the MABC scores. Therefore, it is clear that conflicting results regarding possible DCD in socio-economic environments may be found.

Delgado-Lobete et al. (2019) were of the opinion that the difference in the prevalence rates of DCD depended on the assessment used to identify and/or diagnose DCD. Previous research found results that were similar to those in this study by making use of the DSM-4 and/or DSM-5 and considering only one of the criteria. These findings are summarised in Table 6, and a comparison of the findings of this study with previously reported findings on studies where the socio-economic status of the participants had not been indicated is shown.

Hua et al. (2014) used all four criteria of the DSM-4 with 3–6-year-old learners from China and reported similar results (8.9%) compared with those in this study (9.9%). However, Lingam et al. (2009) indicated a very low prevalence of 1.8% when conducting a large cohort study of learners between 7 and 8 years of age in the United Kingdom. From the literature it is clear that findings vary extensively, even when the full DSM-5 criteria have been applied. It is furthermore important to note the discrepancies in the literature with regard to research conducted in South Africa where no socio-economic environment has been stated. Although De Milander et al. (2014) indicated that 12–15% of 6–8-year-old learners in Bloemfontein could have possible DCD, a very low incidence (1.6%) was reported in Gr.1 learners by Pienaar and Kemp (2014) in the North West Province, South Africa.

With regard to gender, the prevalence of DCD in this study indicated no statistically significant differences (p = 0.9439) between boys (10.5%) and girls (9.3%), showing a boy-to-girl ratio of 1:1. Similar results were reported by Cairney et al. (2005) and Dewey et al. (2002), where no differences between 12- and 14-year-old boys and girls were reported. Comparable findings of a study on Italian learners were reported (Alesi et al. 2019). On the contrary, Delgado-Lobete et al. (2019) indicated that the prevalence of DCD among boys was higher than in girls (16.2% and 8.6%, respectively). Similar to Delgado-Lobete et al. (2019), Gillberg (2003) reported a boy-to-girl ratio of 3–5:1, although Carslaw (2011) found an even higher boy–girl ratio of 9:1. These studies provided evidence of a higher prevalence of DCD in boys than in girls. Research conducted in South Africa showed results that were contrary to this study. Pienaar and Lennox (2006) found a boy–girl ratio of 2–6:1 in a North West Province study, and De Milander et al. (2014) found a boy–girl ratio of 1.6:1 in Bloemfontein. In addition, another study in the North West Province found that mostly girls were identified with possible DCD (Venter et al. 2015).

It has been reported that boys were at greater risk for DCD than girls (Wade & Kazeck 2018), and girls outperformed boys with regard to their overall motor proficiency (Pienaar & Kemp 2014). Amador-Ruiz et al. (2018), however, argued that the occurrence of DCD could be influenced by the tool used to evaluate the learners. Boys tend to be more skilful with ball activities, which increases their aiming and catching performance, whereas girls perform better on fine motor skills (Cardoso & Magalhães 2009). Furthermore, it has been suggested that factors such as cultural differences might have an impact on motor skill abilities (Blank et al. 2012), and also socio-demographic variables (Delgado-Lobete et al. 2019), and should be considered before evaluating a learner for possible DCD.

Disadvantaged educational, social and family circumstances are one of the main reasons for low socio-economic conditions in South Africa and could contribute to a lack of motor skill proficiencies and experience (Isaacs-Martin 2015; Narsai et al. 2013; Pappin et al. 2015; Pienaar & McKay 2014). Tsiotra et al. (2006) concluded that lifestyle differences, such as neighbourhood, environment and culture, should be taken into account when identifying motor skill difficulties or possible DCD. Barba et al. (2017) and Valentini et al. (2015) supported the argument of Tsiotra et al. (2006), confirming that a low socio-economic environment and family status are risk factors for DCD and increase the risk for motor skill difficulties.

