PERILIMBAL CONJUNCTIVAL PIGMENTATION AND ITS ASSOCIATION WITH VERNAL KERATOCONJUNCTIVITIS IN CHILDREN FROM THE WEST RAND

Dissertation submitted in fulfilment of the requirements in respect of the Master's degree of Optometry in the Department of Optometry in the Faculty of Health Sciences at the University of the Free State

Format: Full dissertation

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February 2021

DECLARATION

I, Chandre' van Vuuren, declare that the Master's Degree research dissertation, that I herewith submit for the Master's Degree qualification of Optometry at the University of the Free State, is my independent work; and that I have not previously submitted it for a qualification at another institution of higher education.

02.02.2021

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Date

DEDICATION

For my fiancé, Kyle, my parents, Andre' and Marian and my parents-in-law, Craig and Charmian.

I will never be able to thank you enough for your endless support and encouragement. Your unconditional love has been my light and comfort through every step of writing this dissertation.

ACKNOWLEDGEMENTS

I am extremely grateful for the contributions which I have received, and I would like to acknowledge the following individuals:

My supervisor, **Dr Elzana Kempen**, Department of Optometry, School of Health and Rehabilitation Sciences, University of the Free State for all the hours devoted to this study, her insightful guidance, patience and essential support.

Mr Benre Strydom, for permitting me to use his private optometry practice for the duration of my research as well as his invaluable advice.

Ms Riette Nel (Biostatistician), for the statistical analysis of the data in this study and her thoughtful feedback.

Dr Marsha Oberholzer, for her critical reading and helpful recommendations.

The Postgraduate school of the University of the Free State, for providing a tuition bursary to fund this study.

To **Mr T Mabasa** and **Ms N Nakedi**, for translating the consent, assent and information forms of this study from English to Setswana.

The children who participated in this study and their parents/caregivers, for their contribution.

My Father in Heaven, who has gifted me this opportunity.

My fiancé, you have been my inspiration through this journey.

My parents, parents-in-law, family and friends, for all your thoughts, prayers and believing in my abilities.

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LIST OF ACRONYMS

AKC	Atopic Keratoconjunctivitis
AOA	American Optometric Association
CAM	Complexion Associated Melanosis
GPC	Giant Papillary Conjunctivitis
HSREC	Health Science Research Ethics Committee
IgE	Immunoglobulin E
IOP	Intraocular Pressure
KRTS	Kids Right To Sight
NSAID	Non-Steroidal Anti-Inflammatory Drug
PAC	Perennial Allergic Conjunctivitis
PCP	Perilimbal Conjunctival Pigmentation
PEK	Punctate Epithelial Keratitis
SAC	Seasonal Allergic Conjunctivitis
SPEE	Superficial Punctate Epithelial Erosions
SPK	Superficial Punctate Keratitis
UFS	University of the Free State
VA	Visual Acuity
VKC	Vernal Keratoconjunctivitis

ABSTRACT

Keywords: vernal keratoconjunctivitis, perilimbal conjunctival pigmentation, quantitative research, ocular disorders, West Rand, skin complexion, allergic responses.

Vernal keratoconjunctivitis (VKC) is a recurrent inflammatory disorder which affects the anterior ocular structures of pre-pubertal children resulting in preventable vision loss. Certain risk factors such as gender, warm and dry climates as well as systemic allergies, have been identified to increase the onset of VKC. Recently, perilimbal conjunctival pigmentation has been found to be a consistent and early indication of the development of VKC.

Aim: The study aimed to evaluate the presence of perilimbal conjunctival pigmentation and its association with VKC in children from the West Rand, South Africa. Not only is there limited information regarding VKC in South Africa, but a gap has been identified in the literature concerning perilimbal conjunctival pigmentation in VKC and its association with ocular allergic responses and racial factors such as varying skin tones. This study was designed to provide a better understanding of these features and highlight the clinical relevance of the presenting pigmentation. With this knowledge, the appropriate ocular treatment of VKC can be provided, which may promote childhood eye care, especially in the West Rand.

Methods: This study consisted of an observational quantitative study design employing cross-sectional sampling. The sampling method consisted of non-probability convenience sampling. The data was collected through structured interviews and clinical examinations, which were performed to measure selected variables during a given period. The presence of VKC and perilimbal conjunctival pigmentation was determined through the symptoms reported by the participants during structured interviews. Furthermore, anterior and posterior ocular health examinations were performed with a slit lamp to identify VKC and perilimbal conjunctival pigmentation, based on a diagnostic criterion. The findings of the participants were divided into groups for the purpose of analytical non-parametric comparison to determine significant associations.

Results: This study consisted of 125 participants between the age group of 6 and 12 years. The sample predominantly consisted of 68 female participants. The larger part of the sample population, being 75 participants, were of Black African race. Furthermore, most of the sample, 80 participants, resided in Krugersdorp. The findings of this study determined a VKC prevalence of 28% as well as a perilimbal conjunctival pigmentation prevalence of 28% in the sample population. Ocular pigmentation in the absence of VKC was found in 6.40% of the sample. More female participants displayed VKC (62.50%) while more male participants displayed both VKC and the perilimbal pigmentation (55.56%). Both VKC and perilimbal conjunctival pigmentation was identified more frequently in participants of 8 to 11 years of age. Furthermore, it was recognised that all the participants who displayed VKC and perilimbal conjunctival pigmentation were of the Black African ethnicity. The data also indicated that 62.96% of these affected participants resided in Kagiso, a local township settlement in the West Rand. Moreover, most of the participants displaying both VKC and the perilimbal pigmentation experienced ocular allergic responses in the form of symptoms such as ocular itching (96.30%) and clinical signs such as conjunctival hyperaemia (88.89%) and tarsal conjunctival papillae (88.89%).

Conclusion: The results of this study has identified that age, gender, ethnicity and residential distribution affects the prevalence of VKC and perilimbal conjunctival pigmentation. Considering that all the affected participants were of the Black African race, a conclusion was made that a darker skin tone may increase the presence of perilimbal conjunctival pigmentation found in VKC. Most of the participants displaying both VKC and perilimbal conjunctival pigmentation experienced ocular inflammatory reactions in the form of ocular symptoms and signs. This identification signifies that the presence of allergic responses may intensify perilimbal conjunctival pigmentation. The study has determined that the presence of perilimbal pigmentation, which is found in VKC, is not only produced by the darker skin tones of an individual. The pigmentation is also induced by ocular allergic responses linked to this ocular disorder. Therefore, eye care practitioners may use this clinical sign to identify the early development of VKC to provide prompt treatment and encourage the promotion of ocular health amongst children.

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION

This study was aimed at determining the prevalence of vernal keratoconjunctivitis (VKC) amongst children in the West Rand, South Africa, as well as perilimbal conjunctival pigmentation and its association with specific factors. VKC has been classified as a form of allergic conjunctivitis and is characterised as a bilateral and chronic recurring inflammatory disorder. This treatable ocular disorder may lead to severe visual complications and blindness if not treated promptly and appropriately.

Recent interest has evolved regarding the consistent presence of perilimbal conjunctival pigmentation in patients affected by VKC. What remains insufficiently researched throughout South Africa is the association of perilimbal conjunctival pigmentation and VKC. This study described the associations which exists between perilimbal conjunctival pigmentation, VKC, allergic responses and racial factors such as varying skin tones. Considering that perilimbal conjunctival pigmentation may aid in the early diagnosis of VKC development, it is of great importance to investigate its association with the factors mentioned above.

To achieve the aim of this study, data was collected from 125 children between the age of 6 and 12 years of the Black African, Indian, Mixed-race and White ethnic groups, within the West Rand, who received comprehensive ocular examinations. The findings of this study may encourage the promotion of eye care amongst local schools and optometry practices. Likewise, it may address preventable visual loss and the visual challenges which VKC creates for children. The purpose of this chapter is to provide an overview of the study in order to orientate the reader. Firstly, the background of the study will be discussed, followed by the problem statement and research questions. Secondly, the aim of this study and the study objectives will be specified, followed by the significance and value of the study. Furthermore, the study design, methodology and research implications will be outlined. Chapter 1 will conclude with a review of the organization of the chapters to follow.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Vision is regarded as a critical human sense and is significantly involved in the essential development and learning abilities of a child (Sim & Mackie, 2015). Statistics have estimated that 19 million children below the age of 15 years are visually impaired and a further 1.4 million children have irreversible blindness (World Health Organization, 2017). Numerous barriers and challenges in social and academic areas are experienced by children affected by visually threatening ocular disorders. The early detection and effective treatment of these ocular disorders may prevent the onset of blindness and therefore improve the quality of life (Pathai, 2010).

Globally, it is recognised that one of the leading causes of visual loss is attributed to chronic eye diseases (World Health Organization, 2017). VKC is a treatable chronic ocular disorder linked to a personal or family history of systemic allergic diseases. This disorder most commonly presents in pre-pubertal males and results in disturbances of everyday activities such as schoolwork (Al-Akily & Bamashmus, 2011). Furthermore, this condition displays a seasonal variation as most patients diagnosed with VKC are in regions with a hot and dry climate (Sethi *et al.* 2018).

As mentioned previously, the lack of early diagnosis and appropriate treatment may aggravate the symptoms and signs of VKC, leading to sight-threatening conditions and severe visual impairments (Arif *et al.* 2017). Typical symptoms experienced by individuals with VKC are severe ocular itching, ocular lacrimation, photophobia and a foreign body sensation. Clinical signs such as conjunctival hyperaemia, tarsal conjunctival papillae and Horner-Trantas dots differentiate VKC from other allergic disorders, namely seasonal and perennial allergic conjunctivitis (Leonardi *et al.* 2012). Amongst these established indications, perilimbal conjunctival pigmentation has been reported consistently throughout existing research, leading to a greater interest regarding its relevance to VKC (Duke *et al.* 2017; Khan *et al.* 2012; Kumah *et al.* 2015; Luk *et al.* 2008).

Researchers are now showing interest in finding whether perilimbal conjunctival pigmentation may be used as an indicator to identify the early development of VKC and prevent this condition's aggravation (Khan *et al*. 2012; Luk *et al*. 2008). There is insufficient data regarding the features and associations of perilimbal conjunctival pigmentation and VKC, particularly in South Africa. Therefore, the aim of the study is to determine the prevalence of perilimbal conjunctival pigmentation and its association with VKC in children from the West Rand, South Africa to aid in the early diagnosis of the development of this ocular disorder.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTIONS

1.3.1 Problem statement

VKC is a significant ocular health problem affecting children across the globe. Inadequate awareness amongst the public regarding the presenting symptoms and signs of VKC, such as ocular itching and perilimbal conjunctiva pigmentation, results in poor intervention seeking behaviour. The lack of early diagnosis and appropriate treatment of this disorder may accelerate sight-threatening complications, such as corneal shield ulcers and keratoconus, and possible vision loss.

Although numerous studies regarding the features of VKC have been conducted internationally, it is not known whether perilimbal conjunctival pigmentation in VKC is associated with ocular allergic responses or racial factors such as varying skin tones in a South African population. The possible association of perilimbal conjunctival pigmentation with ocular allergic responses may assist in the early identification of the development of VKC amongst South African children. Therefore, the findings may aid in the diagnosis of VKC and lead to the implementation of early interventions to promote eye care amongst children.

1.3.2 Research questions

The following research questions were formulated in order to address the stated problem:

1. What is the prevalence of VKC amongst children aged 6 to 12 years in a private optometry practice in the West Rand, South Africa?
2. What is the prevalence of perilimbal conjunctival pigmentation amongst children with and without VKC?
3. Is perilimbal conjunctival pigmentation in VKC associated with ocular allergic responses or racial factors amongst individuals?

1.4 STUDY AIM AND OBJECTIVES

The aim and objectives of the study were as follows:

1.4.1 Aim of the study

The aim of this study was to determine the presence of perilimbal conjunctival pigmentation and its association with VKC in children from the West Rand, South Africa.

1.4.2 Study objectives

The specific objectives of the study were as follows:

1. To determine the prevalence of VKC amongst children aged 6 to 12 years in a private optometry practice in the West Rand, South Africa.
2. To determine the presence of perilimbal conjunctival pigmentation in children with and without VKC.
3. To determine whether perilimbal conjunctival pigmentation in VKC has a significant association with ocular allergic responses or race.

1.5 VALUE AND SIGNIFICANCE OF THE STUDY

To date, no South African study has been conducted regarding the association between perilimbal conjunctival pigmentation and VKC. There is insufficient knowledge in South Africa regarding the possibility that perilimbal conjunctival pigmentation may not merely originate from an abundance of melanin in individuals with darker skin but may also contribute to the early diagnosis of VKC. It is therefore important to investigate the association of perilimbal conjunctival pigmentation with ocular allergic responses and skin colour. The results of this study may contribute to the scope of optometry, fill the current gap in South African knowledge and further improve the ocular health amongst children in the West Rand.

The findings and conclusions of this study are valuable to eye care professionals as it reports the identification and relevance of perilimbal conjunctival pigmentation in VKC. These results may be communicated to various optometric practices nationally to enhance the manner of VKC patient care. Furthermore, the results may also be distributed to schools in the surrounding area to educate teachers and parents of the early symptoms and sign of VKC. Therefore, caregivers will be made aware of this early diagnostic sign which may lead to prompt and accurate treatment. By making use of this ocular sign in the diagnostic process, optometrists and ophthalmologists may ensure that patients promptly receive treatment which may therefore prevent further ocular damage.

1.6 STUDY DESIGN AND RESEARCH METHODOLOGY

The following section will describe the study design and the methods used in this study.

1.6.1 Study design

An observational quantitative study design was used which employed cross-sectional sampling. Hopkins (2000) defined quantitative research as a structured, systematic investigation method aimed to classify and objectively measure certain variables within a sample by determining the association between features in the population.

Furthermore, cross-sectional study designs branch from analytical studies and select participants according to an inclusion criterion. The prevalence of an outcome and associations between variables of interest can then be determined by comparing the groups of participants (Hopkins, 2000; Setia, 2016). The study design will be explained in greater detail in Chapter 3.

1.6.2 Methodology

This study utilised a non-probability convenience sampling method to address the research questions and objectives. Convenience sampling has been reported as the most widely used sampling method throughout the existing literature (Elfil & Negida, 2017). This investigation method included the use of an inclusion criterion to sample children from the West Rand, who attended a private optometry practice for ocular examinations. These children received ocular examinations, and data forms were used to record the findings, which were analysed by a biostatistician. The investigation and data collection took place over the course of six months.

The sampling method is explained throughout Chapter 3. The sample consisted of 125 children between the age of 6 and 12 years residing in the West Rand, South Africa. The sample selection, including the target population, the sample method and size and the description of the sample will also be discussed. Furthermore, the measurement method, operational definitions, step by step procedures, measurement errors and the pilot study will also be reviewed. Finally, Chapter 6 will present an additional overview of the study, followed by the main research conclusions. The limitations, implications and recommendations will also be discussed.

1.7 IMPLICATIONS OF THE STUDY

The findings of the research may be communicated to local optometrists and ophthalmologists in the West Rand and possibly nationally to enhance the investigation of ocular surface diseases. Furthermore, the data may be distributed to surrounding schools so that teachers and adults are aware of the presenting signs of VKC, such as perilimbal conjunctival pigmentation.

By providing the public with more knowledge regarding this ocular disorder, more cases may be referred at an earlier stage, which may lead to efficient treatment and more favourable outcomes. This study essentially strives to promote the eye care of children in the West Rand, as it may not always be thought of as a priority.

1.8 ARRANGEMENT OF THE REPORT

This research report has been arranged as follows:

Firstly, this chapter, Chapter 1, served as an orientation for the reader by providing an overview of the study. The background to the study, which included a short description of VKC and perilimbal conjunctival pigmentation, was discussed followed by the problem statement and research questions. Furthermore, the aim of the study and the study objectives were specified. The significance and value of the study were explained to justify the need for this research. Moreover, the study design, measurement procedures and research implications were outlined to provide the reader with a glimpse of the research methodology in Chapter 3. This chapter concluded with a review of the organisation of the report as well as a summative remark.

Secondly, a literature review regarding the features which characterise VKC will be provided in Chapter 2. This review will create a more refined understanding of this ocular allergic disorder and serve as a basis for the discussion chapter, Chapter 5. Furthermore, the traits of perilimbal conjunctival pigmentation and its ocular significance and association with VKC will be included. The optometric scope of practice and professional responsibility will be highlighted, and the methods of VKC detection and treatment will be identified. Thereafter, the conclusion of the chapter will indicate the importance of ocular health promotion as well as the significance of early detection and intervention of VKC.

Thirdly, Chapter 3 will discuss the methodology of this study which will include the proposed study design, the sample selection, target population, sampling method and size as well as a description of the sample. In addition, the measurement procedures used to collect the data will be presented in diagrammatic formats. The pilot study, data analysis and methodological errors will be explained, and the ethical considerations associated with this study will be reviewed.

Chapter 3 will conclude with a summary of the key aspects covered in the methodological section. Chapter 4 presents the results and findings of the data collected during this study. The findings provided by this research, through the measurement procedures specified in Chapter 3, were calculated and analysed by a biostatistician. Furthermore, a comprehensive discussion of the results identified in Chapter 4 will be found in Chapter 5. This chapter will provide the study's outcomes and the researcher's conclusions pertaining to VKC and perilimbal conjunctival pigmentation in the West Rand. Finally, Chapter 6 will present a summative overview of the study, followed by the main research conclusions. The limitations experienced during the study will be identified and the study's implications and recommendations will be discussed.

1.9 CONCLUSION

The purpose of this chapter was to introduce the reader to the research, which essentially consists of the prevalence of VKC and perilimbal conjunctival pigmentation amongst children in the West Rand. Furthermore, an overview of the organisation of the research report was provided. An in-depth literature review concerning VKC and perilimbal conjunctival pigmentation as well as its association to specific factors will be reported in the following chapter, Chapter 2.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

VKC is an allergic conjunctivitis defined as a bilateral chronic and recurrent inflammatory disorder that essentially affects the anterior ocular structures. The cornea and conjunctiva are the main anterior ocular structures affected and may present signs of conjunctival hyperaemia, perilimbal conjunctival pigmentation, tarsal conjunctival papillae and Horners-Trantas dots (Freeman, 2006; Hayilu *et al*. 2016; Malu, 2014; Pokharel *et al.* 2007). VKC was first described by Arlt in 1846, who identified the manifestation of perilimbal conjunctival swelling in young patients (Kraus, 2016). The symptoms typically experienced by patients affected by VKC are severe ocular itching, ocular lacrimation, photophobia and a foreign body sensation (Leonardi *et al.* 2012). Additionally, this disorder is classified as a treatable ocular disease which may lead to severe visual complications, such as corneal shield ulcers and keratoconus, that cause blindness when left untreated. (Addis & Jeng, 2018; Arif *et al.* 2017; Ashwini *et al.* 2015; Gokhale, 2016; Rao *et al.* 2016). Globally, VKC has become an increasingly public health challenge, as patients suffering from this disorder experience significant vision loss which inevitably affects the quality of life (Ashwini *et al.* 2015; Rao *et al.* 2016).

The content of this chapter will discuss the features which characterise VKC, such as the epidemiology, risk factors, pathogenesis as well as symptoms and signs, to create a more refined understanding of the ocular disorder. In addition, the traits of perilimbal conjunctival pigmentation will be discussed to determine its ocular significance and association with VKC. Furthermore, the scope of practice and professional responsibility of an optometrist will be highlighted with a focus on the methods of VKC detection and treatment. Thereafter, the conclusion will outline the importance of eye care promotion as well as the significance of early detection and intervention of this chronic ocular disorder.

2.2 VERNAL KERATOCONJUNCTIVITIS

The following section discusses the characteristics of VKC such as the epidemiology, the associated risk factors, the pathogenesis as well as the experienced symptoms and clinical signs.

2.2.1 Risk factors

Derived from the Greek language, *vernal* is defined as 'occurring in the spring', which indicates that regions of humid tropical climates exhibit a greater prevalence of VKC compared to regions with colder arid climates (Freeman, 2006; Jivangi *et al.* 2015; Pokharel *et al.* 2007; Saboo *et al.* 2013). This seasonal characteristic has further been confirmed in an observation by Malu (2014) in Central Nigeria, who identified that the incidence of VKC increased through spring, peaked in summer and decreased after that. In comparison, Nagpal *et al.* (2017) recognised that the ocular inflammation caused by VKC tends to decrease during the colder months of the year. In contrast to this statement, Vichyanond *et al.* (2014) indicated that although *vernal* implies a seasonal occurrence, it commonly occurs throughout the year and has been reported in large numbers through colder regions of Asia such as Japan.

The majority of patients diagnosed with VKC have been reported between the age group of 4 and 12 years. However, VKC has also been identified to persist in patients above 20 years of age (Freeman, 2006; Jivangi *et al.* 2015; Malu, 2014; Mathys & Barry Lee, 2013; Saboo *et al.* 2013). Investigations by Kawuma (2001) and Shafiq and Shaikh (2009) reported that the highest incidence of VKC occurred in children after the age of 5 years and ceased around the phase of puberty. Immunological deviations and responses to environmental elements have been considered to be influenced by hormonal and neuroendocrine factors. Hormonal factors have been considered to play a role in the development of VKC amongst children, which justifies the disorder's resolution at puberty (Stagi *et al.* 2014). Despite this observation, limited information and data are present regarding the specific reason for the higher prevalence of VKC in childhood as opposed to adulthood, therefore indicating a clear gap in the knowledge.

Considering the gender distribution of this disorder, VKC most commonly presents in males, as previous studies have observed a male predominance of 55% (Malu, 2014) and 72% (Jivangi *et al.* 2015). In contrast, one study by Cingu *et al.* (2013) reported a female predominance of 69.5% in Turkish participants affected by VKC. According to prior research, hormones such as androgens and testosterone may have an impact on IgE synthesis, eosinophil proliferation and the balance between Th1 and Th2 cytokines (proteins which mediate immunity and inflammation), thus regulating the development of allergic reactions (Sacchetti *et al.* 2015). This identification has led to the hypothesis that sex hormones may play a role in the pathogenesis of VKC, resulting in male predominance. Furthermore, De Smedt *et al.* (2011) identified a further lack of information regarding the specific risk factors which give rise to the high prevalence of VKC in the African continent. To date, the risk factors of VKC have been recognised as allergic predisposition, socio-economic status and environmental stimulants (Ahmed *et al.* 2019; Malu, 2014).

Nevertheless, there are conflicting reviews in the literature regarding the association between a history of systemic allergic disorders (atopy) and the onset of VKC. In Ethiopia, the presence of non-ocular allergic disorders such as asthma, eczema, bronchitis and hay fever have been identified to increase the development of VKC by four times (Hayilu *et al.* 2016). Kanski (2003) suggested that 75% of patients diagnosed with VKC reported the presence of systemic allergic diseases. In contrast, further studies in Nigerian and Indian hospitals identified that the history of systemic allergic reactions was less common as only 5.04% of VKC cases were associated with a history of allergies (Jivangi *et al.* 2015; Malu, 2014; Saboo *et al.* 2013). Moreover, Rao *et al.* (2016) found that 57.6% of VKC patients in an Indian tertiary eyecare institute were associated with a low socio-economic group, whilst 42.4% were associated with a high socio-economic group. Besides, Marais (2017) reported a significant association between environmental factors in South Africa's setting and the occurrence of wheezing, asthma and rhino-conjunctivitis, as individuals residing within proximity to rural mining areas commonly display these allergic disorders.

According to evaluations, environmental stimulants which typically intensify this ocular disorder are pollen, wind, sunlight, dust, smoke and re-exposure to allergens (Addis & Jeng, 2018; Ahmed *et al.* 2019; Leonardi *et al.* 2012; Malu, 2014). Ahmed *et al.* (2019) stated that the dusty, pollen loaded environments of agricultural and rural areas in Egypt increase the prevalence of VKC. Consequently, exposure to dust leads to the development of VKC being ten times higher compared to cases without dust exposure (Addis & Jeng, 2018; Leonardi *et al.* 2012; Malu, 2014). Additionally, Hayilu *et al.* (2016) found that children were 6.25 times more likely to develop VKC when exposed to smoke from fires used for food preparation compared to children in households using electricity.

Considering the statement above, it is important to note that Statistics SA have reported a total of 5 761 354 South Africans who use electricity as an energy source for food preparation, whilst 2 292 674 using open fires (Statistics SA, 2003). Alemayehu *et al.* (2018) conducted a study regarding the risk factors associated with the development of VKC in 574 children from Gambella town, Southwest Ethiopia. The researchers found that 68.75% of children with VKC were males and that 40.62% of children with active VKC have been exposed to dust. Furthermore, 44.44% of children with VKC had been in contact with animal dander, and 32.81% of children with VKC were exposed to open fields and fires while cooking. These results correspond to the risk factors discussed earlier and are displayed below in Figure 2.1.

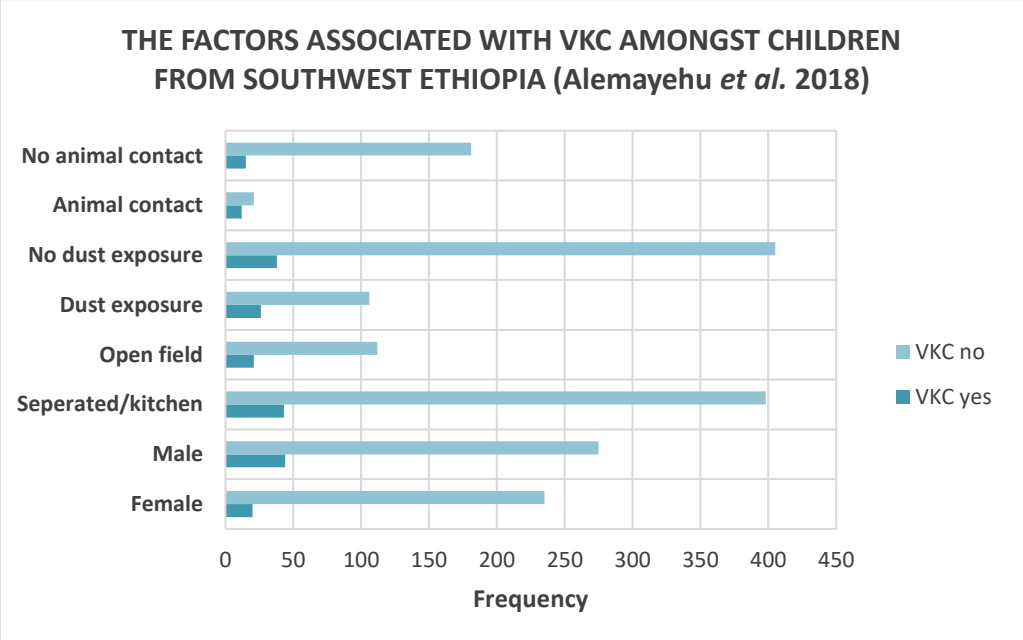

FIGURE 2.1: THE FACTORS ASSOCIATED WITH VKC AMONGST CHILDREN FROM SOUTHWEST ETHIOPIA (Alemayehu *et al.* 2018).

2.2.2 Epidemiology

La Rosa *et al.* (2013) stated that ocular allergy appears as one of the most common ocular conditions encountered in clinical practice. Allergic conjunctivitis is an ocular inflammatory reaction which encompasses a group of disorders that trigger inflammation of the anterior ocular surfaces (Quinones & Foster, 2008). Patients affected with allergic conjunctivitis typically present with symptoms of ocular itching, ocular lacrimation, a burning sensation, as well as clinical signs of conjunctival chemosis and vasodilation (Ackerman *et al.* 2016).

According to prior investigations, allergic conjunctivitis and its diagnosis have increased throughout the years and has become a significant problem from a public health perspective (Rathi & Murthy, 2015). With reference to this information, allergic conjunctivitis has been estimated to affect at least 15 to 20% of the population in developed countries such as the United States (La Rosa *et al.* 2016; Vally & Irhuma, 2017). The immunopathogenesis of ocular allergic disorders is mediated by an Immunoglobulin-E (IgE) hypersensitivity reaction. Mast cells are activated during the ocular inflammatory response and induce an enhanced tear level of histamine, which results in the clinical allergic presentation (La Rosa *et al.* 2013). Consequently, allergic conjunctivitis may result in an impaired quality of life as poor diagnosis and late treatment or the lack thereof may lead to sight-threatening complications or blindness (Marais, 2017; Pathai, 2010). The five divisions which compose allergic conjunctivitis include seasonal allergic conjunctivitis (SAC), perennial allergic conjunctivitis (PAC), vernal keratoconjunctivitis (VKC), atopic keratoconjunctivitis (AKC) and giant papillary conjunctivitis (GPC) (Ackerman *et al.* 2016; Gokhale, 2016; La Rosa *et al.* 2013).

