THE MOTOR PROFICIENCY OF OBESE 8 - 11 YEAR OLD CHILDREN

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B.A. Hons

to the fulfillment
of the degree

MAGISTER ARTIUM
(KINDERKINETICS)

in the

Faculty of Humanities
(Department of Human Movement Science)

at the

UNIVERSITY OF THE FREE STATE

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BLOEMFONTEIN
2005

PREFACE

This study would not have been possible without the assistance of several people, whom I would like to thank:

First of all, I want to thank the Lord for the opportunity that he gave me to do this study. Without His love, strength and insight, this study would never have taken place. Thank you my Jesus.

To my parents for all their support throughout this study. Especially to my father for the financial support. There were times that I thought this study will never be completed, but you two kept me going. I could never have asked for more supportive, loving parents. I love you with all my heart.

To the Principle and his personnel at the Primary School where the research took place, I would like to thank you for your exceptional helpfulness and friendliness. I've enjoyed working with all of you.

To the children and their parents of the Primary school, without you there would have been no study. Thank you for you co-operation and the hours you sacrificed.

Dr. B. Pretorius for analyzing the statistics. I know you have a very busy schedule, but you were never too busy to help me. Without the statistics, this study would have been meaningless.

To Willemien for proof reading my dissertation, thank you very much for your hard work.

Dr. Derick Coetzee for his assistance. You've made sure that I stay on the right track with the study. Thank you.

Last but not least, Dr Botes, you've been my mentor for the past 3 years. Thank you for all your good advice and input into this study. Thank you for hours of reading and corrections. God bless you!

DECLARATION

I declare that the dissertation hereby submitted by me for the Masters degree at the University of the Free State is my own independent work except to the extent indicated in the reference citations and that this dissertation has not previously been submitted by me at another university. I further more cede copyright of the dissertation in favour of the University of the Free State.

Signed on this _____ day of _____ 2005.

_____

Student: Carika Potgieter

_____

Promotor: Dr. S.L. Botes

ABSTRACT

THE MOTOR PROFICIENCY OF OBESE 8-11 YEAR OLD CHILDREN

A rapid increase in the prevalence of obesity in children has been seen around the world. There was a 60% increase in the prevalence of being overweight and a 70% increase in the prevalence of obesity between 1989 and 1998 (Ogden et al., 1997:1, Reilly et al., 1999:1039, Martorell et al., 2000:959).

What's more, motor abilities can be influenced by excess weight from a very early age. Groups of normal weight and obese babies were compared, and a delayed gross motor development was found in the obese. A significant correlation was found between excessive weight and gross motor delay. Over the following year, both weight and motor development reverted to normal in the majority of infants (Jaffe & Kosakov, 1982:619).

Parizkova (1996) found that the potential deteriorating effect of excess fat on dynamic performance increases with age and the longer the duration of obesity. This researcher discovered that in preschool children, the effect of increased weight and body mass index is only apparent in some areas, such as broad jump and the 20 meter dash, and much less so in other measured variables. The significant effect of increased weight and fat is most marked during puberty.

From the above mentioned statistics and research, the question is raised on whether obesity has an influence on the motor proficiency of 8-11 year old children.

The first goal of the study was to identify 30 children with obesity (age 8-11) and 30 non-obese children (age 8-11) to form the control group. Body mass index was used as criterium to determine obesity. Boys with a body mass index of 18-21kg/m^2 and girls with a body mass index of 18-22 kg/m^2 were identified as obese, while the control group all had a body mass index of less than 18kg/m^2. Fat percentage was determined using the Heath and Carter method (skinfolds of the triceps, sub-scapula, para-umbilicus, supra-iliac, medial thigh and medial calf) (Heath and Carter, 1969:57). Furthermore, somatotyping has been used for the estimation of body composition. Somatotyping of an individual is expressed by a three digit evaluation comprising three consecutive numbers (rated from lowest to highest, 1-7) and always listed in the same order. Each number represents the evaluation of a basic component, *endomorphy* (relating to relative adipose), *mesomorphy* (relating to skeletal muscle development), and *ectomorphy* (relating to the relative linearity of the body).

There after, the obese (n=30) and non-obese (n=30) children, age 8-11, were evaluated with the Bruininks-Oseretsky test (Bruininks, 1978) to determine their motor proficiency. The Bruiniks-Oseretsky Test of Motor Proficiency is an individually administered test that assesses the motor functioning of children from 4½ to 14½ years of age. The complete battery – eight subtests (Running Speed and Agility, Balance, Bilateral Coordination, Strength, Upper Limb Speed, Response Speed, Visual Motor Control and Upper Limb Coordination and Dexterity) comprised of 46 separate items – provides a comprehensive index of motor proficiency as well as separate measures of both gross and fine motor skills. The Short Form – 14 items from the Complete Battery – provides a brief survey of general motor proficiency (Bruininks, 1978:11).

The data was analyzed by means of the t-test. This test was used because it is the most commonly used method to evaluate the differences in means between two groups.

The study revealed that there was no significant difference in any age group (8, 9, 10 or 11) between the motor proficiency of obese versus non-obese children. This is in contrast with the hypothesis that states that there will be a significant difference between the motor proficiency of obese versus non-obese children.

Although the study can conclude that there was no major difference between the two groups, obesity remains a concern. The prevalence of this epidemic is rising year after year and it is therefore recommended that obesity should be prevented as far as possible and that those who suffer from obesity should be treated as soon as they are diagnosed with obesity. Treatment of obesity is most successful if realistic goals are set; a balanced diet is emphasized; a safe rate of weight loss of about 0.5 kg a week is achieved through moderate reduction of energy intake (about 20-25% decrease); increased physical activity is emphasized as much as diet; parental support is strong and behavior therapy is provided to help both child and parents achieve the diet, exercise and behavior goals (Frühbeck, 2000:328).

Another concern is that the motor proficiency of children between 8 and 11 years is not what it is suppose to be. Both the obese and non-obese group had a low score of motor proficiency, which means that they were probably never exposed to appropriate motor development in their early childhood years. It is therefore recommended that more attention be given to early motor development to help children improve their motor proficiency which is essential for the performance of specialized movements in later childhood and adolescence. Motor development programs may be implemented in pre-school and primary schools as part of the curriculum.

Key words: Obesity, Motor Proficiency, Motor development, Body mass index, Fat percentage, Somatotype, Bruininks-Oseretsky Test Battery.

OPSOMMING

DIE MOTORIESE VAARDIGHEID VAN VETSUGTIGE 8- TOT 11-JARIGE KINDERS

'n Vinnige toename in die voorkoms van vetsug by kinders word regoor die wêreld waargeneem. Daar was 'n 60%-toename in die voorkoms van die oorgewigtoestand en 'n 70%-toename in die voorkoms van vetsug tussen 1989 en 1998 (Ogden et al., 1997, Reilly et al., 1999:1039, Martorell et al., 2000:959).

Wat meer is, motoriese vermoëns kan reeds van 'n baie vroeë ouderdom deur 'n oormaat gewig beïnvloed word. Groepe babas van normale gewig en vet babas is vergelyk en vertraagde groot motoriese ontwikkeling is by die vetsugtige babas gevind. 'n Betekenisvolle korrelasie is tussen oormatige gewig en groot motoriese vertraging gevind. Oor die volgende jaar het beide gewig en motoriese ontwikkeling in die meerderheid babas na normaal teruggekeer (Jaffe en Kosakov, 1982:619).

Parizkova (1996) het gevind dat die potensiële verslegtende effek van 'n oormaat vet op dinamiese prestasie, na gelang van ouderdom en hoe lank die vetsug duur, verhoog. Die navorser het ontdek dat die effek van verhoogde gewig en liggaamsmassa-indeks by voorskoolse kinders slegs in sekere areas duidelik is, soos by staande verspring en die 20 meter spoed toets, en aansienlik minder by ander gemete veranderlikes. Die betekenisvolle effek van verhoogde gewig en vet is die merkbaarste gedurende puberteit.

Na aanleiding van die voorafgaande statistiek en navorsing, word die vraag gevra of vetsug ’n invloed op die motoriese vaardigheid van 8- tot 11-jarige kinders het.

Die eerste doel van die studie was om 30 kinders met vetsug te identifiseer (ouderdomme 8 tot 11 jaar) en 30 nievetsugtige kinders (ouderdomme 8 tot 11 jaar) om die kontrolegroep te vorm. Die liggaamsmassa-indeks is as kriterium gebruik om die vetsug te bepaal. Seuns met ’n liggaamsmassa-indeks van 18-21 kg/m^2 en meisies met ’n liggaamsmassa-indeks van 18-22 kg/m^2 is as vetsugtig geïdentifiseer, terwyl die kontrolegroep almal ’n liggaamsmassa-indeks van minder as 18 kg/m^2 gehad het. Vetpersentasie is bepaal deur die Heath en Carter-metode (huidplooie van die driekopspier, die onderbladbeen, paranawel, supraderm, middelbobeen en middelkuit) te gebruik (Heath en Carter, 1969:57). Verder is die liggaamsbouvorm gebruik vir ’n estimasie van die liggaamsamestelling. Die liggaamsbouvorm van ’n individu word uitgedruk deur ’n driesyfer-evaluering wat bestaan uit drie opeenvolgende syfers (bepaal vanaf die laagste tot die hoogste, 1-7) en altyd gelys in dieselfde volgorde. Elke syfer verteenwoordig die evaluering van ’n basiese komponent, *endomorfie* (wat verband hou met relatiewe vet), *mesomorfie* (wat verband hou met skeletale spierontwikkeling) en *ektomorfie* (wat verband hou met die relatiewe lineariteit van die liggaam).

Daarna is die vetsugtige (n=30) en die nievetsugtige (n=30) kinders, ouderdomme 8 tot 11 jaar, met die Bruininks-Oseretsky-toets (Bruininks, 1978) geëvalueer om hul motoriese vaardigheid te bepaal. Die Bruininks-Oseretsky-toets van motoriese vaardigheid is ’n individueel geadministreerde toets wat die motoriese funksionering van kinders vanaf 4½ tot 14½ jaar evalueer. Die volledige battery – agt subtoetse (Hardloopspoed en Ratsheid, Balans, Bilaterale Koördinasie, Krag, Spoed van Boonste Ledemate, Responsspoed, Visueel Motoriese Kontrole en Koördinasie van Boonste Ledemate en Behendigheid) bestaande uit 46 afsonderlike items – verskaf ’n omvattende indeks van

motoriese vaardigheid, asook afsonderlike indekse van beide groot en fyn motoriese vaardighede. Die Kort Vorm – 14 items van die Volledige Battery – verskaf ’n kort opname van algemene motoriese vaardigheid (Bruininks, 1978:11).

Die data is deur middel van die t-toets geanaliseer. Hierdie toets is gebruik omdat dit die mees algemene metode is om die verskille in vermoëns tussen twee groepe te evalueer.

Die studie het getoon dat daar geen betekenisvolle verskil is tussen enige van die ouderdomsgroepe (8, 9, 10 of 11) wat betref die motoriese vaardigheid van vetsugtige versus nievetsugtige kinders nie. Dit is in teenstelling met die hipotese wat stel dat daar ’n betekenisvolle verskil tussen die motoriese vaardigheid van vetsugtige versus nievetsugtige kinders sal wees.

Alhoewel die studie tot die gevolgtrekking kon kom dat daar geen groot verskille tussen die twee groepe is nie, bly vetsug ’n bekommernis. Die voorkoms van hierdie epidemie styg jaar na jaar en daar word daarom aanbeveel dat vetsug so ver as moontlik voorkom moet word en diegene wat aan vetsug ly moet so gou as moontlik behandel word wanneer hulle met vetsug gediagnoseer word. Behandeling van vetsug is die suksesvolste indien realistiese doelstellings gestel word; ’n gebalanseerde dieet beklemtoon word; ’n veilige tempo van gewigsverlies van omtrent 0.5 kg per week word bereik deur middelmatige vermindering van energie-inname (omtrent ’n afname van 20-25%); verhoogde fisiese aktiwiteit word net soveel beklemtoon as dieet; ouerlike ondersteuning is sterk en gedragsterapie word verskaf om beide die kind en die ouers te help om die dieet-, oefening- en gedragsdoelstellings te bereik (Frühbeck, 2000:328).

’n Ander bekommernis is dat die motoriese vaardigheid van kinders tussen 8 en 11 jaar nie is wat dit veronderstel is om te wees nie. Beide die vetsugtige en nievetsugtige groepe het ’n lae telling van motoriese vaardigheid gehad wat

beteken dat hulle waarskynlik nooit aan toepaslike motoriese ontwikkeling in hul vroeë kinderjare blootgestel is nie. Daar word dus aanbeveel dat meer aandag gegee moet word aan die vroeë motoriese ontwikkeling om kinders te help om hul motoriese vaardigheid te verbeter wat noodsaaklik is vir die uitvoering van gespesialiseerde bewegings in latere kinderjare en adolessensie. Motoriese ontwikkelingsprogramme kan in voorskoolse en laerskole as deel van die kurrikulum geïmplementeer word.

Sleutelwoorde: Vetsug, motoriese vaardigheid, motoriese ontwikkeling, liggaamsmassa-indeks, vetpersentasie, liggaamsbouvorm, Bruininks-Oseretsky-toetsbattery.

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CHAPTER 1

PROBLEM STATEMENT AND GOAL OF THE STUDY

1.1 INTRODUCTION

The global epidemic of obesity in adults is now a major health problem for children and youth as well. While childhood obesity has existed since ancient times, there is increasing evidence that prevalence rates today are greater than ever before. This increase in fatness heightens the health risks for later periods of life but has a substantial impact during the growing years too (Klein, 2004:6).

Parizkova and Hills (2005:3) found that the increasing prevalence of obesity is, however, a component of the bigger general health situation of increasing diseases of "affluence". These health problems have resulted from an unsuitable and unhealthy lifestyle. With increasing obesity came a corresponding increase in accompanying health risks such as type 2 diabetes, atherosclerosis, and hypertension. This may indicate that children in the current generation are at risk of dying at a younger age than their parents.

Genetic factors and environmental conditions play a central role in the early development of obesity, but the situation varies in different countries. The prevalence of obesity in all age groups, however, has increased so fast that significant changes in the gene pool cannot be considered as the only explanation. Prevalence varies significantly in different parts of the world, especially when comparing some populations in Asia or Africa with Western populations (Parizkova and Hills, 2005:3).

Also, childhood obesity has been identified in lower socioeconomic groups in the industrially developed countries, which suggests that obesity is mainly due to poor lifestyle behaviors, such as the consumption of cheaper fats and sugar products, commonly combined with reduced physical activity. Given the widespread nature of obesity, particularly under conditions of an improving economic and social situation, the adequate management of the condition during growth is an urgent challenge for most countries of the world (Florencio, 2001:277).

1.2 PROBLEM STATEMENT

Jaffe and Kosakov (1982:619) did important research on fat babies and they found that motor abilities can be influenced by excess weight from a very early age. Groups of normal weight and obese babies were compared, and a delayed gross motor development was found in the obese. A significant correlation was found between excessive weight and gross motor delay. Over the following year, both weight and motor development reverted to normal in the majority of infants.

Also, Parizkova (1996) found that the potential deteriorating effect of excess fat on dynamic performance increases with age and the longer the duration of obesity. In preschool children, the effect of increased weight and body mass index is only apparent in some areas, such as broad jump (Figure 1) and the 20 meter dash (Figure 2), and much less so in other measured variables. The significant effect of increased weight and fat is most marked during puberty.

N

O

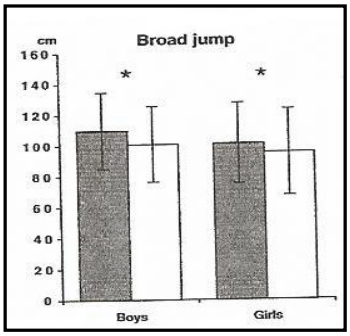

Figure 1: Comparison of broad jump motor performance in normal-weight (N) and obese (O) children. * Indicates ($p<0.05$) (Parizkova, 1996; Parizkova, 1998)

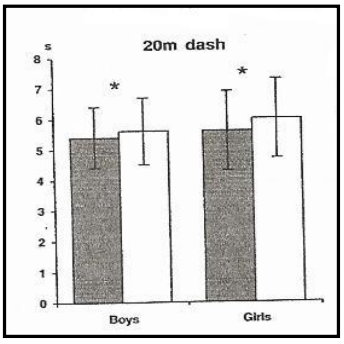

Figure 2: Comparison of a 20m dash motor performance in normal-weight (N) and obese (O) children. * Indicates ($p<0.05$) (Parizkova, 1996; Parizkova, 1998)

Some 19 years earlier, Parizkova (1977) tested obese boys aged 12 to 14 years in 19 physical fitness and motor ability items, and obesity was evaluated by 6 skinfolds and bio-electrical impedance analysis. This researcher found that obese boys had significantly poorer results in the 1500 meter run, 5 minute run,

50m run, running long jump, and many other variables. Obese boys were superior in back strength only. This data confirms previous studies on the differentiated effect of obesity on physical performance, which has the most negative influence during dynamic workloads of aerobic, weight bearing activities.

In a study by Goulding et al. (2003:410) he used a balance test and two computerized posturography tests for the evaluation of the effect of increased body weight. The results of the balance test correlated negatively with body weight, body mass index, percentage of fat and total fat mass. Obese children had lower scores than children with normal weight, supporting the view that obese adolescents have poorer balance.

Moreover, the level of motor proficiency and co-ordination of an individual influences physical activity levels. Similarly, difficulty in visual co-ordination is also considered as a possible cause of problems during exercise in obese children that may result in the preference for sedentary behaviors (Petrolini et al., 1995:928).

An essential characteristic of obesity is an excess of fat relative to body mass (Parizkova and Hills, 2005:6). Figure 3 (Chapter 2) shows the difference in height, weight, percentage of fat and Body Mass Index in normal and obese boys aged 11, 12 and 16 years.

The question that can be asked from the above mentioned literature is whether the motor proficiency of obese 8 to 11 year old children differs significantly from that of non obese children.

1.3 GOAL

1.3.1. PRIMARY GOAL

The primary goal of this study will be to determine:

- Whether the motor proficiency of obese children (n=30) differs significantly from that of non-obese (n=30) 8 – 11 year old children (Highly significant difference = $P < 0.01$, and a significant difference = $P < 0.05$).

1.3.2 SECONDARY GOAL

The secondary goal of the study will be to identify 30 children with obesity, age 8 to 11, based on Body Mass Index cutoffs (Boys: 18-21kg/m^2 and girls 18-22kg/m^2). Body mass index will be determined by taking physical measurements of height (m) and weight (kg) of the children. Fat percentage (%) will be determined by taking six skinfold measurements (triceps, sub-scapula, para-umbilicus, supra-iliac, medial thigh and medial calf) according to the Heath and Carter Method, as well as somatotype. Those who are identified as obese will be tested to determine their motor proficiency through the Bruininks-Oseretsky test of motor proficiency. In addition a control group of 30 non-obese 8 to 11 year old children will be identified and will be evaluated on the Bruininks-Oseretsky test of motor proficiency too.

1.4 HYPOTHESIS

A hypothesis can be formulated as follows:

- The motor proficiency of obese children will be significantly inferior to that of their non-obese counterparts.

1.5 STRUCTURE OF THE STUDY

In Chapter 1 a short introduction of obesity is given. The problem statement and goals of the study are addressed as well as a hypothesis. The structural layout of the study follows.

Obesity is discussed in greater detail in Chapter 2. This includes prevalence, diagnose, causes, complications, treatment and prevention of obesity. This will only by a literature review and not a complete literature study.

In Chapter 3 the correlation between motor development and motor proficiency is discussed. Factors affecting motor development, and in turn motor proficiency, will be addressed. Furthermore, the contribution of movement skill acquisition on motor proficiency will be discussed.

In Chapter 4 the research design and statistical analyses of the study are provided. Methods used in the study are discussed. Statistical findings are presented in tables and figures and results are discussed.

Chapter 5 includes the conclusion and recommendations of the study.

Several enclosures are included in the study. Enclosure A, B and C contains the permission granted for the study from the Free State Department of Education (Enclosure A), the principal (Enclosure B) and the parents (Enclosure C) of the children involved in the study. Enclosure D contains a medical history form that the parents had to complete before their children enrolled for the study.

A complete list of references is provided.

There upon Chapter 2.

