Determinants of Health Care Needs in Relation to Vision Correction Among Adolescents in the United Arab Emirates: A Cross-sectional Study

by

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A thesis submitted to the
School of Graduate and Postdoctoral Studies in partial
fulfillment of the requirements for the degree of

Master of Health Sciences in Community, Public and Population Health

Faculty of Health Sciences

University of Ontario Institute of Technology (Ontario Tech University)

Oshawa, Ontario, Canada

May, 2023

THESIS EXAMINATION INFORMATION

Submitted by: **Faryal Kiran Maniyali**

Master of Health Sciences in **Community, Public and Population Health**

Thesis title: **Determinants of Health Care Needs in Relation to Vision Correction Among Adolescents in the United Arab Emirates: A Cross-sectional Study**

An oral defense of this thesis took place on May 03, 2023 in front of the following examining committee:

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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

ABSTRACT

Uncorrected refractive error (URE) has been suggested to affect children's development, educational performance, and socialization. Sociodemographic and environmental differences among individuals may impact their accessibility in utilizing appropriate services, impacting their vision-dependent activities.

Guided by the population health framework, this retrospective study examined the prevalence and determinants of self-reported vision correction needs for a sample of adolescents (n=6363) from the United Arab Emirates (UAE) aged 13 to 20 years between 2007 to 2009.

Findings suggest a relatively high prevalence of self-reported vision correction needs (26.8%). Factors that were significantly associated with vision correction needs included age, biological sex, location of residence (emirate), nationality, parental education and employment level, household financial status, screen time use, visiting an eye specialist in the past year, and daily functional capacity. Further research on identifying modifiable barriers to accessing vision care may help the adolescent population improve in visual tasks and overall quality of life.

Keywords: vision correction; adolescent; self-reported; UAE; prevalence

AUTHOR'S DECLARATION

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_____ Faryal Kiran Maniyali

STATEMENT OF CONTRIBUTIONS

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication. I have used standard referencing practices to acknowledge ideas, research techniques, or other materials that belong to others. Furthermore, I hereby certify that I am the sole source of the creative works and/or inventive knowledge described in this thesis.

ACKNOWLEDGEMENTS

I would like to give my heartfelt acknowledgments and gratitude to all the amazing members of Ontario Tech University who guided me in every step throughout the course of my studies, along with my beloved family for their greatest support and assistance along the way.

I would like to thank my research supervisor, Dr. Caroline Barakat for always displaying utmost patience, providing helpful guidance, and helping me bring out my highest potential throughout the program with my thesis as well as my academic works in my courses. I would also like to thank my supervisory committee members, Dr. Otto Sanchez and Dr. Efrosini Papaconstantinou for sharing valuable feedback, suggestions, and expertise along with taking out time to review my work along the way.

I would like to thank my family who has always stood by me with encouragement, patience and support so I could fulfill and excel in my academic endeavours. A special thank you to my parents and my husband for being my pillars of strength, believing in me and cheering me in conquering my goals.

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LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviations	Definitions
VI	Vision impairment
URE	Uncorrected refractive error
RE	Refractive error
WHO	World Health Organization
D	Diopters
SE	Spherical Equivalent
RESC	Refractive Error Study in Children
COVID-19	Coronavirus 2019
SES	Socioeconomic status
UAE	United Arab Emirates
EBP	Essential Benefits Plan
AED	United Arab Emirates dirham (currency)
USD	United States dollar (currency)
HAAD	Health Authority of Abu Dhabi
MoH	Ministry of Health
DHA	Dubai Health Authority
SEIHU	Schools and Educational Institutions Health Unit
PHCSS	Primary Health Care Services Sector
SEN	Special education needs
CHASE	Child Heart and Health Study in England
SAGE	Study on Global Aging and Adult Health
LMICs	low- and middle-income countries
SCORM	Singapore Cohort study of Risk factors of Myopia
DALYs	disability-adjusted life years
SDI	Sustainable development index
HDI	Human development index
NSPHUAE	National Study of Population Health in the UAE
ISAAC	International Study of Asthma and Allergies in Childhood
PHF	population health framework
RAK	Ras Al Khaimah
UAQ	Umm Al Quwain

Chapter 1: Introduction

1.1 Background

1.1.1 Vision Impairment due to Refractive Error

Vision function and vision care are fundamental to independence and quality of life, therefore vision loss significantly interferes with daily activity (Berger & Porell, 2008). Vision impairment (VI) due to uncorrected refractive error (URE), which impacts a large proportion of the global population, is the leading ocular problem affecting all age groups and most easily preventable cause of disability (Hashemi et al., 2018; Lou et al., 2016; Holden, 2007). Refractive errors are the most common ocular problems impacting all age groups, and thus are considered a public health challenge (Pascolini & Mariotti, 2012). Refractive errors occur when the eye's optical system is unable to converge parallel rays of light to focus on the fovea (Sherwin et al., 2011). The magnitude is based on biometric data such as axial length, anterior chamber depth and corneal curvature, where there may be an error due to mismatch between biometric components of the eye and integrity of the structures (Warrier, 2008).

Among young adults evaluated in recent studies, axial length is one of the most important aspects of refractive error. Refractive error is known as the first cause of VI and second cause of visual loss worldwide, with 43% of VI ascribed to refractive errors (RE) (Pascolini & Mariotti, 2012). According to Flaxman et al. (2017), the number of people impacted by blindness due to URE globally has increased between 1990 and 2015 from 6.2 million to 7.4 million, and more significantly by vision impairment from 84.8 million to 116.3 million.

The three main forms of refractive error are astigmatism, myopia, and hyperopia. Astigmatism occurs when the curvature of the cornea is not spherical resulting in a target object reaching the retina in two areas and causing visual blur in either near or far (Stein et al., 2017). It poses an additional power above the spherical refractive error. Hyperopia, or far-sightedness, is when near objects are out of focus as the far objects get focused behind the retina. Myopia, or near-sightedness, is when distant objects are out of focus as the far objects get focused in front of the retina. A meta-analysis evaluating prevalence of refractive error worldwide from 1990-2016 separately according to World Health Organization (WHO) regions, revealed that astigmatism (cylinder power greater than 0.5 diopters (D)), hyperopia (spherical equivalent (SE) cut point greater than +2 D), and myopia (SE cut point less than -0.5 D) were the most common refractive errors in children and adults (Hashemi et al., 2017). A collection of population based surveys (Dandona et al., 2002; Goh et al., 2005; Maul et al., 2000; Murthy et al., 2002; Naidoo et al., 2003; Pokharel et al., 2000; Zhao et al., 2000; He et al., 2004) and school based surveys (Gao et al., 2012; He et al., 2007; Lindquist et al., 2011; Sapkota et al., 2008) for Refractive Error Study in Children (RESC) conducted in numerous countries with different ethnic origins and cultural environments identified myopia as a major public health concern (Paudel et al., 2014).

The global economy loses $269 billion annually due to lost productivity from URE (Smith et al., 2009). Visual impairment due to refractive error (VI-RE) negatively affects school performance, economic advantages, employability, physical safety in work and play, and general quality of life (Dandona & Dandona, 2001), thus requiring early detection, screening and assistance in increasing correction of refractive errors among school students. The blurred vision associated with refractive error is often treated with corrective lenses (spectacles or contact

lenses) or refractive surgery (Sherwin et al., 2011), leading to improved visual function and enhanced educational outcomes (Estesto et al., 2007; Ma et al., 2014). However, socioeconomic factors such as poverty and limited ability to access treatment may influence the correction of refractive errors, where the URE can also contribute to the individuals' and their respective families' socioeconomic status (Naidoo & Jaggernath, 2012).

Impaired vision has been suggested to affect children's cognitive and motor development, their educational performance, and socialization, since they continue to receive increasing visual tasks as they progress in school (Rudnicka et al., 2008; World Health Organization, 2000). Among children aged 5-15 years globally, 12.8 million were estimated to be VI-RE, accounting for 0.97% (Alomair et al., 2021). As this is a critical period of eye development and approximately 80% of student learning occurs through visual tasks (reading, writing, board work, computer), children and adolescents may have higher sensitivity to environmental factors and high risk of suffering from vision impairment from URE, leading to reduced student academic and social participation (Yang et al., 2021; Rudnick et al., 2008). Differences in socioeconomic and demographic factors (such as location, biological sex, ethnicity and socioeconomic status (SES)) among individuals may impact their affordability and accessibility in utilizing the appropriate ophthalmic services and devices, thereby impacting their daily vision-dependent activities (Rudnick et al., 2008). For example, school-aged children during the coronavirus 2019 (COVID-19) pandemic period may be susceptible to undiagnosed myopia (near-sightedness) due to staying at home and not attending in-person class where their vision impairment may be highlighted, as well as having restricted in-person access to an eye specialist. (Yang et al., 2021). Moreover, previous studies have shown that 60% of schoolchildren,

identified as problem learners, had undetected vision problems and more than 75% of juvenile offenders had undetected and untreated vision problems (Rudnicka et al., 2008). The WHO recommends the integration of vision screening and refractive services for school students and to prioritize the control of blindness in children in "Vision 2020-the right to sight" program (Resnikoff et al., 2008). This is particularly important in areas where integration of vision screening and refractive services is absent. Therefore, it is important to examine differences in the prevalence of URE in relation to SES, ethnic groups, and geographic regions, and to identify determinants of health care needs in relation to vision correction in the school age population. Identifying determinants of vision care needs and who is at most risk can assist in implementing interventions with respect to visual aid services for students to help them improve academically, socially, and functionally in their developing years.

1.1.2 Overview of the UAE and its Healthcare sector

The UAE, formed in 1971, is a country comprising of seven emirates located in the southeast region of Arabian Peninsula (Grivna et al., 2012). Post the discovery of oil, the country has had a significant increase in economic and industrial growth, including in petroleum, maritime, aviation, construction and health care (Aw, 2010). According to the Federal Competitiveness and Statistics Centre, the population of UAE was 9,282,410 in 2020, with an estimate of 947,997 nationals/Emiratis and an estimate of 7,316,073 non-nationals in 2010 (Fact Sheet, 2020). Emiratis/nationals are the native Arab population who are citizens of the UAE. The population of UAE has increased greatly over the past four decades, mainly due to the high net inward migration of expatriate workers, creating a population structure of 11% Emiratis and the rest expatriates of different nationalities (United Arab Emirates National Bureau of Statistics,

2011; Dhabi, 2011). Therefore, the country is made of a multinational population, with varying educational backgrounds, cultural practices, and religious beliefs, which present an opportunity to explore the various health outcomes across the population of UAE (Loney et al., 2013).

The health sector in the UAE is regulated by the Ministry of Health, responsible for the public health sector, and the Emirates health authorities, responsible for service delivery at the state level in Dubai and Abu Dhabi (Health Insurance and the Healthcare System in the UAE Explained, 2021). Health care is provided for all nationals, but non-nationals are expected to secure mandatory health insurance.

As of 2018, there are 104 hospitals, 33 government and 71 private hospitals in the UAE. Table 1 outlines the distribution of government and private hospitals for each of the seven emirates.