From an epidemiological perspective, Vichyanond *et al.* (2014) stated that VKC manifests worldwide as its distribution has been reported from numerous continents. Observations by Hayilu *et al.* (2016) and Kawuma (2001) identified that VKC appeared to be less common amongst the populations in areas such as Northern Europe and North America. However, Mediterranean areas namely Italy and more arid countries such as India, Nigeria, Pakistan, Rwanda and South America have reported a greater prevalence of VKC (Ahmed *et al.* 2019; De Smedt *et al.* 2013; Khan *et al.* 2012; Leonardi *et al.* 2006; Malu, 2014; Saboo *et al.* 2013).

Epidemiological reports have recently provided evidence of a genetic component observed in patients located in areas with a low prevalence of VKC. These patients have been identified as first and second-generation immigrants from countries where VKC is considered to be more habitual (Ahmed *et al.* 2019). In France, Bremond-Gignac *et al.* (2008) found a VKC prevalence rate of 0.7 (0.07%) to 3.3 (0.33%) per 10'000 inhabitants. Furthermore, Hall and Shilo (2005) recorded a VKC prevalence in 25% of patients in a paediatric eye clinic in the hot coastal climate of Tanzania, East Africa. In addition, Kawuma (2001) identified a further 420 children affected by VKC in the warm tropical region of Uganda. Duke *et al.* (2017) examined a total of 1226 Nigerian school children, of which 18.2% were diagnosed with VKC. Singh *et al.* (2018) additionally studied 415 participants for the prevalence of ocular disorders and reported that of these participants, 111 cases presented with VKC. Epidemiological evidence has suggested a clear gap in the existing knowledge of South Africa, as limited information regarding the prevalence of VKC amongst specific South African cities could be found.

2.2.3 Pathogenesis

In 1998, Avunduk *et al.* stated that the exact pathogenesis of VKC was unknown. In 2014, Stagi *et al.* reported that the aetiology and immunopathogenesis of VKC remained unclear. To date, the immunopathogenesis of VKC is believed to be multifactorial. Both antigens and pathogenic mechanisms may cause harm to the eye as the ocular surface is directly exposed to the external environment (Duke *et al.* 2017). The hypersensitivity reaction of VKC is mediated by both immediate and delayed inflammatory responses (Dahal & Bhattarai, 2015; Khan *et al.* 2012). IgE-dependant (immediate) responses occur directly after the exposure to an allergen and IgE-independent (delayed) responses occur up to 72 hours after exposure to a topical medication. Furthermore, IgE mediated reactions are the most critical component of the VKC pathogenesis. IgE reactions and cell-mediated Th2 involvement activate a variety of cells such as basophils, eosinophils, macrophages, mast cells and lymphocytes (Dahal & Bhattarai, 2015; Chigbu & Sandrasekaramudaly-Brown, 2011; Leonardi *et al.* 2012; Malu, 2014).

These inflammatory cells, namely basophils, eosinophils and mast cells, are involved with local and systemic inflammatory reactions. Histamine is an important inflammatory mediator and is released through the activity of mast cell degranulation. Elevated levels of histamine results in ocular hyperaemia, oedema and vasodilation of the ocular vessels (De Smedt *et al.* 2013; Naggalakshmi *et al.* 2014). Furthermore, high levels of IgE, histamine, mast cells, basophils and eosinophils are found to be consistently present in the tears of patients with VKC (Cruzat & Colby, 2017). Similarly, De Smedt *et al.* (2015) identified an infiltration of these inflammatory cells in the substantia propria and epithelium of a conjunctival biopsy from a patient affected by VKC. According to the findings above, the activation of these inflammatory cells leads to the release of vasoactive amines which induces the clinical manifestation of VKC (Dahal & Bhattarai, 2015).

2.2.4 Signs and symptoms

Throughout the year, patients may experience various episodes of active VKC (Kumar, 2009). Due to the chronic and recurrent nature of this disorder, its symptoms may affect the physical activity, school performance and somatic sensation of a child, thus influencing the quality of life (Bremond-Gignac *et al.* 2008; Duke *et al.* 2017; Vichyanond *et al.* 2014).

As with any allergic conjunctivitis, the most common symptom of VKC is severe ocular itching. Other symptoms include photophobia, ocular lacrimation and a foreign body sensation. (Duke *et al.* 2017; Freeman, 2006; Malu, 2014). In a study done by Ahmed *et al.* (2019), they identified that ocular lacrimation was present in most of their patients, followed by photophobia. In addition to these symptoms, clinical signs such as hyperaemia of the bulbar and tarsal conjunctiva and a thick purulent mucous discharge may be observed. Unlike the feature of the mucous discharge produced by bacterial conjunctivitis, few VKC patients experience the glue-like effect of the discharge when opening their eyes in the mornings (Vichyanond *et al.* 2014).

The signs of VKC have been found to present bilaterally; however, through the initial stages, it may occasionally present unilaterally (De Smedt *et al.* 2013). The classification of VKC is based on the main site of the hypersensitive reaction and is divided into three clinical forms: palpebral, limbal and mixed VKC (De Smedt *et al.* 2013; Kanski, 2003; Leonardi *et al.* 2012; Vichyanond *et al.* 2014).

Firstly, clinical signs of palpebral VKC are identified by performing upper lid eversion. Large hypertrophic papillae on the superior tarsal conjunctiva are frequently observed. Conjunctival papillae are classified as smooth or ulcerative projections of 0.2 millimetres in diameter, which may regress into larger flat lesions resembling cobblestones, known as giant papillae. In 1871, Von Graefe was the first to describe the cobblestone papillae attributed to palpebral VKC (Kraus, 2016). Along with conjunctival papillae, other signs such as hyperaemia and a mucous discharge may be noted in this specific area. Kumar (2009) stated that this sign of conjunctival papillae might persist, although the disease is inactive.

Secondly, limbal VKC is distinguished by signs of limbal opacification and oedema with the presence of translucent viscous nodules surrounding the limbus. These nodules contain inflammatory infiltrates of degenerating eosinophils and epithelial cell debris. As these nodules mature, they form calcified punctate lesions containing gelatinous infiltrative substances, called Horner-Tranters dots (Naggalakshmi *et al.* 2014). The limbal findings of VKC were first described by Desmarres in 1855 and are now used to differentiate the forms of VKC (Kraus, 2016). Prior research has further identified that neovascular pannus of the peripheral cornea accompanies limbal VKC, which results in the appearance of a swollen limbal area. Additionally, ocular hyperaemia and a ropy discharge may also be observed. Limbal papillae differentiate VKC from other ocular allergies which present with similar symptoms of ocular itching, photophobia and a foreign body sensation (De Smedt *et al.* 2013).

Thirdly, mixed VKC is a combination of giant papillae on the upper tarsal conjunctiva as well as limbal nodules or Horner-Trantas dots around the limbal area, frequently accompanied by ocular hyperaemia and discharge (De Smedt *et al.* 2013; Gokhale, 2014; Kumar, 2009; Mathys & Barry- Lee, 2013; Vichyanond *et al.*2014). Mushtaq *et al.* (2016) reported that VKC is not a blinding ocular disorder; however, the involvement of the cornea may lead to visual impairments resulting in visual loss. It has been identified that 50% of VKC cases present with corneal involvement such as epithelial necrosis, punctate epithelial keratitis (PEK) and pannus (Naggalakshmi *et al.* 2014). According to the literature, these corneal conditions are the result of mechanical trauma caused by giant papillae and toxic substances released from eosinophils and mast cells (Mushtaq *et al.* 2016).

A clinical grading system is a useful method to utilise when classifying the severity of this disorder to provide the most appropriate method of treatment. Gokhale (2014) created a grading system and categorized the ocular disorder as quiescent, mild, moderate and severe. Quiescent VKC is defined as the absence of symptoms and clinical signs while with mild VKC, there is the presence of symptoms without corneal involvement. Moderate VKC is defined as the presence of symptoms especially photophobia, without corneal involvement. Lastly, severe or chronic VKC is defined as the presence of symptoms, photophobia and mild to moderate corneal superficial punctate keratitis (SPK) or corneal ulcers. The VKC grading system compiled by Gokhale (2016) is displayed in Table 2.1.

TABLE 2.1: GRADING SYSTEM OF VKC (Gokhale, 2016).

CLINICAL FINDINGS	GRADING		
	Mild	**Moderate**	**Moderate or Chronic**
Symptoms	Present	Present	Present
Papillae	Present	Present	Present
Horner-Trantas dots	Not present	Present	Present
SPEE	Not present	Present	Present
Limbal inflammation	Not present	Present	Present
Cobblestones	Not present	Not present	Present

* Superficial Punctate Epithelial Erosions (SPEE)

Concerning the literature, Malu (2014) identified that the palpebral form of VKC presented predominantly in European and America populations, whilst the mixed and limbal form were more predominant in African and Asian populations. Additionally, Hall and Shilo (2005) identified that the limbal form of VKC presented more frequently in females and individuals of a darker skin complexion. In India, Saboo *et al.* (2013) reported that 71.8% of patients were affected with mixed VKC, 15.6% had isolated palpebral VKC and 12.6% displayed limbal involvement. Furthermore, a Nepalese study by Pokharel *et al.* (2007) diagnosed 82.3% of patients with the mixed form of VKC and 17.7% of patients with the palpebral form.

Duke *et al.* (2016) conducted a study in Nigeria amongst primary school children and found that limbal papillae were present in 35.4% of the children's right eyes and 35% of their left eyes. Horner-Trantas dots were identified in 17.4% of the children's right eyes and 17.9% of their left eyes. Only 8% of children presented with the palpebral form of VKC.

To conclude, VKC is a chronic form of allergic conjunctivitis and is classified as a preventable ocular disorder. This inflammatory disorder can lead to numerous academic or social barriers and physical challenges as well as severe visual complications or blindness. The development of VKC favours a humid tropical climate. Thus, Mediterranean areas have reported a greater prevalence of VKC. Prior observations have identified that VKC is linked to a personal or family history of allergic diseases. The risk factors of VKC have been identified as allergic predisposition, socio-economic status and environmental stimulants. Moreover, the pathogenesis of VKC is described as multifactorial; nevertheless, research has demonstrated that IgE mediated responses play a large role in the progression of the disorder.

Pre-pubertal males are predominantly affected by VKC, and most patients have been reported between the age group of 4 and 12 years. Furthermore, VKC typically presents with symptoms of severe ocular itching, ocular lacrimation, photophobia and a foreign body sensation. The classification of this ocular disorder is divided into three clinical forms: palpebral, limbal and mixed VKC. Palpebral VKC is described by clinical signs such as conjunctival hyperaemia, tarsal conjunctival papillae or cobblestone papillae. Limbal VKC is identified by signs similar to the palpebral form, including the presence of limbal infiltrates and Horner-Trantas dots. Mixed VKC is classified by the presence of palpebral papillae as well as limbal infiltrates or Horner-trantas dots. These distinctive clinical signs differentiate VKC from other allergic disorders, namely seasonal and perennial allergic conjunctivitis.

2.3 PERILIMBAL CONJUNCTIVAL PIGMENTATION

Perilimbal conjunctival pigmentation, a brown discolouration of the conjunctival surface, was recognised in South African patients affected by VKC as early as 1983 by Dahan and Appel. Furthermore, the pigmentation of the conjunctiva has been identified as a consistent and possible clinical sign of VKC throughout numerous published studies (Duke *et al.* 2017; Khan *et al.* 2012; Kumah *et al.* 2015; Luk *et al.* 2008).

The following section will describe the features and characteristics of perilimbal conjunctival pigmentation, including its prevalence, aetiology and association with VKC.

2.3.1 Features and characteristics

As mentioned above, Dahan and Appel (1983) noted an unusual clinical appearance presenting in Black South African children. Patients exhibited an oedematous hyperpigmented perilimbal conjunctival region, which was unlike the typical picture of VKC displayed in Western Europeans. Following this finding, Rao *et al.* (2002), as cited by Khan *et al.* (2012) mentioned that perilimbal conjunctival pigmentation was recognised as a new diagnostic sign of VKC. Perilimbal conjunctival pigmentation is characterised by scattered spot-like or granular deposits of faint golden to dark brown pigment, distributed around the exposed perilimbal surface. Overall, the pigmentation remains a consistent colour from the limbal area to the bulbar and interpalpebral conjunctiva as well as the fornix (Khan *et al.* 2012).

Khan *et al.* (2012) recorded the patient's skin complexion and extent of perilimbal conjunctival pigmentation found in their study by using a numbered scale. Firstly, the skin complexion was graded from one to five as little or no tan (one), minimal tan (two), light brown (three), dark brown (four) and black (five). Secondly, the perilimbal conjunctival pigmentation was graded according to the number of conjunctival quadrants involved on a scale of one to four.

Thirdly, the density of the pigmentation was graded on a scale from one to three from mild (one) to moderate (two) and severe (three). Finally, the intensity of the pigment shade was graded on a scale of one to three from light brown (one) to dark brown (two) and black (three). The numbered scale is presented in Table 2.2.

TABLE 2.2: NUMBERED SCALE FOR SKIN COMPLEXION AND EXTENT OF PERILIMBAL CONJUNCTIVAL PIGMENTATION (PCP) (Khan, 2012).

VARIABLES	GRADING				
	1	**2**	**3**	**4**	**5**
Skin complexion	No tan	Minimal tan	Light brown	Dark brown	Black
Quadrants involved	One	Two	Three	Four	-
Density of PCP	Mild	Moderate	Severe	-	-
Intensity of PCP	Light brown	Dark brown	Black	-	-

2.3.2 Prevalence

Perilimbal conjunctival pigmentation has been identified as a consistent sign and possible indication of VKC in individuals with a darker skin complexion. Following the discovery of perilimbal conjunctival pigmentation in 1983, numerous researchers including Duke *et al.* (2017), Khan *et al.* (2012), Kumah *et al.* (2015) and Luk *et al.* (2008) have described a brown pigmentation in the perilimbal conjunctival region of patients affected with VKC. Further studies by researchers in China, India, Nepal, Nigeria, Pakistan and the USA agreed that the pigmentation appeared to be a constant clinical sign amongst the diagnosed patients (De Smedt *et al.* 2013; Duke *et al.* 2017; Chigbu & Sandrasekaramudaly-Brown, 2011; Jivangi *et al.* 2015; Malu, 2014; Pokharel *et al.* 2007; Saboo *et al.* 2013).

The prevalence of a disease is the measurement of individuals who present with a disease at a particular period. Research has identified perilimbal conjunctival pigmentation to be most prevalent amongst African and Asian patients affected with VKC and presents especially in younger children (Ahmed *et al.* 2019; Luk *et al.* 2008).

In China, Luk *et al.* (2008) identified that bilateral perilimbal pigmentation presented in 84.2% of VKC patients. Furthermore, a study by Ahmed *et al.* (2019) in Egypt noted that pigmentation was seen in 60% of patients diagnosed with VKC. In India, Rao *et al.* (2016) recorded that 24% of patients with VKC displayed perilimbal conjunctival pigmentation simultaneously. Moreover, as stated by Duke *et al.* (2017), 59.2% of Nigerian patients with VKC exhibited hyperpigmentation of the perilimbal area while another 14.7% of patients from Nepal were identified with VKC and perilimbal pigmentation (Phokharel *et al.* 2007).

In contrast to the higher percentage of pigmentation recognised in India by Rao *et al.* (2016), Saboo *et al.* (2013) identified only 11% of VKC patients with pigmentation. On account that higher percentages of pigmentation were reported by different researchers, Saboo *et al.* (2013) assumed that the smaller percentage rate in their study was the result of poor documentation of this new sign. Concerning the spreading of the pigmentation on the ocular surfaces, Khan *et al.* (2012) documented the quadrant distribution of bulbar conjunctival pigmentation in 50 patients diagnosed with VKC from South Asia. Among these patients, 56% displayed perilimbal conjunctival pigmentation in three to four quadrants of the bulbar conjunctiva. The quadrant distribution of the pigment of this specific study is displayed in Figure 2.2.

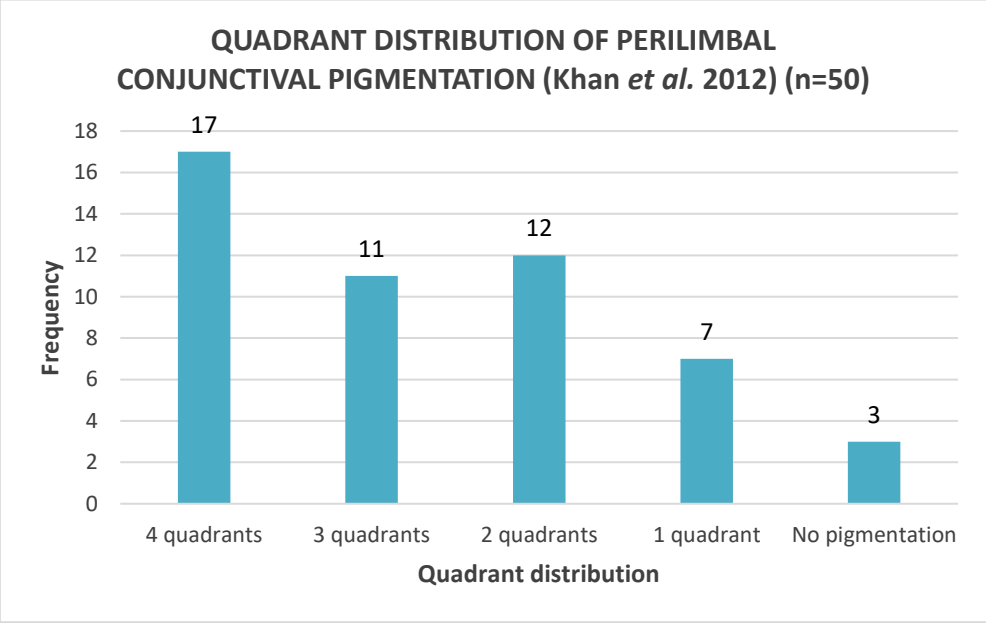

FIGURE 2.2: QUADRANT DISTRIBUTION OF PERILIMBAL CONJUNCTIVAL PIGMENTATION (Khan *et al.* 2012).

The results of Figure 2.2 demonstrate that at least 34% of patients displayed pigmentation in all four conjunctival quadrants, whilst 6% of patients displayed no pigmentation.

2.3.3 Aetiology

By virtue that most of the previous research only included VKC patients with a medium to dark complexion, researchers have argued that the reported perilimbal conjunctival pigmentation may be influenced by skin complexion (Khan *et al.* 2012; Luk *et al*. 2008). Duke *et al.* (2017) stated that individuals of a darker skin tone tend to have an abundance of melanocytes around the limbus, which causes a brown discolouration of the conjunctiva. However, with regard to the statement, individuals without active VKC may similarly present with ocular and/or conjunctival pigmentation. Disorders which may induce this clinical picture includes complexion associated melanosis, vitamin A deficiency and chemical injury of the conjunctiva (Khan *et al.* 2012). Complexion associated melanosis is a benign pigmented lesion which presents in individuals with a darker complexion (Sayyad & Karp, 2013).

Unlike the pigmentation associated with VKC, this specific pigmented lesion appears more intense in colour at the limbal area and fades outward to the fornix (Rao *et al.* 2002 as cited by Khan *et al.* 2012; Sayyad & Karp, 2013). Vitamin A deficiency may affect the ocular structures which leads to symptoms of night blindness as well as clinical signs of conjunctival xerosis, corneal ulcers, scarring and Bitot's spots (Gilbert, 2013). Contrary to the pigmentation associated with VKC, perilimbal pigmentation seen in patients with vitamin A deficiency can be differentiated by the presence of Bitot's spots, which are small Caucasian keratin deposits found on the conjunctiva. In addition, patients who have experienced ocular chemical injury may display signs of bulbar conjunctival pigmentation. In contrast to the fine granular appearance of the pigmentation found in patients with VKC, conjunctival pigmentation linked to chemical trauma appears to be streaked and patchy (Gilbert, 2013; Khan *et al.* 2012). As opposed to the assumption that perilimbal conjunctival pigmentation in VKC is influenced by skin complexion, studies by Khan *et al.* (2012) and Luk *et al.* (2008) found that there was no significant link between skin tone and perilimbal conjunctival pigmentation, as patients who presented both with and without VKC were of a similar skin complexion.

Further contradictions have emerged from the literature regarding the aetiology of perilimbal conjunctival pigmentation recognised in VKC. The substantia propria and epithelium of the cornea and conjunctiva contain infiltrates of eosinophils, macrophages, mast cells and melanocytes. Macrophages are white blood cells which digest cellular debris to reduce inflammation and bring about tissue repair (De Smedt *et al.* 2013; Leonardi, 2013). Mast cells initiate the ocular inflammatory process by binding to IgE mediators whilst eosinophils cause damage to the corneal and conjunctival epithelium by releasing cytotoxic proteins (Naggalakshmi *et al.* 2014).

Melanocytes and mast cells appear to be in abundance around the limbal area; thus, the limbus plays a role in the immunology of VKC (Duke *et al.* 2017; Khan *et al.* 2012). Furthermore, Luk *et al.* (2008) reported the possibility that growth hormones and factors may stimulate limbal melanocytes to produce perilimbal conjunctival pigmentation. Thus, the ocular pigment displayed in children affected by VKC may be due to the elevated level of active growth hormones during childhood.

On the contrary, there are researchers who have suggested that perilimbal conjunctival pigmentation may be caused by melanophages, which are inflammatory macrophage cells that have ingested melanin and cause melanogenesis. Thus, concluding that there may be an association between inflammatory responses and melanocytic activity (De Smedt *et al* .2013; Duke *et al.* 2017; Khan *et al.* 2012; Luk *et al.* 2008). Zimmerman, as cited by Khan *et al.* (2012), noted that the melanocytic activity and density of pigmentation diminished once the inflammatory response had subsided during a study in 1966. Perilimbal conjunctival pigmentation has further been shown to persist in patients with quiescent VKC and when the disorder is in remission (Duke *et al.* 2017). Similarly, Khan *et al.* (2012) reported that the density of pigmentation found in VKC did not correlate to the duration and chronicity of the allergic disorder and was thus classified in active and quiescent forms of VKC. Nonetheless, Dahan and Appel (1983) were the only researchers to publish a South African study regarding perilimbal conjunctival pigmentation seen in VKC, stating that the pigment in the interpalpebral fissure was most likely caused by exposure to harmful UV rays.

Therefore, the researchers also questioned the male predominance could be attributed to the fact that young males more often spend time outdoors in the sun compared to young females. With reference to the literature, there are numerous theories regarding the aetiology of perilimbal conjunctival pigmentation recognised in patients with VKC. To conclude, the aetiology may be attributed to an abundance of melanin cells around the limbus in individuals of a darker complexion, the presence of melanophages during ocular allergic reactions and the frequent exposure to harsh sunlight.

2.3.4 Association of perilimbal conjunctival pigmentation with vernal keratoconjunctivitis

Recent interest has evolved regarding the consistent presence of perilimbal conjunctival pigmentation in patients with VKC. Numerous researchers have argued whether the pigmentation is triggered by ocular inflammatory responses or by an abundance of melanin cells around the limbus in individuals of a darker skin tone (De Smedt *et al.* 2013; Duke *et al.* 2017). Although studies have been conducted on international levels, to date, no South African study concerning perilimbal conjunctival pigmentation in VKC and its association with ocular allergic responses and racial factors has been performed. Thus, an insufficient amount of knowledge is present in South Africa concerning the possibility that perilimbal conjunctival pigmentation may contribute to the early identification, diagnosis and treatment of VKC.

In 2001, a South African census recorded the number of individuals presenting with a disability within the population. All forms of physical or mental disabilities, which prevented the individual from executing daily routines or participating in social, economic or educational activities, were included. Out of the total population, 2 255 982 (5%) South Africans presented with a disability of which the largest group (1.3%) was the disability of sight (Statistics SA, 2003). Considering the large prevalence of visual disability, it is of utmost importance that South African optometrists contribute towards promptly addressing visually threatening conditions, such as VKC (Sacharowitz, 2005).

The question which comes to mind is whether perilimbal conjunctival pigmentation is significantly relevant to VKC, as racial factors may influence the clinical picture. Therefore, it is equally important to identify whether perilimbal conjunctival pigmentation displayed in VKC is induced by ocular allergic responses or racial factors.

Sithole (2017) stated that the ocular health promotion in South Africa appeared non-existent as a lack of developmental strategies to implement improved primary eyecare projects was observed. Similarly, Malik *et al.* (2018) reported a detectable global shortage in the management of childhood ocular problems, the development of vision and the promotion of eye care. Considering these statements, early clinical signs of VKC may be used to implement the progression of enhanced primary eyecare amongst health professionals. Provided that perilimbal conjunctival pigmentation recognised in VKC originates from ocular allergic responses, optometrists and ophthalmologists may use this clinical sign to identify the early development of VKC. The promotion of ocular health amongst children may encourage the development of motor and mobility skills to improve academic and social challenges and prevent the onset of sight-threatening conditions (Khan *et al.* 2012; Luk *et al.* 2008; Naidoo, 2014).

To summarise, in other studies, children affected by VKC consistently present with the clinical sign of perilimbal conjunctival pigmentation. Research has identified that the African and Asian populations tend to display this pigmentation more frequently. The aetiology of perilimbal conjunctival pigmentation may be influenced by an abundance of ocular melanocyte cells or the inflammatory activity of melanophages. Perilimbal conjunctival pigmentation has been identified as an early indication of the development of VKC and may assist optometrists and ophthalmologists in the identification thereof. Ocular health amongst children may thus be promoted if this ocular sign contributes to the early diagnosis and prompt intervention of the allergic disorder. Throughout this study, the prevalence of perilimbal conjunctival pigmentation will be investigated to establish the association of this feature with ocular allergic responses and racial factors.

2.4 DIAGNOSIS AND TREATMENT OF VERNAL KERATOCONJUNCTIVITIS

Present-day medical science supports the concept that the early identification and diagnosis of a disease leads to prompt implementation of intervention and treatment, resulting in a more favourable outcome. On account of this, the early diagnosis of VKC is a crucial aspect to prevent the visual complications previously described.

The following section will discuss the multi-dimensional approach required for the management of VKC. The optometric scope of practice will be included as well as the optometrist's role in identifying VKC through ocular investigations. Furthermore, this section will focus on the available treatment and intervention options for VKC.

2.4.1 The role of the optometrists

Public healthcare is a spectrum of services which provide empathetic care for individuals (Gilbert, 1998). These services include the prevention, management and palliative care for chronic conditions. Primary eyecare provided by optometrists and ophthalmologists is a division of public healthcare which includes the identification, diagnosis, treatment and prevention of sight-threatening and potentially blinding ocular conditions (Gilbert, 1998). Secure public healthcare systems deliver greater efficiency and effectivity in services provided, thus creating more favourable health outcomes (Maphumulo & Bhengy, 2019). Optometrists are qualified independent professionals who are dedicated to the healthcare of the ocular system (NCSL, 2018). As derived from the Greek language, the word optometry is defined as *optos* which means 'sight or view' and *metry* signifying 'to measure' (Bergin, 2017). To become a qualified optometrist, individuals complete a four year accredited university degree, upon which the optometrists become licensed to examine, identify, diagnose and treat ocular conditions (NCSL, 2018; Schleiter, 2010). The scope of optometry in South Africa includes the performance of ocular examinations to detect refractive errors and provide clear, comfortable vision through the correction of spectacles and contact lenses, as well as providing visual therapy and low vision rehabilitation (Schleiter, 2010).

Furthermore, optometrists are trained to identify ocular disorders or pathology, namely dry eyes, ocular infections, cataracts, glaucoma, age-related macular degeneration and retinopathy. Additionally, optometrists may further identify underlying systemic health conditions such as diabetes mellitus, hypertension, connective tissue disorders and hyperthyroidism which disturb the visual system and ocular structures (Bergin, 2017; HPA, 2007; Maake, 2014; Schleiter, 2010). Arising from the fact that optometrists in South Africa are not permitted to treat patients with surgical procedures, it is of importance that optometrists refer patients who require pharmaceutical treatment to an ophthalmologist.