CHAPTER 2

OBESITY

2.1 INTRODUCTION

There is growing agreement among experts (Hill and Peters, 1998:1371; French et al., 2001:63) that the environment, rather than biology, is driving the obesity epidemic. Biology clearly contributes to individual differences in weight and height, but the rapid weight gain that has occurred over the past three decades is a result of the changing environment. The current environment encourages consumption of energy and discourages expenditure of energy. A possible factor is an environment that promote over consumption of good-tasting, inexpensive, energy-dense foods and the serving of these foods in large portions. Other environmental factors tend to reduce total energy expenditure by reducing physical activity. These include reductions in jobs requiring physical labor, reduction in energy expenditures at school and in daily living and an increase in time spent on sedentary activities such as watching television, surfing the Web, and playing video games (Hill and Peters, 1998:1371).

Although there is an agreement that the environment is fueling the obesity epidemic, the relative contributions of factors influencing food intake and physical activity are not clear. Numerous changes in both aspects have occurred simultaneously with the rise of obesity, and their magnitude and impact have not been well documented and are probably impossible to estimate retrospectively (French et al., 2001:63).

Therefore, the numerous environmental factors that affect eating and physical activity behaviors may merely be symptoms of deeper social forces that are accountable for our present environment (Gleick, 1999:6). Our ancestors aspired

to create a better life for themselves and their children. This goal meant building a society in which more people would have access to affordable food, the amount of hard physical labor required to subsist would be reduced, and there would be an opportunity to enjoy some leisure time. These inspirational values are the modern version of "a good life". The assumption is that high productivity will make the "good life" possible and technology will fuel higher productivity. The irony is that technology and the accompanying productivity have created a faster and more stressful pace of living, with time pressures for all of us (Gleick, 1999:6). We no longer have sufficient time for traditional food preparation, which has created the demand for prepackaged and fast food. Time pressures have fuelled the need to get to places faster, which causes us to drive rather than walk, to take the elevator instead of the stairs, and to look to technology for ways to engineer inefficient physical activity out of our lives. Our relentless quest for improved productivity and efficiency has fuelled increasing demands for getting better and better deals, that is, getting more for less (Reich, 2001:20).

A testament to this trend is the dramatic increase in the number of large retail discount stores dedicated to bringing more goods to consumers at the lowest possible cost. Valuing more for less is a key driver behind the rise of "super sizing" as a strategy for competing for the consumer's fast-food money. Changing family structures have also shaped the food and physical activity environment. The entry of large numbers of women into the workplace and the increase in single-parent families have changed the structure of many families and increased the value of convenience. Now, more than ever, we value the ability to conduct many aspects of everyday business without ever having to step out of our cars (Hill et al., 2003:854).

Health is only one factor contributing to the decisions that people make every day about food and physical activity and, because its consequences are long-term, it often has less impact than factors with immediate influence, such as short-term reward and convenience. It is no wonder that our previous attempts to change

health behavior have not been entirely successful: We have been trying to change the long-term outcome by targeting only the health-related fraction of the total equation explaining an individual's behavior choices (Hill et al., 2003:854).

2.2 CONSEPTUALIZATION OF TERMS

2.2.1 OBESITY

Obesity may be defined as a multifactor syndrome that consists of anthropological, physiological, biochemical, metabolic, anatomical, psychological, and social alterations. The condition is characterized by an increased level of adiposity and a corresponding increase in body weight, which has to be evaluated according to the standard values for the individual age categories of girls and boys (Parizkova and Hills, 2005:6).

However, Lohman (1987:98) defines obesity as an excessive accumulation of body fat. Obesity is present when total body weight is more than 25 percent fat in boys and more than 32 percent fat in girls.

Other definitions of obesity and severe obesity:

Table 1: Definitions of obesity and severe obesity (Williams et al., 1997:225)

INDEX	***OBESITY***	***SEVERE OBESITY***	***RELEVANT INFORMATION***
Mean weight for height	> 120 percent	> 140 percent	Actual weight is 20 percent or more above the mean weight for children of this height.
Weight for height	> 85 percent	> 95 percent	Readily available reference charts.

			Easy to use but do not differentiate lean body mass from fat
Triceps skin fold	> 85 percentile	> 95 percentile	Direct measurement of subcutaneous fat. More accurate measurement of obesity but more intra-observer variability.
Body mass index (kg per m^2)	> = 85 percentile	> = 95 percentile	Percentiles are age- and gender- specific. Better correlates excess weight to fat in younger children and adolescents.
Ponderal index (kg per m^3)	> 85 percentile	> 95 percentile	Percentiles are age- and gender-specific. Better correlates excess weight to fat in older children.

2.2.2 BODY MASS INDEX (BMI)

A clinically useful assessment of obesity must reflect excess body fat and still be simple to use. Body mass index (BMI), expressed as body weight in kilograms divided by the square of height in meters (kg/m^2), is a weight-for-height index that meets these criteria. Body Mass Index is the standard obesity assessment in adults and its use in children provides a consistent measure across age groups (Barlow and Dietz, 1998:223).

Furthermore, Body Mass Index correlates with measures of body fatness in children and adolescents. The correlation coefficient ranges from 0.39 to 0.90, depending on the method of fatness measurement and the age and sex of the subjects (Killeen et al., 1978:530, Duerenberg et al., 1991:107, Dietz and

Robinson, 1998:191). Body Mass Index also correlates with markers of secondary complications of obesity, including raised blood pressures, (Kotchen et al., 1980:125; Clarke et al., 1986:195), blood lipids and blood lipoproteins, (Higgins et al., 1980:119), and with long-term mortality. Table 2 below shows the International cutoffs to identify overweight and obesity (Must et al., 1992:1353).

Table 2: Body Mass Index cutoffs for overweight and obesity (Cole, 2000:1240)
Abbreviations: yrs = Years

AGE (yrs)	Body Mass Index 25kg/m^2		Body Mass Index 30 kg/m^2	
	Males (kg/m^2)	Females (kg/m^2)	Males (kg/m^2)	Females (kg/m^2)
8.5	18.76	18.69	22.17	22.18
9	19.10	19.00	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05

2.2.3 SOMATOTYPE

Somatotype is used for the estimation of body composition. Somatotype of an individual is expressed by a three digit evaluation comprising three consecutive numbers (rated from lowest to highest,1-7) and always listed in the same order. Each number represents the evaluation of a basic component, *endomorphy* (relating to relative adiposy), *mesomorphy* (relating to skeletal muscle development), and *ectomorphy* (relating to the relative linearity of the body) (Parizkova and Carter, 1976:327).

The Medford Growth Study (1956-1968) directed by Clarke, was a large mixed longitudinal and cross-sectional study of boys, aged 7-18 (normal weight). Table 3 below illustrates his results of the 9-11 year old age group. Later in this study we will see how his results of non-obese children compare with that of obese children.

Table 3: The Medford Growth Study (Clarke, 1971)

Abbreviations: N = Sample; yrs = Years

N	Age (yrs)	Somatotype
106	9	3.4-4.2-2.9
106	10	3.6-4.2-2.9
106	11	3.4-4.2-3.2

2.3. PREVALENCE AND IDENTIFICATION

A rapid increase in the prevalence of obesity in children has been seen around the world. There was a 60% increase in the prevalence of being overweight and a 70% increase in the prevalence of obesity between 1989 and 1998 (Ogden et al., 1997:6; Reilly et al., 1999:1039; Martorell et al., 2000:959).

Given what we know about the natural history of being overweight in childhood and obesity in children these findings should heighten concern. Although the risk of obesity in adulthood is not increased among children who are overweight at 1 and 3 years old, the risk rises steadily thereafter regardless of parental weight (Whitaker et al., 1997:869). After the age of three, however, the likelihood that obesity will persist into adulthood increases with the advancing age of the child and is higher in children with severe obesity in all age groups. After an obese child reaches six years of age, the probability that obesity will persist exceeds 50% and 70 to 80% of obese adolescents will remain so as adults (Whitaker et al., 1997:869). The persistence of obesity into adulthood depends on several factors, including the age at which the child becomes obese, the severity of the disease and the presence of obesity in at least one parent. Furthermore, more than 60% of overweight children have at least one additional risk factor for cardiovascular diseases, such as raised blood pressure, hyperlipidaemia, or hyperinsulinaemia, and more than 20% have two or more risk factors. Type 2 diabetes, which was previously rare in children and adolescents, now accounts for over 30% of new cases; most cases of type 2 diabetes in children and adolescents are attributable to obesity (Freedman et al., 1999:1175).

Approximately 30.3% of children (ages 6 to 11) are overweight and 15.3% are obese. Excess weight in childhood and adolescence has been found to predict overweight in adults (http.www.obesity.org/subs/fastfacts/obesity_youth.shtml) . Overweight children, aged 10 to 14, with at least one overweight or obese parent (Body Mass Index > 27.3 kg/m^2 for woman and > 27.8 kg/m^2 for men) were

reported to have a 79% likelihood of overweight persisting into adulthood. The increase in obesity over the past two decades is dramatic, as shown in Table 4.

Table 4: Prevalence of obese children
(http.www.obesity.org/subs/fastfacts/obesity_youth.shtml)

(Ages 6 to 11) at the 95th percentile of Body Mass Index (BMI)	
1999 – 2000	15.3%
1988 – 1994	11.0%
1976 – 1980	7%

2.4 DIAGNOSIS OF OBESITY

There are some signs that may help to determine if a child has or is at risk for childhood obesity, such as:

- Family history of obesity
- Family history of obesity-related health risks such as early cardiovascular disease, high cholesterol, high blood pressure levels, type 2 diabetes.
- Family history of cigarette smoking and sedentary behaviors.
- Signs in the child of obesity-related health risks from a pediatrician's evaluation including:

1. Cardiac risk factors. Studies of children with obesity show higher than average blood pressure, heart rate and cardiac output when compared to children without obesity.

2. Type 2 diabetes risk factors. This involves glucose intolerance and insulin levels that are higher than average.
3. Orthopedic problems. Some symptoms include weight stress in the joints of the lower limbs, tibia torsion and bowed legs, and slipped capital femoral epiphysis (especially in boys).
4. Skin disorders. Some are heat rash, intertrigo, monilial dermatitis and acanthosis nigricans.
5. Psychological / psychiatric issues. Poor self-esteem, negative self image, depression, and withdrawal from peers have been associated with obesity.

- Patterns of sedentary behavior (such as too much television viewing) and low physical activity levels.
- Taller height – children with obesity are often above the 50th percentile in height.
- Smoking initiation. Youngsters use smoking as a method of weight control.

(http://www.obesity.org/subs/childhood/healthrisks.shtml).

2.5 CAUSES OF OBESITY

There are many factors that contribute to causing child obesity – some are modifiable and others are not.

2.5.1 MODIFIABLE CAUSES

A person gains weight when energy input exceeds energy output. Energy input is food. On the other hand, energy output comprises the basal metabolic rate, the thermal effect of food and activity. The thermal effect of food is the energy required to absorb and digest meals. Of these variables, activity is the one least influenced by genetic inheritance and is therefore the one most susceptible to change. By measure, 833 kilojoules is equivalent to 0.45 kg; thus, an excess intake of only 12 to 24 kilojoules per day will lead to a 2.25 to 5 kg weight gain over one year. As a result, a relatively small imbalance between energy input

and output can lead to significant weight gain over time. In fact, most obese children demonstrate a slow but consistent weight gain over several years (Moran, 1999:3).

According to Dietz (2001:313) modifiable causes include the following aspects:

- Physical activity – The amount of physical activity that children engage in has been reduced by an increase in the use of cars, an increase in the amount of time spent watching television, and a decrease in the opportunities in many communities for physical activity on the way to school or in school.
- Sedentary behavior – High frequency of television viewing, computer usage, and similar behavior that takes up time that can be used for physical activity must decrease.
- Socioeconomic status – Low family income and non-working parents increase obesity.
- Eating habits – Over consumption of high-calorie foods. Important changes have occurred in family eating patterns and in the consumption of fast foods, pre-prepared meals and fizzy drinks. Some eating patterns that have been associated with this behavior are eating when not hungry, eating while watching television or doing homework.
- Environment – Some factors are over-exposure to advertising of foods that promote high-calorie foods and lack of recreational facilities.

2.5.2 NON-CHANGEABLE CAUSES

2.5.2.1 GENETICS

- Genetics – Greater risk of obesity has been found in children of obese and overweight parents.

Comuzzie and Allison (1998:1375) showed that there is much evidence supporting the role of genetic influences on body morphology and the interplay of genetic and environmental influences in determining adiposity. The quantitative genetic theory is used to estimate the heritability of obesity and, in twin studies, to estimate the variation in adiposity that is due to within-population genetic variation (Maes et al.,1997:325). Obese parents have been reported to frequently have obese children, although normal weight parents may also sometimes have obese children. Body Mass Index values are more similar among family members than among unrelated persons. Studies conducted by Bouchard (1994) with comparison of identical twins and fraternal twins, and in comparison of identical twins raised apart, have led to the suggestion that 70% of the variation in Body Mass Index may be genetically based in etiology. In adoption studies the heritability estimates are about 30%, and in family studies the estimates of heritability of Body Mass Index have been intermediate. In twins, a substantial genetic contribution to fat mass was detected, with genes estimated to account for 75% to 80% of the phenotypic variation and for 62.5% of the total variation in percentage body fat (Raman, 2002:134).

2.5.2.2 ADIPOCYTES

An essential characteristic of obesity is an excess of fat relative to body mass (Parizkova and Hills, 2005:6). Figure 3 (Parizkova, 1977) below shows the difference in height, weight, body mass index and percentage of fat in normal and obese boys aged 11, 12 and 16 years. Regarding the cellularity of adipose tissue, there is a poor proliferation in non-obese children until 10 to 12 years. In contrast, in the obese there is a constant proliferation from one year of age. As a result, the number of fat cells at the end of growth is significantly higher in obese subjects (Burniat, 1997: S136).

However, both early, high fat adipocyte content and hyperplasia in these children could account for the early AR in body mass index in the obese before the age of 5.5 years (Rolland-Cachera, 1984:129).

This is significantly associated with increased weight at the end of the growth period. Wabitsch (1997:170) demonstrated that in-vitro fat cell cultures, IGF-1 stimulated fat filling of the preadipocytes and the proliferation of mature adipocytes. An excessively voluminous “fat storehouse” could be formed early in life and then later be filled by an inadequate food intake as related to energy needs. However, a positive excessive fat balance, more than chronic positive energy balance, has been considered recently as a major factor contributing to the increase of the fat deposits.

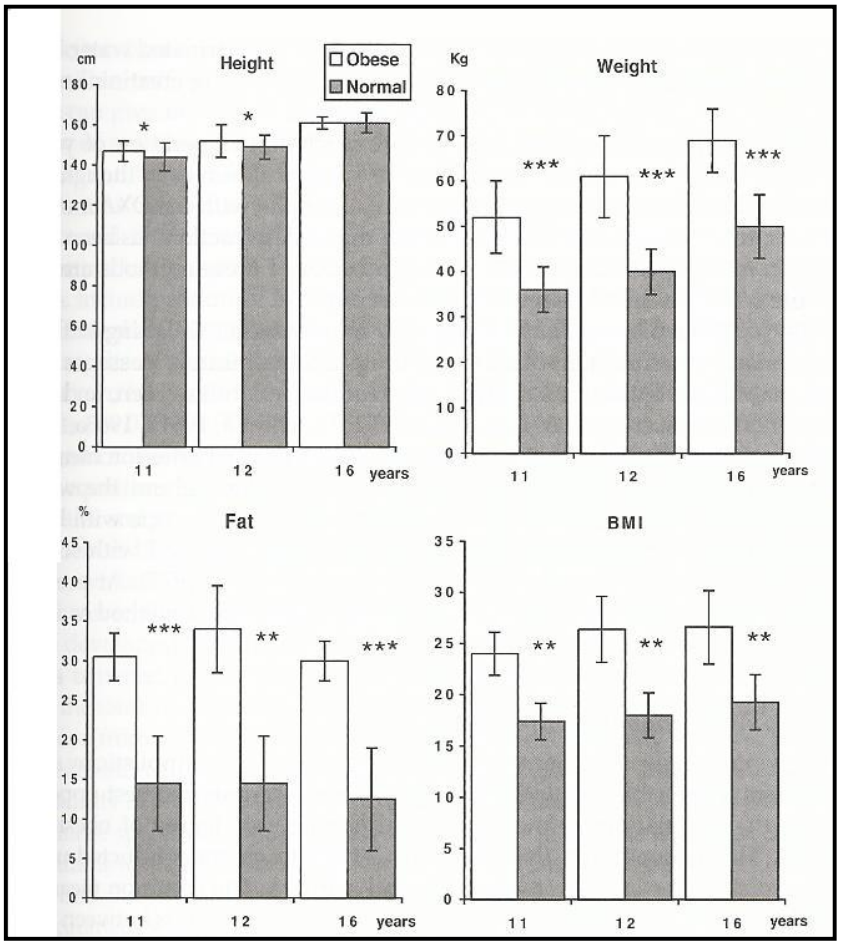

Figure 3: Differences in height (cm), weight (kg), fat percentage (%), and body mass index (kg/m^2) in obese and normal boys. * ($p<0.05$); **($p<0.01$); ***($p<0.0001$) (Parizkova, 1977)

2.5.3 ENDOGENOUS CAUSES OF CHILDHOOD OBESITY

According to Moran (1999:3) the following endogenous causes of childhood obesity are provided in Table 5.

Table 5: Endogenous causes of childhood obesity (Moran, 1999:3)

HORMONAL CAUSES	***DIAGNOSTIC CLUES***
Hypothyroidism	Increased TSH, decreased thyroxin (T4) levels
Hypercortisolism	Abnormal dexamethasone suppression test; increased 24 hour free urinary cortisol level
Primary Hyperinsulinism	Increased plasma insulin, increased C-peptide levels
Pseudohypoparathyriodism	Hypocalcaemia, hyperphosphatemia, increased PTH level.
Acquired hypothalamic	Presence of hypothalamic tumor, infection, syndrome trauma, vascular lesion.
GENETIC SYNDROMES	***ASSOCIATED CHARACTERISTICS***
Prader-Willi	Obesity, unsuitable appetite, mental retardation, hypogonadism, strabismus
Laurence-Moon / Bardet-Biedl	Obesity, mental retardation, pigment retinopathy, hypogonadism, spastic paraplegia
Alström	Obesity, retinitis pigmentosa, deafness, diabetes mellitus
Börjeson-Frossman-Lehmann	Obesity, mental retardation, hypogonadism, hypo metabolism, epilepsy
Cohen	Truncal obesity, mental retardation, hypotonia, hypogonadism
Turner's	Short stature, undifferentiated gonads, cardiac abnormalities, webbed neck, obesity, 45 X genotype
Familial lipodystrophy	Muscular hypertrophy, acromegalic appearance, liver enlargement, acanthosis nigricans, insulin resistance, hypertriglyceridemia, mental retardation
Beckwith-Wiedemann	Gigantism, exomphalos, macroglossia,

	visceromegaly
Soto's	Cerebral gigantism, physical overgrowth, hypotonia, delayed motor and cognitive development
Weaver	Infant overgrowth syndrome, accelerated skeletal maturation, unusual faces
Ruvalcaba	Mental retardation, microcephaly, skeletal abnormalities, hypogonadism, brachymetapody
GENE ASSOCIATIONS	
Leptin	
Beta 3 – adrenergic receptor	
TSH = Thyroid stimulating hormone PTH = Parathyroid hormone	

2.6 COMPLICATIONS CAUSED BY OBESITY

Obesity can cause complications in many organ systems. Orthopedic complications include slipped capital femoral epiphysis, which may manifest as hip or knee pain and limited hip range of motion, (Kelsey et al., 1973:1045; Loder et al., 1993:1143; Richards, 1996:69) and Blount's disease (tibia vara) (Dietz et al., 1982:735). If radiography confirms either of these conditions, an orthopedic surgeon should evaluate the child, and the primary clinician should consult a pediatric obesity specialist about an appropriate weight-loss program to prevent recurrence of Blount's disease or contra lateral slipped epiphysis. Blurred margins of the optic disks may indicate pseudo tumor cerebri, especially when the child reports severe headaches. Pseudo tumor cerebri can occur in the absence of blurred disk margins, however, and a neurologist can help make the diagnosis (Reid et al., 1981:638).

Because this condition may lead to loss of visual fields or visual acuity, clinicians should refer to or consult with a pediatric obesity specialist. If the child experiences daytime somnolence or the family describes breathing difficulty during sleep, a sleep study will identify sleep apnea or obesity hypoventilation

syndrome. (Riley et al., 1976:673; Boxer et al., 1988:552; Mallory et al., 1989:829; Silvestri et al., 1993:126). Enlarged tonsils may interfere with ventilation at night, especially if the child snores heavily. Tonsillectomy may improve quality of sleep and therefore daytime well-being. Sleep apnea and obesity hypoventilation syndrome are potentially fatal disorders that require rapid weight loss and may require continuous positive airway pressure until weight loss decreases intra-abdominal pressure, improves chest wall compliance, and restores adequate ventilation. Clinicians should seek guidance from a pediatric obesity treatment center or specialist.