Conclusion

The prevalence of DCD among Gr. 1 learners in low socio-economic environments in the Motheo District of the Free State Province is high in comparison with previously reported South African findings. This finding highlights the need to identify learners as early as possible and enhance motor competencies to prevent further motor skill difficulties. Screening tools for the identification of possible DCD, such as the MABC-2 Checklist and the DCDQ'07, should be investigated in low socio-economic environments to increase early identification to assist these learners. Although it has been found that the prevalence of DCD may be higher among boys, the difference in gender ratio has been reported in recent studies to be decreasing. Although socio-economic status might be a reason for a higher prevalence of DCD, limited research has been conducted in South Africa. Given the contradicting prevalence of DCD in this study and other studies in South Africa, it is clear that the prevalence of DCD in South Africa, especially with regard to low socio-economic status, is unknown and not fully identified, warranting further research in this area. Furthermore, it is important to make use of all four criteria of the DSM-5 when identifying DCD and ensure early identification to establish timely intervention. Finally, it is important to evaluate the role that socio-economic situations play on the development of DCD in learners.

This study increased our knowledge of the importance to establish the prevalence of DCD in all provinces of South Africa to ensure a thorough knowledge of the occurrence of this disorder. Furthermore, increased awareness of prevalence of DCD in South Africa can assist in treating this disorder at an earlier stage by means of appropriate interventions. These interventions will contribute to improved motor proficiency levels in learners necessary for activities of daily living in addition to the school environment. Lastly, increasing the awareness of DCD in South Africa, especially in low socio-economic environments, increases our ability to attend to this disorder in future by means of implementing strategies for teachers to improve learners' motor abilities.

Limitations

Although the research was performed on a randomly selected sample, only one province and one district in South Africa were included in the study. Therefore, the findings could not provide a comprehensive reflection of the actual prevalence of possible DCD in all the low socio-economic environments of South Africa. It is therefore recommended that a larger sample group should be used in other parts of low socio-economic environments in South Africa to further investigate the prevalence of possible DCD.

It has to be noted further that DCD studies within various socio-economic environments are limited, and therefore, the results of this study could not be used to make comparisons or evaluate differences. Furthermore, it should be kept in mind that the daily living activities of the learners in this study could not be established and was therefore a limitation. It is probable that several learners with possible DCD in this study might have a functionality challenge at home, but because of the language challenge parents were not able to complete a standardised questionnaire such as the DCDQ'07 and the MABC-2 checklist.

Lastly, criteria C and D of the DSM-5 were assessed by using feedback from parents and did not follow the recommendations of the EACD by making use of a medical doctor to ensure that physical and neurological disorders were not present, as well as a psychological evaluation to confirm that cognitive and intellectual problems were absent. Although limitations were recognised in the present study, the opportunity was created to evaluate more learners and establish the extent of DCD in learners living in low socio-economic environments.

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Competing interests

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Authors' contributions

A.M.d.P. was the main researcher reporting on her PhD study and the primary author of the article. M.d.M was the supervisor of the study and contributed to the article by providing guidance regarding structure and content. F.F.C. was the co-supervisor of the study and provided guidance on writing of the manuscript. M.N. was the biostatistician involved in the study and gave input during the planning and analysis of the study. All the authors approved the final version of the article.

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Data availability statement

Data are available from the corresponding author on request.

Disclaimer

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APPENDIX J

PROOF OF ARTICLE SUBMISSIONS TO JOURNALS

From: <aosis@sajce.co.za>
To: "Alretha du Plessis" <20268319@nwu.ac.za>, "Monique de Milander" <demilanderm@ufs.ac.za>, "Derik Coetzee" <coetzeef@ufs.ac.za>, "Riette Nel" <gnbsmn@ufs.ac.za>
Date: 2020/01/10 06:38
Subject: SAJCE Submission 836 – Acknowledgement of manuscript receipt to all the co-authors

****
Ref. No.: 836
Manuscript title: Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa
Journal: South African Journal of Childhood Education
****
Dear Alretha du Plessis, Monique de Milander, Derik Coetzee, Riette Nel

The above manuscript, for which you are listed as a contributing author, has been received by the journal. Future communications regarding this manuscript will be sent to the corresponding author only, Alretha du Plessis.

If you need to contact us or the publisher about your manuscript for any reason, please be sure to quote the journal name and manuscript reference number 836.