Ophthalmologists are medical practitioners who have graduated with a degree in medicine and have further specialised in the diagnosis and surgical or pharmaceutical treatment of ocular disorders (Bergin, 2010; HPA, 2007; Maake, 2014). International entities have indicated that optometrists play an important role in the eyecare system. The American Optometric Association (AOA) (2013) estimated that out of 104 million eye examinations performed by American eyecare professionals, 88 million of these exams were performed by optometrists. Moreover, the AOA (2013) determined that optometrists prescribed at least 90% of visual corrective devices such as spectacles and contact lenses to patients.

Ocular investigations which are performed by optometrists to diagnose VKC accurately include a complete case history, preliminary ocular tests, ocular refraction and a detailed anterior segment examination. Firstly, on commencement of the ocular examination, detailed case histories are recorded to collect information regarding the patient's symptoms and factors affecting the development of the ocular disorder (Ashwini *et al.* 2015; Dahal & Bhattarai, 2015; Duke *et al.* 2017; Pokharel *et al.* 2007). The optometrist enquires about the patient's ocular, medical and family history, noting the presence of systemic disease and the use of medication. Hayilu *et al.* (2016) determined that the presence or history of non-ocular allergies such as asthma, eczema, bronchitis and hay fever increased the development of VKC. According to this information, it is of importance to note whether the patient has reported a presence or history of systemic allergies. The optometrist further probes the onset, severity and duration of the patient's symptoms to initiate the diagnostic process.

Secondly, preliminary ocular tests such as visual acuity (VA) measurements are performed to determine the best-corrected VA. The best-corrected distance VA is the resolving power of the eye or the smallest line of letters which an individual can identify with a spectacle or contact lens prescription in place (Williams *et al.* 2008). Furthermore, ocular refraction is performed to determine the patient's refractive error which may indicate the possible visual influence of VKC (Duke *et al.* 2017). Ocular refraction consists of a series of objective and subjective tests performed to assess the refractive error and prescription of an individual (National eye institute, 2010). Finally, the identification of clinical signs occurs during ocular health assessments, which include comprehensive investigations of the anterior ocular surface.

The anterior surface assessment is performed with the use of a slit lamp biomicroscope to identify conjunctival hyperaemia, perilimbal conjunctival pigmentation, tarsal papillae, limbal infiltration and Horner-Trantas dots. A slit lamp biomicroscope examines the anterior and posterior ocular surfaces by using magnification and the projection of light beams (Clover, 2018). In conjunction with a cobalt blue light filter, fluorescein staining is used to assess the cornea and conjunctiva for possible epithelial defects such as SPEE which is identified in moderate and chronic VKC (Khan *et al.* 2012; Luk *et al.* 2008).

2.4.2 Prognosis and treatment options

Ocular allergic disorders can negatively affect the quality of life, as late diagnosis and poor management of symptoms and signs may lead to severe sight-threatening complications and possible visual loss (Rathi & Murthy, 2015). Accordingly, there is a considerable need for a better understanding of the management of ocular allergic disorders. Consequently, the lack of distinct management guidelines results in limitations to the current management strategies (Gokhale, 2016). Kumah *et al.* (2015) noted that 70% of children diagnosed with VKC in Ghana did not receive any form of medical treatment. A possible explanation, provided by Kumah *et al.* (2015), for not receiving treatment was the fact that parents and legal guardians did not consider their child's itching and brown coloured eyes as a concern. Additionally, in their study, Ashwini *et al.* (2015) identified that only 22% of patients affected with VKC sought medical care for their ocular problems. The researchers stated that this finding highlighted the need for increasing public awareness regarding ocular diseases and treatment options in order to improve the healthcare system.

VKC has been classified as a self-limiting disorder which resolves spontaneously after puberty (De Smedt *et al.* 2015). However, studies have revealed that the untreated symptoms and signs of VKC may cause ocular complications which lead to irreversible damage of the ocular structures and possible blindness (Ashwini *et al.* 2015; Freeman, 2006; Saboo *et al.* 2013; Vichyanond *et al.* 2014). Complications such as punctate epithelial erosions or superficial punctate keratitis may be found on the superior corneal epithelium and near the visual axis. Peripheral corneal neovascularisation and corneal scarring are additional complications noted in patients diagnosed with VKC.

Moreover, corneal epithelial defects may become confluent to form circular shield ulcers and scars which compromises the patient's vision. Freeman (2006) noted that patients with VKC displayed a higher incidence of corneal thinning and ectasia, which are common signs of keratoconus. Furthermore, some patients have displayed ptosis of the upper eyelid which may be induced by the constant rubbing of the eyelids due to the itchy sensation (Ashwini *et al.* 2015; Freeman, 2006; Saboo *et al.* 2013; Vichyanond *et al.* 2014). In East Africa, up to 10% of patients affected by VKC risked visual loss due to the development of corneal ulcers, corneal pannus, glaucoma and cataracts (Hall & Shilio, 2005). Therefore, prompt and appropriate treatment of VKC is of great importance to encourage ocular health and prevent the onset of these sight-threatening complications (Duke *et al.* 2017; Rao *et al*. 2016; Saboo *et al.* 2013). The method of treatment of VKC depends on the duration and consistency of the symptoms as well as the severity of the accompanying ocular complications (Leonardi, 2013).

Preventative or conservative measures and pharmacological treatment may be used to prevent the onset of VKC and treat the presenting signs and symptoms. Optometrists are responsible for providing the first line of VKC treatment which consists of providing awareness regarding preventative measures that should be aimed at eliminating specific factors which trigger VKC, to delay the development thereof. These preventative measures consist of avoiding environmental triggers such as dust, wind, harsh sunlight and smoke by using sunglasses, hats, visors and avoiding close contact with smoke from open fires. Patients should be advised to avoid rubbing their eyes as this may aggravate epithelial defects found on the cornea and may worsen their symptoms (Freeman, 2006; Hayilu *et al.* 2016; Leonardi *et al.* 2012; Vichyanond *et al*. 2014).

Furthermore, optometrists may demonstrate and implement the use of cold compresses and preservative-free eye drops or saline solution to relieve symptoms of itchiness and foreign body sensations (Addis & Jeng, 2018; Chigbu & Sandrasekaramudaly-Brown, 2011; Mashige, 2017). As stated by Vichyanond *et al.* (2014), frequently rinsing the eyes with preservative-free saline solution removes epithelial cell debris and offers more ocular comfort. Referring back to the optometric scope, optometrists do not have licensed privileges to treat patients with schedule medications or surgical procedures. Thus, patients with severe cases of VKC need to be referred to an ophthalmologist.

The symptoms and signs of VKC are further managed through the prescription of anti-allergic medications such as antihistamines, mast cell stabilizers, non-steroidal anti-inflammatory drugs (NSAIDs) and corticosteroids. When considering pharmacological treatments, topical antihistamines such as levocabastine and emedastine are examples of the initial line of therapy. These antihistamines contain H1-antagonists and vasoconstrictors, which reduce inflammation of the conjunctiva and minimize symptoms of VKC (Mashige, 2017). However, studies have identified that these H1-antagonists do not produce the desired outcome. For this reason, newer agents with enhanced potencies such as epinastine are preferred (Vichyanond *et al.* 2014). Compared to systemic antihistamines, Kumar (2009) indicated that topical antihistamines produce a more effective and efficient outcome with a faster and longer duration of mechanical action.

In addition to antihistamines, other useful drugs such as mast-cell stabilizers, for example, lodoxamide and stop-allerg, block the migration of neutrophil and eosinophil cells which prevent the release of histamines. Mast-cell stabilizers can be administered one to four times per day; however, their effectiveness is only visible following ten days of usage (Freeman, 2006). NSAIDs such as diclofenac reduce conjunctival hyperaemia and symptoms of ocular itching. Research has identified that oral NSAIDs, such as aspirin, work effectively for patients with VKC. On the contrary, NSAIDs administered in the form of eye drops provide no relief to the symptoms or signs (Freeman, 2006).

Antihistamines and mast-cell stabilizers should be used as short-term treatment options and the effects should be monitored after a month (Mashige, 2017). More severe cases of VKC require topical corticosteroids which inhibit the production and release of histamine thus suppressing the late-phase reaction of VKC (Ackerman *et al.* 2016). Examples of these corticosteroids are fluorometholone, which is administered one to four times per day and prednisolone which is administered one to 12 times per day (Gokhale, 2016; Vichyanond *et al.* 2014). Additionally, cyclosporine-A is a potent steroidal immunosuppressant which may also be used in the form of eye drops to treat severe cases of VKC (Freeman, 2006). Compared to corticosteroids, cyclosporine eye drops have been found to produce fewer ocular side effects (Al-Akily & Bamashmus, 2011). Ang *et al.* (2012) reported that children with VKC often require long-term corticosteroid treatment which may result in an ocular response that leads to corticosteroid-induced glaucoma.

Therefore, patients receiving steroids should be administered with short dosages and need to be monitored closely, as its prolonged usage is associated with the development of cataracts and an increase in IOP which may result in secondary glaucoma (Saboo *et al.* 2013; Vichyanond *et al.* 2014). In their study, Al-Akily and Bamashmus (2011) stated that the development of steroidal induced complications could arise from the fact that patients alternate between different practitioners for treatments, resulting in the prolonged and unsupervised use of steroids. Therefore, it is of great importance that corticosteroids be used diligently (Saboo *et al.* 2013). Some severe cases of VKC presenting with shield ulcers may be treated surgically by means of excimer laser phototherapeutic keratectomy, which promotes the re-epithelisation process. Furthermore, corneal epithelial transplants may be required to treat the associating ocular surface complications (Naggalakshmi *et al.* 2014). Gokhale (2014) published a treatment guideline regarding the different severities or stages of VKC. The guideline of Gokhale (2014) is displayed below in Table 2.3.

TABLE 2.3: TREATMENT GUIDELINE FOR VKC (Gokhale, 2014).

SEVERITY OF DISEASE	TREATMENT REQUIRED
Mild	Allergen avoidance, ocular lubricants, antihistamines and mast cell stabilizers. This formula is known as "ALHM".
Moderate (with corneal involvement)	Chronic ALHM and therapy with topical cyclosporine (immunosuppressant).
Severe	Chronic ALHM, continuous cyclosporine and topical steroids.

Conclusively, optometrists play an important role in providing awareness of VKC, recognising and identifying early symptoms and signs and preventing ocular complications or possible visual loss through appropriate patient referral. This role is crucial since research has reported that a vast majority of patients affected by ocular disorders do not seek medical care for their ocular problems. Although VKC may be a self-limiting disorder, prompt and effective eyecare is required to avoid visual impairment and promote the quality of life. Ocular complications may arise when the symptoms and signs of VKC remain untreated. Untreated VKC may lead to irreversible ocular damage induced by corneal abnormalities such as neovascularisation, scarring and thinning as well as eyelid ptosis, corneal ulcers, glaucoma and cataracts.

Preventative or conservative measures such as cold compresses and preservative-free eye drops or saline solution may be used to improve the symptoms displayed. Pharmacological prescriptions administered to treat the clinical signs of VKC are antihistamines, mast cell stabilizers, NSAIDs and corticosteroid medications. However, patients receiving steroids should be monitored closely to prevent steroidal induced complications. Ultimately, attention to early signs needs to be emphasised, as early identification and conservative treatment provided by optometrists and ophthalmologists may reduce the burden on private and public healthcare systems.

2.5 CONCLUSION

In this chapter, VKC and perilimbal conjunctival pigmentation were discussed in detail. The literature review introduced the definition, characteristics and scientific features of VKC. Furthermore, the aspect of perilimbal conjunctival pigmentation, an important clinical sign of VKC, was reviewed to establish its association with VKC as well as its significance. VKC has become a significant ocular health problem in children across the globe. This inflammatory disorder may lead to numerous academic or social barriers, physical challenges as well as severe visual complications or blindness. Evidence regarding the prevalence rate of VKC in the West Rand, South Africa could not be found, thus suggesting a gap in the knowledge.

A further lack of information has been identified regarding the specific risk factors which aggravate the prevalence of VKC throughout the South African continent. Previous studies have identified that VKC is linked to a personal or family history of allergic diseases. However, conflicting reviews have surfaced regarding the association between the presence of systemic allergic disorders and the onset of VKC.

Recent investigations have identified that the African and Asian populations tend to display the early sign of perilimbal conjunctival pigmentation more frequently than others. Contradictions have emerged regarding the aetiology of perilimbal conjunctival pigmentation as it may either be influenced by an abundance of melanocyte cells or melanophages. A group of researchers have hypothesised that the reported perilimbal conjunctival pigmentation may be influenced by skin complexion. These studies have stated that an abundance of melanin cells was identified around the limbus of individuals with a darker skin tone, thus creating the clinical picture of perilimbal pigmentation.

However, it has been argued that individuals without VKC may similarly present with ocular and/or conjunctival pigmentation. Moreover, there have been researchers who have stated that growth hormones may equally stimulate limbal melanocytes to produce perilimbal conjunctival pigmentation. This may explain the presence of pigmentation in children affected by VKC, as there is an elevated level of active growth hormones during childhood. On the contrary, it is suggested that perilimbal conjunctival pigmentation may be caused by inflammation, thus concluding that there may be an association between inflammatory responses and melanocytic activity.

This statement indicates that the pigmentation presented in VKC is induced by the inflammatory nature of the ocular allergic disorder and not only by the individual's skin complexion. Although these studies have been conducted on international levels, to date no South African study concerning perilimbal conjunctival pigmentation in VKC and its association with ocular allergic responses and racial factors has been performed. Early identification of VKC needs to be emphasised amongst South African healthcare practitioners to support a swift referral of patients for the appropriate treatment. Considering that perilimbal conjunctival pigmentation contributes to the diagnosis of this disorder, ocular health amongst children may be promoted though the provision of prompt treatment thus reducing the burden on healthcare systems.

The affected patient may then be educated regarding this disorder and receive a referral for treatment. Considering the vast number of South Africans diagnosed with a visual disability, South African optometrists urgently need to address patients displaying perilimbal conjunctival pigmentation. The scenario above illustrates a possible consequence granted that perilimbal conjunctival pigmentation is emphasised as an allergic or inflammatory indication of VKC. The following chapter, Chapter 3, will outline the research methodology used to determine whether perilimbal conjunctival pigmentation in VKC originates from a darker skin complexion or ocular allergic responses.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter includes an explanation of the research methodological approach, which essentially consists of a breakdown concerning the applied research methods and procedures. The specific methods and procedures listed in this chapter were used to investigate the research questions and achieve the objectives. The clinical data was obtained from consultations with participants attending a private optometry practice in the West Rand, South Africa.

Chapter 3 is divided into different sections and will start by discussing the theoretical aspects of a study design, as well as the proposed design of this research. Secondly, the sample selection will be outlined, which includes the target population, the sampling method and size and a description of the sample. The measurement methods used to collect the data are presented in diagrammatic formats which include the step by step procedures. The data analysis, pilot study and methodological errors will be explained, and the ethical considerations of this study will be reviewed. This chapter will conclude with an overview of the main aspects covered in this methodological section.

3.2 STUDY DESIGN

Quantitative research consists of structured, systematic investigations of a research question which aims to classify and objectively measure variables within a sample or population. Hopkins (2000) mentioned that quantitative research might be used to determine the association between specific features in a community. Furthermore, the data collection and measurement methods in quantitative research include questionnaires, clinical trials and various forms of surveys. Quantitative research is furthermore divided into two study designs, namely observational and experimental designs. Observational designs are divided into two additional groups: descriptive studies and analytical studies. Firstly, descriptive studies establish the incidence and prevalence of a selected factor or characteristic amongst individuals during a specific time frame.

Secondly, analytical studies compare the association between dependant and independent variables amongst two or more groups. Numerical tables form the basis of this design and are constructed to enable the grouping of information. Cross-sectional study designs branch from analytical studies and select participants according to an inclusion and exclusion criteria. The cross-sectional design requires that the participants be measured only once during the study period. The prevalence of the outcome and associations between the variables of interest may be determined by comparing groups of participants (Hopkins, 2000; Setia, 2016).

For the purpose of this study, a cross-sectional quantitative study design was utilised, noted in Figure 3.1. With regards to the first study objective (*cf.* 1.4.2), descriptive elements were also incorporated Participants were included in the research according to a specific inclusion and exclusion criteria. Individuals were invited to participate in the study regardless of the presence or absence of VKC. Structured interviews and clinical examinations were performed to measure selected variables during a given period. The participants were further divided into four groups for the purpose of analytical comparison in order to determine significant associations.

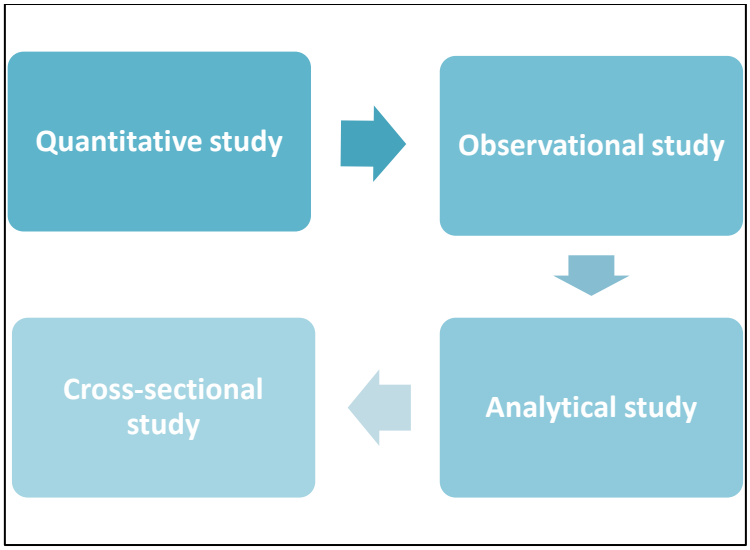

FIGURE 3.1: STUDY DESIGN USED FOR THE RESEARCH.

The proposed study design was justified by previous research published within the same optometric field. Firstly, Ashwini *et al.* (2015) administered a cross-sectional study to describe the demographic profile and clinical presentation of VKC found amongst school children. In comparison, Duke *et al.* (2017) reported the pertinent clinical features of VKC in Nigerian school children by using a cross-sectional study. Additionally, Hayilu *et al.* (2016) used a cross-sectional study design to examine young children and determine the association between VKC and socio-economic, demographic and environmental factors.

3.3 SAMPLE SELECTION

The sample selection of a study plays a crucial role in answering the research questions. Sampling consists of the selection of particular individuals from a population to examine a specific factor within a community. The target population, sample method, sample size, as well as the inclusion and exclusion criterion, will be outlined in the following sections.

3.3.1 Target population

The setting of this study was based at a private optometry practice in Krugersdorp, located in the West Rand district of Gauteng. This geographic area (Krugersdorp) consists of an urban establishment within a gold mining reef. The West Rand encompasses the towns Carletonville, Kagiso, Krugersdorp, Randfontein and Eastern Roodepoort in Gauteng, South Africa (West Rand District Municipality, 2013).

In 2011, the South African Census established that the West Rand extended across a total area of 4,087.42 km^2, whilst hosting a population of 820,995 individuals (Statistics SA, 2011). Furthermore, Statistics SA (2011) calculated that 79.2% of the individuals within the population were of Black African race, 16.7% were Caucasian, 2.5% were of Mixed-race, and 1.1% were Indian raced. Furthermore, children aged 5 to 9 years composed 7.52% of the population and children aged 10 to 14 years constituted 7.49% of the population. Thereafter, the South African Statistical Survey of 2016 identified that the West Rand population increased to 838,594 with individuals below the age group of 15 years forming 23.1% of the community (Statistical Release Community Survey, 2016).

The target population for this study comprised of children between the ages of 6 and 12 years, residing in the West Rand and attending the private optometry practice for ocular examinations. The private practice offers a Kids Right to Sight (KRTS) program which provides children between the ages of 6 and 12 years with free eye examinations, lenses and spectacle frames. Each child may receive KRTS examinations, regardless of their financial status and the presence or absence of refractive errors. The three main languages of patients attending the private practice are Afrikaans, English and Setswana.

The practice makes use of a virtual testing system which electronically stores patient data or files on an online portal. The online system is stored on a private computer and protected by two passwords only accessible to the researcher and practice owner. The practice has all the necessary equipment for an optometrist to practice within the scope of practice in South Africa. From previous data a total of 2552 patients older than 13 years were examined at the practice from the period of October 2017 to May 2018. During this time frame, a total of 331 children younger than 13 years were tested through the KRTS program. Table 3.1 indicates the monthly breakdown of the number of patients examined at the private optometry practice from 2017 to 2018.

TABLE 3.1: TOTAL NUMBER OF PATIENTS EXAMINED AT THE PRIVATE PRACTICE FROM OCTOBER 2017 TO MAY 2018.

MONTH PER YEAR	ADULTS	CHILDREN
October 2017	185	46
November 2017	224	22
December 2017	215	40
January 2018	473	66
February 2018	307	59
March 2018	276	32
April 2018	414	36
May 2018	438	30
Total patients	**2552**	**331**

3.3.2 Sample method and sample size

The sampling method used for this study consisted of non-probability convenience sampling. Convenience sampling enables individuals to be enrolled in a study according to their accessibility and availability (Elfil & Negida, 2017). The sampling process comes to an end once the pre-determined number of participants has been selected (Martinez-Mesa *et al*. 2016).

Convenience sampling has been reported as the most widely used sampling method throughout existing literature, thus confirming that this type of sampling procedure is the most practical for the proposed study (Elfil & Negida, 2017). The sample size was estimated to consist of 200 children between the ages of 6 and 12 years. Considering that 331 patients in the required age groups were previously seen from October 2017 to May 2018, the researcher determined the size of the sample through the calculation that approximately two children would be examined during the weekdays (four consecutive days) from November 2018 to May 2019 (2 (children) x 4 (days) x 30 (weeks)). This calculation adds up to 240 participants, however it was reduced to 200 to compensate for participants who miss or cancel their appointments.

Furthermore, the estimated sample size corresponded to that of prior research within the field which justified the number of participants chosen for this study. Firstly, Rao *et al.*'s (2016) study included 250 participants affected by VKC, whilst Malu (2014) used a similar sample size of 269 participants presenting with VKC. Secondly, Mondal *et al.* (2017) selected 204 consecutive participants for their research and Demir *et al.'*s (2018) sample size consisted of 203 participants. With regard to achieving the estimated sample size, the researcher enlisted eligible participants between the ages of 6 and 12 years, attending the private optometry practice during the period of November 2018 to May 2019. All children attending the practice for ocular examinations were allowed to participate in the study on condition that they met the inclusion and exclusion criteria. The period over which the data collection was selected to commence was based on the knowledge that the incidence of VKC is more prevalent during warmer months of summer (Dahal & Bhattarai, 2015; Jivangi *et al.* 2015; Kumah *et al.* 2015; Nagpal *et al.* 2017; Rao *et al.* 2016; Saboo *et al.* 2013).

With regard to this information, it was determined that more children affected by VKC would be examined during the warmer months of January, February and March.

3.3.3 Description of the sample

The inclusion and exclusion criteria were as follows:

3.3.3.1 *Inclusion criteria*

For the purpose of this study, young males and females residing within the West Rand area (Carletonville, Kagiso, Krugersdorp, Randfontein and Roodepoort) attending the private optometry practice for ocular examinations were selected as participants. The participation of children strictly between the age group of 6 and 12 years was requested to ensure that the participant's profiles corresponded to the age groups of the existing literature. Children from all ethnical groups and languages were included in this study.

3.3.3.2 *Exclusion criteria*

Children below the age of 6 years and above 12 years were excluded from this study. Furthermore, children who did not reside within the West Rand district including Carletonville, Kagiso, Krugersdorp, Randfontein and Roodepoort were excluded. Regardless of the inclusion and exclusion criteria, the researcher still performed ocular examinations while providing appropriate treatment or referral to all the children attending the practice. Therefore, no services were denied due to the fact that the child did not meet the criteria of this study.

3.4 MEASUREMENT OF VARIABLES REQUIRED FOR DATA ANALYSIS

This section describes the process of measuring the assigned research variables amongst the selected sample. The operational definitions will be determined, and the methods used for the data collection, followed by the procedure thereof, will be outlined.

3.4.1 Operational definitions

For the purpose of this study, the following operational definitions were used:

Vernal keratoconjunctivitis (VKC) is defined as a chronic inflammatory reaction of the anterior ocular surface and is identified by two or more symptoms which include ocular itching, photophobia, a foreign body sensation and lacrimation (Ashwini *et al.* 2015). Clinical signs distinguishing VKC consist of two or more of the following: tarsal conjunctival papillae, limbal nodules, Horner-Trantas dots and perilimbal conjunctival pigmentation (Jivangi *et al*. 2015). Mild VKC is classified by the presence of few symptoms and small conjunctival papillae, without the involvement of the cornea. Moderate VKC is classified by troublesome symptoms and medium-sized papillae, without the involvement of the corneal. Severe VKC is classified by severe symptoms, large conjunctival papillae and sight-threatening corneal involvement (Jivangi *et al.* 2015).

Perilimbal conjunctival pigmentation is defined as scattered deposits of pigment which consists of a consistent brown colour distributed from the perilimbal conjunctival area to the fornix. This pigmentation commonly presents in individuals of a darker complexion simultaneously diagnosed with VKC (Luk *et al.* 2008). Complexion associated melanosis is defined as a benign pigmented lesion which appears to have an intense colour at the limbus, fading toward the fornix. This type of pigmentation is most commonly linked to an abundance of melanin cells found near the limbal area of individuals with a darker complexion (Sayyad & Karp, 2013). Thus, this form of pigmentation is not linked to the presence of ocular allergy.

3.4.2 Methods and procedures used for data collection

The procedures used by the researcher for the collection of data are presented in Table 3.2 on the following page.

TABLE 3.2: BREAKDOWN OF DATA COLLECTION METHODS AND PROCEDURES.

CASE HISTORY	
Aim of measurement:	The case history/structured interview was used to probe the onset, duration and severity of the participant's symptoms. Previous ocular and medical history, including the presence of systemic allergies, diseases and the use of medication, were investigated and recorded.
Instruments used:	The data was recorded on the participant data forms (Appendix A).
Room setup:	The case history was performed in a testing room at the private optometry practice. The researcher, participant and parents or caregivers were present in the room. The participant was seated on an examination chair. The researcher used a computer for recording purposes.
Unit of measurement:	The case history was conducted in the form of a structured interview. The researcher proposed questions which were answered by the participants and parents. The responses were recorded on the participant data forms (Appendix A).
Procedure:	Open-ended structured questions were asked by the researcher regarding the participant's symptoms, medical history, family history and ocular history. The responses from the participants and parents were recorded by the researcher on the participant data forms (Appendix A).
BEST-CORRECTED VA	
Aim of measurement:	This measurement was used to determine the best-corrected VA. The method demonstrated whether the VA was reduced due to a refractive error or ocular pathology by using a pinhole occluder.
Instruments used:	LogMAR chart. Oculus trial frame. Pinhole occluder. Blank occluder.
Room setup:	The best-corrected VA was measured by the researcher in a testing room in the private optometry practice. The researcher, participant and parents/caregivers were present in the room. The participant was seated on an examination chair. Full room illumination was used. A LogMAR chart was displayed on a Nidek projector four meters from the participant. The participant was instructed to wear a trial frame containing a blank occluder lens.

Unit of measurement:	The LogMar VA was recorded in decimal notation which was converted to Snellen fraction (6/x). The numerator indicates the testing distance and the denominator indicates the distance at which the smallest line of letters was read.
Procedure:	The participant was seated on the examination chair wearing the trial. The best-corrected VA of the right eye was measured first. The researcher placed the pinhole occluder in front of the right eye and the blank occluder in front of the left eye. The researcher instructed the participant to identify the letters on the LogMAR chart. The participant continued to identify the letters up to the smallest line possible. The VA was automatically converted to Snellen acuity at six meters and recorded in Snellen fraction. The same procedure was completed for the left eye. The researcher recorded these findings on the participant data forms (Appendix A).
SUBJECTIVE REFRACTION	
Aim of measurement:	Subjective refraction was performed to determine the ocular refractive error and spectacle or contact lens prescription required.
Instruments used:	Nidek auto-phoropter. LogMAR chart
Room setup:	The subjective refraction was performed by the researcher in a testing room in the private practice. The researcher, participant and parents/caregivers were present in the room. The participant was seated on an examination chair looking through a Nidek auto-phoropter. Full room illumination was used. The LogMAR chart was displayed on a Nidek projector four meters from the participant.
Unit of measurement:	Spherical and Cylindrical Dioptre
Procedure:	The participant was seated on the examination chair while focusing on the LogMAR chart through the Nidek auto-phoropter. The researcher performed a series of ocular refraction tests by presenting multiple lenses to the participant to determine the prescription which provided the clearest vision. These tests included MPMVA, Duochrome, JCC and Binocular Balancing. The prescription was recorded on the participant data forms (Appendix A).