Table 1 - Distribution of Government and Private Hospitals for each Emirate

Emirate	**Number of Government Hospitals**	**Number of Private Hospitals**
Abu Dhabi	14	25
Dubai	6	32
Sharjah	5	10
Ras Al Khaimah	4	1
Ajman	1	2
Fujairah	2	1
Umm Al Quwain	1	0

Note. From Health Insurance and the Healthcare System in the UAE Explained. (2021). Retrieved from https://www.internations.org/go/moving-to-the-uae/healthcare

Public hospitals only provide basic healthcare services, and in some areas, specialized facility centres (Koornneef et al., 2013). This excludes vision aids and vision correction by surgery or laser (Health Insurance Law of Dubai – ISAHD, 2015). If an employer does not provide health insurance for an individual or dependent, one can take a private healthcare plan or the Essential Benefits Plan (EBP) which covers same coverage as the UAE public healthcare for those who earn less than 4000 AED (146 USD) per month. The EBP costs between 550 to 650 AED (150 USD to 177 USD) per year. A comprehensive private health insurance policy may be an estimate of 10,000 AED (2728 USD) per year with premiums ranging from 5,500 AED (1500 USD) per year for a thirty-year old expat to an estimate of 33,500 AED (9121 USD) for a family of four. If health insurance is not provided, one needs to apply for a health card which only offers basic healthcare coverage, where fees apply for each age group (0-9 years is 100 AED (27 USD), 10-17 years is 200 AED (54 USD), and 18+ years is 300 AED (82 USD)). If health insurance is provided by an employer, it is dependent on the employee's salary and designation. Moreover, expats need health insurance in the UAE to receive a UAE residency visa, and must pay for both private and public health insurance in the UAE. However, there are discrepancies regarding the requirement of employers to provide health insurance coverage based on location. In Abu Dhabi, employers must provide coverage for their employees and four dependents (one spouse and up to three children under the age of 18 years). In Dubai, employers need to provide coverage to employees but are not required to cover dependents. In Sharjah and Northern Emirates, employers do not need to provide coverage for their employees. This greatly impacts the equal and affordable accessibility to vision care services to children under the age of 18 years based on location of residence and household income.

As of 2017 statistics reported by the Federal Statistics and Competitive Authority, there are 8322 physicians in the government sector and 14,785 physicians in the private sector (Healthcare Providers, 2021). Thus, a study reported large differences in average healthcare utilization rates between UAE nationals who used outpatient clinical services once per month, compared to expatriates who used these services 3-4 times less (Blair & Sharif, 2013). Studies assessing the UAE health regulatory system have shown concern over the regulatory fragmentation, lack of regulatory control, and their impact on quality improvement (Koornneef et al., 2013). Abu Dhabi's healthcare regulator, Health Authority of Abu Dhabi (HAAD), noted in 2013 that "the current model of care in Abu Dhabi does not adequately support self-care or prevention and screening programs and diagnostic services are not integrated into care plans" (Health Authority Abu Dhabi, 2014). Since comprehensive vision care and further specialized eye procedures are not uniformly available to all residents, it poses a challenge for residents to seek appropriate and timely vision care in both preventive and curative form.

School health services in Dubai are also categorized into public and private sectors, where the Ministry of Health (MoH) oversees public schools and Dubai Health Authority (DHA) oversees the private schools (Taryam et al., 2017). In Dubai, there are 81 public schools and 186 private schools, where only private schools have a Schools and Educational Institutions Health Unit (SEIHU) from the Primary Health Care Services Sector (PHCSS) of DHA that help conduct health assessments and support. The school health team helps develop guidelines, policies, and training to improve child health at private schools, where each school has a nurse and a doctor. There are 6 out of 186 (3.2%) DHA-supervised special needs schools for children with special education needs (SEN) which includes children dealing with eye disorder as a primary or

secondary cause. Among public schools in Abu Dhabi, the Comprehensive School Screening Program, part of the Preventative Screening for children launched by HAAD in 2010, includes vision screening among other components for early recognition of health problems in children (Al Hajeri, 2020). Vision screening is conducted at grades one, five, and nine, and grade two for those unable to be screened in grade one, with colour blindness assessment from grade five. The screening process by school nurses and technicians includes conducting the pre-screening observation, distance acuity test, and additional stereoacuity in grade one and colour vision in grade five. If the child passes the screening test, the information is recorded in file and updated in the reporting system. If the child did not pass, he/she is reported to the family physician and results are documented on school health record, reporting system, and on parent/guardian notification letter (Al Hajeri, 2020). However, based on the scoping of the literature review below, there are no publications found to be referring to the school-based vision screening process amongst the entire UAE in both public and private schools, and no self-reported concerns of students having difficulty seeing, pursing vision tasks, and/or accessing resources for vision correction. Future research is needed to explore the school-based health services in both the public and private schools within UAE. The potential discrepancies in school-based health care services and assessments between public and private schools due to access to vision screening only in private schools in Dubai and public schools in Abu Dhabi, with unknown vision screening services in other emirates may result in gaps in physician-diagnosed or self-reported vision impairment requiring vision correction.

1.2 Scoping Literature of Health Care Needs in Relation to Vision Correction

This thesis presents a preliminary literature search that was conducted to review the prevalence of health care needs for vision correction in relation to socioeconomic and demographic factors, and lifestyle behaviours. An electronic search of PubMed, Ovid Cochrane, and Web of Science database sources were used. Key words from the research topic were used to focus on articles pertaining to children and adolescents with VI-RE, including prevalence, determinants and/or associations, and vision impairment due to refractive error. Articles that were excluded included subject matter that focused on VI due to other reasons, a population other than children and adolescents, and studies focusing on a vulnerable or diseased population. Findings from the articles were summarized in a table with the characteristics of the study, population, prevalence of VI-RE, and associating factors along with their direction. The literature gave rise to 7 main themes. These include geographic differences, biological sex, ethnicity, socioeconomic status, near work, outdoor activity, and self-reported health care needs.

1.2.1 Literature Evidence on Health Care Needs in relation to Vision Correction

A. Geographic differences in the prevalence of VI-RE

Among studies assessing the visual status of children, there appears to be differences in the distribution of three types of refractive error, ie. myopia, hyperopia, and astigmatism within the WHO regions. The following regions were included: African Region, Region of the Americas, South-East Asia, Europe, Eastern Mediterranean region, and Western Pacific Region (Hashemi et al., 2017). Prevalence of myopia ranged from 4.9% in South-East Asia to 18.2% in the Western Pacific region. Prevalence of hyperopia was 4.6% worldwide, with lowest found in South-East Asia (2.2%) and highest in the Americas (14.3%). Prevalence of astigmatism was

14.9% in children worldwide, with lowest in South-East Asia (9.8%) and highest in the Americas (27.4%) followed by the Eastern Mediterranean region (20.4%). A prevalence of myopia among 73% in 15-year-old children in Guangzhou, China (He, 2004) and prevalence of 84% of myopia among 16- to 18-year-old children in Taiwan (Lin, 1999) suggest high distribution of myopia in East Asia (Powell, 2004). Since children are generally not myopic as the developing axial lengths of their eyes are shorter than adults (resulting in hyperopia), there may be environmental factors that play a more important role.

B. Biological sex as a health determinant of visual impairment

Biological determinants of health – such as individual genetic endowment and functioning of body systems – impact population health (Segall & Fries, 2011). Among children, literature has not established a distinct biological sex difference in the prevalence of visual impairment, though some studies found significantly higher prevalence of visual impairment among girls (Robaei et al., 2005;He et al., 2004; Zhao et al., 2000). Similarly, a cross-sectional study based in Tehran, Iran revealed higher prevalence of myopia among women than men in each age group, including 5-15 years and 16-25 years of age, whereas males appeared to have a higher prevalence of hyperopia (Hashemi, Fotouhi & Mohammad, 2004). On the other hand, studies based in Nepal and Chile did not find significant differences in visual impairment in relation to biological sex (Maul et al., 2000; Pokharel et al., 2000). For specific VI measures, higher levels of myopia have been documented among girls than boys (Robaei et al., 2005), a finding contrasted by Chong et al., 2005. While there is a inconsistent evidence regarding biological sex as a determinant of visual impairment and refractive error among

children, the main focus in research has been on relatively young school-aged children and specific types of visual impairment (such as myopia).

C. Ethnicity as a health determinant of visual impairment

Due to relative homogeneity in research samples, few existing studies report ethnic differences in the prevalence of visual impairment. A study by Robaei et al. (2005), based on an ethnically-diverse sample of Australian school children where more than one third were non-Caucasian did not find differences in prevalence of visual impairment between Caucasian and non-Caucasian children. It was also noted that prevalence of myopia among children in this study (1.4%) was among the lowest prevalence in the literature, compared to a Singapore-based study on a similar age group that reports a prevalence of 20% (Seet, 2001). The Child Heart and Health Study in England (CHASE) assessed the ethnic differences in myopia among 10- and 11-year old children exposed to the same schooling environment (Rudnicka et al., 2010). Results points to prevalence of myopia ranging from 3.4% among children from white European ethnic origin, to 25.2 % among children from South Asian background, and 10.0% among children from black African Caribbean origin. Similarly, a cross-sectional study among students in an Australian study found a higher prevalence of myopia in children of East Asian ethnicity (42.7% in 12-year old children and 59.1% in 17 year old children) than in children of same age groups of European Caucasian ethnicity (8.3% and 17.7% respectively) (French et al., 2013). A study by Kodjebacheva et al. (2011) assessing first-grade students in South California suggested a higher prevalence of decreased visual acuity due to lack of corrective lenses among African American/Latino children compared to non-Hispanic white children. This is supported by findings from a recent study among pre-school American children showing higher prevalence of

myopia among African Americans (6.6%) than non-Hispanic whites (1.2%), Hispanics (3.7%), and Asians (3.98%) (Wen et al., 2013). Findings from these studies call for follow-up research to examine if there are unique environmental influences between the ethnicities. There is some evidence of differences in the prevalence of vision impairment for children of similar age groups in relation to different ethnicities. The relative homogeneity in sampling limits the ability to determine if the independent variable of ethnicity has an influence on the prevalence of visual impairment due to refractive error.

D. Socioeconomic status as a health determinant of visual impairment

1. Socioeconomic status measured through parental employment status, income, and home ownership)

Evidence suggests that parental employment and home ownership were associated with visual impairment for children (Robaei et al., 2005). Children who were from families where both parents were employed were less likely to have visual impairment compared to families where neither were employed. Children whose parents were more likely to own their own home were less likely to have visual impairment than children whose parents did not own their own home. With respect to myopia, higher levels of SES have been reported to be positively related to prevalence of myopia among children (Chong et al., 2005). A study based in Korea found higher prevalence of myopia among children who came from families of higher income, including those living in homes owned by their parents (Lim et al. 2012). Similarly, a population-based study among children aged 5-15 years in Guangzhou, China showed a higher prevalence of myopia in 15-year-old children with a higher income group, and parents with professional occupations (Xiang, He, & Morgan, 2012). Moreover, children who were from

families of a manual social class were less likely to have poor vision than those from a nonmanual social class (Rudnicka et al., 2008). Class status in the form of higher income and higher educational attainment was also significantly associated with receipt of recent eye examination (within 2 years) in low and middle-income countries, based on a WHO Study on Global Aging and Adult Health (SAGE), which includes nationally representative samples of older adults from 6 low- and middle-income countries (LMICs) (Ehrlich et al., 2019). These findings call for further research to determine the differences in children's ability in receiving healthcare services based on their visual status and SES. The positive correlation between SES and prevalence of myopia points to potential social factors leading to environmental exposures that may impact VI, and also indicates potential gaps in receiving vision-related healthcare services or vision correction needed to correct refractive error due to differences in SES.

2. Parental Education

Higher levels of parental education have been reported to have positive correlation with visual impairment with respect to myopia (Chong et al., 2005). Expanding the findings by Xiang, He, & Morgan (2012) noted above, myopic children were shown to have stronger parental history of myopia and with higher parental level of education (university level). A study based in Kathmandu among school children of upper-middle socioeconomic status found positive associations between visual impairment due to myopia and parental education (Sapkota et al., 2008). Similarly, a significant positive correlation was found between myopia and whose parents are of higher educational level among primary school children in a study from Kelantan, Malaysia (Hashim et al., 2008). In a study by Rudnicka et al. (2008), poor unaided distance vision resulted to be worse and more likely among groups of children and adolescents with

higher levels of parental education than children with lower levels. As parental education is related to social class, removal of the social class variable (defined according to the Registrar General system, dichotomized to manual and non-manual groups) resulted in stronger association for parental education, thus suggesting that while both variables had a positive correlation with poor vision, parental education was more strongly positively related to poor vision than social class among this age group, developing in childhood and having a stronger pattern in adolescence.