Kind regards,
Prof Elizabeth Henning
Editor, SAJCE
ehenning@uj.ac.za

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From: aosis@sajce.co.za <aosis@sajce.co.za>
Sent: Monday, 07 September 2020 10:20
To:20268319@nwu.ac.za
Subject: SAJCE Online first publication 836 – your article has been published

Dear Alretha du Plessis, Monique de Milander, Frederick Coetzee, Mariette Nel,

Congratulations!

Your article Prevalence of possible developmental coordination disorder among Grade 1 learners in low socio-economic environments in Mangaung, South Africa has just been published and is available at the following link:

https://sajce.co.za/index.php/sajce/article/view/836

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Thank you again for publishing with the South African Journal of Childhood Education. We look forward to your future contributions.

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To: "Alretha du Plessis" <20268319@nwu.ac.za>
Date: 2020/08/19 11:21
Subject: SAJCE Submission 930 - Confirmation and acknowledgement of receipt

****
Ref. No.: 930
Manuscript title: The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder
Journal: South African Journal of Childhood Education
****

Dear Alretha du Plessis

Your submission has been received by the journal and will now be processed in accordance with published timelines.

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CC: "Monique de Milander" <demilanderm@ufs.ac.za>, "Derik Coetzee" <coetzeef@ufs.ac.za>, "Mariette Nel" <gnbsmn@ufs.ac.za>
Date: 2020/11/15 10:05
Subject: SAJCE External Review Decision 930 - Revisions required

****
Ref. No.: 930
Manuscript title: The ability of teachers to identify Grade 1 learners in low socio-economic environments with possible developmental coordination disorder
Journal: South African Journal of Childhood Education
****
Dear Alretha du Plessis

We thank you for the submission of your manuscript. The peer review process of your manuscript has now been completed and we have reached a decision regarding your submission.

At present, your manuscript requires minor revisions to address the concerns of the reviewers. Their comments are attached to the email and/or to the bottom of this letter. If not, for your convenience log onto your profile to view the reviewers' comments.

Please include with your revised submission an itemised, point-by-point response to the reviewers which details the changes made. The revised manuscript should be submitted by 22 November 2020; if you anticipate that you will be unable to meet this deadline, please notify the Editorial Office.

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We look forward to receiving the revised manuscript.

Yours sincerely,
Prof Elizabeth Henning
Editor, SAJCE

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From: Derik Coetzee
Sent: Wednesday, November 11, 2020 4:06 PM
To: sajrsper@nwu.ac.za
Subject: FW: Submission Alretha #3 SAJRSPER

Beste Hanlie

Hoop die jaar eindig vir jul baie goed, want ek moet erken dit raak lank.

Hanlie- ek kon nie op webwerf ONLINE submition kry nie- nou probeer ek maar die "ou manier"

Laat weet net!!!

Pas jou op!

Derik

[UFS Logo]
Frederik Coetzee
Adjunct Professor: Exercise and Sport Sciences
Adjunk Professor: Oefen en Sportwetenskappe
Faculty / Fakulteit: Health Sciences / Gesondheidswetenskappe
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From:	Santie Peens
To:	Alretha Du Plessis
Date:	2020/11/24 08:37
Subject:	Re: Fwd: FW: Submission Alretha #3 SAJRSPER

Dankie Alretha

Die artikel is nog in "editorial review" , sodra dit aanvaar is kan ek vir jou stuur.

Grte
Santie

APPENDIX K

LETTER OF ACKNOWLEDGEMENT: LANGUAGE EDITING

26 November 2020

TO WHOM IT MAY CONCERN

I hereby confirm that I have performed the language editing of the thesis submitted by Aletta Margaretha du Plessis for the degree Philosophiae Doctor (PhD). I also declare that I do not have any conflict of interest that could have compromised my work on this thesis in any way.

____

DR. MAGDALENA C. STRUWIG, BSc, BSc Hons, MMedSc, PhD

Medical writer/editor

ORCID: 0000-0001-6617-7712

Member of the European Medical Writers Association (EMWA)

Membership number: 19039

CONTACT INFORMATION

Telephone number: +27 (82) 562 8461

Email address: daleenstruwig@gmail.com