IOP	
Aim of measurement:	The IOP was used to determine the pressure inside the eye and rule out abnormalities which cause an increased IOP.
Instruments used:	I-care tonometer (non-contact).
Room setup:	The IOP was measured by the researcher in a testing room in the private practice. The researcher, participant and parents/caregivers were present in the room. The participant was seated on an examination chair. Full room illumination was used.
Unit of measurement:	mmHg (millimetres of Mercury).
Procedure:	The researcher instructed the participant to focus on the LogMAR chart. To determine the IOP, the tonometer lightly touched the front surface of the participant's cornea. The researcher measured the IOP with the I-Care tonometer six consecutive times for each eye. The IOP was recorded on the participant data forms (Appendix A).
ANTERIOR OCULAR HEALTH	
Aim of measurement:	The anterior ocular health examination was used to assess the signs of VKC and the presence of perilimbal conjunctival pigmentation.
Instruments used:	Industrias De Optica SA Slit lamp Biomicroscope. Orange fluorescein dye strips. Saline solution.
Room setup:	The anterior ocular segment was assessed by the researcher in a testing room in the private practice. The researcher, participant and parents or caregivers were present in the room. The participant was seated on the examination chair behind the slit lamp. Dim room illumination was used.
Unit of measurement:	The findings of the assessment were recorded on the participant data forms (Appendix A).

Procedure:	The participant was seated behind the slit lamp with his/her forehead against the head rest. The researcher instructed the participant to focus on a red light presented to the side of the slit lamp. The researcher inspected the anterior surface of each eye with different light beams and light filters. The lids, lashes, cornea, conjunctiva and lens were assessed. An orange fluorescein dye strip was activated with a few drops of saline solution and used to stain the anterior surface of the eye. The researcher used the cobalt blue lighting filter of the slit lamp to assess epithelial defects and papillae stained by the fluorescein. The results were recorded on the participant data forms (Appendix A).
POSTERIOR OCULAR HEALTH	
Aim of measurement:	The posterior ocular health examination was used to assess optic nerve, fundus and macular abnormalities.
Instruments used:	Canon CR 2 Digital Retinal Camera
Room setup:	The posterior ocular segment was assessed by the researcher in a testing room in the private practice. The researcher, participant and parents or caregivers were present in the room. The participant was seated on a chair behind the fundus camera, which is mounted on a table. Dim room illumination was used.
Unit of measurement:	Photographs were captured, and the findings were recorded on the participant data forms (Appendix A).
Procedure:	The participant was seated behind the retinal camera with his/her forehead against the headrest. The researcher instructed the participant to look at a small green light presented inside the camera. The right eye was photographed first followed by the left eye. The photographs were attached to the participant data forms (Appendix A).

3.4.3 Data collection procedures

The children attending the private optometry practice for ocular examinations were chosen as participants for this study once the information documents (Appendix B1, B2, B3), consent forms (Appendix C1, C2, C3) and assent forms (Appendix D1, D2, D3) were completed and signed prior to the ocular examinations.

For the validity of this study, the researcher privately collected the data within the same room while using the same instruments for each examination. The participants were examined for a maximum of 30 minutes. Upon completing the steps of the data collection, each participant's examination results were entered into the practice's online patient system and participant data forms (Appendix A). The steps outlined below were used to collect the data necessary for answering the research objectives and questions.

Step 1: The parents or caregivers of the children attending the private optometry practice for ocular examinations were requested by the researcher to complete a patient welcome form at the reception area. The completion of these forms was a standard procedure for all patients attending the practice. Information such as the child's name, surname, date of birth, ethnical status, residential address and contact details were requested. The information obtained was used to create an online patient file. The information was only used for the purpose of the practice records and was not incorporated into the study.

Step 2: The researcher explained the aim of the study to the parents or caregivers of the children and provided them with information documents (Appendix B1, B2, B3) complied in English, Afrikaans and Setswana, concerning the relevant study details. The researcher further provided consent forms (Appendix C1, C2, C3) and assent forms (Appendix D1, D2, D3) to the parents or caregivers of the children who met the inclusion criteria. These forms permitted the use of the child's clinical data for investigative purposes. The consent and assent documents were completed and signed within the reception area by the participants and parents or caregivers. English, Afrikaans and Setswana are the three most common languages of patients attending the practice. The English and Afrikaans versions of the forms were translated by the researcher. The Setswana version of the forms was translated by Setswana speaking optometrists at the private optometry practice.

As established by prior examinations at the private optometry practice, minors rarely attended the examinations without parental or guardian supervision, therefore obtaining consent was not a difficult task. Under the circumstances that the parent or caregiver did not grant permission for the child to participate in the study, the researcher still performed routine ocular examinations and provided the necessary treatment.

Step 3: Once the documents were signed, the child and parents or caregivers followed the researcher to the private testing room. The room consisted of an examination chair with an auto-phoropter and slit lamp mounted on its table. Furthermore, a projector was mounted on a wall four meters from the examination chair. The researcher used a computer for recording the results, and two additional chairs were available for the accompanying family members. The researcher conducted a detailed case history, in the form of a structured interview, by asking the participant and parent or caregiver orderly questions. These questions included information regarding the participant's ocular history, medical history and family history. Recording whether the participant or parent reported a history of systemic allergies was of importance as Hayilu *et al.* (2016) determined that the presence or history of non-ocular allergies such as asthma, eczema, bronchitis and hay fever increased the development of VKC. Moreover, the researcher probed the onset, duration and severity of the presenting symptoms. The researcher recorded each participant's case history on the participant data forms (Appendix A) once the procedure had been completed. The experienced symptoms of VKC were determined as the presence of at least two of the following: ocular itching, lacrimation, a foreign body sensation and photophobia.

Step 4: The researcher initiated the pre-test procedure by measuring the participant's best-corrected VA. The researcher placed a trial frame with a pinhole occluder in front of the right eye and a blank occluder in front of the left eye on the participant's face. The researcher then instructed the participant to focus on a LogMAR chart displayed on a projector which was mounted four meters away from the examination chair. In cases of the participant being illiterate, a Tumbling E chart was used. The participants identified the letters or tumbling E symbols while each line became smaller until they incorrectly identified three or more of the letters within a specific line. The last line of letters identified correctly was recorded as the participant's best-corrected VA.

The researcher rearranged the occluders in the trial frame and the process was repeated for the left eye. The results were recorded by the researcher on the participant data forms (Appendix A). The best-corrected VA was classified as follows: no or mild visual impairment includes a VA of better than or equal to 6/18. Moderate visual impairment includes a VA worse than 6/18 and better than or equal to 6/30. Severe visual impairment includes a VA worse than 6/60 and better than or equal to 3/60 (World Health Organization, 2010).

Step 5: The researcher determined the IOP by using an I-care tonometer (non-contact). The IOP was measured six consecutive times for each eye while the participant focused on the LogMAR or tumbling E chart. The results were recorded on the participant data forms (Appendix A). The range of a normal IOP was considered to be between 10 mmHg and 21 mmHg (Grosvenor, 2002).

Step 6: The researcher performed subjective refraction to determine the refractive error and prescription of the participant. An auto-phoropter was placed in front of the participant and the researcher instructed the participant to focus on the LogMAR or tumbling E chart. A series of lenses were presented to the participant who chooses the lens, which provided the clearest vision. The subjective refraction performed by the researcher included tests such as Maximum Plus for Maximum VA, Duochrome, Jackson Cross Cylinder and Binocular Balancing. The refractive error was recorded on the participant data forms (Appendix A).

Step 7: The final procedures during the examination included ocular health assessments. These assessments included comprehensive investigations of the anterior and posterior ocular segments conducted by the researcher. The anterior surface was examined with the use of a slit lamp biomicroscope placed in front of the participant. The researcher instructed the participant to focus on a small light mounted to the side of the slit lamp. The researcher used the lighting beams and magnification of the slit lamp to identify existing signs of VKC. In conjunction with the cobalt blue filter, fluorescein staining was used to assess the cornea and conjunctiva for possible epithelial defects and the presence of papillae. The signs identified were recorded on the participant data forms (Appendix A). The diagnostic criteria for VKC consisted of the presence of two or more of the following signs: conjunctival hyperaemia, tarsal conjunctival papillae, limbal infiltration, Horner-Trantas dots and perilimbal conjunctival pigmentation.

Step 8: The researcher assessed the health of the posterior segment with a fundus camera mounted on a table in the reception area. The participant was instructed to sit in front of the camera while focusing on a light presented inside the camera's lens. The researcher captured photographs of each eye's fundus as well as photographs of each eye's anterior surface. The photographs of the anterior ocular surfaces along with the slit lamp findings were used to identify perilimbal conjunctival pigmentation. These photographs were numbered according to the participant's data form for ease of reference.

The anterior ocular photographs only included the ocular surface, and no facial features were displayed. The researcher noted the presence or absence of VKC and perilimbal conjunctival pigmentation as “present” or “absent” on the participant data forms (Appendix A). The presence of limbal papillae and perilimbal conjunctival pigmentation differentiated VKC form PAC and SAC.

Step 9: Once the sample size had been achieved, the results from the data forms were used to compile an Excel spread sheet, which was sent to a biostatistician for analysis. During the analysis, the participants were divided into four groups by using a Chi-squared test which was used to determine the association between VKC and perilimbal conjunctival pigmentation. The results will be presented in the following chapter, Chapter 4. Figure 3.2 represents the steps of the data collection process.

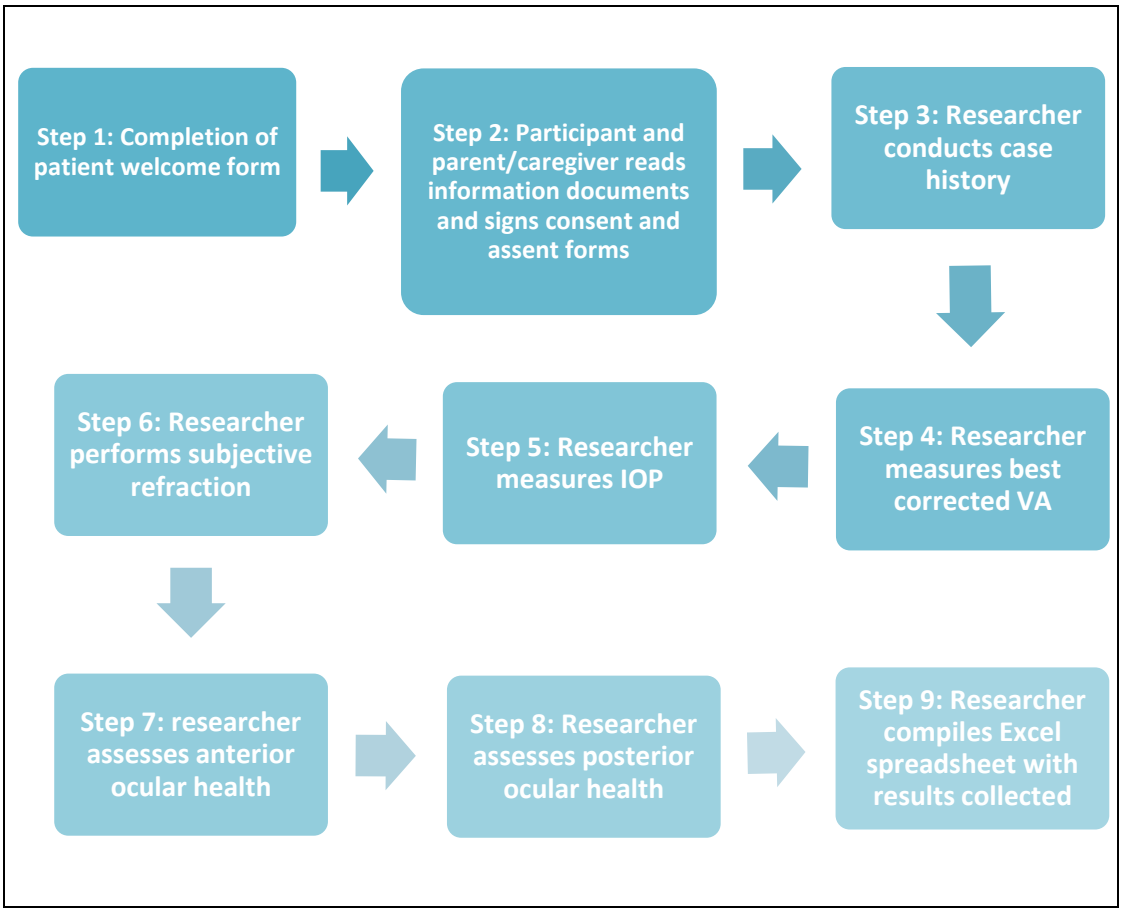

FIGURE 3.2: FLOW DIAGRAM OF THE DATA COLLECTION PROCESS.

3.4.4 Measurement and methodology errors

The measurement and methodology errors which occurred during the study are listed as follows:

The sample size was estimated to consist of 200 children provided that at least two participants were examined daily. However, upon completion of the data collection, only 125 children were examined. The outstanding 75 participants may be explained due to children not attending or cancelling their scheduled appointments during the weekdays. Furthermore, a few consent and assent forms were not completed, which resulted in those children not being able to participants in the study. The proposed schedule was not extended in order to meet the required sample size. The study was implemented during six months of spring and summer as these seasons were indicated most favourable for VKC.

Additionally, typing errors were identified during the process of copying the recordings from the participant data forms (Appendix A) to the Excel spreadsheet. Missing or incomplete data was rectified by the researcher who worked through the participant data forms and Excel spreadsheet to verify the recordings.

3.4.5 Pilot study

The pilot study was conducted by the researcher once the ethical approval was obtained. Three children attending the private optometry practice who met the inclusion criteria were included as a participant. One Afrikaans, one English and one Setswana speaking participant were included to assess the validity of the information documents, consent forms and assent forms. Furthermore, the researcher obtained informed consent and assent from each participant and parent or caregiver, and the examination procedure took place as mentioned in the data collection procedure.

3.5 DATA ANALYSIS

Data analysis outlines and interprets the collected data through statistical reasoning and analysis of associations (Ibrahim, 2015). The data collected during this study, through ocular examinations, were recorded on a data form and analysed by a biostatistician. For the purpose of this study, analytical non-parametric statistics were used to achieve the aim of the study (*cf.* 3.2). Descriptive statistics, namely frequencies and percentages for categorical data, as well as medians, quartile ranges and percentiles for numerical data, were calculated per variable. The numerical variables of this study were non-parametric, which means that there was a skew deviation of the data (Lehmkuhl, 1996). The two non-parametric tests used in this study were the Chi-squared test and Fisher's exact test (Altman & Bland, 2009). The Chi-squared test of independence is designed for smaller groups of data and is used to determine the association between categorical variables. Fischer's exact test is used to analyse categorical variables and was used as an additional test in this study due to the small sample size.

The non-parametric tests were used to investigate the following:

1. The prevalence of VKC and perilimbal conjunctival pigmentation in the sample.
2. The association of variables such as age, gender, ethnicity and residential with VKC and perilimbal conjunctival pigmentation.
3. The association between ocular allergic responses, VKC and perilimbal conjunctival pigmentation.

Furthermore, a *p*-value of ≤0.05 was used to signify whether the null hypothesis was accepted or rejected. The null hypothesis supports the notion that an association does not exist between two variables and that the findings are therefore incidental. The *p*-value represents the significance between two variables and provides the probability that similar results will be generated when implementing the study again. If the *p*-value between two variables is less than 0.05, it indicates a statistical significance suggesting that there is less than 5% probability that no association exists between the variables.

Therefore, a *p*-value of ≤0.05 essentially goes against the null hypothesis (Altman & Bland, 2009). Furthermore, the prevalence of VKC and perilimbal conjunctival pigmentation was calculated and described by means of 95% confidence intervals. These intervals will be discussed in Chapter 4.

3.6 ETHICAL CONSIDERATIONS

Ethical approval (UFS-HSD2018/1289/2711) was obtained from the Health Science Research Ethics Committee (HSREC) of the University of the Free State before the study commenced (Appendix E and Appendix F). Written permission was obtained from the practice owner to approach patients, request their participation and further use the facility for ocular examinations (Appendix G and Appendix H). Completed and signed informed consent forms were obtained from the parents or caregivers of each participant. Informational documents (Appendix B1, B2, B3) regarding the details of the study and consent forms (Appendix C1, C2, C3) were provided to the parents or caregivers. Furthermore, assent forms (Appendix D1, D2, D3) were provided to each minor included in the study. The documents were compiled in three languages, English, Afrikaans and Setswana. The English and Afrikaans versions of the documents were written by the researcher and the Setswana versions were translated by two Setswana optometrists at the private practice. The participants and parents or caregivers were allowed to request the forms in their preferred language.

The personal information of the participants remained confidential as no names, contact details and residential addresses were used during this study. Each participant was assigned a number starting at one and ending at 125. The confidentiality of the participant's case histories and ocular examinations was maintained, as the data was stored on a password protected computer accessible to only the researcher and the practice owner. Furthermore, the ocular photographs also maintained the participant's confidentiality as no facial features were visible. The parents and caregivers were informed by the researcher that they had the right to withdraw the child from the study at any given period or request that the data from the ocular examinations should not be used.

There was no compensation required from the parents or caregivers for the examination of the children in this study and the participants were not remunerated for their involvement. The refractive treatment of visual errors did not form a part of this study; however, both participating and non-participating patients received spectacles, contact lenses or referrals to ophthalmologists when necessary.

3.7 CONCLUSION

In this chapter, the theoretical aspects of the study design were described to advocate the cross-sectional quantitative study design chosen to answer the research questions. Secondly, the target population of this study was described in detail. Moreover, the sampling method, which consisted of non-probability convenience sampling, was explained with an overview of the inclusion and exclusion criteria. The measurement methods used for the data collection were outlined, which included structured interviews and clinical examinations. The step by step procedure was discussed to provide the reader with a clearer understanding of each method. Furthermore, the pilot study and data analysis was explained, as well as the ethical considerations required to conduct this study. Chapter 4 will highlight the results obtained in the study.

CHAPTER 4: DATA COLLECTION RESULTS AND FINDINGS

4.1 INTRODUCTION

This chapter presents the results and findings of the data collected during this study. The data collection was conducted to determine the prevalence of VKC as well as the significant association of perilimbal conjunctival pigmentation with ocular allergic responses and racial factors. The data was collected through clinical investigations of children who presented at a specific private optometry practice in the West Rand for ocular examinations. As described in Chapter 3, a pilot study was performed before the data collection was initiated which included three accessible participants.

Due to no changes in the data collection process following the pilot study, the findings were incorporated with that of the main study, which consisted of a total number of 125 participants. Firstly, the demographic information of the sample will be presented through quantitative results (*cf*. 3.3.1). These results will include a description of the sample population, mainly focusing on the age, gender, ethnicity and residential areas of the participants. Descriptive statistics, namely frequencies and percentages for categorical data, as well as medians, quartile ranges and percentiles for numerical data, were calculated per variable. Due to the small sample size, groups of participants were compared using analytical non-parametric statistics such as the Kruskal-Wallis test for numerical values and the Fischer's exact test for categorical values. The Chi-square test of independence was used to determine the association between the categorical variables examined and a significance level (*p*-value) of 0.05 was implemented. Furthermore, the prevalence of VKC and perilimbal conjunctival pigmentation was calculated and described by means of 95% confidence intervals.

Secondly, the prevalence of VKC will be discussed in detail. The age, gender, ethnical and residential distribution of participants affected by VKC will also be outlined. This is followed by the significance of perilimbal conjunctival pigmentation as well as the associated symptoms and signs identified throughout the sample population.

Diagrammatic formats and figures will be used for the presentation of these results to provide a dissection of the analysed data. This chapter will conclude by summarising the data results and findings.

4.2 DEMOGRAPHIC DISTRIBUTION OF THE SAMPLE

The target population, for this study, comprised of children between the ages of 6 and 12 years. The children who were recruited resided in the West Rand and attend a private optometry practice for ocular examinations. Children of both genders and all ethnical groups were included (*cf.* 3.3.1). The period over which the data collection commenced was November 2018 to May 2019 and did not extend into the colder months of winter (*cf*. 3.3.2). Participants were requested to provide personal information such as their age, gender, race and area of residence, which was used to describe the sample. A total number of 125 participants were included in the study.

4.2.1 Age distribution of the sample population

The median age of the 125 participants was ten years, with a minimum age of six years and a maximum age of 12 years. Furthermore, the inter-quartile range was calculated between 8 to 11 years of age. The specific age group of 6 to 12 years was determined by the inclusion criteria in order to correspond to the age groups described in existing research (*cf*. 3.3.3.1). The data indicated that most of the participants (70.4%) were between the age group of 9 to 12 years. Table 4.1 shows the percentage breakdown of the participant's age groups.

TABLE 4.1: BREAKDOWN OF THE AGE GROUPS IN THE SAMPLE POPULATION (n =125).

AGE GROUP	N	PERCENTAGE
6 years	13	10.4%
7 years	11	8.8%
8 years	13	10.4%
9 years	22	17.6%
10 years	20	16%
11 years	23	18.4%
12 years	23	18.4%

4.2.2 Gender distribution of the sample population

The sample predominantly consisted of 68 female participants (54.40%). However, as seen in Table 4.2, the distribution of female and male participants was more or less equal with a difference of only 11 participants (8.80%).

TABLE 4.2: GENDER DISTRIBUTION OF THE PARTICIPANTS IN THE SAMPLE POPULATION (n =125).

GENDER	N	PERCENTAGE
Female	68	54.4%
Male	57	45.6%

4.2.3 Ethnic distribution of the sample population

Black Africans formed the highest proportion (60%) of the sample population, followed by Caucasians (33.60%), Mixed-race group (4.80%) and Indians (1.60%). Figure 4.1 shows the percentage distribution of the different ethnic groups in the sample population.

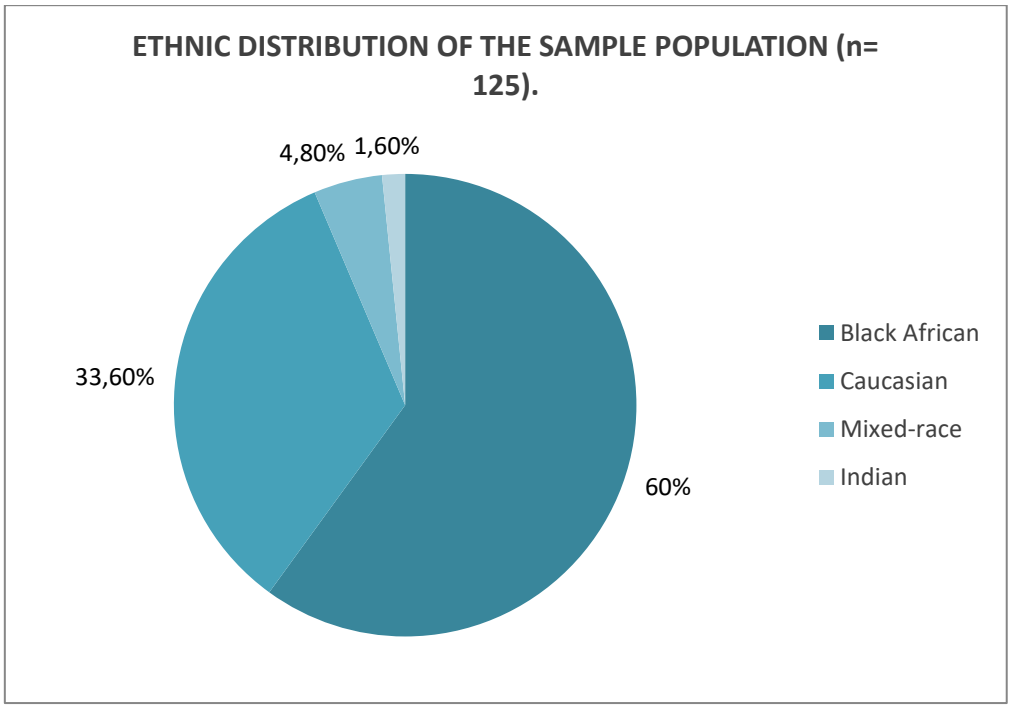

FIGURE 4.1: ETHNIC DISTRIBUTION OF THE SAMPLE POPULATION (n =125).

4.2.4 Residential distribution of the sample population

The findings shown in Figure 4.2 below indicates that most of the participants (64%) resided in the Krugersdorp area, followed by Kagiso (24%), and the remainder (12%) were distributed among Carletonville, Randfontein and Roodepoort. The private optometry practice, which served as the facility for the data collection, was also located in Krugersdorp.

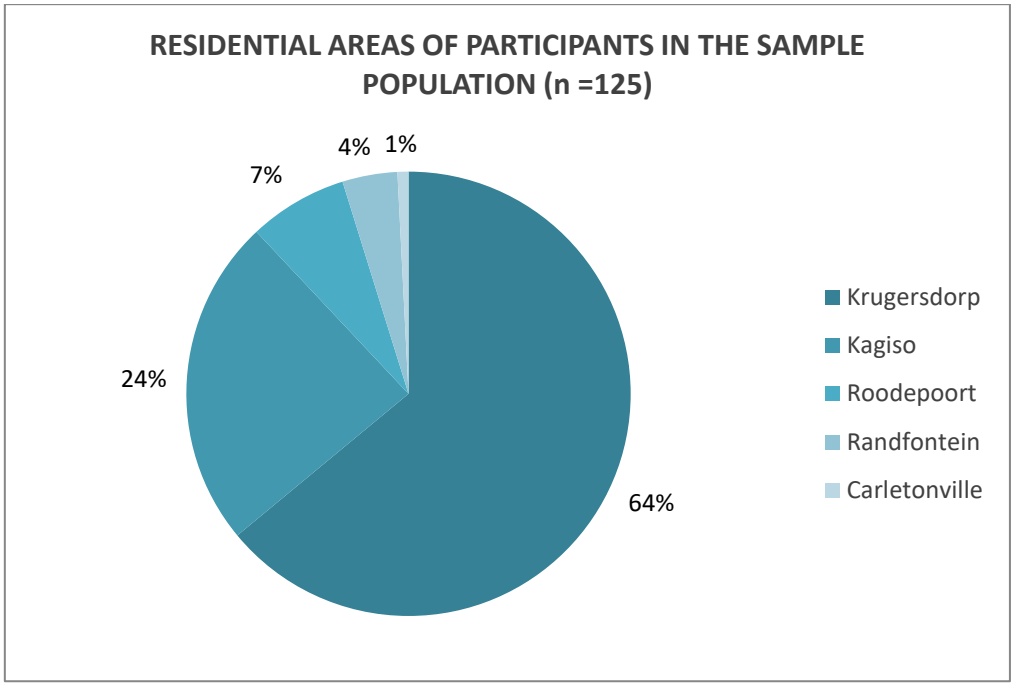

FIGURE 4.2: RESIDENTIAL AREAS OF THE PARTICIPANTS IN THE SAMPLE POPULATION (n =125).

4.2.5 Summary of the demographic information of the sample population

The sample population consisted of a total number of 125 participants who were examined at a private optometry practice in Krugersdorp. The inclusion criteria for the age category consisted of the age group 6 to 12 years, with the median age of the participants being ten years. Most of the participants in the sample were female, as there were 11 more female participants than males. The sample population predominantly comprised of Black African participants followed by Caucasians. Lastly, more than half of the sample resided in Krugersdorp and a further 30 participants resided in Kagiso.

4.3 THE PREVALENCE OF VERNAL KERATOCONJUNCTIVITIS

The following section describes the prevalence of VKC as well as the age, gender, ethnic and residential distribution of the participants affected by VKC. Furthermore, the clinical profile of the sample population will be outlined by presenting the frequency of the reported allergic disorders, ocular symptoms and the identified clinical signs.