Abdominal pain or tenderness may reflect gall bladder disease, for which obesity is a risk factor in adults (Everhart, 1993:1033), although the risk in obese children may be much lower (Palasciano et al., 1989:1380). Blood tests and ultrasonography may be needed to evaluate further these signs and symptoms (Acalivschi et al., 1997:127; Stampfer et al., 1992:655).

Endocrinologic disorders related to obesity include polycystic ovary disease, which commonly presents with oligomenorrhea or amenorrhea and hirsutism (Wild, 1992:71; Bringer et al., 1993:118; Balen et al., 1995:2107), and noninsulin-dependent diabetes mellitus, an increasingly common condition in children (Pinhas-Hamiel et al., 1996:608; Scott et al., 1997:84). Furthermore, Acanthosis nigricans, the coarse, hyper pigmented areas in the neck folds or axilla that are associated with insulin resistance in obese adults (Hud et al., 1992:942) occurs frequently but not exclusively in children with noninsulin-dependent diabetes mellitus and in insulin-resistant children (Richards et al.,1985:893; Hud et al., 1992:942; Scott et al., 1997:84). Fasting blood insulin and glucose will screen for insulin resistance and a pediatric endocrinologist should evaluate children with suspected diabetes.

Clinicians should identify hypertension, dyslipidemias and other conditions that add to the long-term cardiovascular risks conferred by obesity (Axelsen et al.,

1995:449; Nilsson et al., 1995:557). Cardiovascular disease, hypertension, or dyslipidemias in siblings, parents, aunts, uncles, and grandparents indicate increased risk for the child. Blood pressure should be measured with a cuff of an appropriate size to avoid overestimation of hypertension. Also, lipoprotein profile will uncover dyslipidemias. Hypertension and dyslipidemias may respond to successful weight control.

2.7 EVALUATION FOR TREATMENT

2.7.1 READINESS TO MAKE CHANGES

Importantly, a weight program for a parent or child who is not ready to change may be not only futile but also harmful because an unsuccessful program may diminish the child's self-esteem and impair future efforts to improve weight. If a younger child is not ready for change, the parent who is ready can modify diet and activity successful. Families who are not ready to change may express a lack of concern about the child's obesity or believe the obesity is inevitable and cannot be changed, or are not interested in modification of activity or eating. Depending on the severity of the obesity, families who are not ready for change may benefit from counseling to improve motivation or from deferral of obesity therapy until they are ready. A practical way to address readiness is to ask all members of the family how concerned they are about the patient's weight, whether they believe weight loss is possible, and what practices need to be changed (Epstein et al., 1990:2519).

2.7.2 DIET HISTORY

A child's dietary intake is one of the most important assessments to be done before treatment starts. It identifies the child's eating habits as well as food and patterns of eating that may lead to excessive caloric intake. Families can describe the meals and snacks in a typical day and estimate daily or weekly consumption of high-calorie and high-fat foods, such as chips, granola bars,

cookies and desserts, and high-calorie liquids, such as soda, juice, and whole milk.

Furthermore, meals prepared outside the home may be important sources of high-calorie eating, whether they are from “take-out” or “fast food” restaurants, at school or day care facilities, or with grandparents or other caregivers. When families eat at restaurants, parents may exert less control over food choice than they do at home. For younger children, extended family or caregivers other than the parents may be responsible for supervision of some meals or snacks and should be identified and involved in treatment.

Periods of unsupervised eating, especially after school, may also be a time of high-calorie consumption. For adolescents, social activities may revolve around meals and snacks consumed outside the home. A clinical dietitian should obtain the diet history when the primary care provider lacks time or has limited skills in dietary assessment (Barlow and Dietz, 1998:223).

2.7.3 PHYSICAL ACTIVITY HISTORY

Epstein et al. (1995:109) suggests that a careful history of physical activity will uncover opportunities to increase energy expenditure. This assessment should quantify not only vigorous activity, such as organized sports and school-based physical education, but also activities in daily living, such as walking to school or to the bus stop, unorganized outdoor play, yard work, and household chores. Time spent in sedentary behavior, such as television-viewing, should also be estimated. Clinicians should recognize deterrents to activity, including unsafe neighbourhoods and lack of adult supervision after school. Identification of caregivers other than parents who may be responsible for supervision of the child’s activity will allow the development of alliances with them. Such alliances may improve the success of treatment recommendations.

2.8 GOALS OF TREATMENT

The most successful weight reduction programs are those that combine diet and exercise within a framework of behavior modification (Williams et al., 1997:225). However, limited information is available about the use of aggressive treatment such as drugs and surgery for children, although such treatments are generally discouraged at that age. Evaluation of obese children and adolescents should include assessment of weight for height and body fatness; rule out endocrine and genetic causes, and evaluate other risk factors, such as those for cardiovascular diseases, cancer, diabetes, orthopedic disorders, and psychological problems.

Treatment of obesity is most successful if realistic goals are set; a balanced diet is emphasized; a safe rate of weight loss of about 0.5 kg a week is achieved through moderate reduction of energy intake (about 20-25% decrease); increased physical activity is emphasized as much as diet; parental support is strong and behavior therapy is provided to help both child and parents achieve the diet, exercise and behavior goals (Frühbeck, 2000:328).

2.8.1 BEHAVIOR GOALS

The primary goal of a program to manage uncomplicated obesity is healthy eating and activity, not achievement of ideal body weight. To this end, the program should emphasize the skill necessary to change behavior and to maintain those changes. Skills that families should learn include:

1. Development of awareness of current eating habits, activity, and parenting behavior;
2. Identification of problem behavior. Clinicians can help identify specific high calorie foods or eating patterns and obstacles to activity;
3. Modification of current behavior. Specifically, families should learn to make a few small, permanent changes at a time and make additional changes only after the previous changes are firmly in place;

4. Continued awareness of behavior and recognition of problems that arise as the child becomes more independent, as family schedules change, or as other changes occur that alter the initial treatment plan (Barlow and Dietz, 1998:227).

2.8.2 MEDICAL GOALS

Barlow and Dietz (1998:226) suggest that for children with a secondary complication of obesity, improvement or resolution of the complication is an important medical goal. Such an improvement is a concrete benefit of the new behavior that can reinforce psychologically the changes the patient has made. Abnormal blood pressure or lipid profile may improve with weight control, and assessment during follow-up visits of these parameters, if abnormal at baseline, and of weight-related symptoms such as exercise intolerance, will remind the family that weight control leads to overall well-being even if the child does not approach ideal body weight.

2.8.3 WEIGHT GOALS

The first step in weight control for all overweight children older that two years should be the maintenance of baseline weight. This can be achieved through modest changes in the diet and activity. Initial success can be the foundation for future changes.

Therefore, prolonged weight maintenance, which allows a gradual decline in Body Mass Index as a child grows in height, is a sufficient goal for many children. For children younger than seven years, prolonged weight maintenance is an appropriate goal in the absence of any secondary complications of obesity, such as mild hypertension or dyslipidemia. However, children in this age group with secondary complications of obesity may benefit from weight loss if their Body Mass Index is at the 95^{th} percentile or higher. For children older than seven years, prolonged weight maintenance is an appropriate goal if their Body Mass Index is between the 85^{th} and 95^{th} percentile and if they have no secondary

complications of obesity. Weight loss is however recommended for children in this age group with a Body Mass Index between the 85th and 95th percentile who have a nonacute secondary complication of obesity and for children in this age group with a Body Mass Index at the 95th percentile or above.

The families of these children should first demonstrate that they can maintain the child's weight, and then clinicians should recommend additional changes in eating and activity to achieve weight loss. An appropriate weight goal for all obese children is a Body Mass Index below the 85th percentile, although such a goal should be secondary to the primary goal of healthy eating and activity (Epstein et al., 1984:430).

2.9 TREATMENT

According to Epstein et al. (1990:2519), childhood obesity programs can lead to sustained weight loss when treatment focuses on behavior changes and is family based. Therefore the following general approach is recommended:

1. Intervention should begin early. Clinicians should initiate the treatment suggestions described below when children older than three years become overweight. The risk of persistent obesity increase with the age of the child (Whitaker et al., 1997:871).
2. The family must be ready for change. The lack of readiness would probably lead to failure, which will frustrate the family and perhaps prevent future weight-control efforts. When the family believes that obesity is inevitable or resists effort to modify activity or meals, deferral of treatment is recommended until the family is ready.
3. Clinicians should educate families about medical complications of obesity. The child and family should understand the long-term risk of obesity, including hypertension, high cholesterol, heart disease, and diabetes. Family history of these disorders will identify children at particular risk and

may help motivate the parents to try and prevent these problems in the child.

4. Clinicians should involve the family and all caregivers in the treatment program. If the child is the only family member who changes eating habits or who must exercise, the child may feel deprived, or resentful, and relapse is more likely. Furthermore, regular caregivers who do not participate in the changes may undermine the treatment program. Involvement of the entire family and all caregivers will create new family behavior consistent with the child's new eating and activity goals. Such environmental change will be essential to the long-term success of the treatment (Brownell et al., 1983:515; Israel and Shapiro, 1985:449).
5. Moreover, treatment programs should institute permanent changes, not short-term diets or exercise programs aimed at rapid weight loss. Methodic, gradual, long-term changes will be more successful than multiple, frequent changes.
6. As part of the treatment program, a family should learn to monitor eating and activity. Monitoring ensures that change has occurred and is maintained. Hence, this skill is the first step in independent problem solving. Common problems identified by monitoring are "saboteurs" (people who interfere with the changes the family is making), food consumption outside the home, lack of time for physical activity and food preparation, and identification of safe environments for activity.
7. The treatment program should help the family make small, gradual changes and clinicians should recommend two or three specific changes in diet or activity at a time and recommend additional steps only after the child and family have mastered these changes. The clinicians should emphasize the problem and the lack of a "quick fix".
8. Clinicians should encourage and empathize and not criticize. Clinicians promote continued efforts to improve eating and activity when they emphasize successful behavior changes rather than weight changes.

Clinicians who are sensitive and not critical about “failure” are in a position to help families try again.

2.9.1 PARENTING SKILLS

As parents and caregivers institute the changes needed for successful treatment of obesity, they need support and guidance in basic parenting skills. Clinicians should emphasize the following principles in the management of eating and activity behavior.

1. Find reasons to praise the child’s behavior. Remind the parents that although children’s *behavior* can be good or bad, children are always good. Therefore, praise and correction should focus on the child’s behavior, not on the child.
2. Never use food as a reward. Instead, activity and time with parents should reward desired behavior.
3. Parents can ask for “rewards” from children in exchange for the changes in their own behavior, such as increasing time with the child or modifying activity and meals. For example, children could agree to allow parents to sleep late to reward parents for playing soccer with them.
4. Establish daily family meal and snack times.
5. Parents or caregivers should determine what food is offered and when, and the child should decide whether to eat.
6. Offer only healthy options. Parents can ask the child to choose between an apple and popcorn for a snack, not an apple or a cookie, or ask the child to choose between playing outside and going to the park rather than to choose between playing outside and watching television. When children can choose, they are less likely to view the alternative they select as unattractive.
7. Remove temptations. Parents can control food that is purchased and limit or eliminate high-fat or high-sugar foods.

8. Be a role model. Parents should improve their own eating habits and level of activity.
9. Be consistent. Inconsistent acquiescence may reinforce undesirable behavior even more than no limits.
10. Clinicians should assess parental mastery of these skills during follow-up visits. This may prevent the development of obesity (Barlow and Dietz, 1998:228).

2.9.2 INCREASE ACTIVITY LEVEL

Furthermore, children and adults should be more active, not only for weight control, but also for general health and well-being. Most preadolescent children find periods of defined exercise (aerobic classes or videos, stationary bicycles or treadmills) boring or punitive. Children who are active as part of their daily routine are more likely to continue the activity (American Academy of Pediatrics, 1995:786).

Epstein et al. (1995:109) suggests that several approaches may increase activity. The simplest is reduction of inactivity. The American Academy of Pediatrics has recommended limitation of television to one or two hours per day. Such limitations of television, video games, and computer games will compel children to choose other pastimes, most of which will generate more physical activity and may lead to improved weight.

Also, incorporation of activity into usual daily routines is another simple way to increase activity and improve weight (Epstein et al., 1984:429). Many children can walk to school instead of ride, or play with a friend in the afternoon instead of talking on the telephone. However, clinicians should help families address safety issues. Some solutions to safety problems may have hidden benefits. For instance, when the parent walks the child to school several times a week, the child is safe, the parent benefit from the activity, and the parent and child will enjoy some time together.

The family can add more vigorous activity gradually. At least 30 minutes of activity on most days is a goal that most families can achieve. For young children, unstructured outdoor play with friends is often vigorous. Some children enjoy organized sports. However, the child must be active in the sport, not sitting on the bench. Parents, especially those of younger children, can seek teams whose coaches emphasize participation over winning. Swimming, dance, and martial arts may appeal to children who dislike team sports. Basketball, walking, and biking with parents or siblings are all enjoyable and inexpensive activities. Clinicians should advocate for good school-based activity programs in their communities and can urge parents to be advocates as well (Barlow and Dietz, 1998:230).

2.9.3 REDUCE CALORIE INTAKE

The key is that the dietary goals for children and their families are well-balanced, healthy meals and a healthy approach to eating. These changes should be considered permanent rather than a temporary eating plan for rapid weight loss. The most helpful guide to healthy eating is the Food Guide Pyramid. Counting calories is tedious, difficult, and inaccurate (Bandini et al., 1990:421). Other strategies are easier and therefore more likely to succeed. Reduction or elimination of specific foods may reduce calories without making patients feel hungry or deprived. For example, the clinician and family can eliminate from the diet one or two high-calorie foods, such as chips, ice cream, or fried foods, or they can replace all but one glass of juice a day with water. A clinical dietitian can work with families to identify high-calorie eating habits and to guide the families as they make changes. Families may be encouraged by the recognition that modest caloric deficits can lead to significant weight loss over time. A 420 kilojoules deficit per day could lead to a 4.54 kg weight loss over one year.

Another approach, the “stoplight diet,” does not forbid any foods but instead stresses an appropriate balance of high-, medium-, and low-calorie foods. In this diet, “green light” foods contain 20 less calories per average serving than

standard food in that group, “yellow light” foods contain not > 20 calories above the standard for food in that group, and “red light” foods contain > 20 calories above the standard for food in that group and should be eaten infrequently (Epstein and Squires, 1988).

As outlined above, changes in diet are more likely to be achieved if the clinician involves the entire family; recommends one or two small changes at a time; teaches problem solving, especially how to handle eating outside of the home and saboteurs; and follows the family closely.

2.10 SIDE EFFECTS OF TREATMENT

2.10.1 POSITIVE PHYSIOLOGICAL SIDE EFFECTS

Besides the overtly obvious goal of a decrease in percentage of overweight or over fat, treatment goals for pediatric obesity should include improvement in other physiological parameters such as blood pressure, serum lipids, and insulin resistance (Epstein et al., 1998:554).

Research has found that after treatment that has produce significant decrease in body fat, percent of overweight, or weight, children demonstrated a significant decrease in systolic and diastolic blood pressure (Coates et al., 1982:175; Brownell et al., 1983:515; Figueroa-Colon et al., 1993:160). A change in serum lipids also has been documented as a positive outcome in the comprehensive treatment of pediatric obesity (Coates et al., 1982:175; Epstein et al., 1989:454; Wadden et al., 1990:345; Endo et al., 1992:303; Grugni et al., 1993:71; Knip and Nuutinen, 1993:490).

For children, significant reductions in fasting serum cholesterol and triglycerides and significant increase in high-density lipoprotein (HDL) serum cholesterol have been found after comprehensive treatment, with serum HDL levels remaining

significantly higher than baseline levels at 5 year follow-up (Epstein et al., 1989:455; Endo et al., 1992:303; Knip and Nuutinen, 1993:490). Epstein et al. (1989:454) reported that at 5-year follow-up, changes in relative weight and fitness were significantly associated with change in HDL levels. On the other hand, Sasaki et al. (1987:339) found that a long-term aerobic exercise program, which resulted in significant decreases in body fat in children, resulted in significant increases in HDL concentrations. In addition, dietary treatments have been associated with significant reductions in fasting serum cholesterol, triglycerides and low-density lipoproteins (Zwiauer et al., 1989:192; Fanari et al., 1993:487).

Other improvements in the metabolic profile of obese children have been documented after treatment. Investigators have reported a decrease in fasting serum insulin levels after comprehensive treatment for obese children and adolescents (Knip and Nuutinen, 1993:490; Rocchini et al., 1987:267). At 5 year follow-up, insulin levels were not significantly different from levels at baseline, but occurrence of hyperinsulinaemia had decreased, and a significant negative correlation was found between serum insulin levels at the end of treatment and a decrease in relative weight over the follow-up (Knip and Nuutinen, 1993:490).

Also, Hoffman et al. (1995:17) reported significant increases in mean insulin sensitivity when obese children treated with an energy-reduced diet showed significant reductions in body weight, but Gutlin et al. (1996:19) found no significant changes in fasting insulin after weight change (Epstein et al., 1998:554).

2.10.2 PSYCHOLOGICAL BENEFITS OF WEIGHT REDUCTION

Obese children seeking treatment often experience psychological comorbidity, (Emery et al., 1983:398; Israel and Shapiro, 1985:449; Martin et al.,1988:879; Epstein et al., 1994:509; Tershakovec et al., 1994:323), and obesity treatment may improve their psychological status. There has been considerable research

on self-esteem (French et al., 1995:479; Friedman and Brownell, 1995:3) and psychopathology in obese children. Moreover, there has been some debate about whether psychological problems cause obesity or are caused by obesity and whether the prevalence of psychological problems is greater in obese than in non-obese children and adolescents.

Most of the research in this area has targeted self-esteem. Although self-esteem may change during some interventions, this change is not consistently associated with a decrease in the percentage of overweight. For example, in school-based interventions designed for pre-pubertal children, increases in self-esteem occurred in the absence of weight change (Sherman et al., 1992:183), and equivalent improvements in self-esteem were demonstrated for both experimental and control groups (Foster et al., 1985:538). Wadden et al. (1990:345) found significant increases in self-esteem and decreases in depression in black girls; however, consistent with other studies, no relationship was found between self-esteem or depression and changes in weight (Rohrbacher, 1973:150; Stoner and Fiorillo, 1976:30). Furthermore, studies of adolescents have demonstrated equivalent increases in self-esteem for both treatment and control groups (Mellin et al., 1987:333) as well as no increase in self-esteem during treatment. Research to date suggests that improvement in self-esteem in obese children in treatment may be better accounted for by non-specific treatment effects than by improvement in weight status.

However, Uzark et al. (1988:185) found that parent and child psychological problems may influence treatment outcome. Also, Epstein et al. (1994:509) demonstrated that parental distress had a negative effect on the child's weight loss during the treatment phase, which were mediated by their child's level of anxiety and depression. At 2 year follow-up, parental distress affected child weight change through effects on the child's social problems; children who had greater social problems had less successful treatment. Obesity treatment may also influence child psychological changes. In a 16 week family-based

behavioral treatment program, studies showed an improvement in child behavior checklist (Achenbach, 1991) values at one year, with the greatest decrease shown for social problems. Significant reduction has been observed for anxiety and depression, withdrawn behavior, attention problems, and somatic complaints. The broad band internalizing and total-problems scales also show significant improvements. More importantly, the improvement in weight status from baseline to one year is associated with improvement in psychosocial functioning, with significant positive correlations between weight loss and social problems, somatic complaints, and total problems (Epstein et al., 1998:560).

2.10.3 NEGATIVE PHYSIOLOGICAL EFFECTS OF TREATMENT

Unfortunately, with any dietary intervention that reduces energy and consequential macro- and micronutrient intake during a period of growth, there is a potential of impairing linear growth. Growth failure has been reported in the overzealous treatment of hypercholesterolemia in children because of inadequate energy, fat, and micronutrient intake (Lifshitz and Moses, 1989:537), and investigators (Craighead et al., 1981:1124; Figueroa-Colon et al., 1993:160) have reported significant reductions in height velocity during interventions with obese children.

Amador et al. (1990:73) found that a more restrictive energy intake (0.17 instead of 0.25 MJ/kg) prescribed to children in the early stages of puberty produced significantly less height gains in the children during a six month treatment; there was no significant difference in height gain between the two groups from baseline to twelve month measures.