E. Near work as a health determinant of visual impairment

The association between near work and myopia has been reported in several studies. Near work includes activities pursued in short working distances such as near reading and academic work (studying, writing), computer use and/or playing video games, and watching television (Mutti et al., 2002). With respect to astigmatism, some studies have suggested a positive relationship between near work and astigmatism due to incyclotorsion (inward eye turn) (Buehren et al., 2003; Yasuda & Yamaguchi, 2005). However, studies among similar age groups of 15-year-old adolescents across different countries have shown greater time spent on near work by individuals from Asian countries than those from UK and USA (Dolgin, 2015). Thus, near work among this age group may have had a role in inducing astigmatism in previously non-astigmatic children due to incyclotortion (inward eye turn), resulting in astigmatism and myopia in adulthood (Hashemi et al., 2017). Myopia is suggested to be increasing in the past three decades, especially in East Asian countries. Worldwide, lifestyle changes and increasing use of computer have resulted in increased near work. There have been some studies assessing the means of developing myopia from near work. During accommodation of the eyes to focus at

near, the intraocular lens thickens and its surrounding ciliary muscle increases pressure on the globe wall, thus increasing axial length during accommodation. Accommodation during near work can lead to optical changes in the eye (increased accommodative lag or increased higher order aberration), changing choroidal thickness, and resulting in axial length changes (Hashemi, 2015).

Along with reporting the association of near work with visual impairment, several studies assessed the optical changes from near work, coinciding with the optical changes indicative of refractive error. This helps combine environmental and behavioural factors with biological optic changes resulting in a refractive error. While some studies have provided some insight on myopia and near work, associations with different forms of near work, duration, and refractive error as a whole or visual impairment have yet to be examined.

F. Outdoor activity as a health determinant of visual impairment

Due to increased computerization, more people are less engaged in outdoor activities (Ramamurthy, Lin Chua & Saw, 2015). Several studies have assessed the influence of outdoor activity on myopia (Jin et al., 2015). A clinical trial study reported that children engaged in outdoor activity had 10% less incidence of myopia (He et al., 2015). Adolescents aged 11-20-years examined in the Singapore Cohort study of Risk factors of Myopia (SCORM) showed that children with myopia participated in significantly less time for total outdoor activities than non-myopic children, including leisure and sports (Dirani et al., 2009). These findings support those from the Sydney Myopia Study, which showed a protective role for outdoor activity in myopia among 12-year-old children (Buch, 2005). Some studies have hypothesized light as a factor of outdoor activity that prevents myopia (Ashby & Schaeffel, 2010). Light stimulates the secretion

of dopamine in the retina, which would prevent ocular elongation during the ocular development process, thereby preventing myopia. Moreover, due to increased intensity of light outside, the pupils may constrict more, resulting in greater depth of field and reduced image blur (Rose et al., 2008).

The studies give insight to an overall trend of increased outdoor activity having association with reduced prevalence of myopia. This helps connect both factors of increased near work and/or reduced outdoor activity with higher prevalence of myopia. However, there have been varying measures to assess outdoor activity through self-reported questionnaire surveys including duration of time spent outdoors, frequency of pursuing outdoor activity, comparing duration of outdoor vs near work in similar number of hours, and time of day spent outdoors to evaluate lighting conditions. Comparing the number of hours spent in outdoor activity versus indoor activity, especially near work, and the amount of sunlight gained from pursuing outdoor activity in the daytime may help determine the comparative benefits of and reduced prevalence of myopia among those pursuing outdoor activity with those pursuing less outdoor activity and have less exposure to sunlight.

G. Self-reported healthcare need in relation to vision correction

Several studies report observed issues related to the mental health of adolescents with vision impairment. These include building and maintaining peer relationships among students (Christian, 2001; Huurre & Aro, 2000), greater difficulty in attaining developmental tasks (Huurre & Aro, 2000; Lifshitz et al., 2007), and higher levels of internalizing symptoms (Kammerer et al., 2003). There have been limited studies regarding self-reported healthcare

needs in relation to vision correction, particularly among adolescents. A cross-sectional comparison study was conducted in the United States to compare prevalence rates of self-reported and examination evaluated vision impairment (VI) and blindness across national surveys (Rein et al., 2021). Sixteen variables among 2 surveys measured VI, with only 1 measuring VI among persons aged 0-17 years, resulting in 3.1% prevalence of self-reported VI. A study by Pinguart & Pfeiffer surveyed 167 students from sixth grade to eleventh grade from 3 German schools (2012) to compare psychological adjustment between adolescents with VI and sighted adolescents. These students had pre-existing vision impairment due to different eye diseases. The study found that students with vision impairment had greater peer problems and emotional problems than sighted peers. A study by Datta & Talukdar investigated the self-concept of 25 students (aged 15 to 25 years) with varying range of vision impairment in South Australia (2015). This included six dimensions: physical, moral, personal, family, social and academic, and total self-concept. While most students obtained low scores in all dimensions, some obtained normal scores with respect to family and academic self-concepts. Though limited in sample size, these findings encourage more self-reported studies to provide educators, policy makers and health care professionals a greater understanding of the self-reported difficulties and experiences with vision impairment among the adolescent population.

1.3 Research Problem

In previous literature, several studies have provided information on the prevalence of visual impairment that requires vision correction. They have identified differences in sociodemographic, environmental and behavioural factors as determinants of visual impairment. However, differences across studies (for instance in defining hyperopia, myopia, and astigmatism; measures used to assess variables such as income and education; and various age-

groups sampled) provide evidence that is challenging to synthesize and is inconsistent. Limited studies on self-reported health care needs in relation to vision correction is a barrier in identifying individuals that require visual aid in order to function in relation to their daily personal and academic activities. The following study aims to fill in the knowledge gaps by answering the following questions:

1) What evidence exists regarding the prevalence of health care needs in relation to vision correction and its determinants among high school students globally?
2) What is the prevalence of health care needs in relation to vision correction among adolescents from the UAE based on self-reported symptoms?
3) What sociodemographic, behavioural, and physical factors are associated with health care needs in relation to vision correction among adolescents from the UAE?
4) Are the health care needs in relation to vision correction affecting the functional capacity of high school students in the UAE?
5) How do the prevalence and determinants of health care needs in relation to vision correction among high school students in the UAE compare to the existing evidence?

1.4 Research Goals

This research intends to firstly assess the prevalence of self-reported health care needs in relation to vision correction and secondly identify the sociodemographic, and behavioural predictors of vision correction needs among a cohort of 6,363 high school students aged between 13 and 20 years and compare the results to existing evidence to assess similarities and differences.

The study will use existing data collected from a survey conducted on high school students between 2007 and 2009 in the seven emirates including nine educational regions of UAE.

1.5 Research Objectives

The research objectives are:

1) To assess the prevalence of self-reported health care needs in relation to vision correction among adolescents from the UAE.

2) To examine if there are significant associations between vision correction needs and each of following factors: socioeconomic status, physical and lifestyle behaviours, and affecting the daily functional capacity among the UAE adolescent population

3) To identify the most significant determinants of vision correction needs among the UAE adolescent population

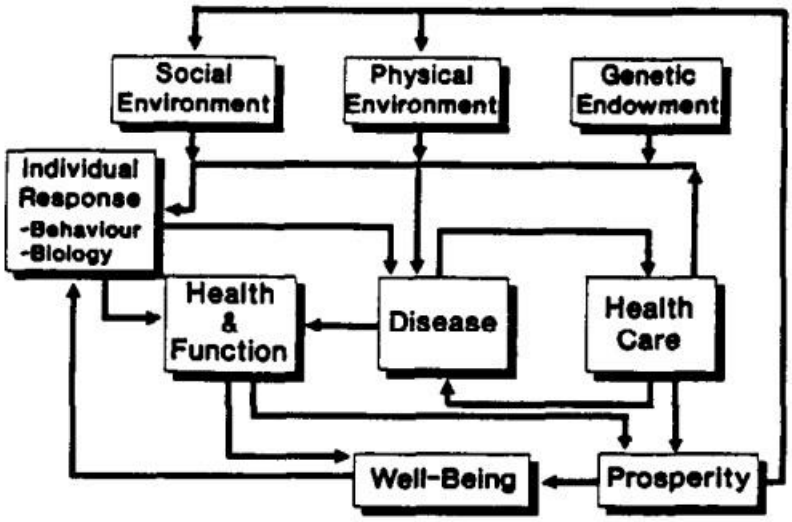
1.6 Conceptual Model – Population Health Framework

This research is guided by the population health framework (Evans & Stoddart, 1990) with the suggestions by Kindig et al. (2008). Population health refers to health outcomes and their distribution in a population, which are gained by health determinants (such as medical and public health, SES, environment and behaviours, and genetics) (Kindig, 2007). These determinants are gained over a life course made by policies and interventions at the personal and population levels. The purpose is to improve health of individuals and populations through contributing towards the determinants of health using influencing policies and interventions.

Evans and Stoddart (1990) identified that narrow concepts of health (such as absence of injury or disease) exclude fewer specific dimensions of health which many people may find significant to their evaluation of their own circumstances or those of their associates. This has led to a growing gap in the understanding of determinants of health and the focus on health policy based on provision of health care. The way a problem is framed will determine what factors are given importance, and which are disregarded. Therefore, they proposed a framework that would be comprehensive and flexible to represent a wide range of relationships among determinants of health. Their goal was to provide meaningful categories as determinants of health and to expand the definition of health to encompass the dimensions which health care providers, policy makers, and ordinary people feel to be important. Their framework proposed to accommodate the distinctions among disease, as defined and treated by the health care system, health and function, as perceived and experienced by people, and greater well-being, a larger concept of health is one of the contributors.

A commentary by Kindig et al. (2008) suggested a population health guiding framework with broad overall goals and prioritized set of policies and interventions coinciding with several determinants of health. The model created was a starting point for a framework more catered to a population health point of view to help reduce disparities within a population. Disparities have several components as policy targets such as demographic, socioeconomic, geographic location, health-related quality of life, etc., where individual consideration is important as different

patterns of determinants may lead to different changes in outcomes.



Note: Figure 5. Evans, R., & Stoddart, G. (1990). Consuming health care, producing health. *Social Science and Medicine*, *331*(12), 489-500.

This study uses data collected from a cross-sectional population-based study on adolescent population from the UAE (Barakat-Haddad, 2013). This combined framework of Evans & Stoddart (1990) and Kindig et al. (2008) guides research in prevalence and determinants of the population health outcome of needing vision correction for reading among adolescents, which is the dependent variable, with other independent variables categorized under sociodemographic profile, behavioural profile, and functional capacity. The sociodemographic profile includes independent variables of biological sex, age, nationality/ethnicity, family income, parental education and employment, and residential ownership. The behavioural profile includes independent variables of various forms of indoor and outdoor physical activities, use and duration of use of near work devices including phone, television, computer, symptoms of blurry vision, and visiting the eye specialist. The functional capacity profile includes handling daily work/school responsibilities.

1.7 Public Health Significance

Upon identifying the gaps in previous literature, further research is suggested to determine the prevalence of vision correction needs among the adolescent population. Reporting the symptomatic complaints of the adolescent population regarding visual blur and difficulty pursuing visual tasks without vision correction may help determine which participants require vision correction rather than objective measures of refractive error. Identifying the determinants will provide information to assess the social determinants of the health outcome and help the population in resolving modifiable barriers to accessing the appropriate health resources and vision correction. This will in turn help improve the ability of the adolescent population to pursue and excel in visual tasks related to academics, physical activity, and overall quality of life. The results may help future researchers use the data to determine patterns of eye care utilization by this population, screening procedures and policies in academic settings to assist those complaining of visual blur and requiring vision correction, and academic and social performance of this population. Decision makers will then be able to use previous literature and further research to set appropriate plans, policies, and strategies to prevent visual impairment, and overall improvement of eye health.

1.8 Overview of Thesis

This thesis includes six chapters along with the introduction. The second chapter comprises the literatures review which includes background summary of the preliminary literature noted in the introduction, the steps taken during literature review search, and the main findings and gaps in the literature. The third chapter describes the methodology used to apply the

conceptual framework into this study, to utilize the selected variables from the retrospective data set, and to describe the univariate, bivariate, and multivariate analysis methods to explore the research objectives. The fourth chapter outlines the results obtained from the analysis with regards to prevalence of self-reported health care needs in relation to vision correction and association of sociodemographic, environmental, and behavioural factors to the outcome. The fifth chapter discusses the findings in this study along with comparison with existing literature, and notes the strengths and limitations in conducting the research. The sixth chapter overviews the main conclusions and recommendations for the improved public health outcomes.