4.3.1 Vernal keratoconjunctivitis in the sample population

For this study, the data indicated that the prevalence rate of VKC was 28%. Out of the 125 participants in the sample population, 35 participants presented with this ocular disorder. The remaining 90 participants did not display VKC. The severity of the condition was not differentiated and the prevalence of VKC was determined by the presence of any of the symptoms and signs indicative of VKC (*cf.* 3.4.1). Furthermore, a 95% confidence interval for the prevalence of VKC was calculated between the range of 20.90% and 36.40% (CI: 20.91%; 36.40%). The statistical analysis utilises confidence intervals to signify the probability that a parameter lies within a specified range. The 95% confidence interval for the prevalence of VKC (CI: 20.90%; 36.40%) signifies a 95% probability if the study should be repeated, that the prevalence of VKC will fall between the limits of 20.90% and 36.40%.

4.3.2 Age groups of the participants with vernal keratoconjunctivitis

According to the data in Table 4.3 on the following page, the majority of the participants affected by VKC were between the ages of 6 to 7 and 9 to 11 years. The median age of the affected participants was found to be 9 years. Furthermore, no participants diagnosed with VKC were identified in the age groups of 8 and 12 years.

TABLE 4.3: AGE DISTRIBUTION OF PARTICIPANTS WITH VKC (n =35).

AGE GROUP	N	PERCENTAGE
6 years	4	12.5%
7 years	9	25%
8 years	0	0%
9 years	9	25%
10 years	9	25%
11 years	4	12.5%
12 years	0	0%

4.3.3 Gender differentiation of the participants with vernal keratoconjunctivitis

As shown in Table 4.4, more than half of the affected participants in this sample were female (62.50%).

TABLE 4.4: GENDER DISTRIBUTION OF PARTICIPANTS WITH VKC (n=35).

GENDER	N	PERCENTAGE
Female	22	62.5%
Male	13	37.5%

4.3.4 The ethnicity of participants with vernal keratoconjunctivitis

Regarding the ethnicity of the participants affected by VKC, more than half (62.50%) were of the Black African ethnicity. Furthermore, 25% of these participants were Mixed-race and 12.50% were Caucasian. No participants of the Indian ethnicity displayed this ocular allergic disorder. These findings are presented in Figure 4.3 below.

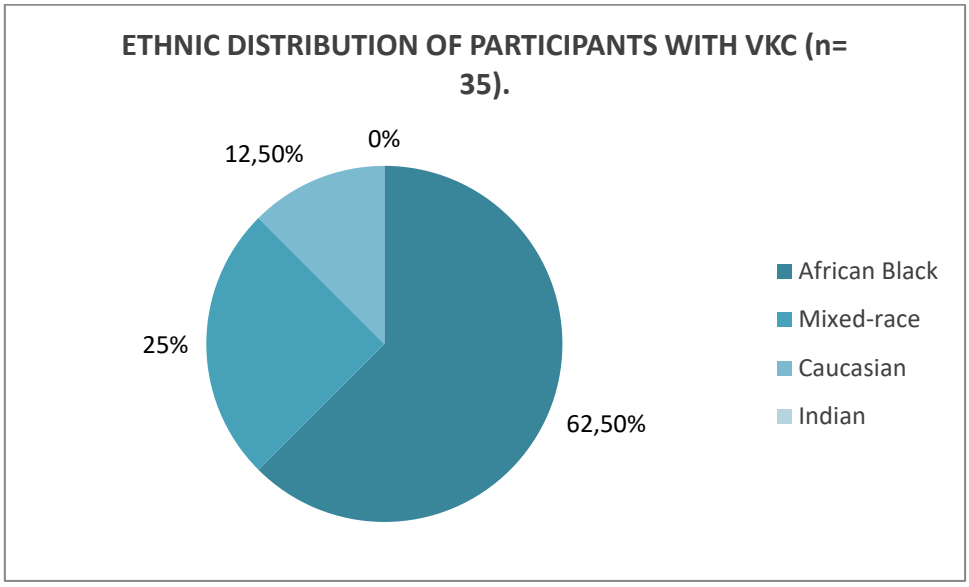

FIGURE 4.3: ETHNIC DISTRIBUTION OF PARTICIPANTS WITH VKC (n=35).

4.3.5 Residential areas of participants with vernal keratoconjunctivitis

Figure 4.4 shows that 50% of the participants with VKC resided in the Kagiso area and the remaining 50% resided in the Krugersdorp area. There were no participants from Carletonville, Randfontein or Roodepoort.

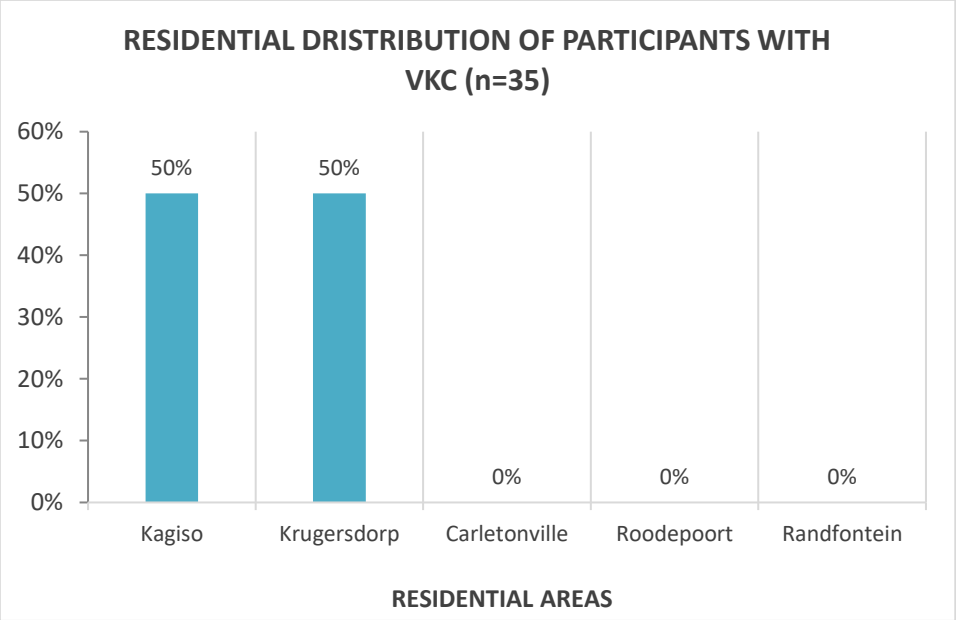

FIGURE 4.4: RESIDENTIAL DISTRIBUTION OF PARTICIPANTS WITH VKC (n=35).

4.3.6 Allergic disorders reported in the sample population

The data has shown that 35 participants reported having allergic disorders with the most frequent allergic disorder being eczema (11.20%), followed by asthma (9.60%), hay-fever (6.40%) and bronchitis (0.80%). A significant proportion (72%) did not report a history of systemic allergic disorders. Figure 4.5 indicates the percentage breakdown of the reported allergic disorders amongst the sample population.

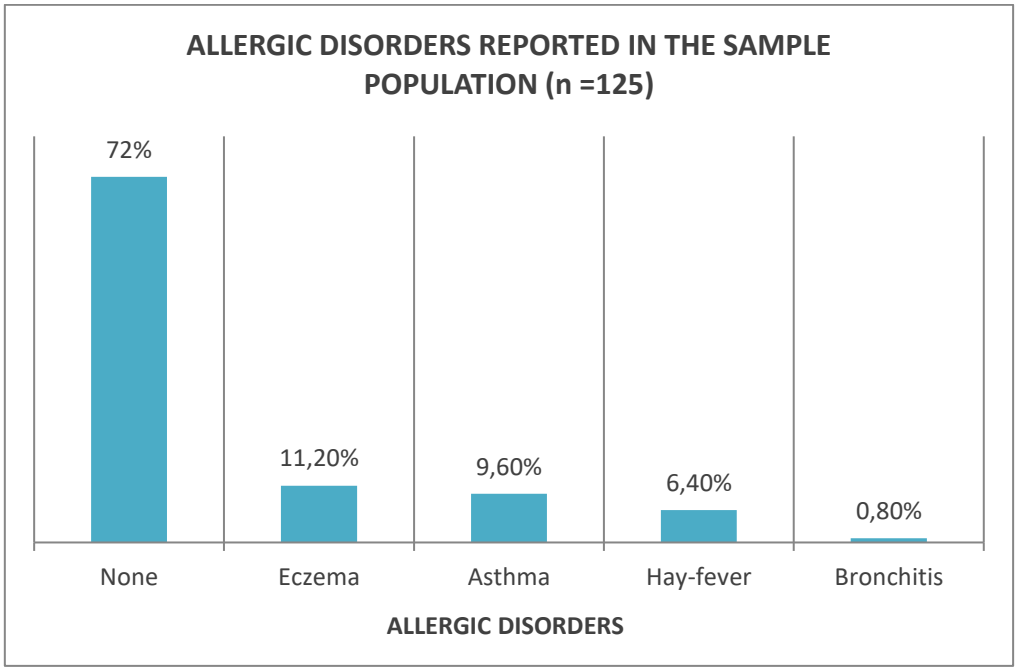

FIGURE 4.5: ALLERGIC DISORDERS REPORTED IN THE SAMPLE POPULATION (n =125).

4.3.7 Symptoms and signs identified in the sample population

The following symptoms were evaluated amongst the sample: ocular itching, lacrimation, foreign body sensation and photophobia (*cf.* 3.4.3). Considering the participants not affected by VKC and perilimbal conjunctival pigmentation, 42.69% experienced one or more symptom as reported above. The data revealed that one participant (0.80%), reported the presence of all four symptoms (itching, lacrimation, foreign body sensation and photophobia), this participant was identified with both VKC and perilimbal conjunctival pigmentation.

The most common ocular symptom experienced by the total sample, irrespective of the presence of VKC and perilimbal conjunctival pigmentation, was ocular itching (53.60%). Other symptoms experienced by the total sample included ocular tearing (19.20%) and photophobia (13.60%). Lastly, a foreign body sensation was reported in only 8.00% of the sample population. With regard to the 35 participants affected by VKC, one participant did not experience any of the symptoms, while 20% experienced one or more symptom. Of these participants, 8.57% experienced only itching without the presence of another symptom. Furthermore, 5.71% experienced itching and tearing simultaneously, while 2.86% reported a combination of itching and a foreign body sensation. Lastly, 2.86% of the participants with VKC reported the presence of three symptoms, namely itching, photophobia and tearing. Moreover, a total of 20% of the participants with VKC, as mentioned above, experienced ocular itching, while 8.57% reported tearing. Photophobia was present in 2.86% of the participants with VKC as well as a foreign body sensation (2.86%). The distribution of the total percentage of symptoms reported amongst the sample population is displayed in Table 4.5. This is followed by Table 4.6, which presents the percentage of symptoms reported in the participants with VKC.

TABLE 4.5 SYMPTOMS EXPERIENCED AMONGST THE SAMPLE POPULATION (n =125).

SYMPTOMS	N	PERCENTAGE
Itching	67	53.6%
Tearing	24	19.2%
Photophobia	17	13.6%
Foreign body sensation	10	8%
None	7	5.6%

TABLE 4.6: SYMPTOMS EXPERIENCED AMONGST THE PARTICIPANTS WITH VKC (n= 35).

SYMPTOMS	N	PERCENTAGES
Itching	7	20%
Tearing	3	8.57%
Photophobia	1	2.86%
Foreign body sensation	1	2.86%
None	23	65.71%

The following clinical signs were evaluated amongst the sample: conjunctival hyperaemia, tarsal conjunctival papillae, limbal infiltrates, Horner-Trantas dots and perilimbal conjunctival pigmentation (*cf.* 3.4.3). Additionally, the frequency of these clinical signs identified in the total sample's right and left eyes are pointed out in Figure 4.6.

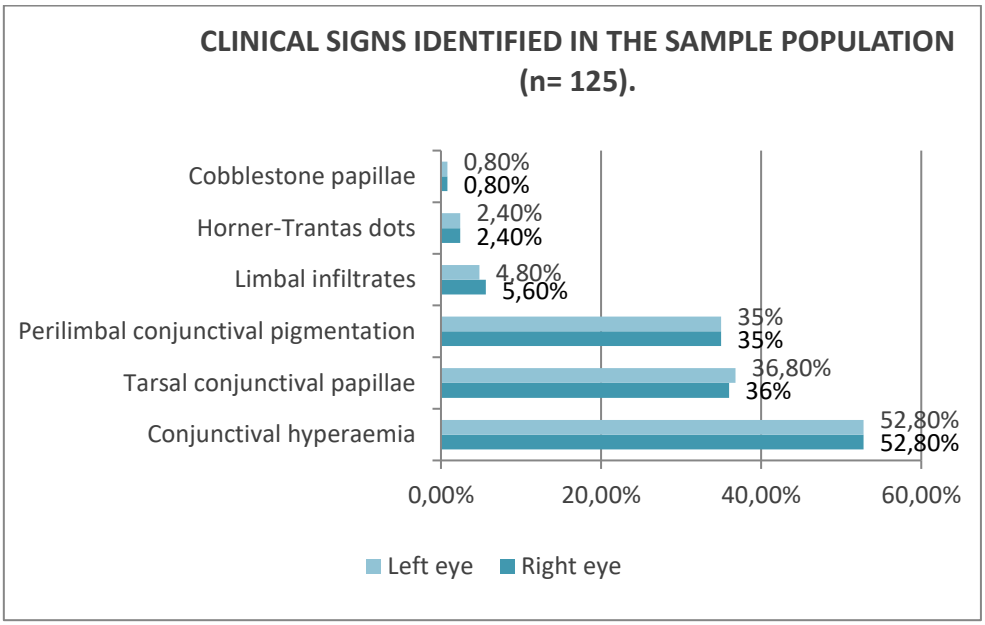

FIGURE 4.6: CLINICAL SIGNS IDENTIFIED IN THE SAMPLE POPULATION (n =125).

The most common clinical signs identified in the sample population were conjunctival hyperaemia (52.80% right and left) and tarsal conjunctival papillae (36.00% right & 36.80% left). This signifies that the palpebral form of VKC was most prevalent (*cf.* 2.2.4). Limbal infiltrates were further identified in 5.60% of the participant's right eyes and 4.80% of their left eyes. Perilimbal conjunctival pigmentation was present in 35% of right eyes and 35% of left eyes. Horner-Trantas dots are commonly identified in more chronic and severe forms of VKC (*cf.* 2.2.4) and were found to be present in only 2.40% of the participant's right and left eyes. Furthermore, merely one participant (0.80%) displayed cobblestone papillae in both eyes.

Regarding the 35 participants affected by VKC (with and without the pigmentation), conjunctival hyperaemia was found in 20% of the participant's right and left eyes and tarsal conjunctival papillae were present in 22.86% of both right and left eyes. No cobblestone papillae, limbal infiltrates or Horner-Trantas dots were identified. Figure 4.7, which follows displays the clinical signs of the participants with VKC (with and without the pigmentation).

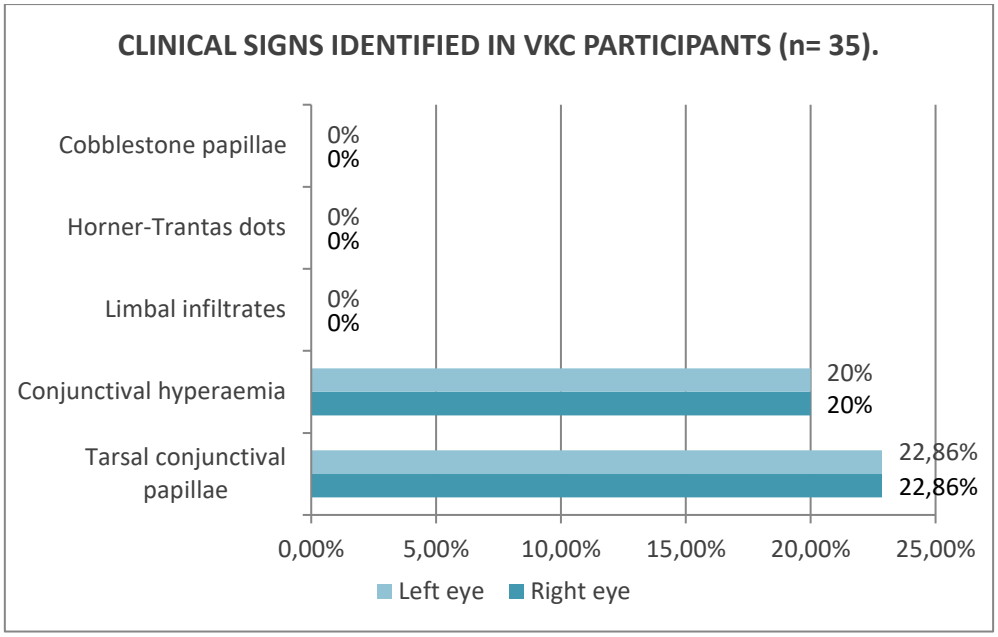

FIGURE 4.7: CLINICAL SIGNS IDENTIFIED IN VKC PARTICIPANTS (n= 35).

4.3.8 Conclusion of the prevalence of vernal keratoconjunctivitis

Regarding the age of the participants identified with VKC (n= 35), more than half were between 6 and 7 years as well as 10 and 11 years. Considering the gender distribution of participants with VKC, a female predominance was identified in this sample. Moreover, these participants were split equally between Kagiso (50%) and Krugersdorp (50%). It is important to note that most of the affected participants are of the Black African ethnicity, as this also corresponds to the distribution of the total sample population (*cf.* 4.2.3).

When investigating the presence of allergic disorders, the majority of the sample did not report the presence of another associated allergic disorder. However, more than half of the sample population experienced ocular symptoms related to ocular allergic disorders and one participant reported the presence of all four VKC related symptoms. With regard to the clinical signs identified in VKC, conjunctival hyperaemia was displayed by the greater part (52.80%) of the sample. Furthermore, the classic VKC sign, tarsal conjunctival papillae, was identified as the second-largest group of ocular signs displayed in the sample.

Considering that more than half of the sample experienced ocular allergic symptoms (itching, tearing, photophobia and a foreign body sensation) and displayed certain signs of VKC, it is interesting that only 28% of the participants had VKC.

4.4 PERILIMBAL CONJUNCTIVAL PIGMENTATION AND ITS ASSOCIATION WITH CATEGORICAL VARIABLES

The content of this section reports the prevalence of perilimbal conjunctival pigmentation in the sample population. Additionally, the association of perilimbal conjunctival pigmentation with categorical variables such as age, ethnicity and residential location is also reported in detail.

4.4.1 The prevalence of perilimbal conjunctival pigmentation

Ocular pigmentation was identified in 28% (35) of the total sample (n= 125) with and without VKC. Of these 35 participants, only 8 displayed the ocular pigmentation in the absence of VKC. Furthermore, perilimbal conjunctival pigmentation was identified in 27 (77.14%) of the 35 participants affected by VKC (*cf*. 4.3.3). This indicates that the majority of participants with the ocular pigmentation also had VKC.

In comparison to the confidence interval for the prevalence of VKC (*cf.* 4.3.1), a 95% confidence interval was established for ocular pigmentation between the values of 20.9% and 36.45% (CI: 20.9%; 36.45%). The confidence interval indicates a 95% probability that if the study should be repeated, the prevalence of ocular pigmentation amongst the population will fall between the reported numerical limits. Ocular pigmentation in the absence of VKC was identified in only 6.40% of participants in the total sample population. Figure 4.8, which follows presents the presence of perilimbal conjunctival pigmentation in participants with VKC.

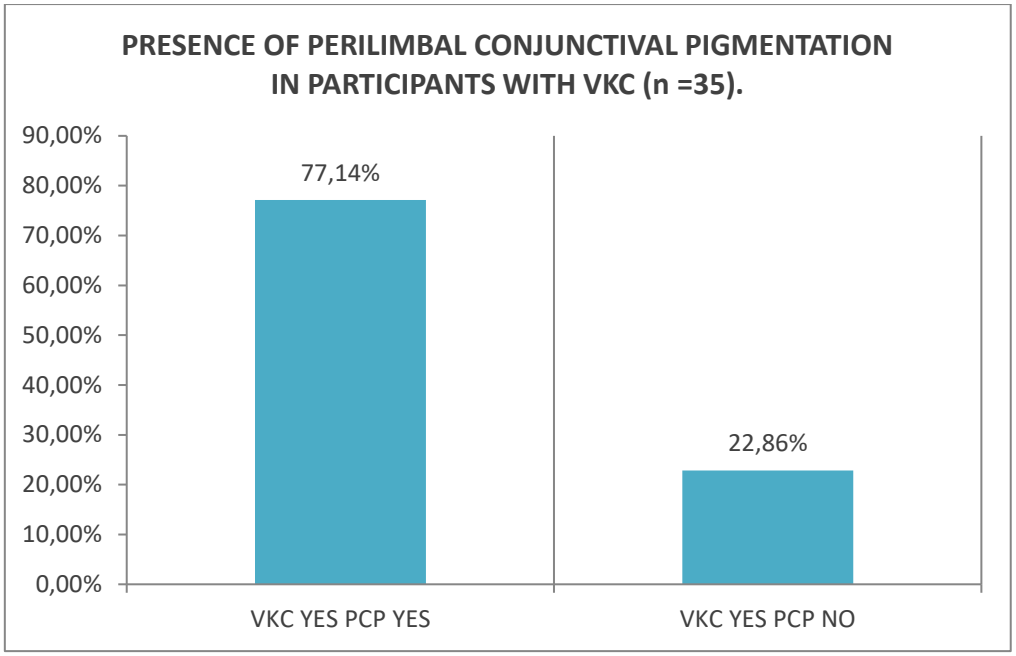

FIGURE 4.8: THE PRESENCE OF PERILIMBAL CONJUNCTIVAL PIGMENTATION IN PARTICIPANTS WITH VKC (n =35).

Furthermore, the presence of ocular pigmentation in the total sample population with and without VKC is displayed in Figure 4.9.

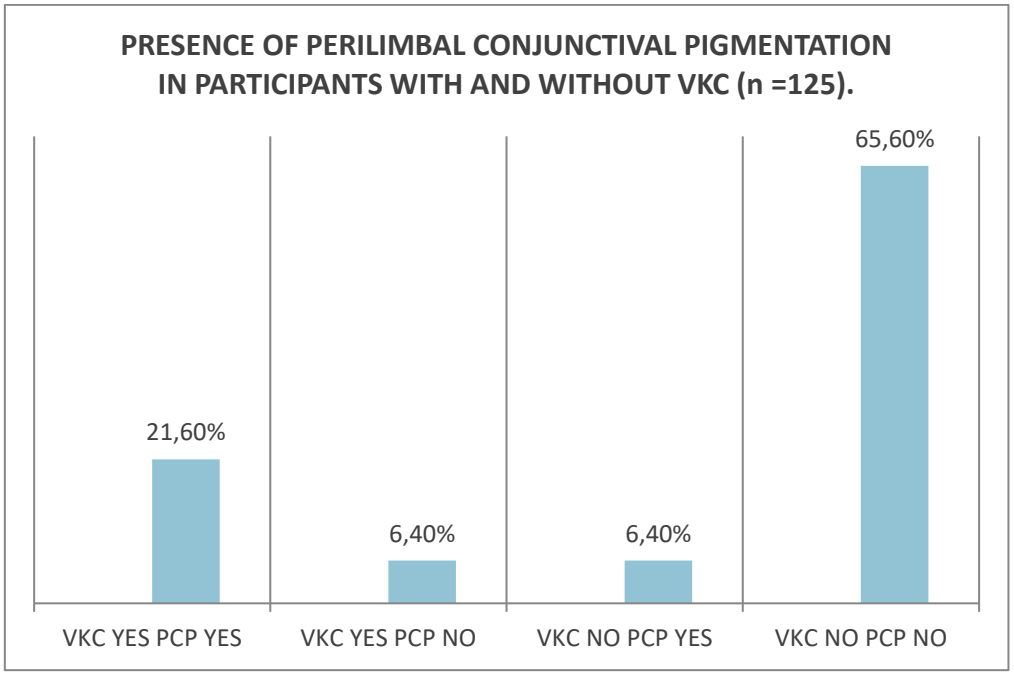

FIGURE 4.9: THE PRESENCE OF PERILIMBAL CONJUNCTIVAL PIGMENTATION IN PARTICIPANTS WITH AND WITHOUT VKC (n =125).

4.4.2 Association of perilimbal conjunctival pigmentation with categorical variables

To determine the statistical significance of certain variables in this study, statistical significance was tested at a 95% level of confidence ($p \leq 0.05$). The data indicated that a *p*-value of 0.0001 was established for the ethnicity of the participants with VKC and perilimbal conjunctival pigmentation. Additionally, a *p*-value of 0.0153 was found for the age distribution of participants with VKC and perilimbal conjunctival pigmentation. These *p*-values indicate a statistically significant difference between different ethnicities and ages with the prevalence of perilimbal conjunctival pigmentation in VKC. Therefore, certain ethnical groups and ages were more prone to developing the perilimbal pigmentation when affected by VKC. The following sections will discuss the statistically significant differences in greater detail. The gender of the participants did not have a significant effect on the prevalence of perilimbal conjunctival pigmentation in VKC, as a *p*-value of 0.4331 was found. Therefore, being male or female did not increase the possibility of developing the perilimbal pigmentation. However, it is important to note that a slight male predominance of 55.56% was found when comparing the gender distribution of participants in this sample with perilimbal conjunctival pigmentation.

4.4.2.1 *Ethnic distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

As mentioned previously, ocular pigmentation was identified in 28% of the total sample (n= 125). Of the 28%, the participants with both VKC and the perilimbal conjunctival pigmentation constituted 21.60%, while the remaining 6.40% presented with only the pigmentation. With regard to the participants in the sample presenting with perilimbal conjunctival pigmentation and VKC (21.60%), all were part of the Black African ethnicity (100%). None of the other ethnical groups (Caucasian, Mixed-race and Indian) displayed both VKC and perilimbal conjunctival pigmentation simultaneously. Considering the remaining participants in the sample who displayed the ocular pigmentation in the absence of VKC, 6.40% were of the Black African race. Therefore, a darker skin complexion may be associated with the presence of perilimbal conjunctival pigmentation in VKC (CI: 20.9%; 36.45%. P= 0.0001). These findings are summarised in Figure 4.10.

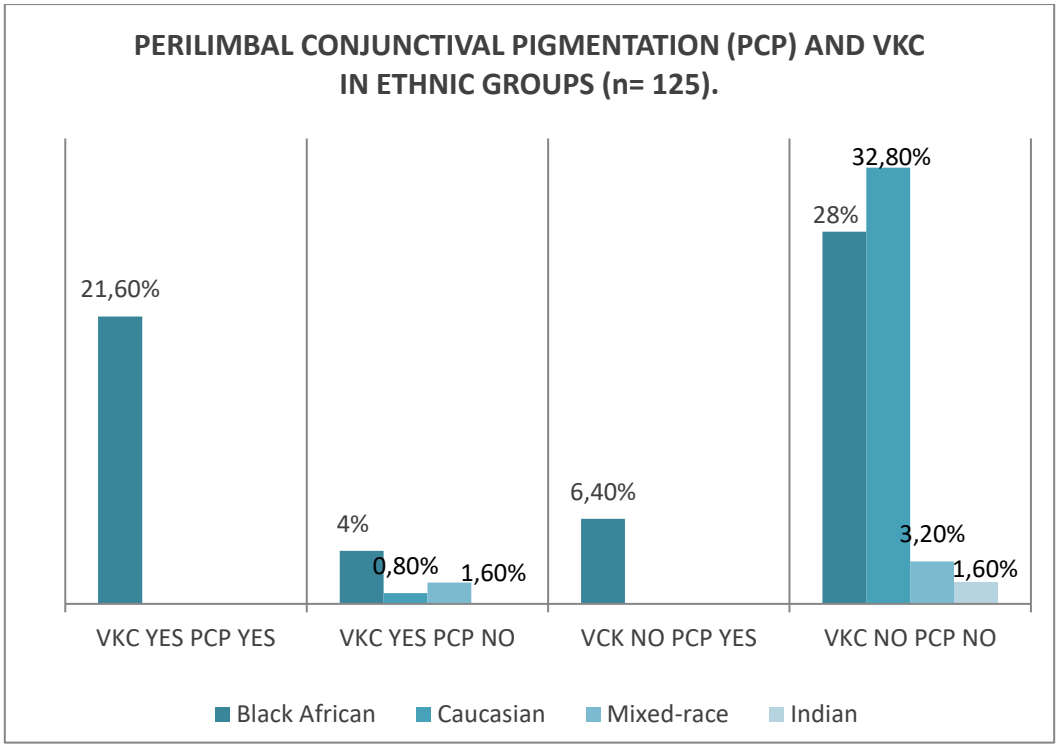

FIGURE 4.10: PERILIMBAL CONJUNCTIVAL PIGMENATION (PCP) AND VKC IN ETHNIC GROUPS (n =125).