Also, increases in lean body mass were lower in the more restricted energy group than in less restricted energy intake group, both after treatment and from baseline to twelve month measures (Amador et al., 1990:73). Positive growth velocity z scores in children also have been documented after the children were treated for obesity (Figueroa-Colon et al., 1996:419).

However, these changes in growth velocity must be interpreted within the context that obese children experience an earlier growth spurt than their non-obese counterparts (Garn et al., 1974:447), thus, obese children may naturally undergo a deceleration in height velocity later in development (Epstein et al., 1993:1076). This hypothesis reconciles the data that children with earlier growth spurts are not taller as adults than children who mature later (Lindgren, 1978:253; Abraham and Johnson, 1980:364).

2.11 PREVENTION OF CHILDHOOD OBESITY

In approaching childhood obesity, we can consider three levels of prevention:

1. Primordial prevention, which aims towards maintaining normal Body Mass Index throughout childhood and adolescence.
2. Primary prevention, directed towards preventing overweight children (BMI : 85^{th} to 95^{th} percentiles) from becoming obese and
3. Secondary prevention, to treat obese children (BMI > 95%) to reduce comorbidities and reverse overweight and obesity, if possible (Williams, 2001:200).

Clearly, there is a need to balance energy intake with energy output and to introduce activity in place of inactivity. In obesity prevention, an emphasis on plant-based foods and vegetable and fruit consumption would be a major step forward in avoiding energy dense foods.

At different stages of development, the following is suggested in the prevention of obesity:

Perinatal:

Supply good prenatal nutrition and health care, avoid excessive maternal weight increase, control diabetes, help mothers lose weight postpartum, and offer nutrition education.

Infancy:

Encourage increased breastfeeding and continuous breastfeeding to > 6 months of age, delay introduction of solid foods until after six months of age, provide a balanced diet and avoid excess high-calorie snacks, and follow weight increase closely.

Preschool:

Provide early experiences with foods and flavors, help develop healthy food preferences, encourage appropriate parental feeding practices, monitoring of weight increases to prevent early adiposity rebound, and provide child and parent with nutrition education.

Childhood:

Monitor weight increase for height (slow down if excessive), avoid excessive prepubertal adiposity, supply nutrition education, and encourage daily physical activity.

Adolescence:

Prevent excess weight increase after growth spurt, maintain healthy nutrition as the next generation of parents, and continue daily physical activity.

For children who are significantly overweight, the goal should be to reduce severity of obesity and to treat, reduce, and eliminate comorbidities (e.g. hypertension, dyslipidemia, insulin resistance, and type 2 diabetes). For energy balance, measures are needed for children to lose weight or to slow down the rate of gain and to grow into their expected heights. This requires some reduction in energy intake and substantial increases in energy expenditure (Deckelbaum and Williams, 2001:5).

2.12 CONCLUSION

As we've seen, the obesity epidemic is rising year after year. Luckily, some causes of obesity are modifiable. As obesity has many complications associated with it, it is important that obesity should be identified as soon as possible and treated effectively. However, everyone involved with an obese child must take hands in the treatment to make a success of it.

CHAPTER 3

MOTOR DEVELOPMENT AND MOTOR PROFICIENCY

3.1 INTRODUCTION

When one looks at the different definitions of motor development and motor proficiency, one can see that there is a definite correlation. Motor development contributes to one's level of motor proficiency. Without proper motor development, motor proficiency will be insufficient because motor development involves continuous adaptation to changes in one's movement capabilities in the never ending effort to achieve and maintain motor control and motor proficiency (Winnick, 2000:266).

Therefore, one can assume that the factors that influence motor development will also have a direct effect on motor proficiency.

3.2 MOTOR DEVELOPMENT

Motor development is progressive change in motor behavior throughout the life cycle. It may be studied both as a process and as a product. As a process, motor development involves the underlying biological, environmental, and task demands influencing both the motor performance and motor proficiency of the individuals from infancy through old age. As a product, motor development may be regarded as descriptive or normative and is typically viewed in stages - infancy, childhood, adolescence, adulthood and old age (Gallahue and Ozmun, 1998:20).

The terms motor pattern, fundamental motor pattern, motor skill, and perceptual-motor skill all refer to the underlying sensory, integrative, and decision-making process that precedes the performance of an observable movement and

therefore the proficiency of the movement. Perception and cognition are important variables because they influence underlying motor processes. Underlying motor processes are involved in the performance of all voluntary movement (Gallahue and Ozmun, 1998:16). According to Haywood and Getchell (2001:5), motor development is the sequential, continuous age-related process whereby movement behavior changes.

Also, motor development is defined as progressive change in motor behavior throughout the life cycle, brought about by interaction among the requirements of the task, the biology of the individual and the conditions of the environment by Gallahue and Ozmun (1998:3).

3.3 MOTOR PROFICIENCY

Saakslahti et al. (1999:327) state that motor proficiency is a person's level of proficiency in performing particular motor skills.

Childhood forms a unique period where children undergo significant social, intellectual, emotional, and physical development. Enhancement of motor proficiency is believed to play an important role in the development of children within the physical domain, with potential carry-over into the social and cognitive domains (Gabbard, 1988:66). Body management activities, manipulation opportunities with a variety of equipment, and both locomotor and non-locomotor activities should form the basis of a young child's school movement experience.

According to Harris (2000:19) children in later childhood are at various stages of cognitive, emotional, social, and motor skill development (See chapter 3 – 3.6). They may not understand the meaning of competition and teamwork. They may lack the cognitive skills to grasp strategies, make rapid decisions, and visualize spatial relationships. Like the development milestones of infancy, such as rolling over, sitting up, crawling and walking, most of the fundamental motor skills (e.g. running, galloping, jumping, hopping, skipping, throwing, catching, striking,

kicking) required for physical activity are acquired in the same sequence. Motor proficiency acquisition appears to be an innate process, independent of the child's sex, age, size, weight, strength, abilities, and level of physical maturity. As with other developmental milestones, the rate at which children master motor proficiency skills varies considerably.

Motor proficiency is determined by fundamental motor skills and transitional motor skills (See Chapter 3 – 3.6.1 – 3.6.2). Fundamental motor skills are basic movements that can be adapted to combined and refined; serving to provide a foundation from which more complicated skills can be established and later applied to lifetime sporting, recreational, and physical activities (Carson, 1994:51; Gallahue and Ozmun, 1998:233). Although children can acquire and refine fundamental motor skills faster by early instruction and practise, they are unlikely to do so until they are developmentally ready. Children usually acquire fundamental motor skills at a basic level through play; however, children need instruction and practise to fully develop these skills and improve motor proficiency (Temple and O'Connor, 2000).

Each fundamental motor skill is characterized by a series of developmental stages (See chapter 3 – 3.6.1.1 – 3.6.1.3). Failure to achieve progression through all of the stages can limit proficiency in physical activities that require fully developed fundamental motor skills. Because success is a strong predictor of motivation to participate and persist in sport, it is essential that young children be provided with opportunities to establish appropriate motor proficiency skill competencies at an early age (Walkley et al., 1993:11; Weiss and Ebbeck, 1996; Weiss, 2000:4). Without those competencies children are less likely to participate in physical activity as they get older. Okley et al. (2001:1899) found fundamental motor skill proficiency, among other things, to be significantly associated with the child's participation in organized physical activity.

Specialized motor skills are fundamental motor skills performed in various combinations and with variations (e.g. throwing for distance, throwing for accuracy (See Chapter 3 – 3.6.2). Specialized motor skills are required to participate in entry-level organized sports. Early in this developmental period, children's vision is almost mature, but it is still difficult for them to tell the direction in which a moving object is moving. Balance becomes more automatic and reaction times become quicker. With improved specialized motor skills, children are able to master complex motor skills and improve motor proficiency (e.g. those required for playing more complex sports such as football or basketball) (Harris, 2000:19).

However, motor proficiency development is difficult for some children. Health professionals need to assess these children to determine whether their difficulties are caused by a developmental delay or a health problem. In some cases, poor motor proficiency development is the result of developmental coordination disorder (DCD) (Harris, 2000:19).

In this study, the Bruininks-Oseretsky test was used to determine the motor proficiency of the children. Table 6 includes the norms for motor proficiency according to the child's point score attained in the 8 separate motor tests. Age was used to determine these norms.

The complete battery – eight subtests comprised of 46 separate items – provides a comprehensive index of motor proficiency as well as separate measures of both gross and fine motor skills. Table 7 shows the norms for the Gross Motor Composite, Fine Motor Composite, and the Battery Composite according to age.

Table 6: Norms of subtests point scores by age (Bruininks, 1978:26)

AGE GROUP	Running Speed and Agility	Balance	Bilateral Coordination	Strength	Upper-Limb coordination	Response Speed	Visual Motor Control	Upper-Limb Speed and Dexterity
8	8.3	23.5	8.8	15.0	15.3	7.0	17.6	34.6
9	9.0	24.5	10.7	17.5	16.9	7.8	19.4	38.3
10	9.6	25.7	11.4	21.0	17.5	9.4	20.1	43.2
11	10.4	26.1	12.4	22.2	18.2	9.6	20.4	45.8

Table 7: Norms of the sum of subtest standard scores for gross motor, fine motor, and battery composite scores by age (Bruininks, 1978:27)

	Sum of Subtest Standard Scores		
AGE GROUP	GROSS MOTOR COMPOSITE (Subtest 1-4)	FINE MOTOR COMPOSITE (Subtest 6-8)	BATTERY COMPOSITE (Subtest 1-8)
	Mean	Mean	Mean
8	59.3	43.6	117.9
9	60.8	45.2	120.9
10	61.0	45.1	120.9
11	60.2	44.5	119.8

3.4 FACTORS AFFECTING MOTOR DEVELOPMENT AND MOTOR PROFICIENCY

Development brings about change in one's functional capabilities and motor proficiency. We generally view development in children as an upward process leading toward increased capabilities. Development as a lifelong process, however, also encompasses the diminishing of capabilities in chronically ill children as well as the gradual regression in motor proficiency with advancing age. The process of motor development depends on a variety of developmental factors. As children develop, gradual shifts or increments in the level of functioning occur in the stability, locomotor, and manipulative categories of movement behavior and motor proficiency. Furthermore, during infancy, children gain the very simplest controls over their movements in order to survive at the lowest level of motor functioning. Preschool and primary grade children are involved in developing and refining their fundamental movement skills. The unique inheritance that accounts for our individuality can also account for our similarity in many areas. One of the similarities is the trend for human development to proceed in an orderly, predictable fashion. A number of factors that affect motor development and motor proficiency tend to emerge from this predictable pattern (Gallahue and Donnelly, 2005:38).

3.4.1 FACTORS WITHIN THE INDIVIDUAL

3.4.1.1 RATE OF GROWTH

One's growth rate follows a characteristic pattern that is universal for all and resistant to external influences. Also, a minor interruption of the normal pace of growth is compensated for by a still unexplained process of self-regulatory fluctuation that enables a child to catch up to his age-mates. For example, a severe illness may retard a child's normal gains in height, weight, and movement ability, but upon recovery there will be a tendency to catch up (Gesell, 1954:340).

However, the same phenomenon is seen with low birth weight infants. Despite low weight at birth, most of these babies catch up to the characteristic growth rates of their age-mates in a few years. Conditions surrounding the causes of low birth weight, such as inadequate nutrition, must not persist. Importantly, appropriate intervention must occur early on for this catch-up process to fully manifest itself in the growing infant. Measures of height, weight, and motor development taken prior to age two are generally meaningless for predicting later growth and development (Malina and Bouchard, 1991:24).

It should be noted that the self-regulatory process of growth will compensate for minor deviations in the growth pattern, but it is frequently unable to make up for major deviations especially during infancy and childhood. For example, low birth weight infants under 1.36 kg, and children experiencing severe and prolonged nutritional deficiencies, frequently suffer permanent deficits in height and weight, as well as in their cognitive, motor development, and motor proficiency (Gallahue and Ozmun, 1998:52).

Furthermore, restricted opportunities for movement and deprivation of experience have been shown repeatedly to interfere with children's abilities to perform movement tasks that are characteristic of their age levels. The effects of sensory and motor experience deprivation can sometimes be overcome when nearly optimal conditions are established for a child. The extent to which the child will be able to catch up to his or her peers, however, depends on the duration and severity of deprivation, the age of the child, and the child's individual genetic growth potential (McGraw, 1939:10).

3.4.1.2 RECIPROCAL INTERWEAVING

The coordinated and progressive intricate interweaving of neural mechanisms of opposing muscle systems into an increasingly mature relationship is characteristic of the developing child's motor behavior. According to Gesell (1954:340), there are two different but related processes associated with this

increase of functional complexity and therefore motor proficiency: *differentiation and integration.*

Differentiation is associated with the gradual progression from the gross overall movement patterns of infants to the more refined and functional movements of children and adolescents. For example, the manipulative behavior of the newborn in terms of reaching, grasping, and releasing objects are quite poor. There is little control of movement, but as the child develops the control improves. The child is able to differentiate among various muscle groups and begins to establish control. Control continues to improve with practise until we see the precise movements of cursive writing, cutting with scissors, block building, etc. (Gesell, 1954:342).

Integration, on the other hand, refers to bringing various opposing muscle and sensory systems into coordinated interaction with one another. For example, the young child gradually progress from ill-defined aiming movements when attempting to grasp an object to more mature and visually guided reaching and grasping behaviors. The differentiation of movements of the arms, hands, and fingers, followed by the integration of the use of the eyes with the movements of the hand to perform eye-hand coordination tasks, is crucial to normal development (Gesell, 1954:342).

However, differentiation and integration tend to be reversible with aging. As one ages and motor proficiency begins to regress the coordinated interaction of sensory and motor mechanisms frequently becomes inhibited. The extent to which one's coordinated movement abilities regress is not merely a function of age, but is influenced greatly by activity levels and attitude. There is little doubt that differentiation and integration operate simultaneously. The complex abilities of the adult cannot be explained merely in terms of a process of integration of simpler responses. What occurs, instead, is a constant interlacing of both differentiation and integration (Gesell, 1954:342).

3.4.1.3 READINESS

Magill (1993) defines readiness as conditions within a task, an individual, and the environment that make mastery of a particular task appropriate. The concept of readiness extends beyond biological maturation and includes consideration of factors that can be modified or manipulated to encourage or promote learning. Several related factors combine to promote readiness. This includes physical and mental maturation, interacting with motivation, prerequisite learning, and an enriching environment. At this juncture we simply do not know how to pinpoint exactly when someone is ready to learn a new movement skill. However, research suggests that early experience in a movement activity before the individual is ready is likely to have minimal benefits.

Recently, a great deal of attention has been focused on developing reading readiness through appropriate types of preschool and primary grade experiences. Entire educational programs have been built around the notion that children must achieve a certain level of development before they are ready to pursue intellectual tasks such as reading and writing, as well as motor proficiency tasks involving locomotion, manipulation, and stability. Readiness training is a part of many preschool and primary grade educational programs. An integral part of these readiness programs has been the use of movement as a means of enhancing basic perceptual-motor qualities. Although it has not been conclusively documented that perceptual-motor experiences have a direct effect on the attainment of specific cognitive readiness skills, it is safe to assume that they have at least an indirect influence because they encourage a child's self-esteem and a positive "Yes I can" approach to learning (Bredenkamp, 1987).

3.4.1.4 CRITICAL AND SENSITIVE LEARNING PERIODS

The concept of critical and sensitive learning periods is closely aligned to readiness and revolves around the observation that there are certain time frames in which an individual is more sensitive to certain kinds of stimulation. Normal development in later periods may be hindered if a child fails to receive the proper

stimulation during a critical period. For example, inadequate nutrition, prolonged stress, inconsistent mothering, or a lack of appropriate learning experiences may have a more negative impact on development if they occur early in life rather than at a later age. The concept of critical periods has a positive side. It suggests that appropriate intervention during a specific period tends to facilitate more positive forms of development at later stages than if the same intervention occurs at another time (Gallahue and Ozmun, 1998:54).

However, one should recognize that the tendency of a child to follow a critical period pattern is closely linked to the theory of developmental tasks and to a lesser degree linked to the milestone and phase-stage views. It is safe to assume that there are sensitive periods or broad time frames for development. The point to be made is that critical or sensitive periods should not be too narrowly defined. Failure to account for individual differences and for special environmental circumstances will lead one to conclude that a sensitive period is a universal point in time. Instead, a notion of sensitive periods as broad, general guidelines susceptible to modification should be adopted. Learning is a phenomenon that continues throughout life. As scientists learn more about the aging brain and the aging motor system, they continually demonstrate this important concept. Learning can be a lifelong process, and the effects of aging can be slowed and reduced through continual use of the brain and motor system (Hinton, 1992:144).

3.4.1.5 INDIVIDUAL DIFFERENCES

Indeed, the tendency to exhibit individual differences is crucial. Each person is a unique individual with his or her own timetable for development. This timetable is a combination of a particular individual's heredity and environment. Although the sequence of appearance of developmental characteristics is predictable, the rate of appearance may be quite variable. Therefore, strict adherence to a chronological classification of development by age is without support or justification (Westman, 1973).

The “average” ages for the acquisition of all sorts of developmental tasks, ranging from learning how to walk (the major developmental task of infancy), to gaining bowel and bladder control (the first restrictions of a civilized society on the child) have been bandied about in the professional literature and the daily conversation of parents and teachers for years. It must be remembered that these average ages are just that and nothing more. They are mere approximation that serves as convenient indicators of developmentally appropriate behavior. It is common to see deviations from the mean of as much as six months to one year in the appearance of numerous movement skills. The tendency to exhibit individual differences is closely linked to the concept of readiness and helps to explain why some individuals are ready to learn new skills when others are not (Westman, 1973).

3.4.1.6 PHYLOGENY AND ONTOGENY

Many of the rudimentary abilities of the infant and the fundamental movement abilities of the young child when viewed from a maturation perspective as proposed by Gesell (1954:342) are considerate to be phylogenetic; that is, they tend to appear automatically and in a predictable sequence within the maturing child. *Phylogenetic skills* are resistant to external environmental influences. Movement skills such as the rudimentary manipulative tasks of reaching, grasping, and releasing objects, the stability tasks of gaining control of the gross musculature of the body, and the fundamental locomotor abilities of walking, jumping, and running are examples of what may be viewed as phylogenetic skills (Bower, 1974).

Ontogenetic skills, on the other hand, depend primarily on learning and environmental opportunities. Such skills as swimming, bicycling and ice skating are considered ontogenetic because they do not appear automatically within individuals but require a period of practise and experience and are influenced by one’s culture. The entire concept of phylogeny and ontogeny needs to be re-

evaluated in light of the fact that many skills heretofore considered phylogenetic can be influenced by environmental interaction (Bower, 1974).

Although there may be a biological tendency for the development of certain abilities due to phylogenetic processes, it is simplistic to assume that maturation alone will account for motor development. The extent or level to which any voluntary movement ability is mastered depends, in part, on ontogeny or the environment. In other words, opportunities for practise, encouragement, instruction, and the ecology or conditions of the environment itself, contribute significantly to movement skill development and motor proficiency throughout life (Bower, 1974).

3.4.2 FACTORS IN THE ENVIRONMENT

Over the past several years considerable speculation and research has focused on the effects of parenting behavior during infancy and early childhood as this influence the subsequent functioning of children. Because of the extreme dependence of the human infant on its caregivers and because of the length of this period of dependence, a variety of parental care factors influence later development. Among the most crucial are the effects of environmental stimulation and deprivation, the temperament of the child, and the bonding that occurs between parent and child during the early days following birth (Kennell, 1974:174).

3.4.2.1 BONDING

Research by Kennell (1974:174) showed compelling evidence that there is a broad “sensitive” period in which parent-to-infant attachment occurs during the early months of post-natal life. If this sensitive period is missed, the parent and child may fail to bond. In fact, this may result in later developmental difficulties, particularly in the affective development of the child.

Bonding, in essence, is a strong emotional attachment that endures over time, distance, hardship, and desirability. Research by Robson (1967), Leifer (1963), and Kennell (1974) has shown that this emotional bond begins developing at birth and can fail to develop or be incompletely established with early separation. The leading factors contributing to initial separation are prematurity and low birth weight, which result in the incubation of the newborn; mild or severe neonatal problems at birth, and standard hospital operating procedures.

After all, early attachment between parent and child appears to influence development. One must question, however, if bonding is essential to the welfare of the child. Generations of adopted children will attest to the success of their development even though bonding with "mother" was delayed by weeks, months, or even years. Nevertheless, the reciprocal interaction between parent and child creates a mutually satisfying and rewarding relationship, the importance of which cannot be minimized. Care must be taken, however, not to define the concept of bonding too narrowly or to overemphasize its importance. Further research is necessary to clearly establish its link to the process of development and motor proficiency (Lamb, 1985).