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Chapter 2: Literature Review

2.1 Overview of Literature Review

This chapter reviews literature relevant to the research questions and objectives, thus assessing the prevalence of vision correction needs due to refractive error amongst the adolescent school-going population at the global level, and assessing associations between sociodemographic, environmental, and behavioural factors and VI. The chapter starts with a background on relevant findings from existing literature. The chapter then provides the methods used for the literature search, summary of the results, and a general discussion that synthesizes the findings and highlights research gaps. The chapter concludes with a summary of the literature review and recommendations for further research.

2.2 Background

In previous literature, several studies based on children have provided information on the prevalence of visual impairment that requires vision correction amongst various demographic, socioeconomic, and environmental factors. Here is a summary of the preliminary literature search from the Introduction chapter.

Geographic differences in the prevalence of various types of VI due to URE were found including myopia (near-sightedness) to be higher among participants from East Asia, and hyperopia (far-sightedness) and astigmatism to be highest among participants from the Americas (Hashemi et al., 2017; Powell, 2004). Among several studies, a distinct biological sex difference was not found in prevalence of VI. While few studies showed significant ethnic differences due to relative homogeneity in the sample population, there were trends of higher prevalence of

myopia in children of East Asian, South Asian, and African American ethnicity (Rudnicka et al., 2010; Kodjebacheva et al., 2011; Wen et al., 2013).

Socioeconomic status (SES) was positively associated with prevalence of VI (Robaei et al., 2005). Children whose parents were employed, had higher education, high income, and/or had home ownership showed higher prevalence of VI (Chong et al., 2005; Xiang, He, & Morgan, 2012; Rudnicka et al., 2008; Ehrlich et al., 2019).

Environmental exposures to near work (pursuing activities at short distances) were positively linked with VI (specific to astigmatism and myopia) (Buehren et al., 2003; Yasuda & Yamaguchi, 2005), though associations with different forms of near work, duration, and associations with refractive error as a whole or VI were not explicitly detailed. Studies exploring the exposure to outdoor environments through outdoor physical activity found a protective role for outdoor activity in myopia (He et al., 2015; Buch, 2005).

As VI due to URE has been evaluated predominantly through objective measures and screening, there are very limited studies regarding self-reported healthcare needs in relation to vision correction, particularly among adolescents. A comparison study examined national surveys on VI and blindness and found the survey to only have one variable measuring VI among persons aged 0-17 years, in which the findings showed a prevalence of 3.1% of self-reported VI.

There is very limited evidence pertaining to schoolchildren, especially adolescents with VI-RE, leads to the need for future research on the prevalence of VI-RE among adolescents and to identify determinants of health care needs in relation to vision correction. Limited studies assessing self-reported health care needs in relation to vision correction limit the ability to identify individuals that require visual aid in order to function in relation to their daily personal

and academic activities. The following study aims to fill in the knowledge gaps by reviewing the demographic, socioeconomic, behavioural and lifestyle factors associated with vision correction needs among all studies that assessed VI-RE among adolescents at the global level and at the national level in UAE.

The UAE is a country comprised of a multinational population (11% Emiratis (nationals) and the rest expatriates of different nationalities) which present an opportunity to explore the various health outcomes across the population of UAE (Loney et al., 2013). Vision care is accounted as a private healthcare service for non-nationals (Health Insurance Law of Dubai – ISAHD, 2015), and thus it greatly impacts the equal and affordable accessibility to vision care service to adolescents of various households. Moreover, as there are no publications based on school-based vision screening process in UAE, as well as self-reported concerns of VI-RE and self-reported health care need for accessing vision care services, this study seeks to fill this gap by assessing the prevalence and determinants of self-reported health care needs in relation to vision correction in both public and private schools in the UAE, including access to vision care services.

2.3 Methods of Literature Search

A comprehensive search through a literature review was conducted identifying and synthesizing all relevant articles in VI-RE among adolescents (Uman, 2011). The literature search involved five key stages of literature search guidance determined from the Cochrane Collaboration.

2.3.1 Formulating the research question.

The research question for the review is:

What evidence exists regarding the prevalence and determinants of health care needs in relation to vision correction among high school students globally?

What evidence exists regarding the prevalence and determinants of health care needs in relation to vision correction among high school students tin the UAE?

What evidence exists for self-reported outcomes of vision correction needs among high school students globally?

2.3.2 Defining inclusion and exclusion criteria.

In order to list terms of the main concept through an organizing framework, the search tool used for this review is the PECOS method (Methley et al., 2014). This tool is based on the Population, Exposure, Comparison, Outcomes, and Study Design of an article to identify components of clinical evidence in systematic reviews endorsed by the Cochrane Collaboration. The criteria used for this review are:

- **Population:** high school students/adolescents aged 13-18 years
- **Exposure:** exposure to various health determinants including biological sex, environmental, sociodemographic, behavioral,etc…..factors
- **Comparison:** all types of comparators found will be included
- **Outcome:** the dependent variable is the following: “VI needs from refractive error (inability to see well enough to read without corrective lenses)” – thus the outcome is all studies evaluating effects of different factors on prevalence, associations, and predictors of VI needs
- **Study Design:** all types of study designs in the methodology section of the studies

In order to retrieve a wide and thorough collection of relevant studies, all articles of VI-RE amongst the high school student population were included. Vision impairment due to other ocular clinical findings (ie. cataract, macular degeneration, congenital disorder,

systemic disease, trauma, etc.) were excluded from this study. Research studies focusing on a specific vulnerable, disease-based, or those with refractive error and a concomitant ocular diagnosis, were excluded from this review. As this study aims to review extrinsic environmental factors of VI due RE on the human population, genetic/genomics of vision impairment and animal-based studies were excluded. Articles published in the last 10 years in the English language, to provide current information, were included.

2.3.3 Developing a search strategy to locate studies.

An electronic search of PubMed, Ovid Cochrane, and Web of Science database sources were used. The following list of search strategies were used to be able to retrieve all relevant data related to this review (Uman, 2011).

a) Translating research question into key concepts: prevalence, determinants, vision correction, high school students, global, UAE
b) Expanding concepts into keywords: All variations of the concept terms including synonyms, associated terms, and varying forms, were added in the search along with the core keywords to form a comprehensive literature search.
    i. Keywords for **prevalence**: incidence, frequency, prevalence (all fields)
    ii. Keywords for **determinants**: determinants, risk factors, association, predictors, correlation, correlated, link, related, relation, relating, prevalence, frequency, effect (all fields)
    iii. Keywords for **vision correction**: vision correction, refractive error, vision impairment, refraction (title)

iv. Keywords for **high school students**: high school students, adolescents, youth (all fields)

v. Keywords for **global and UAE**: global, UAE, worldwide, world, Dubai, Abu Dhabi (all fields)

c) The keywords for the concept of prevalence are included under determinants, and thus were merged. Similarly, since articles based globally and at the national level of UAE were searched, the keywords for the concepts were merged.

d) Keywords were combined using Boolean operators (AND and OR). When two keywords are combined using 'AND', the results will include articles that mention both words, and when combined using 'OR', the results will include more articles that note either keyword (Uman, 2011). This strategy was used to balance sensitivity, by collecting a high proportion of relevant studies, and specificity, by collecting a low proportion of irrelevant studies.

e) Using filters to refine the search: To maintain relevance and recentness of the search, articles were limited to publication in the last 10 years. As the review is conducted in the English Language, the search was limited to English publications. To be able to screen through all components of the articles including title, abstract and the study, the search was limited to full-text/open-access articles open through public access and/or through the Ontario Tech University library link access.

2.3.4 Selecting studies.

In the initial identification process, some studies found following the literature search were excluded for duplicates and topics that were irrelevant to the study (ie.

animal-based, interventional/experimental, genetic/genome-based, and non-VI-based studies).

The remaining studies were first screened using titles and/or abstracts to exclude those that focused on a vulnerable or disease-based population, those that did not include the adolescent age group, and those that assessed VI due to other reasons outside RE. The selected articles were then examined using full-text to include those with comprehensive information on risk factors, the adolescent age-group, the prevalence of VI-RE, and references regarding the adolescent age-group that were published in the past 10 years, and excluding studies that did not meet those criteria. The study selection process is documented using a modified Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 flow diagram (Page, 2021) (Figure 1).

2.3.5 Data Extraction

The screening process led to 10 articles that met the inclusion criteria and were selected for the review. The extracted data from the articles were noted in a data extraction sheet using Microsoft Excel. The data are listed as follows:

1) Characteristics of the study: Author and year (in-text citation), study design, methods (assessing VI-RE and other factors)
2) Characteristics of the study population: Participants (age range), sample size, study location with note of urban and/or rural
3) Prevalence of RE: subsections of myopia, hyperopia, astigmatism with definitions
4) Prevalence of VI: with and without correction
5) Risk/determinants of V

6) Limitation

2.4 Results

2.4.1 Literature Search – study selection outcome

The databases of PubMed, Ovid Cochrane, and Web of Sciences were searched leading to a total of 159 articles. Prior to screening, the articles were reviewed by title and 91 articles were excluded due to duplication (7) and non-relevance to the review (such as animal based (1), interventional (16), genetic/genome (7), and non-VI based (60)). The remaining 68 articles were screened by title and/or abstract. Studies involving vulnerable/diseased population or having surgery (6), excluding the adolescent age group (33), and VI that was not due to RE (5) were excluded, resulting in 44 articles that were excluded. The remaining 24 articles were screened through full-text for eligibility, where studies were excluded for having lack of or limited information on risk factors (6), the adolescent group (6), refractive error (1), and reviews having out-of-date range of adolescent study references (1). There were 10 studies that were included in the literature review (Figure 1).