4.4.2.2 *Age distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

With regard to the association of age and perilimbal conjunctival pigmentation, the largest age group of participants in the total sample (n= 125), without VKC and perilimbal conjunctival pigmentation, was 10 to 11 years (21.60%), followed by 8 to 9 years of age (19.20%). The median age group for participants without VKC and perilimbal pigmentation was 10 years. In addition, most of the participants displaying only perilimbal conjunctival pigmentation were identified between the age group of 10 to 12 years. Furthermore, VKC was found to be most common amongst participants between 6 to 10 years of age. Both VKC and perilimbal conjunctival pigmentation was identified more frequently in participants of 8 to 11 years of age. The median age group for participants with VKC in both the presence and absence of the ocular pigmentation was 9 years. Figure 4.11 below indicates these results.

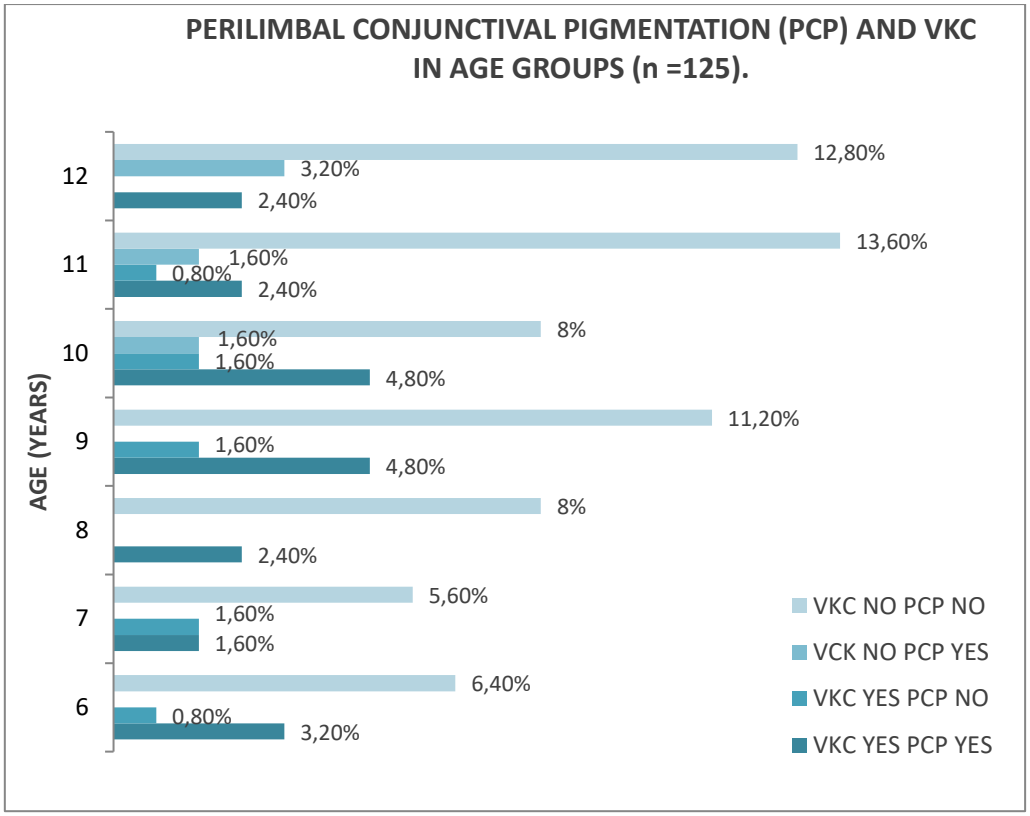

FIGURE 4.11: PERILIMBAL CONJUNCTIVAL PIGMENATION (PCP) AND VKC IN AGE GROUPS (n =125).

4.4.2.3 *Residential distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

The data collection has reported that 62.96% of the participants with VKC and perilimbal conjunctival pigmentation were located in Kagiso. The remaining 37.04% resided in Krugersdorp. These findings are in contrast with the identified residential distribution of participants with VKC as discussed in section 4.3.5. The importance of this difference will be outlined in Chapter 5. Figure 4.12, which follows presents an overview of the described residential locations.

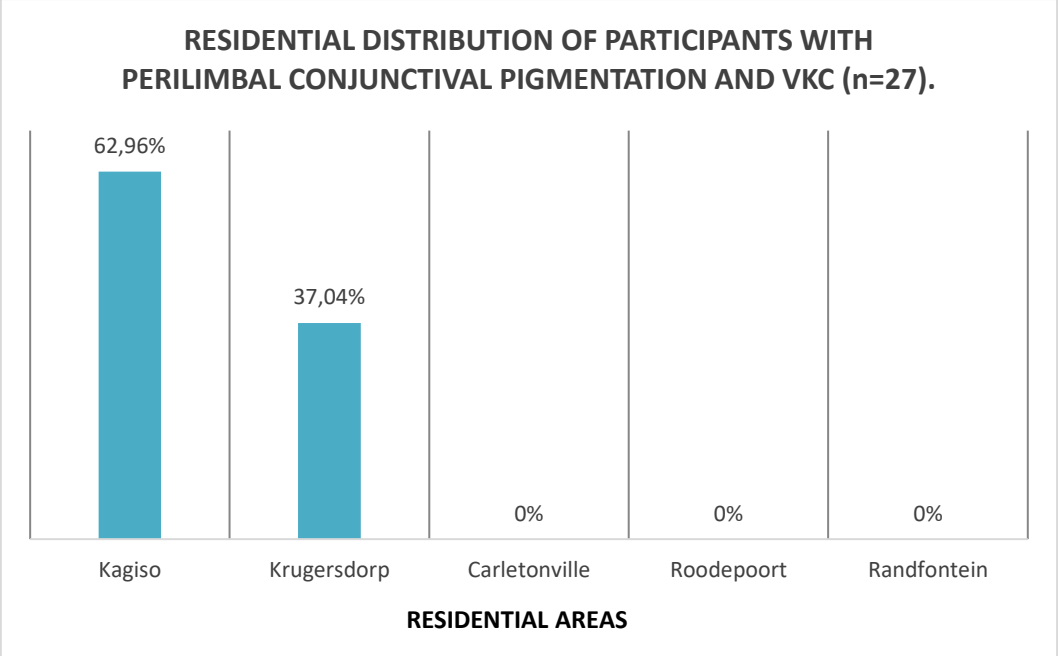

FIGURE 4.12: RESIDENTIAL DISTRIBUTION OF PARTICIPANTS WITH PERILIMBAL CONJUNCTIVAL PIGMENTATION AND VKC (n=27).

4.4.3 Conclusion of perilimbal conjunctival pigmentation and its association with categorical variables

Throughout the total population (n= 125), perilimbal conjunctival pigmentation was identified in 28% of the participants (CI: 20.9%; 36.45%). The majority of participants affected by VKC also displayed perilimbal conjunctival pigmentation simultaneously. With reference to the established *p*-values found, a statistically significant difference was found between ethnicity (P=0.0001) and age (P=0.0153) in VKC and perilimbal conjunctival pigmentation. This indicates that certain ages and ethnic groups are more prone to developing perilimbal conjunctival pigmentation and VKC. The only participants who displayed VKC and the ocular pigmentation were of the Black African ethnic group. Furthermore, the specific ages of 8 to 11 years commonly presented both VKC and perilimbal conjunctival pigmentation simultaneously. Most of these affected participants resided in Kagiso and this study showed a slight male predominance of participants with both VKC and pigmentation.

4.5 ALLERGIC DISORDERS, SYMPTOMS AND SIGNS RELATED TO VERNAL KERATOCONJUNCTIVITIS AND PERILIMBAL CONUNCTIVAL PIGMENTATION

The following section describes the reported systemic allergic disorders, ocular symptoms and clinical signs identified in the participants affected by VKC and perilimbal conjunctival pigmentation.

4.5.1 Association between allergic disorders and the presence of vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

The presence of allergic disorders was compared amongst participants affected by VKC and perilimbal conjunctival pigmentation. Based on the 27 participants identified with both VKC and perilimbal conjunctival pigmentation, 25.93% reported the presence of eczema and 3.70% reported a history of both bronchitis and hay-fever. No accounts of asthma were reported.

Paradoxically, amongst the 35 participants affected by only VKC, asthma (5.71%) was the most reported allergy, followed by eczema (2.86%) and hay-fever (2.86%). No accounts of bronchitis were reported. Furthermore, considering the eight participants who displayed ocular pigmentation in the absence of VKC, only two participants (25%) reported asthma. The remaining 75% did not suffer from bronchitis, eczema or hay-fever. Furthermore, 88.86% of participants with VKC and 66.67% of the participants with both VKC and perilimbal conjunctival pigmentation were not affected by systemic allergic disorders. Figure 4.13 below shows the percentage of VKC participants presenting perilimbal conjunctival pigmentation, affected by systemic allergies.

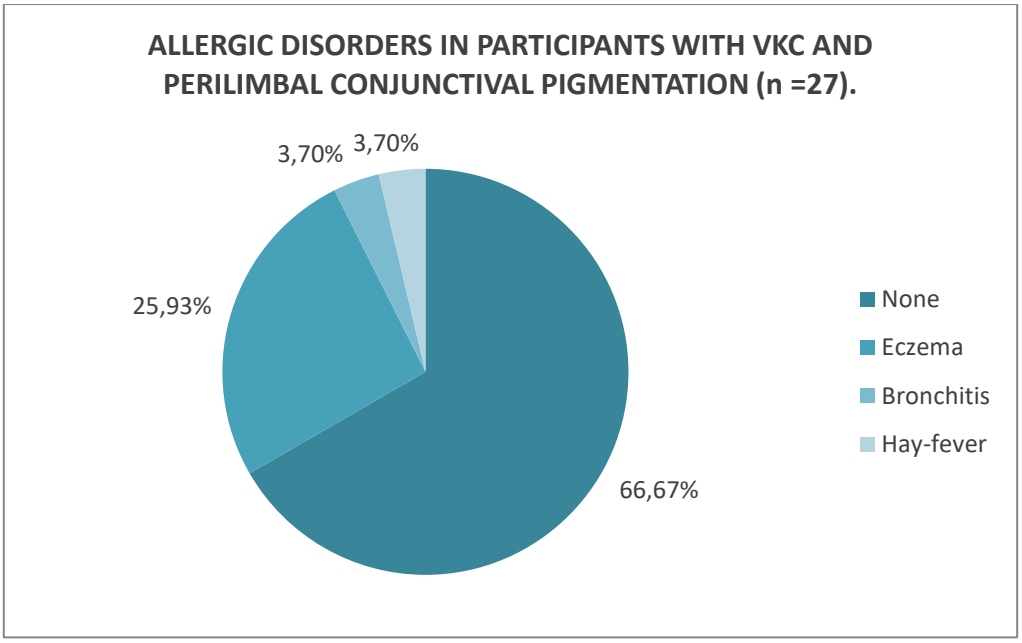

FIGURE 4.13: ALLERGIC DISORDERS IN PARTICIPANTS WITH VKC AND PERILIMBAL CONJUNCTIVAL PIGMENTATION (n =27).

Figure 4.14 further represents the percentage of systemic allergies in participants affected by only VKC.

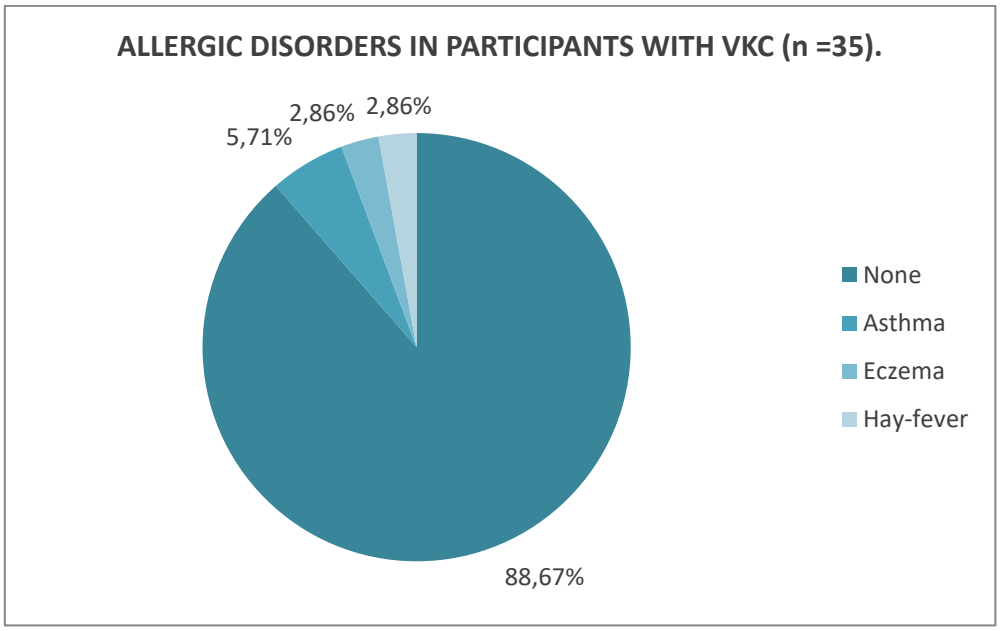

FIGURE 4.14: ALLERGIC DISORDERS IN PARTICIPANTS WITH VKC (n =35).

Figure 4.15 displays the systemic allergic disorders reported in the participants with ocular pigmentation in the absence of VKC.

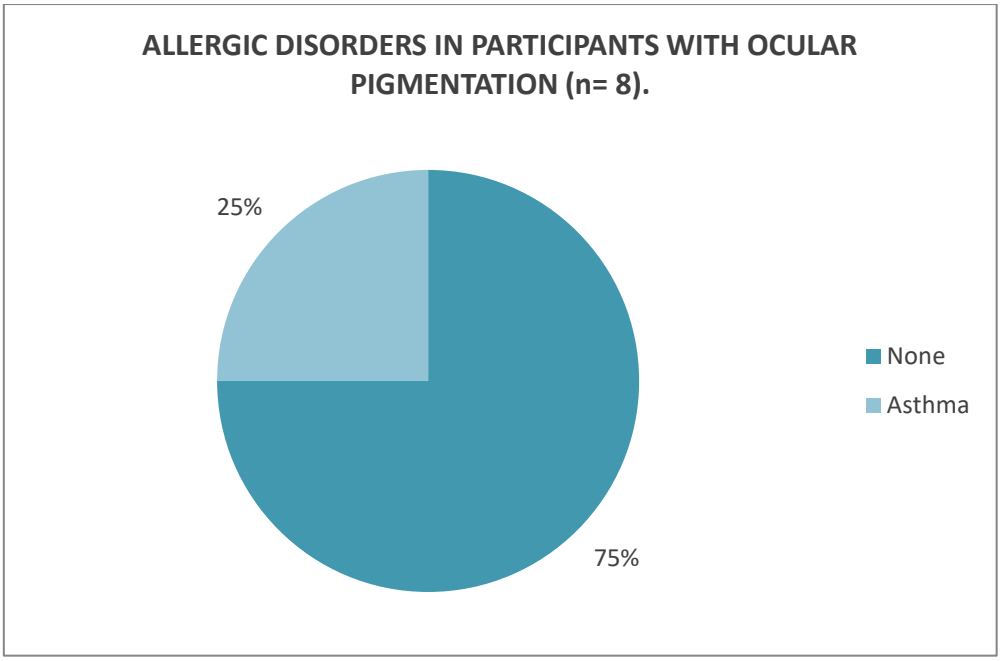

FIGURE 4.15: ALLERGIC DISORDERS IN PARTICIPANTS WITH OCULAR PIGMENTATION (n= 8).

4.5.2 Symptoms in participants with vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

The data presented below suggests that the 27 participants affected by both VKC and perilimbal conjunctival pigmentation experienced one or more ocular symptom (itching, tearing, photophobia and a foreign body sensation). The majority (96.30%) of the 27 participants experienced ocular itching, while 48.15% displayed ocular tearing. Photophobia (33.33%) and a foreign body sensation (25.93%) were additionally reported by the 27 participants. Furthermore, a *p*-value of 0.0001 was determined when investigating the presence of both ocular itching (P= 0.0001) and ocular tearing (P= 0.0001) in participants with VKC and perilimbal pigmentation. This illustrates a statistically significant difference between ocular allergic responses, in the form of itching and tearing, and perilimbal conjunctival pigmentation in VKC. Figure 4.16 displays the symptoms experienced by these participants.

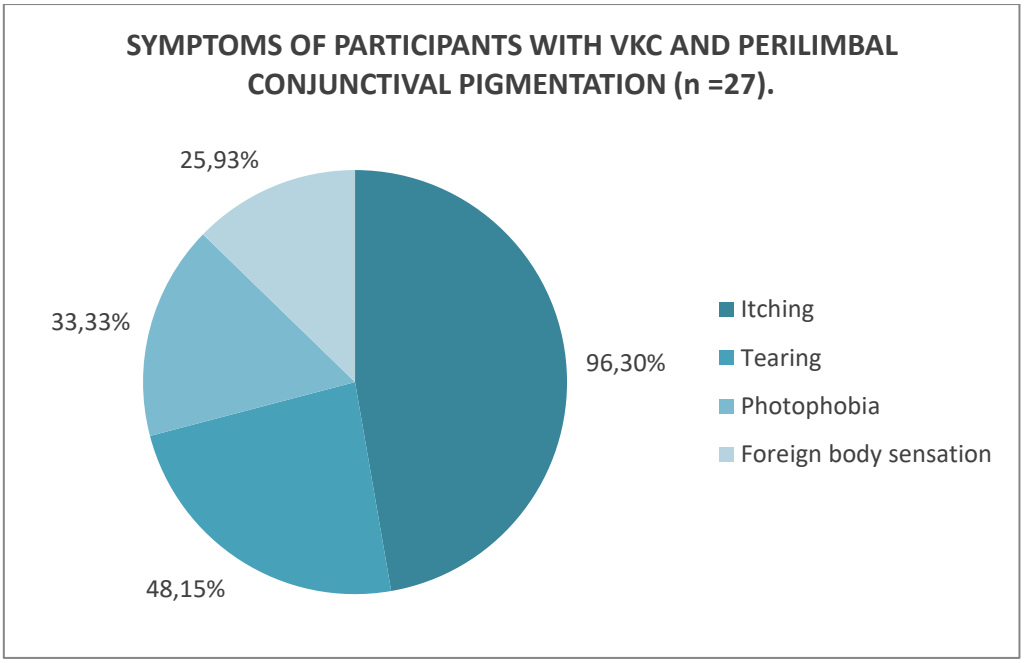

FIGURE 4.16: SYMPTOMS OF PARTICIPANTS WITH VKC AND PERILIMBAL CONJUNCTIVAL PIGMENTATION (n= 27).

4.5.3 Clinical signs in participants with vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

The *p*-values of the ocular allergic responses identified in participants affected by VKC and perilimbal conjunctival pigmentation were calculated to determine significant associations. A *p*-value of 0.0001 for both conjunctival hyperaemia and tarsal conjunctival papillae as well as 0.0005 for limbal infiltrates demonstrates that a statistically significant difference exists between these three inflammatory ocular responses and the presence of VKC and perilimbal conjunctival pigmentation. Therefore, more of the participants with VKC and the pigmentation were affected by conjunctival hyperaemia, papillae and limbal infiltrates.

With reference to the *p*-values, the majority of the 27 participants affected by both VKC and the pigmentation displayed conjunctival hyperaemia (88.89%) and tarsal conjunctival papillae (88.89%). Furthermore, 25.92% of the participants with VKC and the pigmentation had limbal infiltrates as well as Horner-Trantas dots (11.11%) and cobblestone papillae (3.70%). Table 4.7 summarises the percentages and *p*-values of the ocular signs in participants with VKC and the pigmentation (n= 27).

TABLE 4.7: PERCENTAGES AND *P*-VALUES OF CLINICAL SIGNS.

CLINICAL SIGNS	PERCENTAGE	*P*-VALUE
Conjunctival hyperaemia	88.89%	0.0001*
Tarsal papillae	88.89%	0.0001*
Limbal infiltrates	25.92%	0.0005*
Horner-Trantas dots	11.11%	0.0547
Cobblestone papillae	3.7%	0.3430

*Statistically significant difference

4.5.4 Conclusion of allergic disorders, symptoms and signs related to vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

The significant proportion of this sample affected by VKC as well as perilimbal conjunctival pigmentation did not report a history of systemic allergies. Nevertheless, the participants who did report a presence of allergies mainly suffered from eczema (25.93%). The ocular symptoms experienced by most of the participants with VKC and the pigmentation were ocular itching as well as ocular tearing. The data determined a statistically significant difference between these two ocular symptoms (P= 0.0001) and the presence of perilimbal conjunctival pigmentation in VKC. Moreover, it was established that the classical VKC clinical signs of conjunctival hyperaemia (P= 0.0001) and tarsal conjunctival papillae (P= 0.0001) also held a statistically significant difference to the prevalence of perilimbal conjunctival pigmentation in VKC as these were the most recurrent amongst the participants.

4.6 CONCLUSION

This chapter has discussed the results of the data collected during this study, to determine the prevalence of VKC and the significant association of perilimbal conjunctival pigmentation with ocular allergic responses and racial factors. In this chapter, the findings of the demographic sample were reported. The sample consisted of 125 participants, who were mainly female, between the age group of 6 and 12 years.

More than half of the sample population (n= 125) were of the Black African race and resided in the Krugersdorp area. Secondly, the prevalence of VKC was discussed and the age, gender, ethnical and residential distribution of the affected participants was described. The identified allergic disorders, ocular symptoms and clinical signs amongst VKC participants were additionally discussed. Moreover, the prevalence of perilimbal conjunctival pigmentation and its association to variables such as age and ethnicity were outlined. Lastly, the associations between systemic allergies, ocular symptoms and clinical signs with perilimbal conjunctival and VKC were described. The associations mentioned will be discussed in greater detail in the following chapter, Chapter 5.

This chapter's findings have indicated a statistically significant difference between racial factors (P= 0.0001) and the presence of perilimbal pigmentation (CI: 20.9%; 36.45%). found in VKC, as it was only displayed in participants of the Black African ethnical group. In addition, a statistically significant difference was found between allergic responses (ocular itching, tearing, conjunctival hyperaemia and papillae) and the presence of perilimbal conjunctival pigmentation in VKC (CI: 20.9%; 36.45%, P= 0.0001). Therefore, the presence of perilimbal conjunctival pigmentation in VKC is associated with both ocular allergic responses and racial factors.

CHAPTER 5: A DISCUSSION OF THE DATA COLLECTION RESULTS AND FINDINGS

5.1 INTRODUCTION

The purpose of this chapter is to discuss the key findings of this study. The first research question of this study will be answered with a discussion concerning the prevalence of VKC. Secondly, the remaining two research questions will be answered by discussing the association of perilimbal conjunctival pigmentation with ocular allergic responses and racial factors. This study included 125 children living in the West Rand, between 6 and 12 years of age. The data collection process consisted of clinical investigations (*cf.* Chapter 3), and the data was analysed using non-parametric quantitative and descriptive statistics (*cf.* Chapter 4). Non-parametric statistics were used as the data did not follow a normal distribution.

Although numerous studies concerning the associations of perilimbal conjunctival pigmentation have been conducted on international levels, in South Africa, the literature has revealed a gap in the current knowledge regarding perilimbal conjunctival pigmentation and VKC. Moreover, specifically in the South African population, limited information exists concerning the prospect of how perilimbal conjunctival pigmentation may contribute to the early diagnosis of VKC (*cf.* 2.3.3). This is of importance as the prompt identification of VKC needs to be emphasised amongst optometrists to support the swift referral of patients for appropriate treatment and promotion of ocular health (*cf.* 2.4.1).

The first section of this chapter will discuss the demographic findings of the sample population. Secondly, the prevalence of VKC, the associated allergic disorders, as well as the symptoms and signs will be described and compared to previous research. Furthermore, the prevalence of perilimbal conjunctival pigmentation and its association with categorical variables will be outlined. The *p*-values and statistical significance investigated in Chapter 4 will also be described. This chapter will conclude with a summary regarding the reported results and the possible impact of this study on future children in the West Rand, who present with features of VKC and perilimbal conjunctival pigmentation.

5.2 DEMOGRAPHIC PROFILE OF THE SAMPLE

This study consisted of 125 participants, which included children from the Black African, Caucasian, Mixed-race and Indian ethnical groups from the West Rand, South Africa. In comparison to the literature, similar studies regarding VKC have included sample sizes of 203 to 250 (*cf.* 3.3.2). With the planning of this study, it was estimated that 200 participants' data would be included (*cf.* 3.3.2). However, due to the cancellation of ocular examination appointments and incomplete consent and assent forms as some of the older children attended the ocular examinations unaccompanied (*cf.* 3.4.4), only 125 participants were included. Although this is a much smaller sample size than the compared studies, associations and conclusions could still be drawn from the data. It should be mentioned that the data collection occurred only from November 2018 to May 2019 (summer and autumn) as it corresponds to the existing reports indicating that the prevalence of VKC favours warmer seasons (*cf.* 2.2.2). In comparison to this timeline, Nagpal *et al.* (2017) also conducted their study over six months.

However, other researchers within the same field directed their studies over an extended period of 12 to 15 months (Ahmed *et al.* 2019; Dahal & Bhattarai, 2015). The majority of the participants in this study population ranged between the ages of 9 and 12 years (*cf.* 4.2.1). Previous research has identified that VKC may persist in individuals above 20 years of age (*cf.* 2.2.2). However, for this study, the inclusion criteria consisted of individuals younger than 12 years of age and no participants above the age of 12 years were included. The age inclusion agreed to that of prior studies, as VKC has been identified most frequently between 4 and 12 years of age (*cf.* 2.2.2).

The gender distribution of the sample population showed that there were 11 more female participants than males. In other studies, a slightly higher male predominance was found. Ahmed *et al.* (2019) identified that males represented 52.7% of their studied group. Similarly, more than half (55.6%) of the participants in a study by Alemayehu *et al.* (2019) were male. Although more male participants were identified in previous studies, the percentages correlate to this study as only a small difference was noted between the total number of male and female participants.

The largest ethnic group identified in this study population consisted of Black African participants (60%). The predominance of Black African participants may be explained by a large number of South African children within the community, between the ages of 5 and 14 years, who form part of this ethnic group (*cf.* 3.3.1). Concerning the published literature, limited information is available regarding the breakdown of each study's ethnic inclusion as the researchers merely state the regional origin of their participants, namely Northern Europe, North America and India (*cf.* 2.2.1).

The statistical findings have indicated that the most considerable portion of this study population resided in Krugersdorp. Furthermore, 24% of the sample population resided in Kagiso, a township settlement south of Krugersdorp (*cf.* 4.2.4). From the literature, it is clear that geographical locations, such as rural townships play an essential role in the increased prevalence of VKC (*cf.* 2.2.1). There was a 50% prevalence rate of VKC amongst participants from Kagiso. Therefore, the results of this study strongly agree with the literature statement above.

5.3 VERNAL KERATOCONJUNCTIVITIS IN THE STUDY POPULATION

The following section will discuss the prevalence of VKC amongst the sample as well as the age, gender, ethnic and residential distribution of these participants. The systemic allergic disorders, ocular symptoms and clinical signs identified during the investigations will also be discussed.

5.3.1 Prevalence of vernal keratoconjunctivitis

The data has indicated that 35 participants from the sample population (n= 125) were affected by VKC, resulting in a prevalence rate of 28%. In this study, a 95% confidence interval for the prevalence of VKC was calculated between the range of 20.90% and 36.40% (CI: 20.90%; 36.40%). This confidence interval signifies a 95% probability if the study should be repeated, that the prevalence of VKC will fall between the limits of 20.90% and 36.40%. This prevalence rate corresponds to other studies done in different geographical regions. In similar observations, Hall and Shilo (2005) recorded a VKC prevalence of 25% in Tanzania and Singh *et al.* (2018) reported a 26.74% VKC prevalence in India.