3.4.2.2 STIMULATION AND DEPREVATION

A great deal of study has been done over the years to determine the relative effects of stimulation and deprivation on the learning of a variety of skills. In fact, there has been considerable controversy among hereditarians and environmentalists over the issue during the past 100 years. Numerous textbooks have recorded the nature versus nurture debates, but little has been settled in the attempt to categorize the effects of each on development. The current trend has been to respect the individual importance of both nature and nurture and to recognize the complex intertwined influences of maturation and experience (Gallahue and Ozmun, 1998:59).

3.4.2.3 TEMPERAMENT

Anyone who has been around young children for an extended period is quick to notice the difference in temperament (i.e. disposition) that exists. These individual differences in the responsiveness of children are probably caused by their unique environmental and experiential histories. It is interesting to note, however, that differences in temperament are observable even at birth (Osofsky and Conners, 1979).

Because temperament tends to remain consistent from birth, it will have an effect on how the parent responds to the child. The hyperactive child, the chronic crier, or the fussy child may inadvertently impair the nurturing responses of his or her caregivers. In fact, the ill-tempered child may receive less attention than the even-tempered child and, as a consequence, be slower to talk and slower to develop mature movement and socialization skills. The epidemic proportions of child abuse in our culture may be attributable, in part, to the interaction between the ill-tempered child and the parent who in stressful situations is unable to cope with such a child (Osofsky and Conners, 1979).

3.4.3 PHYSICAL TASK FACTORS

A number of additional factors affect motor development. The influence of social class (Malina and Bouchard, 1991), gender (Branta, 1987), and ethnic and cultural background (Brill, 1985) all have an impact on growth, motor development, and motor proficiency. Motor development is not a static process. It is not only the product of biological factors but is also influenced by environmental conditions and physical laws. The interaction of both environmental and biological factors modifies the course of motor development during infancy, childhood, adolescence, and adulthood. Premature birth, eating disorders, fitness levels, and biomechanical factors, as well as the physiological changes associated with aging and lifestyle choice, all impact in important ways on the lifelong process of motor development and motor proficiency (Gallahue and Ozmun, 1998:64).

3.4.3.1 PREMATURITY

The practice of labeling a newborn as premature based on gestation period or weight alone is no longer used, because it is often difficult to accurately determine the gestational age of the infant, and the highest mortality and morbidity rates are present for infants of the very lowest birth weights (Susser, 1972:197). Therefore, as a result, the terms “low birth weight” and “young-for-date” have emerged as more accurate indicators of prematurity in the true sense of the word. But prematurity is of major concern because it is closely associated with physical and mental retardation, hyperactivity, and infant death. Prevention is generally considered to be the most important factor in improving infant health and survival rates (Kopp and Kaler, 1989:226)

3.4.3.2 EATING DISORDERS

We are living in a world far different from that of our ancestors. Unfortunately, vigorous physical exertion is not a necessary part of the daily life pattern of most people. Today, most exercise, if it occurs, is planned and is not an integral part of one’s existence. In addition, most of us enjoy, for the present, an abundance of food. It is possible for an individual to consume a large amount of food and use up little of the energy contained in that food. The maintenance of body weight is relatively simple. It requires maintaining a balance between caloric intake and caloric expenditure. Of course if more calories are consumed than are burned over a period of time, obesity is the eventual result. On the other hand, if fewer calories are consumed than expended, weight loss will result over time. Weight loss caused by a long-term aversion to food (anorexia nervosa) or repeated bingeing and purging (bulimia) is of growing concern (Gallahue and Ozmun, 1998:67).

3.4.3.3 FITNESS LEVELS

It has been stated repeatedly that development does not occur in a vacuum. A wide variety of factors from all three domains of human behavior (cognitive, affective, and psychomotor) influence development, as well as factors within the

individual, the environment, and the task itself. In fact, task factors within the psychomotor domain are termed physical and mechanical factors. These factors have a profound impact on the acquisition, maintenance, and diminution of our movement abilities throughout life. Moreover, our level of physical fitness coupled with the mechanical requirements of a task greatly influences our ability to move with control, skill, and confidence. The physical development aspects of the motor domain may be divided into *health-related fitness* factors and *performance-related fitness* factors that influence motor development and motor proficiency (Henry and Rodgers, 1960:459).

Health-related fitness is generally defined in broad terms because fitness level requirements vary among individuals. Hence this form of physical fitness encompasses the health-related aspects that influence the ability to perform daily tasks at an acceptable level without undue stress. It also is a state in which ample reserves of energy are available for recreational pursuits and emergency needs. Therefore muscular strength, muscular endurance, aerobic endurance, joint flexibility, and body composition are usually considered the components of health-related fitness. On the other hand, the extent to which each of these factors is possessed will influence an individual's performance capabilities in movement. For example, how far a person can run or ride a bicycle is related to his or her level of muscular strength, muscular endurance, and aerobic endurance (Henry and Rodgers, 1960:461).

Performance-related fitness, also widely known as motor fitness, is the performance aspect of fitness. It is also an elusive concept that has been studied extensively over the past several years and is classified as part of the global concept of fitness. Motor fitness is generally thought of as one's current performance level as influenced by factors such as movement, speed, agility, balance, coordination, and power (All these aspects are tested in the Bruininks-Oseretsky test of motor proficiency). For years it is believed that motor fitness was general in nature; as a result, the term general motor ability came into

vogue. Furthermore, they assumed that if an individual excelled in a certain sport that corresponding ability would automatically carry over to other activities. Although this often occurs, it is probably due to the individual's personal motivation, numerous activity experiences, and several specific sport aptitudes, not to a transfer or carryover of skill from one activity to another. Therefore, one's motor fitness has a definite effect on the proficiency of any motor activity that requires quick reactions, speed of movement, agility and coordination of movement, explosive power, and balance (Henry and Rodgers, 1960:448).

3.4.3.4 BIOMECHANICS

Before embarking on a detailed discussion of motor development, it will be useful to review some mechanical principles of movement as they relate to stability, locomotion, and manipulation. There are numerous ways in which the human body is capable of moving. It may appear to be an impossible task to learn all of the skills involved in the performance of children's game, sport, and dance activities. But closer inspection of the total spectrum of movement will reveal, however, that fundamental mechanical laws affect all human movement. According to Gallahue and Ozmun (1998:73) three selected mechanical principles are considered:

1. Balance: (Balance is tested in the Bruininks-Oseretsky test of motor proficiency; hence the discussion). All masses that are within the gravitational pull of the earth are subjected to the force of gravity. The three primary factors of concern in the study of balance principles are: Center of gravity, line of gravity, and base of support.

A *center of gravity* exists within all objects. In geometric shapes it is located in the exact center of the object. But in asymmetrical objects (e.g. human bodies) it is constantly changing during movement. The center of our bodies always shifts in the direction of the movement or the additional weight. The center of gravity of a child standing in an erect position is approximately at the top of the hips

between the front and the back of the trunk. Therefore, activities in which the center of gravity remains in a stable position, such as standing on one foot or performing a headstand, are known as static balance activities. In addition, if the center of gravity is constantly shifting, as in jumping rope, walking, or doing a forward roll, the activities are dynamic balance movements.

The *line of gravity* is an imaginary line that extends vertically through the center of gravity to the center of the earth. The interrelationship of the center of gravity and the line of gravity to the base of support determine the degree of stability of the body.

Additionally, the *base of support* is the part of the body that comes into contact with the supporting surface. If the line of gravity falls within the base of support, the body will be in balance. If it falls outside the base, it is out of balance. The wider the base of support, the greater the stability, as can be seen when one balance on two feet rather than on one foot. The nearer the base of support to the center of gravity, the greater the stability. Someone who is standing erect may be pushed off balance more easily than someone in a lineman's stance with the feet spread and the body slightly forward. The nearer the center of gravity to the center of the base of support the greater the stability. A foot position that allows for a larger base of support in the direction of the movement gives additional stability. This principle is illustrated by the foot position of a runner who is attempting to stop or by a catcher who is trying to receive and control a heavy object (Gallahue and Ozmun, 1998:74).

2. Given Force: Force is one of the basic concepts of movement and body mechanics. Force is the instigator of all movement and may be defined as the effort that one mass exerts on another. The result may be movement, cessation of movement, or resistance of one body against another. There may be force without motion, as seen in isometric activities, but motion is impossible without the application of some form of force. Three forces relative to the human body

are of concern to us: 1. Force produced by muscles, 2. Force produced by the gravitational pull of the earth, and 3. Momentum. The entire science of force is based on Newton's three laws of motion, namely, the law of inertia, the law of acceleration, and the law of action and reaction (Gallahue and Ozmun, 1998:75).

3. Receiving Force: To stop ourselves or a moving object, we absorb force over the greatest distance possible and with the largest surface area possible. Therefore, the greater the distance over which the force is absorbed, the less the impact on whatever receives the force. This may be demonstrated by catching a ball with the arms straight out in front of the body and then catching it again with the arms bent. The same thing may be observed when landing from a jump with the legs bent as opposed to landing with the legs straight. Forces should be absorbed over as large a surface area as possible. The impact is reduced in proportion to the size of the surface area, and the likelihood of injury is diminished. For example, trying to absorb the shock of a fall with the hands and arms extended will probably result in injury because the small surface area of the hand must receive the entire impact. It is far better to let as much of the body as possible absorb the impact (Gallahue and Ozmun, 1998:77).

Separate discussion of the principles of balance, given force, and receiving forces should not be taken to mean that one is used in the absence of the others. Most of our movements combine all three. Furthermore, an element of balance is involved in almost all of our movements, and we give and receive force whenever we perform any locomotor or manipulative movement. A gymnast, for example, must maintain his or her equilibrium when performing a tumbling trick such as a front flip, and also must absorb force from the body on the landing (Gallahue and Ozmun, 1998:77).

Another important determinant of motor proficiency is the acquisition of certain movement skills, which also goes hand in hand with motor development.

3.5 THE IMPORTANCE OF DEVELOPING MOTOR SKILLS

When we look at the definition of motor proficiency by Saakslahti et al. (1999), it is important that we discuss the development of motor skills to gain a better insight into the definition.

Failure to develop and refine fundamental and specialized movement skills during the crucial preschool and elementary school years often leads children to frustration and failure during adolescence and adulthood. Failure to develop mature patterns in throwing, catching, and striking, for example, makes it difficult for children to succeed in and enjoy even a recreational game of softball. Therefore, children cannot take part, with success, in an activity if they have not been taught the essential movement skills contained within the activity (Gallahue and Donnelly, 2005:52).

This does not mean that if people don't learn skills during childhood they cannot develop them later in life, but it is easier to develop these skills during childhood. If a person does not develop the skills early, they too often remain unlearned. Several factors contribute to this situation. One is an accumulation of bad habits from improper learning. It is much more difficult to "unlearn" faulty movements than to learn to do them correctly in the first place. Self-consciousness and embarrassment are a second factor. "I have two left feet," is a self-derogatory phrase that children may use to comment on poor performance that leads to their reluctance to become active participants. A third factor is fear. Fear and anxiety about being injured and of being ridiculed by peers are very real feelings that often contribute markedly to difficulty in learning movement skills later in life. All of this means that it is crucial for children to fully develop their fundamental movement abilities and a variety of basic sport skills during childhood (Wickstrom, 1983:5).

3.6 MOVEMENT SKILLS AND MOVEMENT PATTERNS

Although often used interchangeably, the terms *movement skill, fundamental movement skill, specialized movement skill*, and *movement pattern* have important distinctions. A movement skill, which may be either a fundamental movement skill or a specialized skill, is a series of movements performed with accuracy and precision. In a movement skill, control of movement is stressed and extraneous movement is therefore limited (Gallahue and Donnelly, 2005:52).

3.6.1 FUNDAMENTAL MOVEMENT SKILLS

A ***fundamental movement skill*** is an organized series of basic movements that involve the combination of movement's patterns of two or more body segments (Wickstrom, 1983:5).

The fundamental movement abilities of childhood stem from the rudimentary movement phase of infancy. This phase of motor development represents a time in which young children are actually involved in exploring and experimenting with the movement capabilities of their bodies. It is a time of discovering how to perform a variety of stabilizing, locomotor, and manipulative movements, first in isolation and then in combination with one another. Children who are developing fundamental patterns of movement are learning how to respond with motor control and motor proficiency to a variety of stimuli. Moreover, they are gaining increased control in the performance of discreet, serial, and continuous movements as evidenced by their ability to accept changes in the task of requirements. Fundamental movement patterns are basic observable patterns of behavior. Locomotor activities such as running and jumping, manipulative activities such as throwing and catching, and stability activities such as the beam walk and one foot balance are examples of fundamental movements that should be developed during the early childhood years (these skills are all tested in the Bruininks-Oseretsky test of motor proficiency). Fundamental movement skills develop in three stages: The initial stage, the elementary stage and the mature stage.

3.6.1.1 INITIAL STAGE

In the initial stage of developing a fundamental skill children make their first observable and purposeful attempts at performing the task. This is a stage characterized by relatively crude, uncoordinated movements and poor motor proficiency. The child may make valid attempts at throwing, catching, kicking or jumping, but major components of the nature pattern are missing and movements are either grossly exaggerated or inhibited. Execution of the movement is not rhythmically coordinated. Two and three year olds typically function at the initial stage (Gallahue and Donnelly, 2005:63).

3.6.1.2 ELEMENTARY STAGE

The elementary stage of fundamental movement skill development is typical of the performance of three-to-five-year old children. The elementary stage of development appears to depend primarily on maturation. In this transitional period between the initial and mature stage, coordination and rhythmical performance improve, and children gain greater control over their movements. However, movements at this stage still appear somewhat awkward and lacking in fluidity (Gallahue and Donnelly, 2005:63).

Many adults are only at the elementary stage in such basic activities at throwing, striking, and catching. They have progressed to this stage primarily through maturation but, because of insufficient practise, encouragement and instruction, they have failed to achieve the mature stage (Gallahue and Donnelly, 2005:63).

3.6.1.3 MATURE STAGE

The mature stage of fundamental movement skill development is characterized by the integration of all the component parts of a pattern of movement into a well coordinated, mechanically correct, and efficient act with greater motor proficiency. From this stage, performance improves rapidly, for example, children are able to throw further, run faster and jump higher after attaining the mature stage. A mature fundamental skill may be continually refined, combined

with other movement skills, and utilized in a variety of specialized movements (Gallahue and Donnelly, 2005:63).

Children can attain the mature stage in most fundamental movements by age six or seven. Frequently, however, they get there at varying rates. Some experience a delay or fail to achieve the mature stage in particular skills. Others are advanced and reach this stage more rapidly. If development is delayed over a period of years, certain skills may never be attained in their mature form without considerable effort and outside influence. Failure to develop mature patterns of fundamental movement will limit children in accruing specialized sport skills in later childhood, adolescents, and adulthood. Importantly, mature fundamental movement skills form the basis of all sport skills, and they must be learned. If they are not learned, a cycle of frustration and failure results and motor proficiency will be insufficient (Gallahue and Donnelly, 2005:63).

3.6.2 THE SPECIALIZED MOVEMENT SKILL PHASE

The specialized phase of motor development stem from the fundamental movement phase. During the specialized phase, movement becomes a tool that is applied to a variety of specialized movement activities for daily living, recreation, and sport pursuits. This is a period when fundamental stability, locomotor, and manipulative skills are progressively refined, combined, and elaborated upon for use in increasingly demanding situations and therefore motor proficiency improves. The fundamental movements of hopping and jumping, for example, may now be applied to rope-jumping activities, to perform folk dances, and to performing the triple jump in track and field.

However, the onset and extent of skill development within the specialized movement phase depends on a variety of task, individual, and environmental factors. Reaction time and movement speed, coordination, body type, height and weight, customs, peer pressure and emotional makeup are but a view of these factors. There are three stages within the specialized movement phase: The

transitional stage, the application stage and the lifelong utilization stage (Gallahue and Ozmun, 1998:399).

3.6.2.1 TRANSITIONAL STAGE

Somewhere around the seventh or eighth year children commonly enter a transition movement skill stage. During the transitional period the individual begins to combine and apply fundamental movement skills to the performance of specialized skills in sport and recreational settings. Walking on a rope bridge, jumping rope, and playing kickball are examples of common transitional skills. Furthermore, transitional movement skill contains the same elements as fundamental movements with greater form, accuracy, and control. Fundamental movement skills that were developed and refined for their own sake during the previous stage are applied to play, game, and daily living situations. Transitional skills are simply applications of fundamental movement patterns in somewhat more complex and specific forms (Haubenstricker and Seefeldt, 1986).

Nonetheless, the transitional stage is an exciting time for the parent as well as the child. During this stage children are actively involved in discovering and combining numerous movement patterns and are often elated by their rapidly expending movement abilities. The goal of concerned parents, teachers, and youth sport coaches during this stage should be to help children increase their motor control, movement competence and motor proficiency in a wide variety of activities. Care must be taken not to cause the child to specialize or restrict his or her activity involvement. A narrow focus of skills during this stage is likely to have undesirable effects on the last two stages of the specialized movement phase (Haubenstricker and Seefeldt, 1986).

3.6.2.2 APPLICATION STAGE

From about age eleven to age thirteen (the middle school years) interesting changes take place in the skill development of the individual. During the previous stage the child's limited cognitive abilities, affective abilities, and

experience, combined with a natural eagerness to be active, causes the normal focus (without adult interference) on movement to be generalized to “all” activity. During the application stage, increased cognitive sophistication and a broadened experience base enable the individual to make numerous learning and participation decisions based on a variety of task, individual, and environmental factors (Haubenstricker and Seefeldt, 1986).

The individual begins to make conscious decisions for or against participation in certain activities. These decisions are based, in large measure, on how he or she perceives the extent to which factors within the task, him or her, and the environment either enhance or inhibit changes for enjoyment and success. This self-examination of strengths and weaknesses, opportunities and restrictions, narrow the choices (Gallahue and Ozmun, 1998:233).

During the application stage, the individual begins to seek out or to avoid participation in specific activities. Therefore, increased emphasis is placed on form, skill, accuracy, motor proficiency, and the quantitative aspects of movement performance. This is a time for more complex skills to be refined and used in advanced games, lead-up activities, and selected sports (Gallahue and Ozmun, 1998:233).

3.6.2.3 *LIFELONG UTILIZATION STAGE*

The lifelong utilization stage of the specialized phase of motor development begins around age fourteen and continues through adulthood. The lifelong utilization stage represents the pinnacle of the process of motor development and is characterized by the use of one’s acquired movement repertoire throughout life. The interests, competencies, and choices made during the previous stage are carried over, further refined, and applied to a lifetime of daily living, recreational, and sport-related activities. Unfortunately, factors such as available time and money, equipment and facilities, and physical and mental limitations affect this stage. Among other things, one’s level of activity

participation will depend on talent, opportunities, physical condition, and personal motivation. An individual's lifetime performance level may range anywhere from professional status and the Olympics, to intercollegiate and interscholastic competition, to participation and organized or unorganized, competitive or cooperative, recreational sports, and simple daily living skills. In essence, the lifelong utilization stage represents a culmination of all preceding stages and phases. It should, however, be viewed as a continuation of a lifetime process (Haubenstricker and Seefeldt, 1986).

3.7 CATEGORIES OF MOVEMENT INVOLVED IN MOTOR PROFICIENCY

Movement skills, whether they are fundamental movement skills or specialized movement skills, can be subdivided into categories. The three categories of movement are: stability, locomotion, and manipulation. These categories classify the intended function of one's movement (Gallahue and Ozmun, 1998:233).

3.7.1 STABILITY MOVEMENT SKILLS

Stability movement skills form the basis for all other locomotor and manipulative skills because all movement involves an element of stability. Stability movement skills, sometimes referred to as non-locomotor skills, are those in which the body remains in place but moves around its horizontal or vertical axis. In addition, there are dynamic balance tasks in which a premium is placed on gaining or maintaining one's equilibrium against the force of gravity. For example, dodging an opponent and the forward roll in tumbling are both considered stability skills, because of the strong emphasis placed in maintaining equilibrium throughout each task.

Axial movements and various static and dynamic balance postures are considered the major components of stability. Axial, or non-locomotor movements are orientation movements of the trunk or limbs while in a static

position. This includes reaching, twisting, turning, bending, and stretching, as well as lifting, carrying, pushing, and pulling. Other fundamental stability skills involve a variety of positions that entail inverted support, such as the tripod and handstand. Still others involve transitional postures, such as body rolling and springing movements. Stability skills emphasize static balance or dynamic balance (Both static and dynamic balance are tested in the Bruininks-Oseretksy test of motor proficiency) (Keogh and Sugden, 1985).