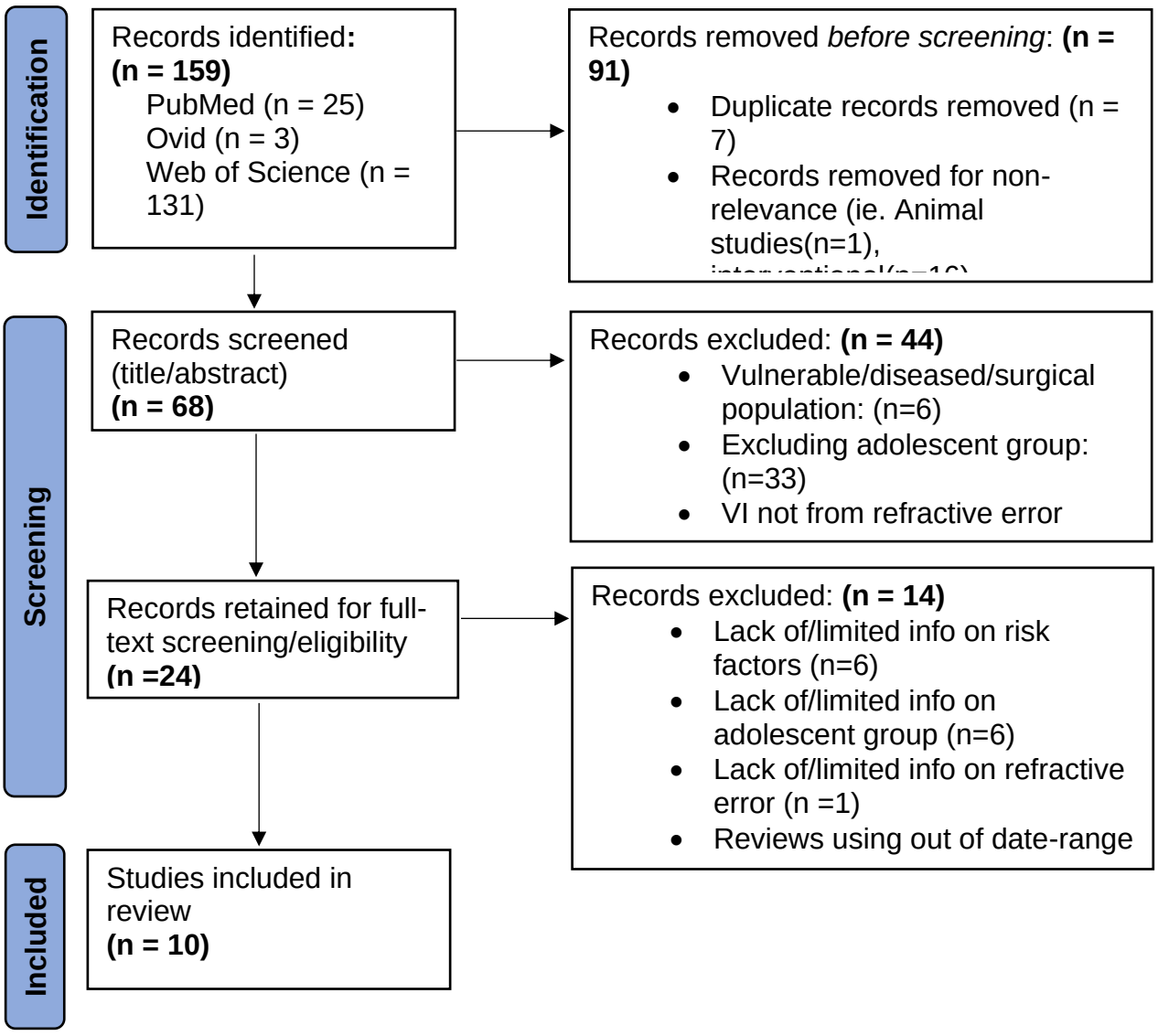

Figure 1. Literature Search – Study Selection Flow Chart

2.4.2 Description of Study Design

Out of the 10 included articles, there were 2 systematic reviews, and 8 cross-sectional studies (7 prospective, 1 retrospective). Out of the 8 cross-sectional studies, 6 studies were school-based and 2 studies were population-based. There were 3 studies that were conducted in the Latin America (Mexico, Paraguay, and Colombia), 3 studies were conducted in Africa (Nigeria,

Somalia, and South Africa), 1 study was conducted in China, 2 studies were conducted in the Middle East (Saudi Arabia and United Arab Emirates), and 1 study was a multicenter global systematic review. From the 8 cross-sectional studies, 7 studies reported the sampling strategy, where 5 studies conducted random or random cluster sampling, 1 study conducted 2-stage cluster sampling, and 1 study conducted convenience sampling. In terms of assessing VI-RE, the refraction methods varied among studies, where 5 studies included retinoscopy (an objective technique to determine the refractive error of the eye using hand held retinoscope observing the movement of reflected light from the eye), 1 study included autorefraction (automated, objective, instrument-based screening of refractive error), and 2 studies included both methods (Corboy, 2003; Di Wang et al., 2020). Only 5 studies included a cycloplegic refraction (a procedure of instilling eye drops known as cycloplegic agents to inhibit accommodation during objective vision assessment, to allow estimation of true refractive error) (Yoo et al., 2017) . The basic characteristics of these studies are shown in Table 2.

2.4.3 Participants

The sample size ranged from 326 to 4241 participants for cross-sectional studies, and 1,051,784 from the systematic review pooling 41 studies (Hansraj et al., 2020; Ebri et al., 2019, Tang et al., 2021). The age groups, while including the adolescent group of 13-18 years, had varying criteria for participant age range. For example, one study included participants aged 15-18 years, where another study included participants aged 3-22 years (Teran et al., 2021; Signes-Soler et al., 2017). However, most studies included an approximate equal distribution of biological sex in the sample size, ranging from 44.1% female to 55% female (Alomair et al., 2021; Teran et al., 2021) (Table 2).

	Author (in-text)	Study Yr	Study Design	Location	Region	Recruitment	Participant	Median (age)	Sample size	% female	Assessing VI-RE	
											Rx	Cyclo
1	Teran et al., 2021	2017-2019	CS; SB	Sinaloa, Northwest Mexico	U	NA	15-18 yrs	16.00	3468	55.0	RE	no
2	Ebri et al., 2019	2018	CS; SB	Calabar, Nigeria	U	2-stage cluster sampling	10-18 yrs	13.26	4241	51.3	AU	yes
3	Alomair et al., 2021	2020	CS; SB	Riyadh, Saudi Arabia	U	random cluster sampling	6-15 yrs	NA	850	44.1	AU and RE	yes
4	Ahmed et al., 2020	2017-2018	CS; SB	Hargesia, Somaliland, Somalia	U	multi-stage random sampling	6-15 yrs	11.80	1204	45.3	RE	no
5	Kandi et al., 2021	2016-2017	CS; PB	Hatta, United Arab Emirates	U	random sampling	6-19 yrs	NA	1591	47.5	RE	yes
6	Hansraj et al., 2020	2016	CS; SB	Sekhukhune District, Limpopo, South Africa	R	multi-stage random sampling	6-18 yrs	13.02	326	50.6	AU and RE	yes
7	Galvis et al., 2017	2013-2014	CS; PB	Urban Bucaramanga, Colombia	U	convenience sampling	8-17 yrs	11.40	1228	50.2	RE	no
8	Signes-Soler et al., 2017	2011	CS; SB	San Roque Gonzalez de Santa Cruz, Paraguay	R	random sampling	3-22 yrs	11.21	1466 114 analyzed (VA < 20/25)	50.1	RE	yes
9	Yang et al., 2021	1990-2019	Review	Global	NA	NA	0-20 yrs	NA	NA	NA	NA	NA
10	Tang et al., 2021	2021	Review	China	NA	NA	0-18 yrs	NA	1,051,784	NA	NA	NA

Table 2. Basic characteristic of study design of included studies.
CS - cross-sectional, SB - school-based, PB - population-based, U - Urban, R - Rural, RE - retinoscopy, AU - autorefraction, NA - not applicable/available, Rx – refraction, Cyclo – cycloplegia, F - female

2.4.4 Prevalence of RE and VI-RE

The prevalence of refractive error (RE) was reported in 9 studies. The proportion of the distribution of refractive errors were categorized into its subtypes of myopia, hyperopia, and astigmatism. Myopia was defined as less than or equal to -0.5 D to -0.75 D of RE, hyperopia was defined as greater or equal to +1.50 D to +2.00 D of RE, and astigmatism was defined as greater or equal to 0.75 D to 1.50 D of RE. There were 5 studies noting a general prevalence of RE ranging from 15.70% to 36.70% (Ahmed et al., 2020; Galvis et al., 2017). Among the total participants in each study, the prevalence of subjects with myopia was found to be highest among participants in the China-based study, with 38.00%, followed by 36.11% among participants in the Mexico-based study (Tang et al., 2021; Teran et al., 2021). The lowest prevalence was found among participants in the study from Paraguay with 0.70%, followed by participants in the Nigeria-based study with 1.72% (Signes-Soler et al., 2017, Ebri et al., 2019). The prevalence of hyperopia among participants with RE was found to be highest among participants in the Saudi Arabia-based study with 6.12%, followed by participants in the China-based study with 5.20% (Alomair et al., 2021; Tang et al., 2021). The lowest prevalence of hyperopia was found among participants in the Paraguay-based study with 0.20%, followed by participants in the Columbia-based study with 1.10% (Signes-Soler et al., 2017; Galvis et al., 2017). The prevalence of astigmatism was found to be highest among participants in the Mexico-based study with 29.27% (1), followed by those from the China-based study (16.50%) and Saudi Arabia-based (16.13%) studies (Teran et al., 2021; Tang et al., 2021; Alomair et al., 2021). The lowest prevalence was found to be among participants from Paraguay 0.6%), followed by those from the Colombia-based study (1.7%) (Signes-Soler et al., 2017; Galvis et al., 2017).

With regards to prevalence of vision impairment (VI), defined as a visual acuity (VA) of less than 20/40 (or 6/12 based on the chart used), there were 6 studies that noted the prevalence of VI. The highest prevalence of uncorrected VI was found among participants of the Mexic0-based study with 33%, which upon provision of corrective lenses for those categorized with VI, decreased to normal vision by 68% among the population with VI (greater than VA of 20/25), and lowest among participants from the Paraguay-based study with 1.9% which upon provision of corrective lenses decreased to normal vision by 58% among the population with VI (Teran et al., 2021; Signes-Soler et al., 2017). The decrease in VI due to correction of vision indicates that a large percentage of this group had VI due to uncorrected refractive error (URE).

There were 4 studies that reported the use of corrective lenses among participants with RE. For participants of the Mexico-based study, the proportion of subjects who did not have corrective lenses but needed them for myopia was 13.32%, and for those who had outdated corrective lenses was 13.40% (Teran et al., 2021). Among those with VI, only 20% wore corrective lenses and achieved normal vision, whereas among the remaining participants, 85.00% achieved normal vision with correction provided. For students sampled in the study based in the United Arab Emirates (UAE), 59% of those with RE did not wear corrective lenses, and 58% of those with VI did not wear corrective lenses (Kandi et al., 2021). Among students sampled in the Somalia-based study, only 17.60% of participants with VI wore corrective lenses (Ahmed et al., 2020). In the Saudi Arabia-based study, majority of the participants with RE did not wear corrective lenses (60.66%) (Alomair et al., 2021). The results describe a high percentage of school-aged children who did not have corrective lenses but needed them, as summarized in Table 3.

From the 10 articles, only 1 study assessed self-reported health outcome of vision correction needs. Among students in the study based in Somalia, 12.7% complained of blurred vision, where prevalence of RE was 15.70% and VI was 7.60% (Ahmed et al., 2020).

To estimate the global disease burden of URE among adolescents, Yang et al. (2021) retrieved data from the open-database of the Global Burden of Disease 2019 Study which compiled disability-adjusted life years (DALYs) due to 369 diseases and injuries for 204 countries and territories from 1990-2019 (Yang et al., 2021). The latter study found that the number of DALYs due to URE increased by 8% between 1990-2019, however the DALY rate showed a downward trend, decreasing by 4.8% between those years. Overall, the numbers and rates of URE prevalence have remained high and stable in the past 30 years.

Table 3. Summary of prevalence of refractive error (RE), vision impairment (VI), and use of corrective lenses among a population of school children aged 0-22 years of age on a global scale from nine studies of the literature review.
Def – Definition (in Diopters (D)), UC – uncorrected, C – corrected, ≥ = greater or equal to, ≤ = equal or less than

	Author	RE									VI		
			Myopia		Hyperopia		Astigmatism		No corrective lenses (%)	Old corrective lenses (%)	UC (%)	C (%)	No corrective lenses (%)
		(%)*	Def (D)	(%)	Def (D)	(%)*	Def (D)	(%)*					
1	Teran et al., 2021		≤ - 0.50	36.11	≥ +2.00	1.49	≥ 0.75	29.27	13.32	13.40	33.00	Reduced by 68%	80.00
2	Ebri et al., 2019		≤ - 0.50	1.72	≥ +2.00	1.30	≥ 0.75	4.20			7.90	Reduced by 91%	
3	Alomair et al., 2021	28.73	≤ - 0.75	14.13	≥ +2.00	6.12	≥ 1.50	8.48	60.66				
4	Ahmed et al., 2020	15.70	≤ - 0.50	9.10	≥ +2.00	2.70	≥ 0.75	3.90			7.60	Reduced by 90%	17.60
5	Kandi et al., 2021	20.90	≤ - 0.50	12.25	≥ +2.00	1.80	≥ 0.50	6.85	59.00		21.37		58.00
6	Hansraj et al., 2020	20.60	≤ - 0.50	10.40	≥ +2.00	2.80	≥ 0.75	7.40			12.30	Reduced by 83%	
7	Galvis et al., 2017	36.70	≤ - 0.50	11.20	≥ +2.00	1.10	≥ 1.00	1.70					
8	Signes-Soler et al., 2017		≤ - 0.50	0.70	≥ +1.50	0.20	≥ 1.00	0.60			1.90	Reduced by 58%	
9	Tang et al., 2021			38.00		5.20		16.50					

*Prevalence

2.4.5 Exposures of VI-RE

All 10 reviewed studies assessed at least one determinant of VI-RE, including demographic factors (biological sex, age, race), socioeconomic factors, environmental factors, lifestyle factors (exposure to near work and outdoor activities). Table 4 summarized these findings.