Furthermore, Demir *et al.* (2018) identified a VKC prevalence of 36.1% in Turkey. In contrast, Alemayehu *et al.* (2019) found a lower VKC prevalence of 11.10% in Ethiopia.

5.3.2 Age distribution of participants with vernal keratoconjunctivitis

Research indicates that individuals of the specific age group, between 4 and 12 years, are more prone to develop VKC (*cf.* 2.2.2). Kawuma (2001), as well as Shafiq and Shaikh (2009), stated that the highest incidence of VKC occurred in children above the age of 5 years and ceased around the phase of puberty. The data of this study established that the majority of the participants affected by VKC were between the ages of 7 and 10 years with a median age of 9 years, indicating that the prevalence of VKC reduced towards the age of adolescence. Therefore, the age distribution of this study's participants correlates to that of the literature.

5.3.3 Gender and ethnical distribution of participants with vernal keratoconjunctivitis

As with the age of an individual, the literature has further identified that the gender of an individual influences the frequency of VKC (*cf.* 2.2.2). This ocular disorder most commonly presents in young males, as prior research has observed a male predominance of 55% to 72% in diagnosed cases (*cf.* 2.2.2). Previous investigations have also identified that androgens and testosterone may regulate the development of allergic reactions. This recognition has led to the hypothesis that sex hormones play a role in the pathogenesis of VKC, resulting in male dominance (*cf.* 2.2.2).

In contrast to the literature, this study has identified a female predominance (62.50%) when comparing males and females affected by VKC (*cf.* 4.3.3). In agreement, a study by Cingu *et al.* (2013) also reported a female predominance of 69.5% in Turkish participants affected by VKC and allergic conjunctivitis. The results of this study agree with De Smedt *et al.* (2013), who reported that VKC appears to affect African females more than African males. For this reason, further investigation should be directed at the effect of estrogen and progesterone on the development of allergic reactions and VKC. Regarding the participant's ethnic distribution, most of the participants in this study, who were diagnosed with VKC (n= 35), were of the Black African ethnicity (*cf.* 4.4.2).

As mentioned earlier, most of the sample population (n= 125) also consisted of participants within this ethnical group (cf. 5.2.1). Furthermore, 25% of the participants with VKC were Mixed-race and 12.50% were Caucasian. Interestingly, no participants of the Indian ethnicity displayed this ocular allergic disorder and may be due to the small percentage of Indian participants (1.60%).

5.3.4 Residential areas of participants with vernal keratoconjunctivitis

Considering the residential areas of participants affected by VKC, all the participants resided in the Kagiso (50%) and Krugersdorp (50%) area, which is also the location of the private optometry practice. Moreover, no participants affected by VKC were identified from the Carletonville, Randfontein and Roodepoort areas. This may be explained by the fact that only a small percentage of the total sample who resided in these areas attended this practice for ocular examinations. Most of these residential locations have numerous optometric practices within proximity, which are easily accessible for comprehensive ocular examinations and treatment. Krugersdorp is an urban establishment and Kagiso, a local township settlement, is situated to the South of Krugersdorp (cf. 3.3.1). Both these areas are located within a dusty mining reef of the West Rand district. The findings furthermore have shown that only 24% of the total sample resides in Kagiso; however, 50% of these participants are affected by VKC (*cf.* 5.2.1). It is known that environmental stimulants, such as open fires as well as residing within a low socio-economic group, may increase the risk of developing allergic conjunctivitis, namely VKC (*cf.* 2.2.2). However, the participants affected by VKC were equally split between Kagiso (a township settlement) and Krugersdorp (an urban establishment). Therefore, no concrete conclusion could be made in this study regarding the effect of an urban environment versus a township settlement on the prevalence of VKC in this specific area of South Africa.

5.3.5 Allergic disorders reported amongst the sample

With regards to the presence or history of an allergic disorder, only a few of the participants in the sample reported disorders of eczema, asthma, hay-fever and bronchitis (*cf.* 4.3.1). Regarding the 35 participants affected by only VKC, asthma (5.71%) was the most reported systemic allergy (*cf.* 4.5.1).

This finding is similar to an African study by Ahmed *at al.* (2019), which also identified that asthma frequently presented in their participants affected by VKC. The presence of asthma amongst the VKC participants in this study may be attributed to the dusty environment of the West Rand. Previous research in Ethiopia has revealed that the presence of allergic disorders is associated with an increase in the development of VKC (*cf. 2.2.2*). In contrast, further studies in Nigeria and India identified that the history of allergic reactions was less common amongst VKC cases (Jivangi *et al.* 2015; Malu, 2014; Saboo *et al.* 2013).

This study agrees with the findings from Jivangi *et al.* (2015), Malu (2014) and Saboo *et al.* (2013), as it appears that systemic allergic disorders did not aggravate the prevalence of VKC amongst the children in the West Rand, South Africa. To confirm this, 88.67% of the participants affected by VKC reported the absence of allergic disorders, demonstrating that VKC in the West Rand is not indefinitely linked to the presence or history of systemic allergies.

5.3.6 Symptoms and signs in the affected participants

As with most forms of allergic conjunctivitis, the classic symptom of VKC is severe ocular itching. Other symptoms may include photophobia; ocular lacrimation and a foreign body sensation (*cf.* 2.2.4). The data indicated that more than half of the sample population experienced one or more symptom of allergic conjunctivitis, of which ocular itching was predominant (*cf.* 4.3.1). The most frequently encountered ocular symptom amongst the participants affected by VKC was ocular itching (20%). Furthermore, only 8.57% reported tearing, while photophobia was present in 2.86% of the participants with VKC as well as a foreign body sensation (2.86%).

The percentage of ocular itching found in this study is less in comparison to other studies in the literature. Pokharel *et al.* (2007), as well as Dahal and Bhattarai (2015), identified itching in all the participants (100%) affected by VKC. Furthermore, Malu (2014) recorded that 71% of the participants with VKC complained of severe itching and Duke *et al.* (2017) additionally indicated that 67.30% of individuals with VKC reported itching. Interestingly, in this study, the majority of the total sample complained of itching, even though they were not affected by the ocular allergic disorder. Little information exists regarding the percentage of ocular itching found amongst participants without VKC in other studies.

One observation was found by Ahmed *et al.* (2019), who reported that only 3.3% of participants without VKC had suffered from ocular itching. As mentioned previously, ocular itching is a common symptom encountered in allergic conjunctivitis and is exacerbated by air pollutants, dust and hot climates (*cf.* 2.2.2). The profound itching observed amongst the entire study population may be due to the West Rand's dry climate and dusty mining environment. Therefore, the treatment of allergic conjunctivitis and ocular itching in school children residing in the West Rand needs to be prioritised. The high incidence of itching which was identified may be attributed to the data collection period which formed part of the allergy season. Provided that the data collection was done during different months, the prevalence of itching may have been lower.

Considering the clinical signs of VKC (conjunctival hyperaemia, tarsal conjunctival papillae, limbal infiltrates, Horner-Trantas dots and perilimbal conjunctival pigmentation), lacrimation, photophobia and a foreign body sensation appeared to be less frequent amongst the VKC cases in this study. In contrast, Ahmed *et al.* (2019) identified that ocular lacrimation was the most common symptom. This symptom presented in 66.7% of the participants affected with VKC and a further 46.7% presented with photophobia.

In this study, ocular signs which are indicative of mild to moderate VKC were observed. The most frequent signs were conjunctival hyperaemia (20%) and tarsal conjunctival papillae (22.86%). Clinical signs indicative of moderate to severe VKC, such as limbal infiltrates, Horner-Trantas dots and cobblestone papillae were seen amongst the participants affected by both VKC and perilimbal conjunctival pigmentation. Likewise, Ahmed *et al.* (2019) reported conjunctival hyperaemia in 53.3% of participants with VKC and palpebral papillae in 40%. Moreover, Hayilu *et al.* (2015) also identified conjunctival hyperaemia in 58.1% of participants, which corresponds to the percentage found in this study. This indicates that these studies also identified participants with a mild to moderate form of VKC. In contrast to the findings previously stated, other studies in the literature have described a greater prevalence of VKC signs amongst their participants such as 73.33% tarsal papillae (Nagpal *et al.* 2018), 25% Horner-Trantas dots (Pokharel *et al.* 2007) and 21.5% cobblestone papillae (Shafiq and Shaikh, 2009). Firstly, the higher percentages of these studies may be explained by the possibility that the participants displayed a more chronic or severe form of VKC.

Secondly, the study by Pokharel *et al.* (2007) included a larger sample size, of 400 participants, affected by VKC. Therefore, they were able to measure the data of more participants, which possibly lead to a higher prevalence of ocular signs.

5.4 PERILIMBAL CONJUNCTIVAL PIGMENTATION IN THE STUDY POPULATION

This section discusses the prevalence of perilimbal conjunctival pigmentation, as well as its association with categorical variables namely age, gender, ethnicity and residential areas. The *p*-values and statistical significance of these variables are also described. Furthermore, the inflammatory features of perilimbal conjunctival pigmentation presenting in VKC will be reviewed to determine whether the pigmentation is associated with allergic responses or racial factors.

5.4.1 Prevalence of perilimbal conjunctival pigmentation

Perilimbal conjunctival pigmentation, a brown discolouration of the conjunctival surface, was recognised in South African patients affected by VKC as early as 1983 by Dahan and Appel. With regard to the total sample population, ocular pigmentation (in the presence and absence of VKC) was identified in 28% (35) of the participants (*cf.* Figure 4.7). Considering the 35 participants affected by VKC, perilimbal conjunctival pigmentation was identified in 77.14% (*cf.* Figure 4.8). Furthermore, ocular pigmentation in the absence of VKC was identified in only 6.40% of the remaining 35 participants (*cf.* 4.4.1). The participants displaying ocular pigmentation in the absence of VKC were possibly affected by complexion associated melanosis, quiescent VKC or may have been in remission (*cf.* 2.3.3). These findings indicate that the majority of the participants in this study, who displayed perilimbal conjunctival pigmentation, were equally affected by VKC. The high prevalence of perilimbal conjunctival pigmentation found in this study leans towards the conclusion that the presence of the perilimbal pigmentation is associated with the ocular inflammatory aspect of VKC.

In comparison to the perilimbal conjunctival pigmentation prevalence rate of this study, Luk *et al.* (2008) identified that bilateral perilimbal pigmentation presented in 84.2% of VKC participants in China. Furthermore, Ahmed *et al.* (2019) noted that the pigmentation was seen in 60% of VKC participants in Egypt (*cf.* 2.3.1).

5.4.2 Association of perilimbal conjunctival pigmentation with categorical variables

As established in Chapter 4, the findings have indicated that a *p*-value of 0.0001 was calculated for the ethnicity of the participants with both VKC and perilimbal conjunctival pigmentation (*cf.* 4.4.2). Moreover, a *p*-value of 0.0153 was found for the age distribution of participants with VKC and perilimbal conjunctival pigmentation (*cf.* 4.4.2). These *p*-values indicate a statistically significant difference between different ethnic and age groups, and the prevalence of perilimbal conjunctival pigmentation in VKC. These findings indicate that certain ethnicities and ages were more prone to developing the perilimbal pigmentation when affected by VKC. The following sections will discuss the statistically significant differences between the categorical variables.

5.4.2.1 *Ethnic distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

The results of this study have shown a statistically significant difference between the ethnicity of an individual and the prevalence of perilimbal conjunctival pigmentation in VKC (*cf.* 4.4.2). When the association of ethnicity and perilimbal conjunctival pigmentation was considered, all participants displaying VKC and perilimbal conjunctival pigmentation were found to be of the Black African ethnicity. Therefore, no participants displaying both perilimbal conjunctival pigmentation and VKC were recognised from the remaining three ethnic groups.

It is equally important to note that Black African participants (6.40%) were the only ethnic group displaying ocular pigmentation in the absence of VKC (*cf.* Figure 4.10). In accordance with the literature (*cf.* 2.3.1), this pigmentation only appeared in participants of a darker skin complexion, irrespective of the presence or absence of VKC. With regard to the statistical significance, the findings of this study show that participants of the Black African ethnicity have an increased the presence of perilimbal conjunctival pigmentation. The literature has revealed that both perilimbal conjunctival pigmentation and VKC was more prevalent amongst Black African and Asian populations, as the pigmentation found in VKC participants was most frequently identified amongst individuals of a Chinese, Egyptian, Indian and Nigerian residence (*cf.* 2.3.1).

In agreement with the findings above, this study also identified that perilimbal conjunctival pigmentation in VKC predominantly presented in the Black African population (*cf.* Figure 4.10). This may justify the findings of this study, which report that perilimbal conjunctival pigmentation in VKC is influenced by ethnicity. In conclusion, the results of this study compare to prior research with the identification that ethnicity has a significant effect on the prevalence of perilimbal conjunctival pigmentation in VKC, as it was only displayed in Black African participants. Therefore, the darker skin complexion of these participants may be associated with the presence of the pigmentation found in VKC. The abundance of melanin cells in individuals of a darker complexion may lead to the development of perilimbal conjunctival pigmentation and may therefore not only be associated with the allergic aspect of VKC itself.

5.4.2.2 *Age and gender distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

As shown in this study, the age of a participant was statistically significantly associated with the presence of perilimbal conjunctival pigmentation (*cf.* 4.4.2). Observations by Khan *et al.* (2012) and Luk *et al.* (2008) established that the average age of participants affected by VKC and perilimbal conjunctival pigmentation was between 7.5 and 11.2 years. However, Duke *et al.* (2017) reported the presence of the pigmentation and VKC in younger children between 1 and 5 years of age.

In this study, the presence of both VKC and perilimbal conjunctival pigmentation was most frequently identified in the older participants, between the age of 8 and 11 years (*cf.* Figure 4.11). As this study only included participants below 12 years of age, the age distribution could not be compared to the findings which state that VKC tends to cease around puberty (*cf.* 2.2.2). Furthermore, due to the inclusion criteria (*cf.* 3.3.3), participants below the age of 6 were not included in this study; therefore, comparisons could not be made with those of Duke *et al.* (2017). As previously mentioned, the sample population of this study was not dominated by a specific gender as the percentages of males and females were relatively similar.

However, the data specified that the gender of an individual influences the frequency of VKC, as this study identified a female predominance amongst the participants (*cf.* 5.3.3). With regard to the gender distribution of participants in this study, affected by both VKC and perilimbal conjunctival pigmentation, slightly more males were affected (55.56%). This percentage agrees with the results from a study by Malu (2014), who also identified a slightly higher number of males affected by VKC and the pigmentation. Considering that there are limited investigations concerning the male predominance when examining both VKC and perilimbal conjunctival pigmentation, this study's findings suggest that VKC and perilimbal conjunctival pigmentation may be linked to the presence of testosterone hormones (*cf.* 2.2.2).

5.4.2.3 *Residential distribution of participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis*

In contrast to the residential data of the participants diagnosed with VKC, a clear demarcation was identified in the participants with both VKC and perilimbal conjunctival pigmentation (*cf.* Figure 4.12). The participants with only VKC were split equally between Kagiso and Krugersdorp (*cf.*5.3.5). However, 62.96% of the participants with both VKC and perilimbal conjunctival pigmentation resided in Kagiso, whilst the rest resided in Krugersdorp. This result may indicate that perilimbal conjunctival pigmentation and VKC may also be aggravated by residential environments, as a more considerable prevalence, as well as a more severe form of VKC and perilimbal conjunctival pigmentation was found in Kagiso, an area known to be a township settlement.

5.5 ALLERGIC DISORDERS, OCULAR SYMPTOMS AND CLINICAL SIGNS RELATED TO VERNAL KERATOCONJUNCTIVITIS AND PERILIMBAL CONJUNCTIVAL PIGMENTATION

The following section describes the allergic disorders, ocular symptoms and clinical signs identified in the participants affected by VKC and perilimbal conjunctival pigmentation.

5.5.1 Association between allergic disorders and the presence of vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

Chapter 4 has indicated that asthma (5.71%) was the most commonly reported allergy amongst participants affected by VKC alone (*cf.* Figure 4.14). Furthermore, eczema (25.93%) was identified most frequently amongst the participants affected by both VKC and perilimbal conjunctival pigmentation (*cf.* Figure 4.13). Lastly, only two participants with ocular pigmentation in the absence of VKC reported the presence of asthma (*cf.* Figure 4.15). These findings are important as prior research has indicated that systemic allergies increase the prevalence of VKC (*cf.* 2.2.2). However, in this study, less than half of the participants with VKC and perilimbal conjunctival pigmentation suffered from allergies such as asthma, eczema, bronchitis and hay-fever. Therefore, indicating that these allergic disorders did not increase the prevalence of VKC or perilimbal conjunctival pigmentation.

Previous observations have suggested that the perilimbal conjunctival pigmentation found in VKC may be induced by inflammatory cells. These investigations suggest an association between inflammatory (ocular symptoms and clinical signs) and melanocytic activity (*cf.* 2.3.2). The findings of this study correspond to this statement, as a large percentage of ocular inflammatory responses, in the form of ocular symptoms and clinical signs, were found amongst perilimbal conjunctival pigmentation and VKC cases. The following section discusses the ocular symptoms and clinical signs experienced by participants with perilimbal conjunctival pigmentation and VKC.

5.5.2 Symptoms in participants with vernal keratoconjunctivitis and perilimbal conjunctival pigmentation

Researchers have argued that perilimbal conjunctival pigmentation displayed in individuals with VKC may not merely be induced by skin complexion but equally triggered by ocular inflammatory responses (*cf*. 2.3.3). Individuals affected by allergic conjunctivitis typically experience symptoms of ocular itching, ocular lacrimation and a burning sensation (*cf.* 2.2.1).

The majority of the participants in this study (96.30%) affected by both VKC and perilimbal conjunctival pigmentation experienced ocular itching, whilst the second most commonly reported symptom was ocular tearing. Provided that ocular itching is a classic symptom of allergic conjunctivitis (*cf.* 2.2.1), the high percentage of itching experienced by participants with VKC and pigmentation may indicate an elevated level of ocular allergic responses within these individuals. A *p*-value of 0.0001 was determined when investigating the presence of both ocular itching and ocular tearing in participants with VKC and perilimbal pigmentation. The non-parametric findings of this study have therefore established a statistically significant difference between symptoms of ocular itching and tearing and the presence of perilimbal conjunctival pigmentation and VKC (*cf.* 4.5.2). This indicates that the perilimbal pigmentation is influenced by the inflammatory reactions, such as itching and tearing, which are linked to VKC.

Previous research regarding individuals displaying the pigmentation and VKC do not thoroughly specify the percentage breakdown of symptoms experienced by these participants. However, one study in China indicated that 47.4% of participants with VKC and perilimbal conjunctival pigmentation reported symptoms of itching and 26.3% reported tearing (Luk *et al.* 2008). The percentage of ocular itching and tearing identified in China is lower compared to the percentages of this study. This may be due to the dry and hot climate as well as the dusty environment of the West Rand. These environmental factors may increase the allergic conjunctivitis symptoms experienced by the participants in this study, resulting in a higher percentage of itching and tearing.

5.5.3 Clinical signs in participants with perilimbal conjunctival pigmentation and vernal keratoconjunctivitis

The data has additionally indicated that the three ocular inflammatory signs identified to be significantly associated with the presence of VKC and perilimbal conjunctival pigmentation, are conjunctival hyperaemia, tarsal conjunctival papillae and limbal infiltrates (*cf.* Figure 4.7). This signifies a statistically significant difference between the presence of these ocular signs and the prevalence of perilimbal conjunctival pigmentation in individuals with VKC. Therefore, in this study, conjunctival hyperaemia, tarsal papillae and limbal infiltrates are linked to the presence of perilimbal pigmentation and VKC.

Conjunctival hyperaemia and tarsal papillae were identified in the majority (88.89%) of the participants with VKC and perilimbal pigmentation. These signs are usually indicative of a mild to moderate form of VKC (*cf.* 2.2.4). Limbal infiltrates were reported less frequently and the signs linked to a more severe form of VKC, such as Horner-Trantas dots and cobblestone papillae, were rarely recognised in these participants. When comparing these results to the existing literature, only one investigation by Luk *et al.* (2008) discussed the presence of ocular signs amongst individuals with VKC and perilimbal conjunctival pigmentation, indicating yet another gap in the knowledge. Luk *et al.* (2008) reported that 73.7% of their participants with VKC and the pigmentation displayed tarsal papillae. This percentage is slightly less compared to the papillae reported in this study (*cf.* 4.5.3); however, the findings remain relatively similar.

To summarise, as previously mentioned, this study's findings have indicated that ocular allergic responses were found to contribute to the prevalence of perilimbal conjunctival pigmentation in VKC cases. Ocular itching, tearing as well as the presence of conjunctival hyperaemia, tarsal papillae and limbal infiltrates are all classified as inflammatory responses which are linked to VKC. Therefore, as the majority of the participants displaying both VKC and perilimbal conjunctival pigmentation experienced these inflammatory signs and symptoms, it is likely that the pigmentation is induced by the ocular allergic reactions of VKC. Furthermore, as only 6.40% of participants displayed ocular pigmentation in the absence of VKC, the results signify an association between perilimbal conjunctival pigmentation and ocular allergic responses.

5.6 CONCLUSION

The contents of this chapter have presented a discussion of the key findings from the study. It included the demographic profile of the sample, the prevalence of VKC, the prevalence of perilimbal conjunctival pigmentation as well as the association of perilimbal conjunctival pigmentation with allergic responses and racial factors. VKC has become an increasing health problem as patients suffering from this ocular disorder experience significant morbidity, which inevitably affects the quality of life. Considering the abundant prevalence of visual disability throughout South Africa, it is of utmost importance that local optometrists promptly address visually threatening conditions such as VKC.

The literature has identified that the ocular sign, perilimbal conjunctival pigmentation, may be used as an early indication of the development of VKC. A gap has been identified in the present South African knowledge regarding perilimbal conjunctival pigmentation in VKC and its associations. From this discussion, it was recognised that perilimbal conjunctival pigmentation most frequently appeared in Black African participants affected by VKC. Furthermore, it was also established that the inflammatory reactions produced by VKC, such as ocular itching, photophobic, conjunctival hyperaemia, tarsal papillae and limbal infiltrates increased the presence of perilimbal conjunctival pigmentation. These findings demonstrate that the pigmentation does not merely originate from a profusion of melanin cells in individuals of a dark skin complexion, but also from allergic responses connected to this ocular disorder. Therefore, the study has determined that both racial factors and allergic responses have a significant effect on the presence of perilimbal conjunctival pigmentation found in individuals with VKC.

The promotion of eye care amongst South African children may improve academic and social challenges, prevent the onset of sight-threatening conditions and encourage the development of motor and mobility skills. With the knowledge provided by this study, optometrists in the West Rand may utilise the ocular sign of perilimbal conjunctival pigmentation as an indication of the development of inflammatory responses produced by VKC. This may assist optometrists in identifying the early onset of VKC and therefore provide the appropriate treatment or patient referral. The findings of this study may assist in increasing the awareness of ocular disorders and their features, such as VKC, amongst the public as well as local schools in the West Rand. The study overview, research conclusion, study limitations and implications, as well as research recommendations and a conclusive remark, will be discussed in the following chapter.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

Recently, perilimbal conjunctival pigmentation has been identified as an early indication of the development of VKC. The aetiology of perilimbal conjunctival pigmentation is attributed to the abundance of ocular melanocytes in individuals of a darker skin tone as well as inflammatory responses generated by melanophage cells. The aim of this study was to determine or investigate the presence of perilimbal conjunctival pigmentation and its association with VKC in children from the West Rand, South Africa. The purpose of this chapter is to present the study's principal conclusions, limitations and suggested recommendations. The first section of the chapter provides an overview of the research followed by the derived conclusions. Secondly, the limitations experienced during the study will be discussed, as well as the implications and potential recommendations for future studies.

6.2 STUDY OVERVIEW

The literature review has revealed a gap in the existing knowledge regarding perilimbal conjunctival pigmentation and VKC, especially in South Africa. International studies have been conducted concerning the association of perilimbal conjunctival pigmentation with ocular allergic responses and racial factors. However, there is insufficient local research related to the prospect that perilimbal conjunctival pigmentation may contribute to the early diagnosis of VKC (*cf.* 2.3.3). For the purpose of investigating the associations between the pigmentation and VKC as well as addressing the research problem, this study was constructed around three research objectives.

The first study objective aimed to identify VKC amongst children aged 6 to 12 years in a private optometry practice in the West Rand, South Africa. The inclusion criterion of 6 to 12 years was selected based on the data from previous findings (*cf.* 2.2.2). Children from the West Rand were examined at the private optometry practice and the presence or absence of VKC was identified during the data collection procedure (*cf.* 3.4.3).

The main findings of the study established that 125 participants were examined and 35 were affected by VKC. Therefore, the first objective was pursued by determining a VKC prevalence rate of 28% (*cf.* 4.3.3).

The second study objective was directed at identifying the presence of perilimbal conjunctival pigmentation in patients with and without VKC. The literature review has characterised perilimbal conjunctival pigmentation as scattered spot-like or granular deposits of brown pigment, distributed around the exposed perilimbal surface. The pigmentation is consistent in colour from the limbal area to the bulbar and interpalpebral conjunctiva as well as the fornix. This pigmentation has been associated with the presence of VKC (*cf.* 2.3). In contrast, complexion associated melanosis is characterised as a benign pigmented lesion which presents in individuals with a darker complexion. Unlike perilimbal conjunctival pigmentation associated with VKC, it appears more intense in colour at the limbal area and fades towards the fornix (*cf.* 2.3.2). The findings indicated that eight participants (6.40%) from this study presented with ocular pigmentation in the absence of VKC (*cf.* 4.4.1). These participants may possibly have complexion associated melanosis or quiescent VKC. These objectives were achieved by investigating the presence of ocular pigmentation amongst the participants with and without VKC during the data collection procedure (*cf.* 3.4.2). The results further presented that perilimbal conjunctival pigmentation was identified in 77.14% of the participants with VKC (*cf.* 4.4.1).

The third study objective intended to investigate whether perilimbal conjunctival pigmentation is associated with ocular allergic responses or racial factors such as varying skin tones. The aetiology of perilimbal conjunctival pigmentation in VKC was discussed in the literature review. Previous research reported that perilimbal conjunctival pigmentation may be influenced by skin complexion as the majority of individuals displaying the pigmentation have a darker skin complexion. Furthermore, perilimbal conjunctival pigmentation may also be caused by inflammatory macrophage cells suggesting an association between inflammatory responses and melanocytic activity (*cf.* 2.3.2). Participants displaying perilimbal conjunctival pigmentation were identified during ocular examinations discussed in Chapter3 (*cf.* 3.4.3).

The findings of Chapter 4 reported that the only participants affected with both perilimbal conjunctival pigmentation and VKC were of Black African ethnicity. Another 6.40% of Black African participants displayed perilimbal conjunctival pigmentation in the absence of VKC (*cf.* 4.4.2). Moreover, the majority of the participants affected by VKC and perilimbal conjunctival pigmentation experienced inflammatory responses such as ocular itching and ocular tearing. Conjunctival hyperaemia, tarsal conjunctival papillae and limbal infiltrates were found to be statistically significant to the presence of perilimbal pigmentation in VKC.

6.3 RESEARCH CONCLUSIONS

Children with sight-threatening ocular disorders face numerous challenges in academic and social areas, which may hinder essential development and learning abilities. The lack of early diagnosis and appropriate treatment of disorders such as VKC may aggravate the symptoms and signs, resulting in severe visual impairments. What remains insufficiently researched in South Africa is the prevalence of VKC and the topic of perilimbal conjunctival pigmentation and its associations, as no such study could be found in the literature. Perilimbal conjunctival pigmentation may aid in the early diagnosis of VKC development. Therefore, it is of great importance to investigate its association with ocular allergic responses and racial factors. Considering these statements, this study originated from the need to provide insight into the current gap in ocular knowledge. The conclusions drawn from this study are discussed below.

Firstly, this study corresponds to previous literature that has concluded that VKC and perilimbal conjunctival pigmentation displays a male predominance, as most of the participants from the West Rand affected with VKC and the pigmentation were young boys. Furthermore, the age inclusion of the participants was constructed to justify the literature which states that VKC was found to be most common amongst participants between 6 and 12 years. This study further concluded that the presence of both VKC and perilimbal conjunctival pigmentation was most frequent amongst children between 8 to 11 years. Secondly, the findings identified that ethnicity is significantly associated to the existence of perilimbal conjunctival pigmentation, as it was only displayed in participants of the Black African ethnic group.