3.7.2 LOCOMOTOR MOVEMENT SKILLS

Locomotion is a fundamental aspect of learning to move effectively and efficiently within one's environment. It involves the projection of the body into external space by altering its location relative to fixed points on the surface. Activities such as walking, running, jumping, hopping, sliding, and skipping are considered fundamental locomotor movements. Performance of these movements must be sufficiently flexible so that they can be altered as the requirements of the environment demand without detracting from the purpose of the act. The child must be able to use any number of type of movements to reach the goal, shift from one type of movement to another when the situation demands it, and alter each movement as the conditions of the environment change. Throughout this process of alteration and modification, attention must not be diverted from the goal. For example, the locomotor pattern of walking may be used singularly, or it may be used in conjunction with manipulative or stability movements. The walking pattern can be elaborated upon by including object handling, such as bouncing a ball, and walking on a balancing beam. Development and refinement of these locomotor patterns in children is essential since it is through these movements that they explore the world and motor proficiency improves (Keogh and Sugden, 1985).

3.7.3 MANIPULATIVE MOVEMENT SKILLS

Manipulative movement skills encompass either *gross motor* or *fine motor* movements. *Gross motor manipulation* refers to movements that involve giving

force to objects or receiving force from them. Throwing, catching, kicking and striking are considered fundamental gross motor manipulative skills (Gallahue and Donnelly, 2005:57).

The term *fine motor manipulation* refers to object handling activities that emphasize motor control, precision, and accuracy of movements. Tying one's shoes and cutting with scissors are all examples of fundamental fine motor manipulative skills (Gallahue and Donnelly, 2005:57).

Because manipulative patterns commonly combine both locomotor and stabilizing movements, efficient use of them should not be expected at the same time that locomotor and stability abilities are developing. Only after these patterns have been fairly well established do we begin to see the emergence of efficient manipulative movements (Keogh and Sugden, 1985).

3.8 ENVIRONMENTAL FACTORS AND MOVEMENT SKILL ACQUISITION

Gallahue and Donnelly (2005:59) states that environmental factors play an important role in movement skill acquisition, therefore it is important that children are encouraged to and get the opportunity for practise and that they receive quality instruction in an ecologically sound environment to develop and refine their movement abilities and improve motor proficiency. It is clear that the preschool and early elementary years are the critical time for mastering fundamental movement skills. Maturation alone will not account for this development. Children who have mastered these skills are ready to begin the exciting process of developing specialized skills and applying them to a wide variety of games, sport, dance, and recreational activities for a lifetime of vigorous movement. Opportunity for practise, the importance of encouragement and the quality of instruction are all factors in the environment that affect movement skill acquisition and therefore motor proficiency.

3.8.1 OPPORTUNITY FOR PRACTISE

Three factors play a crucial role in children's opportunities to practise developing their movement skills – facilities, equipment, and time.

Many children live in congested cities in high-rise apartments, cramped housing complexes, or sprawling suburbs – all of which frequently lack sufficient facilities to meet their needs to move. The facilities to play ball, fly a kite, or play a game of tennis may be lacking. Even in areas where facilities have been set aside for public use, children must share their use with adolescents and adults. All too often, older children, and even adults, preempt the needs and interests of children. Consequently children are left to fend for themselves in the pursuit of vigorous movement experiences.

Opportunity for practise is also frequently limited by a lack of proper equipment. Parents and community centers often find it prohibitively expensive to purchase sufficient amounts and varieties of equipment for children to use.

A third factor, time, may be the most important determinant of opportunities for practise. Many children simply do not have the time to develop their movement skills. Their day is so highly programmed with school, television, computer games, and homework that little time is left for active movement (Gallahue and Donnelly, 2005:59).

3.8.2 IMPORTANCE OF ENCOURAGEMENT

Sadly, many children do not receive sufficient encouragement to develop their movement abilities. In many families today, both parents are employed outside the home. In other families a single parent is raising the children. Therefore, a frequent result of such situations is that the time and energy required to involve children in physical activities are missing. Too often children are quick to imitate the adults in their lives in their pursuit of the "good life", in the "workaholic" ethic that leaves little time for family activities, leisure, and purposeful pursuits. On the

other hand, some children are part of a family in which the cares of the workday are left behind only to be replaced by a mind-dulling escape to the television, the computer, or other passive activities. The failure to stimulate, encourage, and motivate children to engage in physical activity because of a lack of time, energy, interest, or personal example result in the failure of many children to develop their movement abilities (Gallahue and Donnelly, 2005:60).

3.8.3 QUALITY OF INSTRUCTION

The quality of the instruction given to children is perhaps the most crucial factor influencing development of their movement skills. Opportunities for practise and encouragement alone will not bring about the development of skillful movement in most children (Gallahue and Donnelly, 2005:60).

3.9 CONCLUSION

From this literature review on motor development and motor proficiency, it is clear to see how an important role these aspects play in the quality of life of our children.

The question that remains is whether obesity has an influence on the motor proficiency of 8-11 year old children. This question should be answered in the next chapter where the results of the Bruininks-Oseretsky test performed on obese and non-obese participants in this study will be discussed.

There upon Chapter 4.

CHAPTER 4

RESEARCH DESIGN AND STATISTICAL ANALYSES

4.1 METHOD

This is a comparative study between the motor proficiency of obese and non-obese children, 8-11 years of age. Permission from the Free State Department of Education was granted for this study (Enclosure A) as well as permission from the principle of the school involved (Enclosure B). Parents of children gave informed consent that their children may participate (Enclosure C). The parents also completed a medical history form before they engaged in the study (Enclosure D). Research took place at a Primary School in Heilbron, Northern Free State.

4.2 PARTICIPANTS IN THE STUDY

261 Children, aged 8 to 11, from the Primary School were measured to identify 30 obese and 30 non-obese children to take part in the study.

Boys and girls of different age groups that were part of the obese and non-obese group are listed in Table 8. The participants were all black children.

Table 8: Participants in the study of different age and gender

Abbreviations: yrs = years; TOT = Total

AGE (yrs)	OBESE		NON-OBESE	
	Girls	Boys	Girls	Boys
8	8	2	2	5
9	7	3	4	5
10	4	2	4	2
11	2	2	3	5
TOT	**21**	**9**	**13**	**17**

4.3 MEASUREMENTS

4.3.1 BODY MASS INDEX

The most widely used method for defining obesity at present is the body mass index. Variables needed to calculate body mass index is weight and height. In this study, height was measured in centimeters using a stadiometer. Height, defined as the distance between the soles of the feet and the vertex, was measured while the child stretches upright, stands barefoot, with the heel, gluteus maximus, upper back and back of the head up against the stadiometer. The ear, acromion, greater trochantor, the hind part of the patella and the fore part of the calcaneum all lay below one another. The corner of the eye and the upper hole of the ear must form a horizontal level. Weight was measured in kilograms using a calibrated patient scale. Children were weighed with only the minimum of clothing. Weight was determined to the nearest 0.1 kg. Body Mass Index (kg/m^2) was calculated (See Table 2 in Chapter 2 for the international cutoff scores to identify overweight and obesity).

4.3.2 FAT PERCENTAGE

Commonly, skinfold thickness measurements are used as a more direct index of body fat. While the technique is arguably simple to perform, considerable attention to detail is imperative to avoid inter- and intra observer errors. Subcutaneous fat measured by skinfolds correlates significantly with the amount of total body fat assessed by other methods such as dual energy x-ray absorptiometry (DXA). Thus, the total amount of fat can be calculated from various sets of skinfold measurements (Parizkova, 1977).

In this study, fat percentage was determined using a skinfold caliper to measure six skinfolds (triceps, sub-scapula, para-umbilicus, supra-iliac, medial thigh and medial calf). The following formula of Heath and Carter (1969:57) was used to calculate fat percentage:

Girls:
(Sum of the six skinfolds) x 0.1548 + 3.585 = % Body Fat

Boys:
(Sum of the six skinfolds) x 0.1051 + 2.585 = % Body Fat

4.3.3. SOMATOTYPE

Furthermore, somatotyping has been used for the estimation of body composition applying the Heath and Carter Method. This method is a semi-quantitative description of the existing relative shape and composition of a human body. It is expressed as a three numeral rating with one numeral for each of three components of physique, always recorded sequentially. The three numerals written as 2-5-3 for example are a somatotype rating, in which 2 represents the amount of endomorphy or the first component, 5 represents mesomorphy or the second component, and 3 represents ectomorphy or the third component. Thus, a somatotype gives a quantified expression of individual variations in morphology

and of what a body looks like. The three components of a somatotype rating are defined briefly as follows:

Endomorphy is a rating on a continuum of relative fatness of a physique;

Mesomorphy is a rating on a continuum of musculoskeletal robustness relative to stature;

Ectomorphy is a rating on a continuum of relative linearity of a physique.
A low rating in endomorphy describes a markedly lean physique with a minimum of subcutaneous fat, or little relative fatness. High ratings in endomorphy characterize conspicuously obese physique with large deposits of subcutaneous fat, or noticeable relative fatness.

Low ratings in mesomorphy describe physiques with narrow bone diameters and small muscle mass relative to stature. High ratings in mesomorphy signify large muscle mass with wide bone diameters relative to stature.

Low ratings in ectomorphy denote physiques with great mass relative to stature. High ratings in ectomorphy denote physiques with little mass relative to stature and relatively elongated limb segments. Ectomorphy ratings are based largely, but not entirely, on a height-weight ratio (height divided by cube root of weight). Anthropometric somatotypes can be calculated from 10 anthropometric dimensions - (height (cm), weight (kg), 4 skinfolds – triceps, sub-scapular, supraspinale, medial calf (cm), 2 girths – flexed upper arm and calf (cm) and 2 breadths – biepicondylar humerus and femur (cm) (Parizkova and Carter, 1976:327).

4.4 BRUININKS-OSERETSKY TEST OF MOTOR PROFICIENCY

The Bruininks-Oseretsky Test of Motor Proficiency is an individually administered test that assesses the motor functioning of children from 4½ to 14½ years of age. The complete battery – eight subtests comprised of 46 separate items – provides a comprehensive index of motor proficiency as well as separate measures of both gross and fine motor skills. The Short Form – 14 items from the Complete Battery – provides a brief survey of general motor proficiency (Bruininks, 1978:11).

4.3.4.1 CONTENT

Each of the eight subtests in the Bruininks-Oseretsky Test is designed to assess an important aspect of motor development. Four of the subtests measure gross motor skills (Subtest 1-4), three measure fine motor skills (Subtest 6-8), and one measures both gross and fine motor skills (Subtest 5). The differentiated measurement of gross and fine motor skills makes it possible to obtain meaningful comparisons of performance in the two areas. The eight tests are:

Subtest 1: Running Speed and Agility (One item).

This subtest measures running speed during a shuttle run.

Subtest 2: Balance (Eight items)

Three items assess static balance by requiring the subject to maintain balance while standing on one leg. Five items assess performance balance by requiring the subject to maintain balance while executing various walking movements.

Subtest 3: Bilateral Coordination (Eight items)

Seven items assess sequential and simultaneous coordination of the upper with the lower limbs. One item assesses coordination of upper limbs only.

Subtest 4: Strength (Three items)

This subtest assesses arm and shoulder strength, abdominal strength, and leg strength.

Subtest 5: Upper-Limb Coordination (Nine items)

Six items assess coordination of visual tracking with movements of the arms and hands. Three items assess precise movements of the arms and hands. Three items assess precise movements of arms, hands, or fingers.

Subtest 6: Response Speed (One item)

This subtest measures the ability to respond quickly to a moving visual stimulus.

Subtest 7: Visual-Motor Control (Eight items)

This subtest measures the ability to coordinate precise hand and visual movements.

Subtest 8: Upper-Limb Speed and Dexterity (Eight items)

This subtest measures hand and finger dexterity, hand speed, and arm speed (Bruininks, 1978:11).

4.3.4.2 COMPLETE BATTERY

The complete battery of the Bruininks-Oseretsky Test yields three estimates of motor proficiency: a Gross Motor Composite, a Fine Motor composite, and a Battery Composite.

Gross Motor Composite: This score summarizes performance on Subtests 1-4. It is an index of the ability to use the large muscles effectively.

Gross and Fine Motor Skills: The Upper Limb Coordination test tests both gross and fine motor abilities. The test assesses coordination of visual tracking

with movements of the arms and hands, precise movements of the arms and hands, precise movements of arms, hands, or fingers.

Fine Motor Composite: This score summarizes performance on Subtests 6-8. It is an index of the ability to use the small muscles of the lower arm and hand effectively.

Battery Composite: This score summarizes performance on all eight subtests. It is an index of general motor proficiency. See Table 11 for results of the children tested in this study (Bruininks, 1978:12).

4.4 STATISTICAL PROCEDURE

4.4.1 THE t-TEST FOR INDEPENDENT SAMPLES

The t-test is the most commonly used method to evaluate the differences in means between two groups. In the present study, the t-test can be used to test for a difference in scores between an obese group and a non-obese group. Theoretically, the t-test can be used even if the sample sizes are very small (e.g. as small as 10; some researchers claim that even smaller n's are possible), as long as the variation of scores in the two groups is not reliably different (Steyn et al., 1994:382).

The equality of variances assumption can be verified with the F test (which is included in the t-test output), or one can use the more robust Levene's test option. If these conditions are not met, then one can evaluate the differences in means between two groups using one of the nonparametric alternatives to the t-test (Steyn et al., 1994:382).

The p-values reported with a t-test represents the probability of error involved in accepting the research hypothesis about the existence of a difference between

the groups (see Table 9, 10, 11 and 12). Technically speaking, this is the probability of error associated with rejecting the hypothesis of no difference between the two categories of observations (corresponding to the groups) in the population when, in fact, the hypothesis is true. It is suggested that if the difference is in the predicted direction, you can consider only one half (one "tail") of the probability distribution and thus divide the standard p-level reported with a t-test (a "two-tailed" probability) by two. Others, however, suggest that you should always report the standard, two-tailed t-test probability (Steyn et al., 1994:382).

4.4.2 ARRANGEMENT OF DATA

In order to perform the t-test for independent samples, the means of the dependent variable will be compared between the two selected groups.

The α = 0.05* and α = 0.01** levels of significance are used throughout the study. The research hypothesis about the existence of **no difference between the groups** based on any of the variables is rejected if the reported p-value is less than any of the alpha values mentioned above.

4.5 RESULTS

To identify obese children according to their body mass index, two variables are needed: weight and height. The statistical analysis revealed that weight values varied widely among 8 and 10 year old obese and non-obese children (8 yrs: 35.8 kg $\pm$ 5.9 vs. 29.2 kg $\pm$ 2.6 and 38.1 kg $\pm$ 2.2 vs. 30.7 kg $\pm$ 3.1 respectively, p = < 0.01) and that there is a significant difference between 9 and 11 year old children's weight (43.9 kg $\pm$ 16.2 vs. 29.1 kg $\pm$ 3.9 and 40.6 kg $\pm$ 5.9 vs. 34.1 kg $\pm$ 5.4 respectively, p = <0.05) (Table 9 and Figure 4). Interestingly, there were no difference in height between obese and non-obese

children, except in the 10 year old age group (1.31 m ± 0.02 vs. 1.37 m ± 0.04, p = < 0.01) (Table 9).

Thus, the high weight values correlates to a highly significant difference in mean body mass index between obese and non-obese 8, 9 and 10 year olds (8 yrs: 21.7 kg/m^2 ± 2.2 vs. 16.7 kg/m^2 ± 0.4, 9 yrs: 24.5 kg/m^2 ± 5.6 vs. 16.8 kg/m^2 ± 0.7 and 10 yrs: 22.2 kg/m^2 ± 0.7 vs. 17.1 kg/m^2 ± 0.6, p = < 0.01), and a significant difference between 11 year old obese and non-obese children (22.7 kg/m^2 ± 2.3 vs. 17.8 kg/m^2 ± 1.0, p = < 0.05) (Table 9 and Figure 4).

Another variable that showed considerable differences between obese and non-obese children were their percentiles, which derived from body mass index (8 yrs: 91 ± 2.4 vs. 53 ± 5.9, 9 yrs: 92.5 ± 3.2 vs. 55.7 ± 3.1, 10 yrs: 90.8 ± 0.9 vs. 49.3 ± 6.2 and 11 yrs: 90.5 ± 1.0 vs. 54.8 ± 4.1, p = < 0.01).

Moreover, there was a major difference between the fat percentage of obese versus non-obese 8-10 year old children (8 yrs: 20.3% ± 3.2 vs. 9.4% ± 3.8, 9 yrs: 22.0 ± 4.8 vs. 9.1% ± 2.7 and 10 yrs: 20.1% ± 3.2 vs. 12% ± 4.5, p = < 0.01) and a significant difference between the 11 year old obese and non-obese children (19.2% ± 4.4 vs. 10.7% ± 3.9, p = < 0.05) (Table 9 and Figure 4).

Table 9: Comparison between the anthropometric measurements of obese and non-obese 8-11 year old children (P < 0.05*, P< 0.01**)

Abbreviations: yrs = years, O = Obese; NO = Non-obese; n = sample number.

AGE GROUP (yrs)		WEIGHT (Kg)		HEIGHT (m)		BODY MASS INDEX (Kg/m²)		PERCENTILE		FAT PERCENTAGE (%)	
		O	NO	O	NO	O	NO	O	NO	O	NO
8 O n = 10 NO n = 8	Mean	35.8	29.2	1.28	1.32	21.7	16.7	91	53	20.3	9.4
	Variance	35.1	7.1	0.002	0.002	4.8	0.18	6.2	35.5	10.6	14.7
	Standard Deviation	5.9	2.6	0.05	0.05	2.2	0.4	2.4	5.9	3.2	3.8
	t-Stats	df = 13 3.15		df=15 -1.74		df=10 7.12		df=9 16.8		df=14 6.39	
	p-Value	0.007**		0.100		0.000**		0.000**		0.000**	
9 O n = 10 NO n = 8	Mean	43.9	29.1	1.31	1.31	24.5	16.8	92.5	55.7	22.0	9.1
	Variance	263.5	15.4	0.008	0.003	31.8	0.6	10.2	9.9	23.1	7.8
	Standard Deviation	16.2	3.9	0.09	0.05	5.6	0.7	3.2	3.1	4.8	2.7
	t-Stats	df=10 2.79		df=15 0.21		df=9 4.26		Df=15 24.3		df=15 7.08	
	p-Value	0.019*		0.83		0.002**		0.000**		0.000**	
10 O n = 6 NO n = 6	Mean	38.1	30.7	1.31	1.37	22.2	17.1	90.8	49.3	20.1	12
	Variance	5.2	9.7	0.0006	0.0018	0.55	0.4	0.96	39.4	10.47	20.5
	Standard Deviation	2.2	3.1	0.02	0.04	0.7	0.6	0.9	6.2	3.2	4.5
	t-Stats	df=9 4.7		df=8 -3.40		df=10 12.55		df=5 15.9		df=9 3.57	
	p-Value	0.001**		0.009**		0.000**		0.000**		0.005**	
11	Mean	40.6	34.1	1.34	1.39	22.7	17.8	90.5	54.8	19.2	10.7
	Variance	34.8	29.6	0.000	0.005	5.6	1.0	1	16.9	19.8	15.2
	Standard	5.9	5.4	0.02	0.07	2.3	1.0	1.0	4.1	4.4	3.9

O n = 4 NO n = 8	Deviation					
	t-Stats	df=6 1.83	df=9 -2.13	df=4 3.92	df=8 23.1	df=5 3.24
	p-Value	0.115	0.061	0.017*	0.000**	0.022*