Demographic Factors

a. Biological sex

There were 7 articles that assessed biological sex differences in VI-RE. In the study by Teran et al. (2021), there was a significant effect of refractive status and biological sex with more females showcasing a higher refractive error than males on the visual acuity tests for both left ($p=0.03$, z-test) and right eye ($p=0.001$, z-test). In the study by Ebri et al. (2019), more female participants presented with higher prevalence of myopia ($p<0.033$), myopic astigmatism ($p=0.012$), and mild astigmatism ($p<0.03$). Among students assessed by Kandi et al. (2021), a significant increase in myopia with age was more distinct in girls, and a higher percentage of girls wore spectacles (58%) than boys (30%). In the study by Galvis et al. (2017), there was a statistically significant difference in the frequency of refractive errors by biological sex, where girls presented with higher rates of myopic and hyperopic refractive errors ($p=0.026$). In the review by Yang et al. (2021) assessing severity of disease burden due to URE, total DALYs for women were significantly higher than men when comparing the findings from 2019 to year 1990 ($p<0.001$). The other 2 articles assessing this factor did not find any significant biological sex differences. Of the 5 articles that found a significant association between biological sex and VI-RE, female participants appeared to have a higher association with refractive error and resulting vision impairment and poor visual acuity.

b. Age

There were 9 articles that assessed the association of age with VI-RE, where 4 articles noted significant differences in age. In the study by Ebri et al. (2019), older participants presented with hyperopic astigmatism ($p<0.0004$), and the rate of myopia was higher in children aged 13-16 years, with a spike at age 11. In the study by Kandi et al. (2021), a gradual increase in myopia was found with increasing age in both biological sexes. In the study by Galvis et al. (2017), the rate of myopia increased with age, however the rate of hyperopia decreased with age ($p<0.001$). In the study by Yang et al. (2021), both biological sexes showed a similar trend of global DALY rates with age, with a sharp rise from 5-9 years of age, a slower rise thereafter, and reaching a plateau before 20 years of age. Among the findings, there has been a suggested increase in refractive error, especially myopia, and the disease burden with age among the adolescent study sample population.

c. National differences in the prevalence of refractive error

While only 1 article assessed the country-level associations, the 10 articles in the review are based in different countries and population of various nationalities. In the review by Yang et al. (2021), the countries with the largest populations had the highest DALYs number for uncorrected refractive error including India). Upon correction for multiple comparisons, the Eastern Mediterranean region had the highest disease burden for uncorrected refractive error over the past 30 years ($p<0.001$), compared to other WHO regions, followed by Americas, and the lowest in the African region. In the review by Yang et al. (2021), around 80% of adolescents in high schools in urban areas of East Asian countries are myopic with hyperopia and astigmatism of 4.6% and 14.9% respectively. In the Latin Americas, the study by Teran et al.

(2021) based in Mexico showed a prevalence of 36.11% of myopia, consistent with the study by Galvis et al. (2017) based in Colombia with a prevalence of RE of 36.7%, however contrasting with the study by Signes-Solar et al. based in rural Paraguay, with the lowest prevalence of myopia, hyperopia, and astigmatism. Among the African countries reviewed, there were mixed prevalence of RE where the study by Ebri et al. (2019), based in Nigeria showed low prevalence, the study by Ahmed et al. (2020), based in Somalia, showed moderate prevalence, and the study by Hansraj et al. (2020), based in South Africa, showed higher prevalence.

Socioeconomic factors

a. Socioeconomic status and urbanization

The review by Yang et al. (2021) assessed socioeconomic status, in relation to global disease burden of URE in adolescents. This was done by analyzing the income-level and sustainable development index (SDI)-level regions. The DALY rates were highest in high-income regions and lowest in low-income regions. A linear trend was observed between the disease burden of URE and SDI, human development index (HDI), primary school dropout rate, and urbanization rate. However, primary school dropout rates were inversely associated with DALY rates. In the study by Ebri et al. (2019), myopia was found to be higher in urban than in semi-urban schools. In the review by Tang et al. (2021), urban children showed a significantly higher prevalence of myopia, hyperopia, and astigmatism than rural children ($p<0.001$). The study by Signes-Soler et al. (2017), conducted in the rural area of Paraguay, showed the lowest prevalence of all types of refractive error among all 10 articles reviewed, which predominantly were set in urban regions.

Environmental and lifestyle factors

a. Near work

The study by Alomair et al. (2021) assessed near work and outdoor activities through a questionnaire to the parents. There was no significant association found between how often children did their homework, how many hours spent on homework, and having a RE ($p=0.17$ and $p=0.75$ respectively). No association was found between using electronic devices and RE ($p=0.26$).

b. Outdoor activity

In the study Alomair et al. (2021), it was reported that doing outdoor activities was associated with RE ($p<0.01$) (2020). Out of the 69.21% children pursuing outdoor activities, 72.16% did not have RE. Out of the children who had RE, 38.14% did not do outdoor activities. Upon logistic regression modelling and adjusting for age and biological sex, the study findings suggested that children who pursued outdoor activities had 52% lower odds of having an RE than those who didn't pursue outdoor activities.

Table 4. Assessed Determinants of Prevalence of VI-RE

	#	1	2	3	4	5	6	7	8	9	10
	Author	Teran et al., 2021	Ebri et al., 2019	Alomair et al., 2021	Ahmed et al., 2020	Kandi et al., 2021	Hansraj et al., 2020	Galvis et al., 2017	Signes-Soler et al.,	Yang et al., 2021	Tang et al., 2021
Assessed factors	Age	N	DA	N	N	DA	N	DA*	N	DA	
	Biological sex (1)	A(F)	A(F)		N	A(F)	N	A(F)		A(F)	
	SES									A	
	Urban/non-Urban		A(U)							A(U)	A(U)
	Near work-homework			N							
	Near-work-device			N							
	Outdoor activity			A (2)							

(*) = increased rate of myopia and decreased rate of hyperopia with age
(1) = the biological sex that has higher prevalence
(2) = inversely associated
N = no statistically significant association
A = statistically significant association
F = females had higher prevalence
U = urban with higher prevalence
D=direct

2.5 Discussion

The prevalence of myopia reported in several national-based studies is consistent with reports of an increase in the prevalence of myopia at the global level (Teran et al., 2021). However, some studies used cycloplegic refraction and some did not. Using cycloplegia during refraction masks the effect of accommodation, which can help reduce errors of overestimating myopia and underestimating hyperopia.

Age appears to be an associating factor of RE, with an increase in myopia with age. Eye growth is known to be completed at age 13 years, while axial length growth may continue, where the progression initially increases after 13 years before stabilizing during late adolescence (Kandi et al., 2021). The increased study burden among school-aged children with each year may play a role in the increasing prevalence rate of VI-RE.

Biological sex appears to be a relatively consistent determinant of VI-RE, noting higher prevalence of females with VI-RE than males. Ahmed et al. (2020) suggested that it may be due to socioeconomic factors that contributed to better health care services for boys. Indeed, biological sex inequality in the global burden of URE exists among adolescents since 1990 (Kandi et al., 2021). The findings in the review are consistent with the trend of many other studies revealing higher prevalence of females with refractive disorders than males. Suggested reasoning included differing environmental factors, such as a potential tendency of females to spend less time outdoors than boys. Also, the inequality of social, cultural, and economic status between men and women may lead to reduced access to eye care services and refractive correction for women.

Socioeconomic status was found to be positively associated with higher levels of VI-RE. The tendency of schooling with increased levels of myopia and VI have been previously documented, and thus primary school dropout rates were found to be inversely associated with DALY rates due to URE. In terms of urbanization as a factor, living in an urban environment has been suggested to be a risk factor, where regions with middle to high income and SDI have higher DALY rates, and HDI and SDI were significantly positively associated with VI due to URE (Yang et al., 2021). Studies have suggested that less outdoor activities and high academic stress in urban areas may be reasons for higher prevalence of myopia (Tang et al., 2021).

In this review, near work was not significantly associated with VI-RE. While most studies focused on the relationship between myopia and near work, the study by Alomair et al. (2021) did not only focus on one type of RE, but assessed all types of RE and near work, and thus no association was found. However, some studies have found associations between myopia and near work, resulting in a strength of Level 2 (data providing substantial evidence in support of the recommendation), and the recommendation of decreasing near work activities as Level B (moderately important) (Hansraj et al., 2020). Outdoor activity, on the other hand, was found to have an inverse association with VI-RE. Outdoor activities are known as prophylactic measures of progression of myopia, where higher levels of time spent outdoors were associated with less myopia, suggesting outdoor activities can help lower the risk of developing RE (Alomair et al., 2021).

The articles in the review had certain limitations. The ranges of age groups assessed vary greatly between studies, while including the adolescent group. This does not provide an accurate measure of the prevalence of VI-RE in the adolescent population. As some were school-based rather than population-based, thus the results were not generalizable to the whole population of that age group. Lack of cycloplegia in refraction to assess for RE may have accounted for overestimating prevalence of myopia and underestimating prevalence of hyperopia due to accommodation of the eye. A couple of the articles were based in rural settings, where a large percentage of adolescents did not attend school due to poverty, and the distribution of children's ages in school was not uniform. Moreover, any questionnaire provided were given to the parents and not to the children, where only one study inquired on the participant's self-reported symptoms of blur and needing corrective lenses. There was only one recent publication regarding RE among schoolchildren in the Hatta region of the UAE (Kandi et al., 2021), while there still is

no summary of evidence of VI due to URE among the various regions and schools in the adolescent group in the UAE. While several studies suggested environmental factors as potential reasoning for VI-RE such as urban environment, near work, outdoor activity, access to eye care, academic stress and ability of perform daily academic tasks, socioeconomic factors such as income, education, and healthcare, very few studies based on the adolescent population have assessed these various potential risk factors. Further research is necessary to assess these risk factors and add to knowledge on whether they are determinants of VI-RE.

2.6 Conclusion of Literature Review and Future Research

This review confirms the increasing prevalence of VI-RE in various studies across the globe and the high percentage of those with RE not having appropriate correction, thus suggesting the pressing need for a more adequate screening program for schoolchildren with a standardized protocol and bridging barriers to accessing eye care and correction. Associations of age and biological sex suggest further research in assessing the prevalence and risk factors of the older adolescent group and females to help mitigate the health outcomes and academic performance due to VI. Socioeconomic status including income and education status warrant further research on how to help reduce the likelihood of VI-RE in these population groups. Near work and outdoor activity as positive and negative determinants of VI-RE need to be further explored to guide health policies regarding the recommendation of reducing near work and increase outdoor activity through more evidence. Lastly, having evidence of self-reported health care needs by the students themselves regarding their vision, environmental and lifestyle barriers may help provide more grass root level solutions to help treat those with VI-RE optimally and efficiently, thus enabling a better academic, social, and personal future for schoolchildren.

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Chapter 3: Methodology

Prevalence and Determinants of self-reported health care needs in relation to vision correction among high school students in the UAE

3.1 Overview of Methodology

This section describes the methodology used to conduct this research and meet the objectives as listed in Chapter 1. The methodology is guided by the population health framework (Evans & Stoddart, 1990). This chapter begins with a background of the data source used and ethical considerations for this study. The chapter outlines the study population and measurement tools used. It describes the research design and the application of the conceptual framework with respect to the health care needs in relation to vision correction. This is followed by the methods used to prepare the data set, conducting the univariate, bivariate, and multivariate analysis to demonstrate the findings of the prevalence and explore any determinants of self-reported health care needs in relation to vision correction among high school students in the UAE.