Therefore, this study concluded that the presence of perilimbal conjunctival pigmentation in VKC is associated with the darker skin complexion of these participants. This resolution is parallel to the literature which states that perilimbal conjunctival pigmentation in VKC is influenced by skin colour.

Finally, observations from the data collection found that ocular allergic responses in the form of itching, photophobia, conjunctival hyperaemia and papillae were present in participants affected with perilimbal pigmentation and VKC. This concludes that perilimbal conjunctival pigmentation in VKC is associated with ocular allergic responses. This finding corresponds to previous research which suggested an association between inflammatory responses and melanocytic activity. To summarise, this study has concluded that perilimbal conjunctival pigmentation in VKC is associated with both racial factors and ocular allergic responses. Considering that perilimbal conjunctival pigmentation is not only induced by a dark skin complexion, but equally by inflammatory responses, this ocular sign may be used as an early indication of the development of VKC. This is of great importance to the ocular health system of South Africa as it may lead to the prompt and effective treatment of VKC amongst children, especially in the West Rand.

6.4 LIMITATIONS OF THE STUDY

Limitations are identified as factors which may potentially limit the reliability of findings. The following limitations were experienced during the course of this study:

This study required that the parents or caregivers of the children sign a consent form in order for the child to participate in this study. Some of the older children attended the ocular examinations unaccompanied, and therefore the researcher could not include the children's examination results in the study.

Furthermore, the sample size for this study was estimated to consist of 200 participants (*cf.* 3.3.2). However, it was calculated that a total of 125 participants were examined. The reduced number of participants may be explained by cancelled and missed appointments as well as unsigned consent forms. The researcher did not extend the timeline of this study to achieve the estimated sample size as the study was limited to the months of summer.

The data collection for this study was obtained at only one private practice in the Krugersdorp area. Provided that more practices were used for this study, located in either the Carletonville, Kagiso, Randfontein or Roodepoort area, more data could be collected regarding VKC amongst the children in the West Rand.

6.5 IMPLICATIONS OF THE STUDY

The aim of the study, the research objectives and the research questions have been answered and achieved. Therefore, the researcher is confident that the conclusions of this study contributes to the scope of optometry and provides new and useful knowledge regarding VKC and ocular pigmentation in South African children. Concerning the gap in the local literature, this study proclaims that perilimbal conjunctival pigmentation is associated with racial factors as it was only identified amongst Black African participants. Furthermore, this study also proclaims that the ocular sign of perilimbal conjunctival pigmentation can undoubtedly be used as an early diagnostic indicator of the development of VKC. By integrating the use of this ocular sign in the diagnostic process, optometrists and ophthalmologists can accelerate the onset of the patient's treatment and prevent further ocular damage.

6.6 RECOMMENDATIONS

The following recommendations have been made based on the results of this study:

1. The findings of this study may be communicated to local optometrists and ophthalmologists to provide further knowledge and awareness regarding patient management. This may be done through the distribution of written information or at local conferences.
2. The findings of this study may be communicated to local West Rand schools to assist teachers and parents in identifying the primary clinical picture of VKC and perilimbal conjunctival pigmentation. This will ensure prompt referral to eye care practitioners.
3. Further studies should be conducted in different residential areas of South Africa to determine the association of VKC and perilimbal conjunctival pigmentation in other environments.

4. Further studies should be conducted at multiple data collection points to expand the amount of data collected.
5. Future South African studies should be conducted with the purpose of establishing whether VKC is exacerbated by growth hormones in early childhood. This will justify whether VKC in South Africa mainly presents in children below a prepubertal age.
6. The female predominance of VKC in this study indicates a need for future research which focuses on the investigation of the association between sex hormones and VKC.
7. Future studies should be conducted during different seasons to establish if symptoms and signs persist to the same level or intensify.

6.7 CONCLUDING REMARK

The impact of ocular allergic disorders on the developmental aspects of children has been vastly explored across the globe. The lack of early diagnosis and appropriate treatment of these ocular disorders may lead to sight-threatening conditions and severe visual impairments. Modern medicine supports the concept that early identification of disorders, such as VKC, leads to the prompt implementation of an intervention, resulting in a more favourable outcome.

This study has strived to determine the associations of VKC and perilimbal conjunctival pigmentation in the West Rand to fulfill partial gaps in the South African knowledge. The conclusions of the study aim to encourage health care practitioners to devote more attention to the early signs of VKC to reduce the burdens of this ocular disease amongst children. The findings and conclusions of this study may assist in increasing the awareness of ocular disorders and their features, such as VKC, amongst the public as well as local schools in the West Rand. These observations may aid in the education of parents and teachers, regarding VKC symptoms and signs, such as perilimbal conjunctival pigmentation, to enable prompt referral to optometrists for the appropriate treatment.

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APPENDICES A- G

Appendix A

PARTICIPANT DATA FORM

PERILIMBAL CONJUNCTIVAL PIGMENTATION AND ITS ASSOCIATION WITH VERNAL KERATOCONJUNCTIVITIS IN CHILDREN FROM THE WEST RAND

PATIENT NUMBER

PARTICIPANT CLASSIFICATION:

VKC PRESENT
VKC ABSENT
PERILIMBAL CONJUNCTIVAL PIGMENTATION PRESENT
PERILIMBAL CONJUNCTIVAL PIGMENTATION ABSENT

DEMOGRAPHIC INFORMATION:

Age:	
Gender:	
Race:	
Residential area: (Carletonville, Kagiso, Krugersdorp, Randfontein, Roodepoort)	

EXAMINATION INFORMATION:

<u>1. Case History (structured interview)</u>: "When was your last eye test? Did you get glasses or medication? Why did you come in today- with what can I help?"

Previous eye examination :
Main reason for coming for an eye examination:

<u>1.2. Ocular History:</u> "What type of eye problems are you experiencing? Do your eyes itch? Are you sensitive to light? Does it feel like there is something in your eye? Do your eyes tear a lot?"

Reporting of the following symptoms:	
Ocular itching	
Photophobia	
Foreign body sensation	
Tearing	

1.3. Medical history: "Do you or your family have any allergic disorders or are you receiving treatment for allergies?"

Reporting of the following allergic history:	
Asthma	
Eczema	
Bronchitis	
Hay fever	

1.4. Other: "Do you have an illness or do you use chronic medication? Have you had an eye operation?"

2. Preliminary examination:

2.1. Visual acuity (LogMAR):

Right eye:	
Left eye	

2.2. Intraocular pressure (mmHg):

Right eye:	
Left eye	

3. Refractive error and best- corrected VA:

Right eye:	( )
Left eye	( )

4. Anterior ocular surface examination (slit lamp findings):

Right eye			Left eye	
Present	Not present		Present	Not present
		Conjunctival hyperaemia		
		Tarsal conjunctival papillae		
		Cobblestone papillae		
		Limbal infiltrates		
		Horner- Trantas dots		
		Perilimbal conjunctival pigmentation		

5. Posterior ocular findings (fundus):

Any abnormal pathology detected:	Yes	No
Right eye		
Left eye		

Appendix B1

INFORMATION DOCUMENT

Study title: Perilimbal conjunctival pigmentation and its association with vernal keratoconjunctivitis in children from the West Rand.

Dear Parent/Legal Guardian/Caregiver

I, Chandre' van Vuuren, am doing a research study on the perilimbal conjunctival pigmentation presenting in children with vernal keratoconjunctivitis. Vernal keratoconjunctivitis is an eye allergy that affects children between the ages of 6 and 12 years. Perilimbal conjunctival pigmentation is a brown discolouration of the eye which is also seen in children with vernal keratoconjunctivitis.

A research study is a study on a specific question, which is done to find a specific answer. In this study, I want to learn if the brown discolouration seen in children's eyes is caused by eye allergies or by their skin complexion. If the brown discolouration of the eyes is associated with eye allergies, then optometrists may use this feature to diagnose and help children with vernal keratoconjunctivitis. This will allow more children to be treated and it will promote the ocular health of children.

Herewith I am asking you to include your child to participate in the research study. For the research study, 200 children from the West Rand will receive eye tests so that the optometrist can identify how far the child can see, if there are any health problems with the child's eyes and how weak the child's eyes are. These tests will all be done inside a private testing room and the child will only need to read letters shown to them and answer questions asked by the optometrist. The child will not be hurt during the test.

The eye test will take a minimum of 30 minutes. There are no risks or side effects of the study. The benefit of the study is that the research results will help optometrists to test and treat more children who have vernal keratoconjunctivitis and it will help to prevent blindness.

The participation of the child is voluntary and you as the parent/ legal guardian have the right to refuse the child to participate. If you refuse participation, your child will still receive an eye test and treatment for their eye problems. You may withdraw your child from the study at any given time. There is no cost involved to participate and no financial or other incentives will be given to the child for participating. The information of your child will be kept confidential, as I will not use your child's name in any document. The results of this study may be published or discussed in a meeting.

For further questions about the study, please feel welcome to contact the researcher, Chandre' van Vuuren at 079 692 8260 or the study leader, Mrs. E Kempen at 051 405 2692.

To report any problems with this study, please feel welcome to contact the Health Science Research Ethics Committee (HSREC) secretariat and chair office at the University of the Free State (UFS) at 051 401 7795.

Appendix B2

INLIGTINGSVORM

Navorsingstitel: Perilimbal conjunctival pigmentation and its association with vernal keratoconjunctivitis in children from the West Rand.

Geagte Ouer/voog/versorger

My naam is Chandre' van Vuuren en ek is besig met n navorsing studie genaamd "The presence of perilimbal conjunctival pigmentation and its association to vernal keratoconjunctivitis in children from the West Rand". Vernal keratoconjunctivits is n oog allergie wat by kinders gevind word en perilimbal conjunctival pigmentation is n bruin verkleuring van die oe" wat by kinders gesien word.

'n Navorsings studie word gedoen deur n spesifieke vraag te vra en dan word daar gepoog om n antwoord te vind hiervoor. Tydens die studie wil ek probeer uitvind of die bruin verkleuring in die kinders se oe" is as gevolg van n allergie en of die pigment in hul vel dit eerder veroorsaak. Indien ek vind dat die verkleuring n resultaat is van allergiee', mag dit optometriste help om kinders met vernal keratoconjunctivitis te diagnoseer en te help. Meer kinders sal dus behandel kan word, oog gesondheid sal verbeter en blindheid mag voorkom word.

Hiermee vra ek toestemming vir u kind se deelname aan my navorsingstudie. Gedurende die studie, sal 200 kinders van die Wesrand se oe" getoets word. Daar sal getoets word hoe ver die kinders kan sien, of die oe" swak is en of daar enige probleme met die oog gesondheid is. Die toets sal gedoen word in n privaat kamer en die kind sal slegs gevra word om letters te lees en n paar vrae te antwoord. Dit sal ongeveer 30 minute duur en dit sal pynloos wees. Die studie behels geen nadelige effek of skade nie.

Deelname aan die navorsingstudie is vrywillig en u het die reg om die deelname te weier indien u wil. Daar is geen koste betrokke by die deelname nie en u mag u kind onttrek van die studie op enige tydstip.

Al die standaard toetse word op die kinders gedoen, self as hulle nie deel is van die studie nie. Geen finansiele, of enige ander vergoeding sal aan die kinders wat deelneem gegee word nie. Alle inligting van u kind sal konfidensieel wees.

Die kinders se name sal nerens gebruik word nie en sal dus vertroulik bly. Die resultate van die studie mag wel gepubliseer word en tydens n vergadering bespreek word.

Indien u enige vrae aangaande die projek het, is u welkom om die navorser, Chandre' van Vuuren te kontak by 079 692 8260, of die studie leier, Me E Kempen by 051 405 2692.

Vir enige probleme wat u ondervind met die projek, kan u die Health Science Research Ethics Committee (HSREC) se kantoor by die Universiteit van die Vrystaat (UFS) kontak by 051 401 7795.

Appendix B3

KITSO MOKWALO

Study title: Perilimbal conjunctival pigmentation and its association with vernal keratoconjunctivitis in children from the West Rand.

Go Motswadi/ Motlhokomedi

Nna Chandre' van Vuuren, ke dira dipatlisiso ka ga bolwetse jwa matlho bo bo bidiwang "Perilimbal conjunctival pigmentation" bo bo fitlhelwang mo balwetseng ba ba nang le "vernal keratoconjunctivitis". Vernal keratoconjunctivitis ke bolwetse ba matlho bo bo fitlhelwang mo banewg gape perilimbal conjunctival pigmentation ke mmala o borokwa wa matlho ebile o fitlhelwa gantsi mo baneng.

Re dira dipatlisiso go leka go fitlhelela gore bolwetse jo bo tlholwa ke eng. Mo thutong/ patlisiso ee ke leka go. Fitlhelela gore mmala o borokwa o o bonwang gantsi mo matlhong a bana o tlhotlheletswa ke malwetse a matlho kappa ke mmala wa letlalo. Fo go ka fitlhelwa mmala o borokwa otsalanya le go ilwa ke sengwe, dingara tsa matlho di ka kgona go dirisa karolo e go thusa bana ba ba tshwenywang ke bolwetse ba vernal keratoconjunctivitis. Se setla thusa bana ba le bantsi gore ba bone kalafi le go tlhatlosa maemo a boitekanelo.

Ke kopa gore batsadi ba demelele bana go tsaya karolo. Ke tlile go tlhatlhoba bana ba le 200 makgolo a mabedi go tswa ma West Rand. Ngaka etlile go tlhomamisa gore bana bo bonela bokgakala bo le kae, fa gona le mathata le kokoa mo matlhong a bona. Diteko di dirwa mo kamoreng ya sephiri, ngwana o tlile go buisa le go araba dipotso tsa ngaka. Diteko die babalesegile.

Diteko di diriwa ka fa tlase ga metsotso ele. Masome a mararo 30. Diteko di bolokesegile. Botlhokwa jwa dipatlisiso ke go thusa dingaka tsa matlho go thusa bana ba ba tshwenyegang ke bolwetse jwa vernal keratoconjunctivitis, gape go thusa go thibela bofofu.

Go tsenela diteko ga go patelediwe mme motswadi o na le tokelo ya go gana ka ngwana. Le fa go ntse jalo bana ba santse ba kereya thuso ya ga tlhatlhobiwa le go bona kalafi. Ga gona tue lo. Diphitlhelelo tsa diteko di tlile go nna sephiri ebile leina la ngwana ga le kitla le dirisiwa gope.

Fa goua le dipotso, re kopa le letsetse ugaka ya matlho, Chandre' van Vuuren mo mogaleng 079 692 8260, kgotsa moeteledipele Mme E Kempen mo 051 405 4692.

Fa gona le mathata le ka letsetsa lefapheng la "Health Science Research Ethics Committee" (HSREC), University of the Free State (UFS) 051 401 7795.

Appendix C1

CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

You have been asked by Chandre' van Vuuren to allow your child to participate in the research study. You have been informed about the study by Chandre' van Vuuren and the information document provided to you.

You may contact the researcher, Chandre' van Vuuren at 079 692 8260 or the study leader, Mrs E Kempen at 0514052696 for any questions about the research study.

You may contact the Health Science Research Ethics Committee (HSREC) secretariat and chair office at the University of the Free State (UFS) at 051 401 7795 for questions about your child's rights as a participant in the study.

The participation of your child in this study is voluntary and your child will still receive an eye test and treatment if you decide to refuse your child's participation.

You will receive a signed copy of this document and the information document, which explains the research study in detail.

Herewith I, ……., confirm that the research study was verbally explained to me by the researcher and that I voluntarily agree to allow my child to participate in the study.

…… …….

Parent / Legal Guardian/ Caregiver signature Date

Appendix C2

TOESTEMMING OM DEEL TE NEEM AAN DIE NAVORSINGS PROJEK

U is gevra deur Chandre van Vuuren om u kind toe te laat om deel te neem aan die navorsingsprojek. U is ingelig wat die studie behels deur die inligtings blad wat aan u gegee is.

U kan die navorser, Chandre van Vuuren, kontak by 079 692 8260, of die studie leier, Me E Kempen by 051 405 2696 indien u enige verdere vrae sou he.

U kan die Health Science Research Ethics Committee (HSREC) kantoor by die Universiteit van die Vrystaat (UFS) kontak by 051 401 7795, indien u enige vrae het tot u kind se regte tydens die deelname aan die studie.

Die deelname van u kind is vrywillig en indien u deelname weier, sal u kind nogsteeds n oogtoets en behandeling ontvang, soos deur u gevra is.

U sal n afskrif van die getekende document, asook van die inligtings stuk wat die studie volledig bespreek ontvang.

Hiermee bevestig ek, ……., dat die navorsingsprojek deur die navorser aan my verduidelik is en dat ek die deelname van my kind, vrywillig toelaat.

……. ……

Ouer / Wettige Voog / Versorger Datum

Appendix C3

TETLELELO KWA TSAYA KAROLO

Le kopiwa ke Chandre' van Vuruen go lo dumelela bona go tsenela diteko tsa matlho. Le tlhaloseditswe ka ga diteko tsa dipatlisiso tsa malwetse a matlho ke Chandre' van Vuuren mo mogaleng 079 692 8260, kappa moeteledipele ma thuto Mme E Kempem mo 051 405 2696.

Le ka ikopanya le mo lefapheng la Health Science Research Ethichs Committee (HSREC), University of the Free State (UFS) mogala 051 401 7795 go botsa ka ditokelo tsa ngwana.

Go tsenela diteko e santse ele tlhopo ya motswadi fela bana ba santse ba tlile go kereya thuso ya teka. Re tlile go fana ka setlaukana se se nang le tlhaloso ya dipatlisiso ka botlalo

Nna, ……., ke dumela gore dipatlisiso thuto di tlhalositswe ka botlalo ke ngaka le gore ke ithaopa go dumelela ngwana go tsaya karolo.

……. …….

Motswadi/ Motlhokomedi wa ngwana Letiha.

Appendix D1

CHILD ASSENT FORM

You are being asked to take part in a study being done by Chandre' van Vuuren. In this study, she is going to look at the health of your eyes and make sure that everything is OK. She has asked your parent if it is OK for you to take part in the study, but she wants to know if it is also OK with you.

If you want to take part in this study, she will test your eyes to see how far you can read and how strong your eyes are. This will take about 30 minutes to do. You will not get sore while she tests you. Everything that she test will be a secret, so she won't tell anyone. She will not use your name, so no one will know that she tested you.

By writing your name on this paper, you are showing that you understand what is going to happen in the eye test and that you have asked her any questions that you have. You can also ask questions later if you cannot think of them now. If you don't want to be a part of this study later on, you can tell her; and she will not use your test.

How are you feeling about being a part of my study?

…… ……

Child's signature Date

Appendix D2

MINDERJARIGE INSTEMMINGS VORM

Hiermee word jy gevra om deel te neem aan n studie wat gedoen word deur Chandre' van Vuuren. Sy gaan kyk na die gesondheid van jou oe" en ook seker maak dat alles reg is.

Sy het vir jou Ma/ Pa gevra of jy mag deelneem aan die studie, maar sy wil vir jou ook vra of jy asseblief sal deelneem?

As jy gaan deelneem aan die studie, sal sy jou oe' toets en kyk hoe ver jy kan lees en hoe sterk jou oe' is. Die toets sal 30 minute neem en jy sal nie seer kry nie. Alles wat sy doen sal n geheim bly, so sy sal vir niemand iets vertel nie. Jou naam sal ook nerens gebruik word nie so niemand sal weet dat sy jou oe' getoets het nie.

As jy jou naam op die vorm skryf, beteken dit dat jy verstaan wat sy met die oogtoets gaan doen en dat jy ook enige vrae wat jy het, gevra het. As jy nie nou aan enige vrae kan dink nie, kan jy ook later vir haar vra. As jy later nie meer deel wil wees van die toets nie, kan jy haar enige tyd se'.

Hoe voel jy oor die kans om vir Chandre' te help met haar toets/ studie? 

…… ……

Kind se handtekening Datum

Appendix D3

NGWANA MOKWALO

O Kopiwa ha tsaya karolo mo thutonu ee diriwanu ke nuaka ya matiho, Chandre'. Ke tlile go le-belela boitekanelo jwa matiho go dira bonnete gore tsotihe di apare tshiamo. Ke kopilwe babwadi gore ba le dumelele go baya karolo, fela ke batla go dira bonnete gore go siame mo go lona.

Fa le dumela ke tlile go tihola matiho a lona le go bona gore le bonela bokuakala bo le kae le gore matiho a lona a bia me go le kae diteko di. Vaya metsotsi ele 30 minutes mmasome a mararo. Diphitlhelelo tsa tenu e tlile go nna sephiri ebile diteko ga di botlhoko.

Go nuwala leina la gago go nete fatsa gore o tihalouanya se se tlileng go dir aua le gore o botse dipotso. O dumelebwe go botsa dipobo morsgo. Fa o sa battle go tbsys ksrolo, o dumrlrbwe go fetola monagano morago, mme ga ke no dirisa diteko bag ago.

O ikutlwa yang go nna karolo ya dipatlisiso be?

……. ……..

Monwana wa ngwana Letiha

Appendix E

LETTER TO THE HEALTH SCIENCES ETHICS RESEARCH COMMITTEE, UFS, TO REQUEST PERMISSION TO EXECUTE THE STUDY

THE CHAIR: ETHICS COMMITTEE (DR SM LE GRANGE)

FACULTY OF HEALTH SCIENCES

UNIVERSITY OF THE FREE STATE

Study Title: Perilimbal conjunctival pigmentation and its association with vernal keratoconjunctivitis in children from the West Rand.

Dear Chair

I, Chandre' van Vuuren, a postgraduate student in the Master of Optometry class, hereby request approval for the research study that I would like to conduct. The research study will aim to evaluate the presence of perilimbal conjunctival pigmentation and its association to vernal keratoconjunctivitis (VKC) in South African children.

Vernal keratoconjunctivitis is a preventable chronic inflammatory condition that essentially affects the cornea and conjunctiva of children between the ages of 6 and 12 years. If left untreated, VKC may lead to sight threatening complications and blindness. Perilimbal conjunctival pigmentation has been identified as a brown discolouration of the anterior ocular surface and is found to be present in patients with VKC. This ocular pigmentation is also found to be present in individuals of a darker skin complexion.

For the purpose of the study, I would like to identify if there is an association between the perilimbal conjunctival pigmentation in VKC and ocular allergic responses or racial factors. To best obtain the relevant information, the data collected in this research study will be obtained through ocular examinations of participants. This will be done by measuring the visual acuity, intraocular pressure and ocular refractive error.

The anterior and posterior ocular health will also be examined. The equipment used for data collection will be as follows: a LogMAR chart, a trial frame and pinhole occluder, an I-care tonometer, an auto-phoropter, a slit lamp biomicroscope and a fundus camera. The ocular examinations will take a maximum of 30 minutes. The sample size will consist of 200 participants between the ages of 6 and 12 years tested in a private optometry practice in the West Rand. All participants must meet the inclusion criteria.

Parents and legal guardians will receive information documents and consent forms to voluntarily allow their children to participate in the study. Children will also receive assent forms to voluntarily agree to participate. Participants will not receive financial or other incentives for participation nor will there be a fee to participate. The participant's information will be treated as confidential at all times. If participation is refused by the parent, the child will still be examined and treatment will be provided.

There are no risks or side effects of participating in this study. If the perilimbal conjunctival pigmentation is found to be associated to ocular allergic responses, the benefits of this study are that optometrists will be able to use this sign to identify the early development of VKC. Thus, it will lead to the prompt diagnosis and treatment of patients and the promotion of ocular health. I hereby request your approval. Attached please find the above research protocol for your evaluation and approval. You are welcome to contact meat 079 692 8260, or the study leader Mrs E Kempen at 051 405 2692, should you have any concerns or uncertainties.

Yours faithfully,

Ms. Chandre' van Vuuren

Student number: 2012041550

Email: chandre1111@gmail.com

Tel: 079 692 8260

Appendix F

PERMISSION LETTER FROM THE HEALTH SCIENCES ETHICS RESEARCH COMMITTEE, UFS, STATE TO EXECUTE THE STUDY

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

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

25-Oct-2018

Dear **Ms Chandré Van Vuuren**

Ethics Clearance: **THE PRESENCE OF PERILIMBAL CONJUNCTIVAL PIGMENTATION AND ITS ASSOCIATION WITH VERNAL KERATOCONJUNCTIVITIS IN CHILDREN FROM THE WEST RAND.**

Principal Investigator: **Ms Chandré Van Vuuren**

Department: **Optometry Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

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

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2018/1289/2711**

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

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

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

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

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

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

Yours Sincerely

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

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

Appendix G

PERMISSION LETTER TO THE OPTOMETRY PRACTICE OWNER

Study Title: Perilimbal conjunctival pigmentation and its association with vernal keratoconjunctivitis in children from the West Rand.

Dear Mr B Strydom

I, Chandre' van Vuuren, hereby request permission to use your facility to collect the data for my research study in the form of ocular examinations. As you are aware, I am currently a postgraduate student at The University of the Free State doing a Master of Optometry degree.

The research study will aim to evaluate the presence of perilimbal conjunctival pigmentation and its association to vernal keratoconjunctivitis (VKC) in South African children. Vernal keratoconjunctivitis is a preventable chronic inflammatory condition that essentially affects the cornea and conjunctiva of children between the ages of 6 and 12 years. If left untreated, VKC may lead to sight threatening complications and blindness. Perilimbal conjunctival pigmentation has been identified as a brown discolouration of the anterior ocular surface and is found to be present in patients with VKC. This ocular pigmentation is also found to be present in individuals of a darker skin complexion. For the purpose of the study, I would like to identify if there is an association between the perilimbal conjunctival pigmentation in VKC and ocular allergic responses or racial factors.

To best obtain the relevant information, the data collected in this research study will be obtained through ocular examinations of participants. This will be done by measuring the visual acuity, intraocular pressure and ocular refractive error. The anterior and posterior ocular health will also be examined.

The equipment used for data collection will be as follows: a LogMAR chart, a trial frame and pinhole occluder, an I-care tonometer, an auto-phoropter, a slit lamp biomicroscope and a fundus camera. The ocular examinations will take a maximum of 30 minutes. The sample size will consist of 200 participants between the ages of 6 and 12 years tested in a private optometry practice in the West Rand. All participants must meet the inclusion criteria.

Parents or care givers will receive information documents and consent forms to voluntarily allow their children to participate in the study. Children will also receive assent forms to voluntarily agree to participate. Participants will not receive financial or other incentives for participation nor will there be a fee to participate. Financial or other incentives will not be paid to the practice owner for the use of the facility. The participant's information will be treated as confidential at all times as no names will be used on the data collection forms. If participation is refused by the parent, the child will still be examined and treatment will be provided.

There are no risks or side effects of participating in this study. If the perilimbal conjunctival pigmentation is found to be associated to ocular allergic responses, the benefits of this study are that optometrists will be able to use this sign to identify the early development of VKC. Thus, it will lead to the prompt diagnosis and treatment of patients and the promotion of ocular health. I hereby request your approval. Attached please find the above research protocol for your evaluation and approval. You are welcome to contact meat 079 692 8260, or the study leader Mrs E Kempen at 051 405 2692, should you have any concerns or uncertainties.

Yours faithfully,

Ms. Chandre' van Vuuren

Student number: 2012041550

Email: chandre1111@gmail.com

Tel: 079 692 8260

Appendix H

CONSENT FORM FROM THE OPTOMETRY PRACTICE OWNER

You have been asked by Chandre' van Vuuren to provide permission to use your facility and patients for the purpose of her research study. You have been informed about the study by Chandre' van Vuuren and the permission letter provided to you.

You may contact Chandre' van Vuuren at 079 692 8260 or the study leader, Mrs E Kempen at 0514052696 for any questions about the research study.

You may contact Mrs. M Marais at the Health Science Research Ethics Committee (HSREC) secretariat and chair office at the University of the Free State (UFS) at 051 401 7795 for further ethical questions.

The participation of the patients in this study is voluntary and the patients will still receive an eye test and treatment if participation is refused.

I, ……Benre' Strydom…… , give consent for the use of my facility for the research study, as explained to me by the letter for permission and by Chandre' van Vuuren. Furthermore, I give consent that my patients may be approached to voluntarily take part in this research study and I understand that their information will be treated as confidential. I understand that the results of the research study may be published.

BS …… 01.09.2018 ……

B. Strydom Date