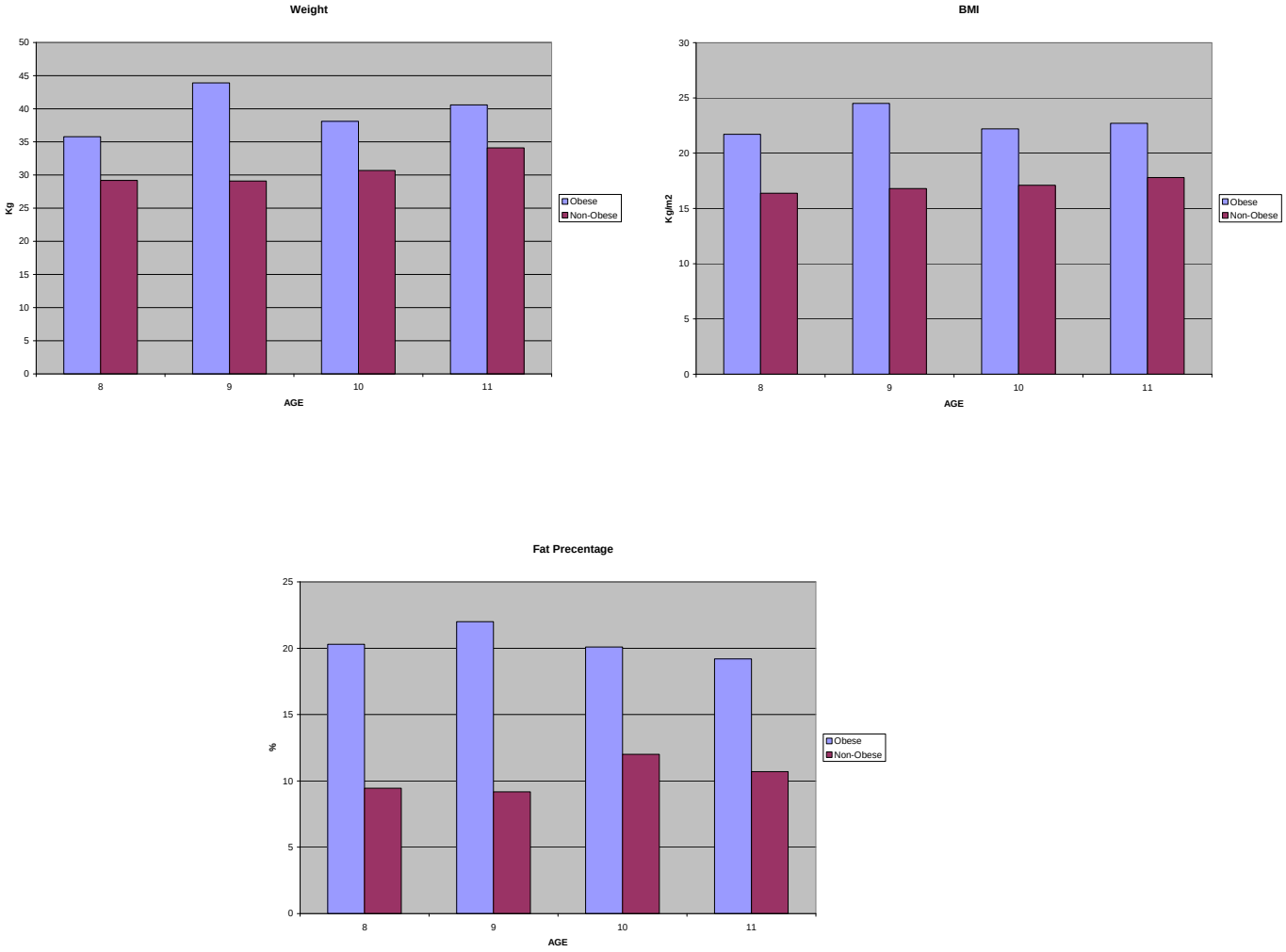

Figure 4: Difference in weight (kg), body mass index (kg/m^2) and fat percentage (%) between obese and non-obese 8-11 year old children

Figure 5 shows that there was a noteworthy difference in all the components of somatotype between obese and non-obese 8-11 year old children. Obese children's endomorphic component (relative fatness) was superior to the other two components of somatotype, while the non-obese children's mesomorphic component (musculoskeletal robustness relative to stature) was superior.

Table 10 stipulates the differences in the mean value between the two group's components of somatotype:

Table 10: Comparison between the components of somatotype between obese and non-obese 8-11 year old children (P < 0.05*, P< 0.01**)

Abbreviations: yrs = years; O = Obese; NO = Non-obese; n = sample number; SD = Standard Deviation

AGE GROUP (yrs)		ENDOMORPHIC COMPONENT		MESOMORPHIC COMPONENT		ECTOMORPHIC COMPONENT	
		O	NO	O	NO	O	NO
8 O n = 10 NO n = 8	Mean	6.45	2.55	6.05	4.57	0.30	3.05
	SD	0.3	0.9	0.6	0.6	0.2	0.3
	Variance	0.14	0.82	0.36	0.42	0.07	0.11
	t-Stats	df=9 11.37		df=15 4.91		df=13 -18.37	
	p-Value	0.000**		0.000**		0.000**	
9 O n = 10 NO n = 8	Mean	7.01	2.36	6.56	4.60	0.24	2.86
	SD	0.5	0.6	1.8	0.4	0.3	0.1
	Variance	0.30	0.42	3.31	0.17	0.11	0.02
	t-Stats	df=14 16.08		df=10 3.30		df=13 -21.09	
	p-Value	0.000**		0.007**		0.000**	
10 O n = 6 NO n = 6	Mean	6.70	2.79	6.40	3.65	0.11	3.70
	SD	0.3	0.4	2.2	0.3	0.2	1.4
	Variance	0.11	1.44	4.84	0.13	0.07	2.14
	t-Stats	df=6 7.66		df=5 3.01		df=5 -6.21	
	p-Value	0.000**		0.029*		0.001**	
11 O n = 4 NO N = 8	Mean	6.42	2.89	5.89	4.20	0.49	3.26
	SD	0.4	0.7	0.8	0.6	0.6	0.2
	Variance	0.22	0.62	0.74	0.38	0.36	0.04
	t-Stats	df=9 9.60		df=5 3.48		df=3 -8.91	
	p-Value	0.000**		0.017*		0.002**	

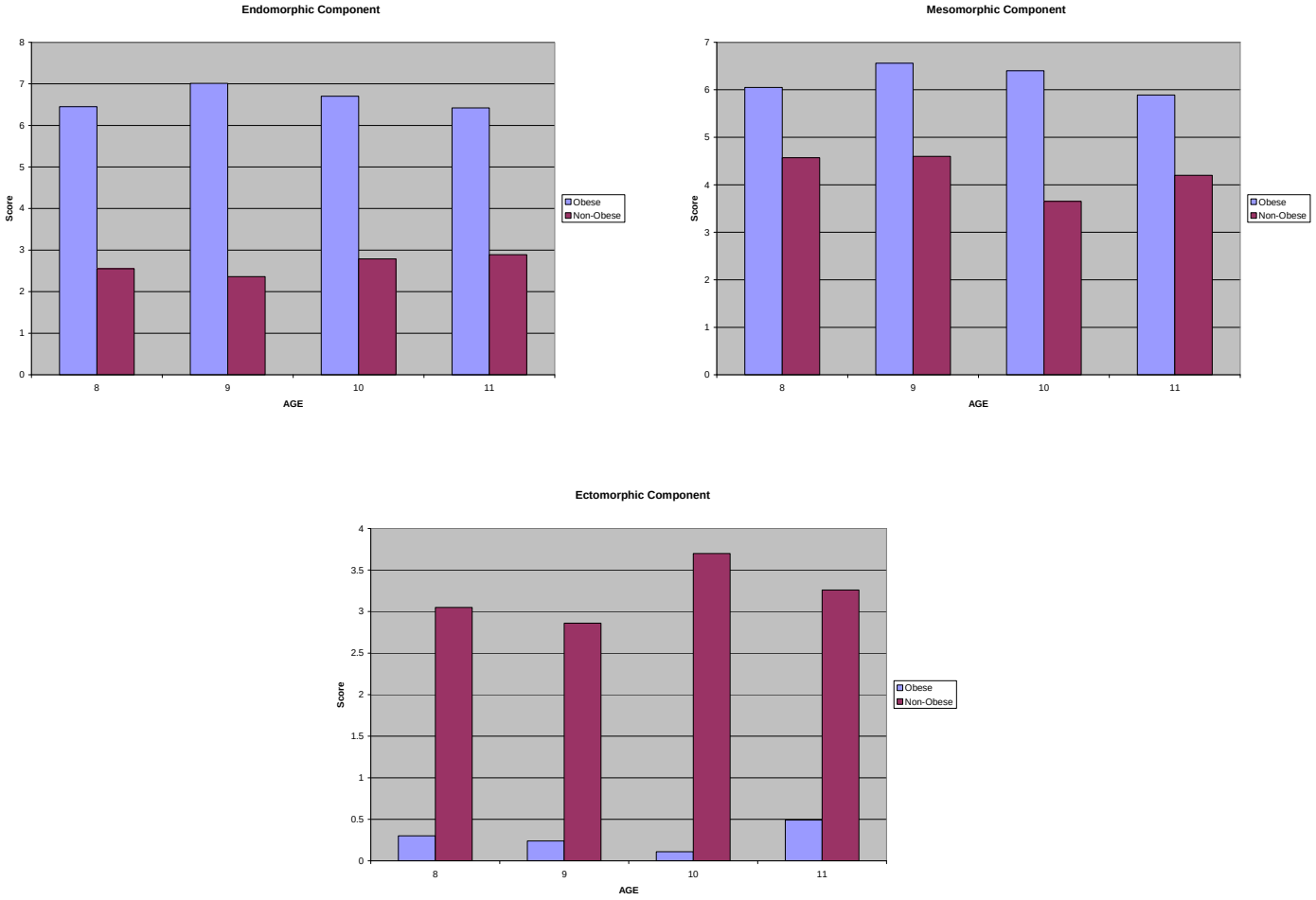

Figure 5: Difference in the endomorphic, mesomorphic and ectomorphic components between obese and non-obese 8-11 year old children

In Chapter 1 a hypothesis was stated that there will be a significant difference between the motor proficiency of obese versus non-obese 8-11 year old children. Surprisingly, the statistics revealed that in this study, no difference between the motor proficiency of obese versus non-obese children was evident as can be seen in Table 11.

Both groups did score below the norm (Table 6) of subtests set by Bruininks (1978). Table 11 shows how the participants compared with these norms.

In the 8 year old age group, the children scored below the norm in Running Speed and Agility (Norm: 8.3, Score O - 6.8 ± 1.7 and NO – 7.0 ± 0.7), Bilateral Coordination (Norm: 8.8, O were above the norm – 9.5 ± 3.2, Score NO – 8.3 ± 1.1), Response Speed (Norm: 7.0, Score NO – 6.5 ± 2.5), and Upper Limb Speed and Dexterity (Norm: 34.6, Score O – 34.1 ± 4.3, NO were above the norm 37.3 ± 2.5). Also, the 8 year old group had p values at the 10% level of significance on the following tests: Upper-Limb Coordination ($p = 0.09$), Visual Motor Control ($p = 0.06$), and Upper-Limb Speed and Dexterity ($p=0.06$).

In the 9 year old age group they scored below the norm in Running Speed and Agility (Norm: 9.0, Score O - 5.7 ± 0.5 and NO - 7.7 ± 1.2), Bilateral Coordination (Norm: 10.7, Score O - 7.8 ± 1.9 and NO - 8.6 ± 1.7), Response Speed (Norm: 7.8, Score O - 5.7 ± 1.3 and NO - 6.3 ± 2.1) and Upper-Limb Speed and Dexterity (Norm: 38.3, Score O - 34.6 ± 7.7, NO were above the norm – 39.5 ± 4.4). This age group had p values at the 10% level of significance in Running Speed and Agility ($p=0.01$), and Strength ($p=0.09$).

The 10 year old group scored below the norm in 6 of the 8 tests: Running Speed and Agility (Norm: 9.6, Score: O – 7.6 ± 1.0 and NO – 7.6 ± 1.5), Balance (Norm: 25.7, Score O – 25.5 ± 3.8 and NO – 24.5 ± 3.6), Bilateral Coordination (Norm: 11.4, Score: O – 7.6 ± 1.0 and NO – 9.6 ± 1.9), Strength (Norm: 21.0, Score: O – 19.8 ± 2.2 and NO – 22.6 ± 3.9), Response Speed (Norm: 9.4, Score: O – 7.0 ± 2.6 and NO – 7 ± 2.8) and Upper Limb Speed and Dexterity (Norm: 43.2, Score: O – 37.3 ± 73.8 and NO – 42.8 ± 3.1).

Interestingly enough the 11 year old group scored below the norm in 5 tests, much the same as the 10 year olds, except for Balance where they were above the norm: They were below the norm in: Running Speed and Agility (Norm: 10.4,

Score: O – 8.0 ± 2.3 and NO – 9.0 ± 1.4), Bilateral Coordination (Norm:12.4, Score: O – 10.0 ± 1.8 and NO – 9.6 ± 1.3), Strength (Norm: 22.2, Score: O – 19.5 ± 6.3 and NO were above the norm – 26.6 ± 3.8), Response Speed (Norm: 9.6, Score: O – 9.2 ± 4.5 and NO – 6.7 ± 2.2), and Upper Limb Speed and Dexterity (Norm: 45.8, Score: O – 39.7 ± 5.1 and NO – 42.6 ± 3.3).

Table 11: Comparison between the subtests of the Bruininks motor proficiency test of obese and non-obese 8-11 year old children ($P < 0.05$*, $P < 0.01$**)

Abbreviations: yrs = years; SD = Standard Deviation; Var = Variance

Point scores of subjects on the different motor proficiency subtests are converted to standard scores which in turn are converted to gross motor, fine motor, and battery composite scores. These composite scores are used to determine the level of motor proficiency. Since there was no distinction in the point scores between the two groups at any age level, there were no distinction between the gross motor-, fine motor-, and battery composite scores as well (Table 12 and Figure 6).

Since the composite scores are derived from the subject's point scores and we have seen that the participants were below the norms on their point scores, it is common sense that they will be below the norms on the composite scores as well. Indeed, the statistics revealed this. The norms for composite scores can be seen in Table 7.

Interestingly, the 8 year old group only had difficulty with gross motor activities (Norm: 59.3, Score: O – 47.9 ± 9.1 and NO – 50.6 ± 6.4) but were well above the norm on fine motor composite scores (Norm: 43.6, Score: O – 50.2 ± 6.7 and NO – 49.6 ± 2.8) and battery composite scores (Norm: 117.9, Score: O – 119.4 ± 22.4 and NO – 118.2 ± 11.3).

The 9 year old group scored below the norm in all 3 categories, except for the non-obese who were above the norm for fine motor composite:

Gross motor composite (Norm: 60.8, Score: O – 40.2 ± 9.6 and NO – 47.2 ± 7.0).
Fine Motor Composite (Norm: 45.2, Score: O – 40.8 ± 6.7 and NO - 45.8 ± 6.5).
Battery Composite (Norm: 120.9, Score: O – 93.8 ± 22.8 and NO – 109.5 ± 10.8).

The 10 year olds had difficulty with gross motor activities but not with fine motor activities. Their very low scores on the gross motor composite caused their

battery composite to be below the norm although they were above the norm on their fine motor composite scores.

Gross Motor Composite (Norm: 61.0, Score: O – 38.8 ± 5.3 and NO – 42.5 ± 8.7).
Fine Motor Composite (Norm: 45.1, Score: O - 46.1 ± 10.5 and NO – 46.1 ± 9.0).
Battery Composite (Norm: 120.9, Score: O – 99.1 ± 18.6 and NO – 105.8 ± 20.1).

The 11 year olds scores looked very much the same as the 10 year olds. Very low scores on gross motor composite, above the norm for fine motor composite scores (obese only), and again, below the norm on battery composite scores:

Gross Motor Composite (Norm: 60.2, Score: O – 44.2 ± 10.8 and NO – 47.8 ± 8.5).
Fine Motor Composite (Norm: 44.5, Score: O – 46.2 ± 12.5 and NO – 43.7 ± 7.2).
Battery Composite (Norm: 119.8, Score: O – 109.2 ± 28.2 and NO – 109.7 ± 12.4).

Table 12: Comparison between the gross motor, fine motor and battery composite scores of obese and non-obese 8-11 year old children ($P < 0.05$*, $P < 0.01$**

Abbreviations: yrs = years; SD = Standard Deviation

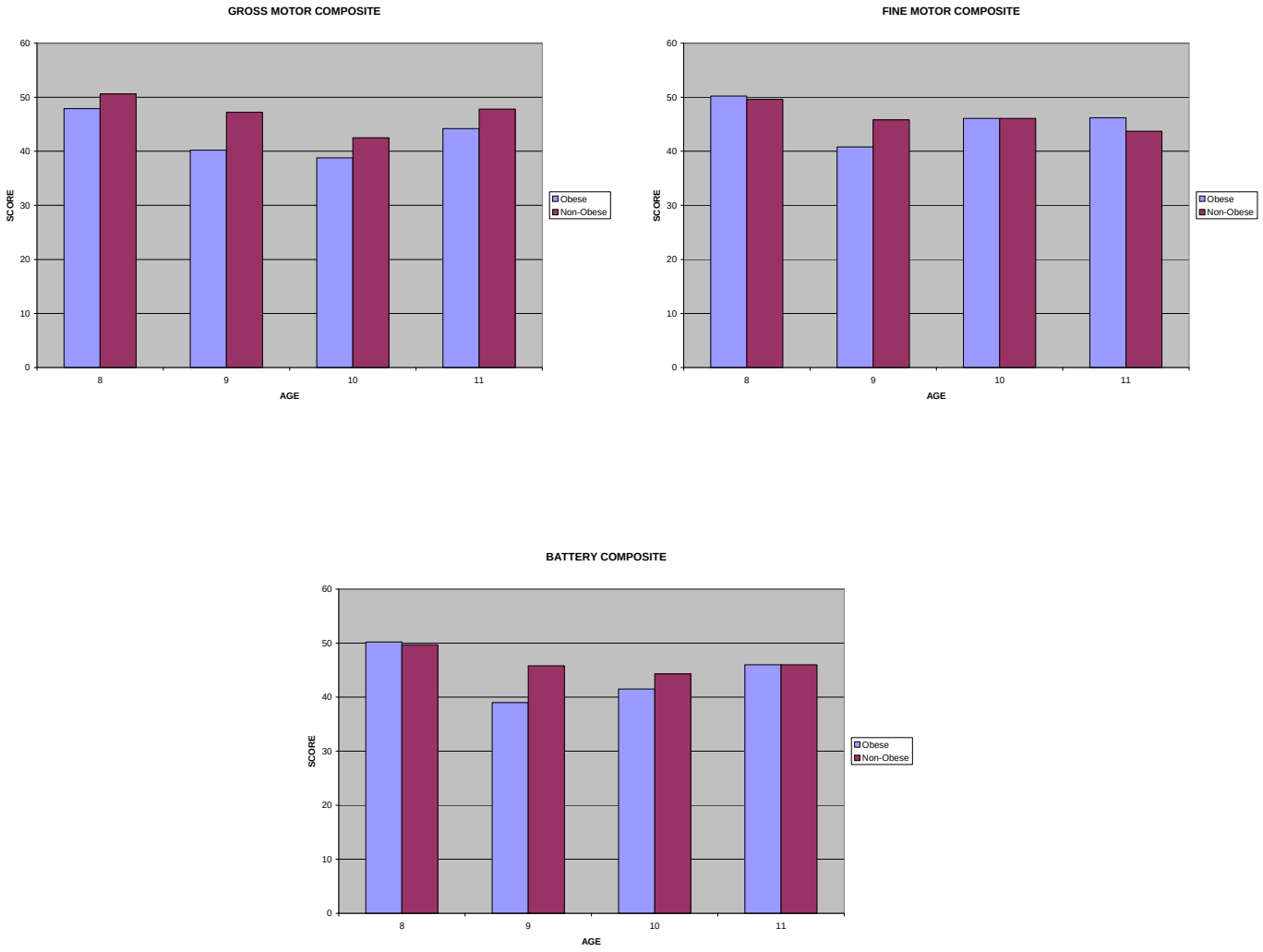

Figure 6: Diversity between the gross motor, fine motor and battery composite scores of obese and non-obese 8-11 year old children

4.6 DISCUSSION OF RESULTS

4.6.1 PARTICIPANTS IN THE STUDY

The obese and non-obese groups consist of 30 children each (**OBESE** - 8 years, Girls = 8, Boys = 2; 9 Years, Girls = 7, Boys = 3, 10 years, Girls = 4, Boys = 2 and 11 years, Girls = 2, Boys = 2. **NON-OBESE**- 8 years, Girls = 2, Boys = 5; 9 years, Girls = 4, Boys = 5; 10 years, Girls = 4, Boys = 2 and 11 years, Girls = 3 and Boys = 5) (Table 8). Arm and leg preference was determined for the purpose of the proficiency evaluation where certain tests must be performed with the preferred arm or leg. The majority of the children were right handed and right footed: 27 children in each group were right handed while only three were left handed. 26 children in the obese group were right footed and only 4 left footed while in the non-obese group 25 were right footed while only 5 was left footed.

4.6.2 WEIGHT AND HEIGHT

Considerable differences between the weight of obese (n = 30) and non-obese (n = 30) children occurred. On average there was a 6.6 kg difference between 8 year olds, a 14.8 kg difference between 9 year olds, a 7.4 kg difference between 10 year olds and a 6.5 kg difference between 11 year olds. This correlates to a study by Parizkova (1977) who found noteworthy differences between the weight of obese and non-obese children, although the study was done with older children (Figure 3). Burniat (1997:S136) suggests that these differences may be due to the cellularity of adipose tissue, where there is a poor proliferation in non-obese children until 10 to 12 years and in contrast, in the obese there is a constant proliferation from one year of age. As a result, the number of fat cells at the end of growth is significantly higher in obese subjects.