3.2 Ethical considerations

The original questionnaire conducted by the National Study of Population Health in the UAE (NSPHUAE) (2007-2009) research program in collaboration with the UAE Ministry of Education received ethics approval from the UAE Ministries of Education and Health. This research study has been approved by the Ontario Tech University Ethics Committee (REB file # 16553).

3.3 Background of the Data Source

This study uses data from the National Study of Population Health in the UAE (NSPHUAE) (2007-2009) research program in collaboration with the UAE Ministry of Education. The purpose of the original survey conducted in 2007 was to examine the health of the adolescent UAE population (Barakat-Haddad, 2013) including sociodemographic, environmental, behavioural and medical health factors. The program involved administering a comprehensive cross-sectional health survey to adolescents across public and private schools in the seven emirates of the UAE.

3.4 Population and sampling

The NSPUAE program presents a cross-sectional survey administered on 6363 adolescents from 147 schools aged 13 to 20 years attending public and private schools in seven emirates of the federation including nine educational zones (Barakat-Haddad et al., 2015). Social workers, employed by the UAE Ministry of education and trained by researchers through workshops, conducted the developed survey on students from three randomly selected classes (grades 10, 11, and 12) from each participating school through random stratified sampling strategy. The completed two-component self-reporting questionnaires were then collected by the social workers.

3.5 Measurement tools

The survey developed a two-component self-reporting questionnaire (Barakat-Haddad, 2013).

The first component was completed by adolescent participants in a classroom setting in a defined one-hour spare period. It comprised of data on sociodemographic information,

recreational behaviours such as smoking and physical activity, medical conditions, and symptoms with respect to respiratory health. This included data on demographic and socioeconomic information, active and smoking behaviours, type and frequency of tobacco use, hygiene practices, health improvement behaviours, consumption of fish, exposure to ultraviolet, any injury and its severity and location, physical activity and inactivity patterns, wireless usage frequency as a measure for exposure to electromagnetic fields, use of medications, self-reported medical diagnoses and sensory health including vision, school absenteeism, functional capacity, quality of life, symptoms with respect to respiratory health, use and access to health care, and road traffic risk factors (Barakat-Haddad, 2013).

The second component was completed by adolescents at home with parental assistance and returned the next day, where they were given a participant identification code to match with the first component. This section comprised of data on residential and neighbourhood characteristics, and previous residence information. This included residential mobility and locations, details of the residence such as age and number of residents, exposures to renovations, pesticides and insecticides, water supply sources, distance from overhead power or industry lines, medical diagnoses information for parents and siblings, and overall concern for air pollution. The variety of information from the survey with respect to different health outcomes provided the ability to use the survey for diverse health issues.

3.6 Research Design and Application of the Population Health Framework

This study uses a quantitative approach and cross-sectional research design to examine the prevalence of and identify associating sociodemographic and behavioural factors of the outcome of self-reported health care needs in relation to vision correction among adolescents in the UAE. Through this process, the various factors acting as health determinants of the outcome were identified and categorized guided by the population health framework (PHF) (Figure 2). Population health refers to health outcomes and their distribution in a population, which are gained by health determinants (such as medical and public health, SES, environment and behaviours, and genetics) (Kindig, 2007). These determinants of health are known to be originated from interactions between social, economic, cultural, and physical environments (Evans & Stoddart, 2003). Using this model of population health helps showcase how genetics, physical and social environments, and access to health care influence individual behavior and health outcome in a specific population (Evans & Stoddard, 1990; Boothe, 2013). To address the gaps in the literature with respect to the factors in the population health framework, this study includes the following study variables under the guided categories.

Disease / Health Outcome

With respect to the health outcome, this study assesses the prevalence of self-reported health care needs in relation to vision correction in the adolescent population of the UAE. This is defined through their response of being able to see well enough to read without the use of eye corrective lenses. This is incorporated into their *well-being* as it a self-reported perception of their health.

Genetic Endowment / Biology

The model formed by Evans and Stoddart (1990) describes genetic endowment as the genetic and biological make-up of an individual. For genetic components in this study, the participant's biological sex, age, and ethnicity/nationality are included as potential determinants of the health outcome.

Physical Environment

The model defines physical environment as physical surroundings including exposure to specific elements (Evans & Stoddart, 1990). Under the physical environment category, the participant's location of residence (emirate) and housing environment including number of residents are included as a physical determinant of the outcome.

Social environment

Social environment is described as social surroundings comprised of socioeconomic factors, support system, stress factors and other related characteristics (Evans & Stoddart, 1990). For the social environment, the participant's parental marital status, education level, household income level, and residential ownership are included as potential health determinants.

Individual response

The participant's self-reported information regarding personal use of screen time including hours of television, telephone, and computer use per day are included. Outdoor activity for physical/recreational activities is also included in the individual response.

Access to Health care

The participant's response of visiting an eye specialist in the past year is used as an indicator of access to health care with respect to their health care needs in relation to vision correction.

Health and Function

The participant's response to handling daily work/school responsibilities is included as an indicator of their function based on their health determinants and health outcome.

Prosperity

Prosperity is noted as the social status that accumulates from various aspects of social determinants of health including socioeconomic factors, housing, income, individual behavior, and access to health services (Evans & Stoddart, 1990), therefore are incorporated into other categories and is not considered a single category for the purpose of this study.

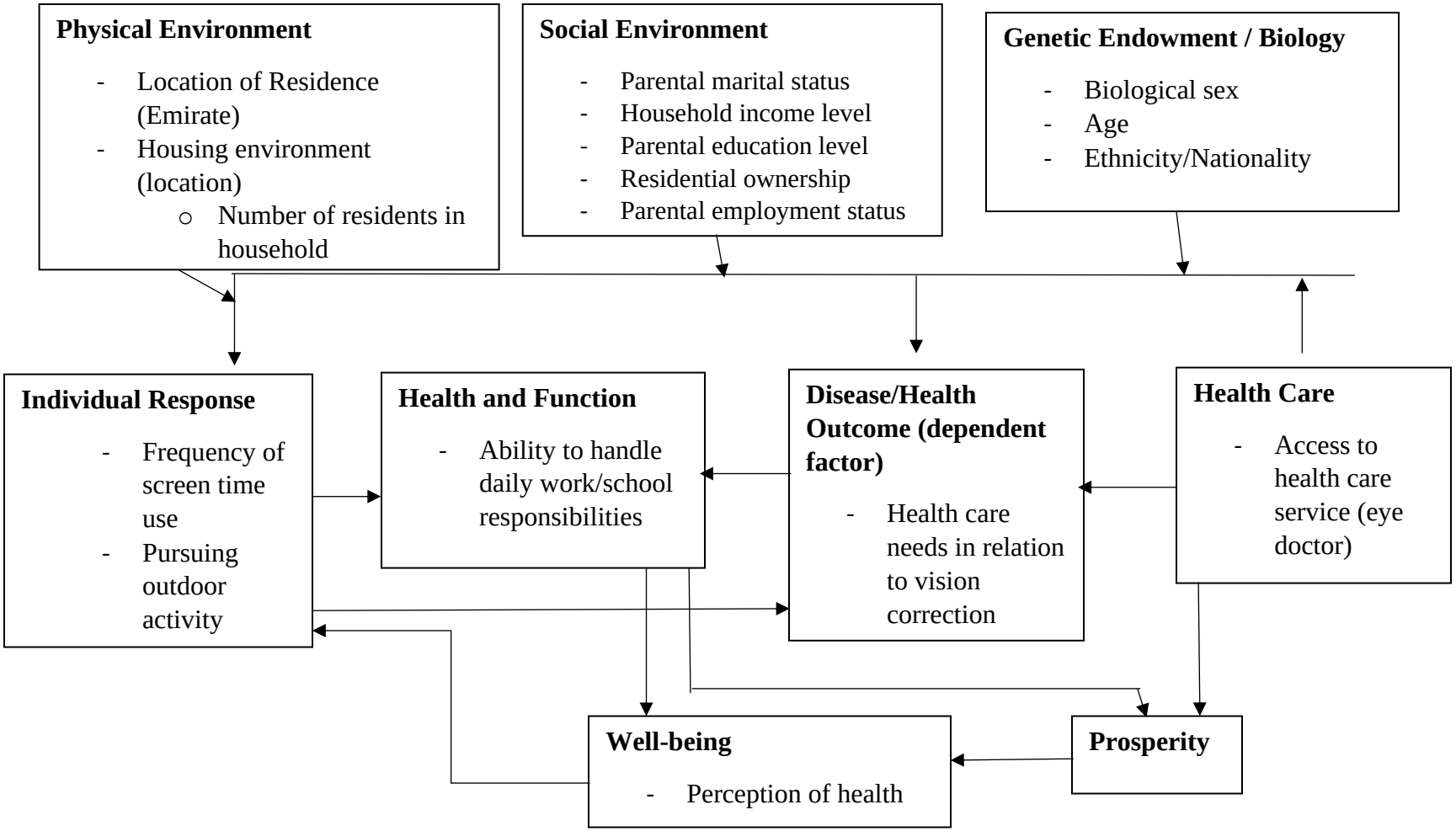

Figure 2: Application of the Population Health Framework to assess the prevalence and determinants of health care needs in relation to vision correction in the adolescent population of the UAE

In accordance with the research objectives, the study is conducted in three steps: a descriptive data analysis for differences in prevalence of vision correction needs and visiting an eye specialist, descriptive inferential data analysis for identifying associating factors of vision correction needs and visiting an eye specialist, and inferential analysis on comparing significant associating factors of vision correction needs and visiting an eye specialist.

3.7 Methods

3.7.1 Phase 1 – Preparation of data set

The dataset provided was inspected and analyzed using IBM SPSS version 26. Any errors, inconsistencies, and missing data were cleaned. Each variable was checked for having outlier values that were not part of the response options, where the outlier responses were modified to "missing value". For example, if the response values were 1 (yes), 2 (no), and 99 (not applicable), then values outside these referenced numbers were modified to "missing value". Certain variables provided a list of responses such as parental education levels, parental marital status, parental employment status, nationality, household income, hours of screen viewing, and handling daily work, where the values were recoded into broader categories and responses of not applicable (N/A) were modified to "missing value" to provide more meaningful outcomes. For example, the list of responses for the participant's parental highest education is originally a 10-level categorical variable comprising of stages of schooling and post-graduate education, which was modified to a 2-level categorical variable to group the responses into completion of high school and lack of completion of high school. While recoding the values into broader categories, a frequency analysis was conducted with the original and recoded variable to ensure the response values remain consistent in the recoded variables. Each variable was checked to ensure it has the correct measure such as scale, ordinal or nominal. As there were several forms of physical

activities surveyed to inquire the level of outdoor activity, these variables were recoded into one holistic variable of pursuing outdoor physical activity. The variables were recoded to provide more interpretable analysis and associations. Below are the variables used in this study.

1. **Dependent variable – Disease / Health Outcome**

   In the questionnaire, participants were asked if they were able to see well enough to read without the use of corrective lenses. A negative response to the question was part of the outcome variable. This variable was originally a three-level nominal (categorical) variable including: yes, no, do not know. This was recoded into a new variable merging the response of no and do not know, resulting in a 2-level nominal (categorical) variable of yes or no.

   a. Ability to see well without use of glasses. "Are you able to see well enough to read without the use of glasses?" A negative response to the question will be part of the outcome variable.