In comparison to the study of Parizkova (1977) there was no major difference between the height of obese and non-obese children with the non-obese children

being 5cm taller on average. This does not correlate with research by Garn et al. (1980) indicating that obese children may be taller than non-obese children because they go into their growth spurt earlier than non-obese children.

4.6.3 BODY MASS INDEX

Because weight is one of the variables needed to determine body mass index, one can assume that, because of the significant difference in the weight of the two groups, there will be a significant difference between their body mass indexes as well. In fact, this was proven to be the case. On average, the obese group's (n=30) body mass index was 5.8 kg/m^2 higher than that of the non-obese group (22.9 kg/m^2 vs. 17.1 kg/m^2). Again, this correlates with the study of Parizkova (1977) who in addition documented a momentous difference between the body mass index of obese versus non-obese boys (Figure 3). What's more, the body mass index of different age groups of the obese children correlates with the international cutoff of overweight and obesity by Cole (2000:1240) (Table 2).

4.6.4 FAT PERCENTAGE

Body mass index has been validated as a measure of size and shape and displays significant correlations with percentage body fat, measured by skinfolds in children ($r=0.86$, $p<0.00$ Parizkova 1977, 1998). Therefore, to no surprise there was a major distinction between the fat percentage of obese and non-obese children. In fact, the overall fat percentage of the age groups in the obese category was more than double that of the non-obese children: 20.7% vs. 10.2%. Once more Figure 3 shows that this correlates to the study of Parizkova (1977).
Thickness of the six skinfolds of obese and non-obese children differed notably too. Figure 7 and Figure 8 illustrate the comparison of this study with a study done by Parizkova (1993) between skinfold thickness (mm) of obese and non-obese children. Although Parizkova's study was done on 12-14 year old children, the difference between the two groups (obese and non-obese) remains significant, despite age.

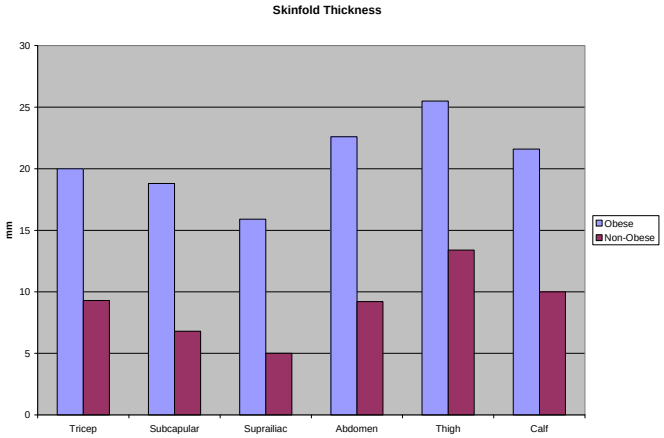

Figure 7: Comparison of skinfold thickness (mm) distributions in obese and normal weight children (8-11 years)

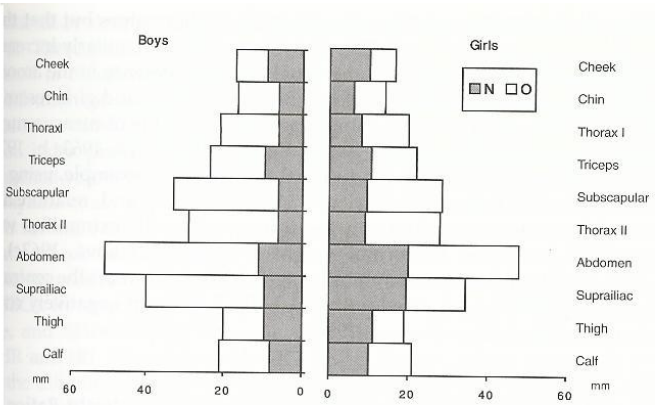

Figure 8: Comparison of skinfold thickness (mm) distributions in obese (O) and normal weight (N) boys and girls (12-14 years) (Parizkova, 1993)

4.6.5 SOMATOTYPE

Somatotype is a semi-quantitative description of the existing relative shape and composition of a human body. Earlier in this chapter the different components of somatotype were discussed. We saw what high and low scores on each component (endomorphy, mesomorphy and ectomorphy) meant. This study showed that the obese children had extremely high scores (average 6.6) on the endomorphic component which characterize conspicuously obese physique with large deposits of subcutaneous fat, or noticeable relative fatness. Their mesomorphic component was relatively high (average 6.2) which goes to show that they have wide bone diameters relative to stature. Their ectomorphic

component, in contrast, was very low (average 0.3) which denotes physiques with great mass relative to stature.

When we compare the non-obese group with this, it is the opposite of the obese. Non-obese children's endomorphic component was the lowest of all (2.6), the mesomorphic component the highest (4.3) and a relative high ectomorphic component (3.2). These scores of non-obese children compares well with the study of Clarke (1971) (Table 3).

Table 13 shows the scores of somatotype of the obese and non-obese children in different age groups.

Table 13: Comparison of somatotype scores between obese and non-obese children

Abbreviations: n = number of children; O = obese; NO = Non-Obese; yr = years.

N	Age (yr)	Somatotype	
		Obese	Non-Obese
O = 10 NO = 8	8	6.4-5.4-0.3	2.5-4.5-2.6
O = 10 NO = 8	9	7.0-6.5-0.2	2.3-4.6-2.8
O = 6 NO = 6	10	6.7-6.4-0.9	2.7-3.6-3.9
O = 4 NO = 8	11	6.4-5.8-0.4	2.8-4.2-3.2

73.3% of the children in the obese group were classified as Mesomorphic-Endomorphic. 26.6% was classified as Endomorphic-Mesomorphic. In the non-

obese group 6.6% was classified as Mesomorphic-Endomorphic, 16.6% as Endomorphic-Mesomorphic, 66.6% as Ectomorphic-Mesomorphic, 3.3% as Endomorphic-Ectomorphic and 6.6% as Mesomorphic-Ectomorphic.

4.6.6 MOTOR PROFICIENCY

Although the study revealed that there was no difference between the motor proficiency of obese and non-obese children, it is still a concern that both groups have scores well below the norm in some tests. Running Speed and Agility proved to be a weakness in both obese and non-obese children and in all age groups. This correlates with the study of Parizkova (1996) who found that obese boys performance on a 20m dash were inferior to that of non-obese boys (Figure 2). What remains a concern is that the non-obese children in this study scored below the Running Speed and Agility norm too.

A study by Goulding et al. (2003) on the balance of obese children confirms that excess body weight had a negative effect on the balance of a child and that obese children's balance was inferior to that of non-obese children. However, balance proved to be one of the participant's better skills in this study. All the age groups were above the norm for balance set by Bruininks (1978), except for the 10 year old age group.

Another shortcoming of both groups was bilateral coordination. All the age groups scored well below the norm except, surprisingly, for the obese 8 year old group which was above the norm. This shows that children do not practise these skills enough to let the upper limbs work in coordination with the lower limbs. It does not mean that they have to put in hours of hard work to master these skills. It could be attained on the school playground and everyday activity. This proved that children are no longer involved in voluntary physical activity where they can practise these skills.

The 8 and 9 year olds did well on the strength test and were well above the norm, however, the 10 and 11 year olds were in contrast well below the norm.

Parizkova (1977) confirmed the differentiated effect of obesity on physical performance, which has the most negative influence during dynamic workloads of aerobic, weight bearing activities. The question that remains unanswered is why the 8 and 9 year olds are well above the norm for strength while the 10 and 11 year olds are in return well below the norm?

The first four tests that were discussed above presents the gross motor components of the Bruininks-Oseretsky test of motor proficiency. Except for balance it is clear that the majority of the tests were below the norms set by Bruininks (1978). This should be a major concern to all of us!

The Upper Limb Coordination test tests both gross and fine motor abilities. The test assesses coordination of visual tracking with movements of the arms and hands, precise movements of the arms and hands, precise movements of arms, hands, or fingers. The children had no difficulty with this test and were all above the norms. The reason for this may be that children practise these skills, without knowing, when they are sedentary.

Response speed proof to be a weakness as well. Like strength, the reason for this is not clear and further research needs to be done on this aspect.

The participants did reasonably well on the Visual Motor Control test which measures precise hand and visual movements. Research by Petrolini et al. (1995:928) suggests that difficulty in visual co-ordination is considered as a possible cause of problems during exercise in obese children that may result in the preference for sedentary behavior. This sedentary behavior contributes to the deterioration of other motor proficiency skills as well.

The Upper-Limb Speed and Dexterity test measures hand and finger dexterity, hand speed, and arm speed. Interestingly enough the participants were below the norm on this test as well. We have seen in the above discussion that they

also had difficulties on Response Speed and Running Speed and Agility. All of these tests present a different aspect of motor development, but they all contain the same factor: SPEED!! Is this a major complexity for our children today?

4.6.7 COMPOSITE SCORES

The complete battery of the Bruininks-Oseretsky Test yields three estimates of motor proficiency: a Gross Motor Composite, a Fine Motor Composite, and a Battery Composite.

The Gross Motor Composite score summarizes performance on Running Speed and Agility, Balance, Bilateral Coordination and Strength. It is an index of the ability to use the large muscles effectively. The study revealed that both obese and non-obese children struggled with gross motor activities (Table 12). This correlates well with a study of Jaffe and Kosakov (1982:619) done on fat babies. Groups of normal weight and obese babies were compared, and a delayed gross motor development was found in the obese. A significant correlation was found between excessive weight and gross motor delay. Over the following year, both weight and motor development reverted to normal in the majority of infants. The fact that children in this study of 8-11 year olds still had difficulties with gross motor activities may well be caused by their weight and motor development that never reverted to normal. Is this the pattern that our children in the 21st century follow? Thus, if the child is obese as an infant and have delayed motor development that it does not revert, even in later childhood?

The Fine Motor Composite is a score that summarizes performance on Response Speed, Visual Motor Control and Upper-Limb Speed and Dexterity (Table 12). It is an index of the ability to use the small muscles of the lower arm and hand effectively. Fine motor development of the participants proved to be up to standard, except for the obese 9 year olds and the non-obese 11 year olds. It is true that our children are not as active as they use to be. Computers and TV games causes this problem. This may not be all that bad. While they are

sedentary in these activities, they practise some fine motor skills. However, these activities take up so much time that children do not get to play outside, hence the delay in gross motor development.

The Battery Composite score summarizes performance on all eight subtests. It is an index of general motor proficiency. Although the participants were up to standard with fine motor composite scores, their gross motor composite scores were so low that it caused the battery composite score to be below the norm as well (Table 12). Therefore, the outcome is that the motor development of obese and non-obese children is not up to standard.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This comparative study rejects the hypothesis and surprisingly revealed that there was no difference between the motor proficiency of obese and non-obese children. However, another important end result came to the fore. Thus is, the motor proficiency of 8-11 year old children is inadequate with regard to their age. This accounts for obese and non-obese children who took part in the study.

This brings us back to the study of Westman (1973) where he suggests that it is common to see deviations from the mean of as much as six months to one year in the appearance of numerous movement skills. The tendency to exhibit individual differences is closely linked to the concept of readiness and helps to explain why some individuals are ready to learn new skills when others are not. The question is whether these children involved in the study group ever had the opportunity to develop their movement skills because it is unlikely that 60 children weren't developmentally ready to master movement skills.

Further research planned on this topic is to determine what effect a motor development intervention program will have on the motor proficiency of obese children.

Although the study had only a small sample (n=60), the end result remains important. Research on the motor development of children is well documented, but research on the motor proficiency is still limited. Similar studies to this end in different race, age and gender groups and with bigger samples are needed.

5.2 RECOMMENDATIONS

Although there was not a significant difference between the motor proficiency of obese versus non-obese children, the fact remains that obesity is starting to become an international epidemic. Therefore, an effort should be made to prevent obesity as far as possible, and those who suffer from this epidemic should be treated effectively.

Parents need to know throughout growth whether or not their child is too heavy. It is believed that this information would encourage the adoption of strategies to limit excessive fat gain. An opportune time to provide this information would be when the child starts school. Although measurements of percentage fat yield the best information regarding excess fatness, these are not very accessible measurements of weight and height. Thus, it seems reasonable to advocate that children should be weighed and measured carefully then, so that body mass index status can be determined and the parents told where their child ranks on the body mass index growth charts. This would facilitate early identification of children who have elevated body mass index values and may encourage families to adopt lifestyle changes to limit excessive fat gain. If the current obesity epidemic is to be curbed, it is desirable that sensitive eating patterns and regular physical activity patterns should be put in place for all children during their early years when the seeds of adult obesity are being sown (Goulding et al., 2003:410).

Although pediatric treatment has been relatively successful, many treated children also regain weight during follow-up (Epstein et al., 1998:560). Given difficulties in changing established eating and exercise behavior, research is needed to prevent obesity during development. Primary prevention may involve modifying intake, because research suggests that obese and non-obese children have similar activity levels (Treuth, 1998:1130; Maffeis, 1996:258).

Components of programs to prevent obesity in at-risk children can include modifying environmental cues leading to positive energy balance, changing parental eating habits, thereby providing healthy models for children to observe, and teaching new parenting skills that exclude using food as a reward. Because parental obesity represents one of the major risk factors for pediatric obesity, many at-risk children will live in families with obese parents. The inclusion of parental behavior change as a target for obesity prevention programs may have benefits beyond prevention of pediatric obesity, because a change in the eating habits related to parental obesity may result in a reduction in parental obesity. If obese parents of at-risk children reduce access to low-nutrient dense foods available in the shared family environment, model healthier eating and activity habits, and share positive food-related family experiences that reinforce eating, this could all help their obese children.

The end result of the study was that the participants motor proficiency level was not appropriate to their age. This should be a major concern to all of those involved in the development of children. The fact that there was not a significant difference between the two groups could be possible because both of these groups level of proficiency was very low. With the world we are living in today, less and less attention is given to the motor development of our children which leads to poorer motor proficiency. It is essential that young children be provided with opportunities to establish appropriate motor proficiency skill competencies at an early age, therefore, it is recommended that motor development programs should be introduced as part of the school curriculum to give our children the opportunity to master these critical skills.

ENCLOSURE A

PERMISSION FROM THE FREE STATE EDUCATION DEPARTMENT

FREE STATE PROVINCE

Enquiries : Mrs M V Wessels/
Reference no. : 16/4/1/50-2004

Tel :(051) 404 8075
Fax :(051) 4048074

2004-08-10

Ms CF Potgieter
5 Sunningdale
Koringspruit Street
Fleurdal
BLOEMFONTEIN
9301

Dear Ms Potgieter

REGISTRATION OF RESEARCH PROJECT

1. This letter is in reply to your application for the registration of your research project.

2. Research topic: **A comparison study between the motor proficiency of obese versus non-obese ten-year old boys and girls.**

3. Your research project has been registered with the Free State Education Department and you may conduct research in the Free State Department of Education under the following conditions:

   3.1 Learners and their parents participate voluntarily in the project.
   3.2 The names of all schools, learners and their parents involved remain confidential.
   3.3 The questionnaires are completed and the interviews are conducted outside normal tuition time.
   3.4 This letter is shown to all participating persons.

4. You are requested to donate a report on this study to the Free State Department of Education. It will be placed in the Education Library, Bloemfontein. It will be appreciated if you would also bring a summary of the report on a computer disc, so that it may be placed on the website of the Department.

5. Once your project is complete, you will be invited to present your findings to the relevant persons in the FS Department of Education. This will increase the possibility of implementing your findings wherever possible.

6. You are requested to confirm acceptance of the above conditions in writing to:

   The Head: Education, for attention: CES: IRRISS
   Room 1204, Provincial Government Building
   Private Bag X20565, BLOEMFONTEIN, 9301

6. We wish you every success with your research.

Yours sincerely

WB van Rooyen
CES: IRRISS

ENCLOSURE B

PERMISSION FROM THE PRINCIPAL

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

339 BLOEMFONTEIN 9300 REPUBLIEK VAN SUID-AFRIKA / REPUBLIC OF SOUTH AFRICA / REPHABLIKE YA AFRIKA BORWA

The Principal : Mr Mofokeng
P.O.Box 867
35 Cilliers Street
Heilbron
9650

PERMISSION TO DO RESEARCH AT THE SCHOOL

I Hereby ask your permission to do research at your school to the fulfillment of the degree: MAGISTER ARTIUM – HUMAN MOVEMENT SCIENCE : KINDERKINETICS at the University of the Free State.

The theme of the study is: The motor proficiency of obese 8 – 11 year old children.

All 8 – 11 year old children's body mass index will be taken to identify 30 obese and 30 non-obese children. They will then be evaluated on the International Bruininks – Oseretsky test of motor proficiency. The complete battery – eight subtests comprised of 46 separate items – provides a comprehensive index of motor proficiency as well as separate measures of both gross and fine motor skills. The test takes 45-60 minutes to administer. Evaluation will take place after school hours and participation is voluntary.

Although obesity is a growing problem in our society today, it s necessary that further research needs to be done.

I thank you for your time

Kind regards

_____

Carika Potgieter

(B.A. Hons. Kinderkinetics)

Contact number

084 430 6053

ENCLOSURE C

PERMISSION FROM PARENTS

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

339 BLOEMFONTEIN 9300 REPUBLIEK VAN SUID-AFRIKA / REPUBLIC OF SOUTH AFRICA / REPHABLIKE YA AFRIKA BORWA

Dear Parents

PERMISSION FOR PARTICIPATION TO A RESEARCH PROJECT

It is my privilege to announce that your child has been chosen to participate in a research study conducted by the University Of The Free State at your school. The theme of the study is: The motor proficiency of obese 8 – 11 year old children.

Your child's motor proficiency will be evaluated with an international test battery, namely the Bruininks-Oseretsky Test Battery of Motor Proficiency. The test consists of 8 sub tests with 46 items. Aspects that will be tested include balance, co-ordination, ball skills etc. Evaluation will take place at the school and participation is voluntary with no cost.

Parents are hereby asked to complete the permission form as well as the medical form and send it back to school no later than Tuesday, 15 February 2005.

Thank you for your time.

Kind regards

_____

Carika Potgieter
(B.A. Hons. Kinderkinetics)
Contact Number: 084 430 6053

ENCLOSURE D

MEDICAL HISTORY

KINDERKINETICS

To be completed by the parents

DATE	
NAME	
DATE OF BIRTH	
ADDRESS	
TEL:	

MEDICAL HISTORY

Has the doctor ever said that your child has a heart problem? If so, what is the problem?	Y	N
Are your child using any chronic medication at the moment?	Y	N
Does your child suffer from high blood pressure?	Y	N
Does your child suffer from any orthopedic problems?	Y	N

ILLNESS

Exercise Indicated asthma?	Y	N
Regular headaches or migranes?	Y	N
Regular tiredness?	Y	N
Cramps in the lower legs?	Y	N

Diabetes?	Y	N
Epilepsy?	Y	N
Lung Diseases?	Y	N
Dizziness or Fainting?	Y	N
Any history of rheumatic, tic- or glandular fewer?	Y	N
Flu, bronchitis or infections?	Y	N
Is your child currently using antibiotics?	Y	N

FAMILY HISTORY

	SELF	VADER / FATHER	MOEDER / MOTHER	SUSTER / BROER/ BROTHER	ANDER/ OTHER
High cholesterol?	Y / N	Y / N	Y / N	Y / N	Y / N
Chronic heart diseases?	Y / N	Y / N	Y / N	Y / N	Y / N
Diabetes? Hypertension	Y / N Y / N	Y / N Y / N	Y / N Y / N	Y / N Y / N	Y / N Y / N
Obese?	Y / N	Y / N	Y / N	Y / N	Y / N

Stroke?	Y / N	Y / N	Y / N	Y / N	Y / N

RISK FACTORS

Does your child have a healthy appetite and a healthy diet?	Y	N
Does your child sleep enough?	Y	N
Does your child participate in sport? If yes, what sport, how many times a week and how long?	Y	N
When last did your child participate in physical activity?		

INFORMED CONCENT

I hereby declare that all the above mentioned information about my child is correct. I will not hold the researcher responsible for any injury sustained during evaluation.
_____ _____ SIGNATURE DATE

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http.www.obesity.org/subs/fastfacts/obesity_youth.shtml – 21 March 2004

http://www.obesity.org/subs/childhood/healthrisks.shtml - 21 March 2004

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