2. **Other (Independent) variables:**

   <u>Demographic variables – Genetic Endowment and Location of Residence</u>

   a. Biological sex. "What is your biological sex?". This was a two-level categorical variable, male and female.

   b. Age. It was a ratio (continuous) variable, ranging from 13 to 20 years.

   c. Ethnicity (Nationality). "What is your nationality?" This nominal (categorical) variable originally included 8-level responses including:

      1. UAE
      2. Other Gulf Corporation Council (GCC) countries (Kuwait, Kingdom of Saudi Arabia, Oman, Qatar, Bahrain, and Yemen)

3. Other Middle East Arab countries (Lebanon, Syria, Jordan, Palestine, and Iraq)
4. North Africa (Egypt, Tunisia, Morocco, Algeria, Libya, Somalia, and Mauritania)
5. South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)
6. Western countries (Europe, USA, Canada, and Australia)
7. Iran (Persian)
8. Other ethnicities

The variable was recoded into a new variable with 6-level responses including:

1. UAE
2. Other Gulf Corporation Council (GCC) countries
3. Other Middle East Arab countries (Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia)
4. South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)
5. Western countries (Europe, USA, Canada, and Australia)
6. Others and no nationality

d. Location of Residence (Emirate). "Please enter your current address". This was a 7-level categorical (nominal) variable, which included the seven emirates:

a. Abu Dhabi
b. Ajman
c. Dubai

d. Fujairah

e. Ras Al Khaimah (RAK)

f. Sharjah

g. Umm Al Quwain (UAQ)

Socioeconomic variables – Social Environment

a. ***Parental marital status.*** "What is your parent marital status?" This was originally a 4-level categorical (nominal) variable; married, widowed, separated/divorced, others. It was recoded into a new variable, resulting in a 2-level categorical (nominal) variable;

1. Married
2. Separated/divorced/widowed/others.

b. ***Parental highest education***. Father's and mother's highest education level respectively. This was originally a 10-level categorical (ordinal) variable including the following responses:

1. Did not attend school
2. Completed primary school
3. Some intermediate school
4. Completed intermediate school
5. Some secondary school
6. Completed secondary school
7. Some community college, technical school, or university
8. Completed college or university
9. DNK

10. Completed post-graduate training

These responses were recoded into a 2-level categorical (ordinal) variable;

1. Did not complete high school
2. Completed high school

c. Parental employment status. Father's and mother's employment status respectively. This was originally a 5-level categorical (nominal) variable; government employee, private employee, self-employed, not employed, retired. The variable was recoded into a 4-level categorical (nominal) variable; government employee, private employee, self-employed, and not employed/retired.

d. Residential ownership. "Does your family own or rent?" This was a two-level categorical variable; own or rent.

e. Household income. "Household income monthly including all members and sources." This was originally an 8-level categorical variable of different ranges of income in AED including:

1. Less than 2000
2. Between 2000 and 5000
3. Between 5000 and 8000
4. Between 8000 and 10000
5. Between 10000 and 12000
6. Between 12000 and 15000
7. Between 15000 and 20000
8. More than 20000

These responses were grouped and recoded into a 2-level categorical variable of different ranges of income;

1. Less than 15000 AED
2. 15000 AED and above

Household – Physical environment

a. ***Number of individuals in residence.*** "How many people live in your household, including you, relatives, and staff?" This was a continuous variable (ratio).

Behavioural and lifestyle variables – Individual response

a. Duration of use of near work devices.

- **For television, computer/video display games, and mobile phone use,** the questionnaire asked the following: "How many hours do you use it in a regular day?" This was originally a 4-level categorical variable; less than 1, 5 or more, 1 to 4, NA. These responses were recoded into a 3-level categorical variable; less than 1/NA, 1 to 4, and 5 or more. Responses of NA were merged into the less than 1 category of responses.
- **Screen time use:** To assess the combined screen time use of television and computer/video display games, a new variable was formed to include the combined hours. Mobile phone use was not included in this combined variable as the study was conducted in 2007, when mobile phones were not as regularly owned and used by the adolescent population. The original 3 categories of both variables were tabled together to form new ranges of screen time use in hours. The original categories were the following for each: less than 1/NA, 1 to 4, and 5 or more. Below provides a detail of the process of combining both categories:

Television (# hrs)	Computer/Video display games (# hrs)	Combined time (# hrs)
Less than 1/NA	Less than 1/NA	Less than 2
Less than 1/NA	1 to 4	1 to 5 (computer > tv)
1 to 4	Less than 1/NA	1 to 5 (tv > computer)
Less than 1/NA	5 or more	6 or more (computer > tv)
5 or more	Less than 1/NA	5 or more (tv > computer)
1 to 4	5 or more	6 or more (computer > tv)
5 or more	1 to 4	6 or more (tv > computer)
1 to 4	1 to 4	2 to 8
5 or more	5 or more	10 and above

The combined hours resulted in nine categories. These categories were reformatted into four categories in increasing scale as minimal (0-5 hours), mild (2-8 hours), moderate (5-9 hours) and high (10 or more hours).

Categories combined (# hrs)	New category (# hrs)
Less than 2 1 to 5 (computer > tv) 1 to 5 (tv > computer)	0 to 5 (minimal)
2 to 8	2 to 8 (mild)
6 or more (computer > tv) 5 or more (tv > computer) 6 or more (computer > tv)	5 to 9 (moderate)

6 or more (tv > computer)	
10 and above	10 and above (high)

b. Outdoor activity

- A list of recreational activities was surveyed where the participant responded if the activity was conducted outdoors. This was originally a 2-level nominal variable, with a response of yes or no. These activities were recoded into a new variable that provides information on the participant **pursuing at least 1 outdoor activity.** This was a 2-level categorical (nominal) variable. The activities include the following**:** walking, swimming, bicycling, dance, home exercise, skating/rollerblading, jogging/running, golfing, exercise class/aerobics, bowling, tennis, weight-training, fishing, volleyball, basketball, soccer, and other sports.

Functional capacity – Health and Function

a. Challenges in functional capacity

- **Work/school responsibilities**. "How do you rate your ability to handle day to day work or school responsibilities?" This was originally a 6-level categorical (ordinal) variable, varying from excellent to poor and do not know. Responses from this variable were recoded into a new variable as a 2-level categorical (ordinal) variable, varying from good to excellent, and poor to fair.

Health care – Access to Health

a. **Visiting an eye specialist.** In the past 12 months have you seen or talked about your health to an eye specialist?" This was a 2-level nominal variable; yes or no.

3.7.2 Missing data

Missing data is a concern affecting the data used during the cleaning, recoding, analysis and interpretation/conclusions found. As most statistical models including SPSS provide outputs on complete observations of exposure and outcome variables, missing data need to be addressed by either presenting the value alongside the complete values, deleting the incomplete responses, or replacing the missing value with an estimated known response value based on the other available information for that variable (Salgado et al., 2016). However, deletion and replacement of the missing value may significantly affect the results and conclusions interpreted from the data. Therefore, the missing values for each variable have been presented separately in a table to demonstrate the varying distribution of missing data from some proportions having little significance to the overall response rate, and some proportions having a significant percentage of missing values from the responses of that variable.

3.7.3 Data analysis

The variables collected from the questionnaire including demographic, social and physical environment, behavioural and lifestyle factors, functional capacity, and health care analyzed using univariate analysis to retrieve descriptive data such as prevalence. These factors were then analyzed using bivariate and multivariate analysis as a total sample and biological sex-based analysis to assess potential associations between the independent variables and the dependent variable of self-reported health care needs in relation to vision correction.

3.7.3a – Univariate Analysis

To analyze each variable individually, univariate analyses are conducted to describe the patterns for continuous data including mean, mode, median, standard deviation and overall summary of the data (Guo, 2013). Categorical and nominal variables were placed in a frequency table that included the valid number of responses (after adjusting for missing values), the title of the value for each variable, and the frequency in actual number and percentage, to showcase the prevalence of each value within the variable. The continuous variables of age and number of individuals in a residence were analyzed with the descriptive outputs of mean and standard deviation of the variable. Descriptive analysis also meets the study objective of assessing the prevalence of self-reported health care needs in relation to vision correction among high school students in the UAE.

3.7.3b – Bivariate Analysis

Bivariate analyses were conducted to assess associations between independent variables and the outcome of self-reported health care need in relation to vision correction. The nominal / categorical variables were analyzed using Pearson chi-square tests presenting the observed values in percentages, followed by the chi-square value and p-value of the analysis for each variable (Zhang, 2016) Continuous variables including age and number of individuals in a residence underwent the independent t-test to assess their relation to seeing well enough to read without the use of corrective lenses. The results were expressed using chi-square (X^2) and p-value for categorical variables, and t-value and p-value for the t-test for continuous variables (where a p-value of less than 0.05 was considered a significant association), where p-values of 0.1 and less were also included to be added in the multivariate analysis (Barakat-Haddad, 2013).

3.7.3c – Multivariate analysis

Statistically significant variables with a p-value of less than 0.1 in the chi-square test for categorical variables and a p-value of less than 0.1 in the t-test for continuous variables were entered in the multivariate analysis. As the dependent variable was a binary variable of yes or no for “seeing well enough to read without the use of corrective lenses”, a binary logistic regression analysis was conducted to identify determinants of vision correction needs (King, 2008). In addition to the model test using significant p-value of less than 0.05 to potentially represent significant improvement in fit relative to the null (intercept only) model, a Hosmer and Lemeshow test was also included to use non-significance as an indicator of goodness of fit, to check how well the data fits the models.

As the binomial logistic regression estimates the probability of the student reporting to not see well enough to read without the use of corrective lenses, it is important to use this method to predict if the cases are correctly classified from the independent variables by assessing effectiveness of the predicted grouping/classification against the observed classification. This was done through the classification table (Abdulqader, 2017). Indication of fit of the model through specificity and sensitivity was observed using the percentage of correct classification of the predicted and observed values of the dependent variable. Among the variables entered into the analysis, the statistical significance of the variables and their response values were observed. For the statistically significant variables, the odds ratio, confidence interval and the p-value (including p-values of 0.05 or below) were presented, thus indicating the likelihood of a response value being associated with the self-reported vision correction needs compared to the reference response value.

3.7.3d – Assessing the daily functional capacity

To assess the fourth research question of assessing the daily functional capacity of high school students in the UAE needing vision correction, a flow chart was formed. The first row included the percentage of students needing vision correction between each emirate. Within each emirate, the percentage of students who visited an eye specialist in the past 12 months and those who didn't was noted. Within each response between emirates, the percentage of students able to handle daily work/school responsibilities at a good to excellent or poor to fair was noted. The purpose of the flow chart is to identify the action of accessing health care and the resulting functional capacity among those with vision correction needs between each emirate.

3.8 - References for Chapter 3: Methodology

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Chapter 4: Results

The current study includes 6363 students in the UAE who completed the questionnaire. There were 19 variables used to assess the distribution of dependent and independent variables including sociodemographic, lifestyle, behaviour and functional capacity, access to health care, and self-reported health care needs in relation to vision correction. Table 5 includes a descriptive analysis including the valid number for each categorical variable with frequency of each value and its proportion. It also includes the mean and standard deviation for continuous variables. Table 5a includes the percentage of missing values for the variables used in this study. The findings are further categorized into biological sex-based descriptive analysis.

4.1 Descriptive Analysis

Overall, 2826 (44.4%) were male, and 3533 (55.6%) were female, with an average age of 17 years for males and 16 years for females. From the questionnaire, 28.6% of the students responded that they could not "see well enough to read without the use of corrective lenses", indicating needing vision correction. Among the males, 694 (24.8%) reported needing vision correction, and among the females, 1112 (31.7%) reported needing vision correction. The nationality of 3127 (49.4%) of the students was from the UAE, with 3202 (50.6%) from other countries, which included other GCC countries (5.7%), Middle Eastern countries (25.8%), South East Asian countries (15.9%), Western countries (1.3%) and other countries (1.9%). Among the males, 1233 (44.4%) of the students was from the UAE, with 1542 (55.5%) from other countries, majorly comprising of Middle Eastern countries (31.1%) and South East Asian countries (13.2%). Among the females, there were more participants from the UAE, with 1855 (53%) compared to males, and 1644 (46.9%) from other countries, mostly from Middle Eastern countries (21.8%) and South East Asian countries (18.1%). There were 2532 (47.0%) students

who reported to reside in the emirate of Abu Dhabi, with 2860 (53.0%) from other emirates, including Sharjah (16.7%), Ras Al Khaimah (RAK) (11.3%), Dubai (10.0%), Fujairah (7.0%), Ajman (5.8%), and Umm Al Quwain (UAQ) (2.2%). Among males, 1190 (52.4%) reported to reside in Abu Dhabi, with other 1082 (47.7%) reporting to live in Sharjah (21.8%), Ajman (7.1%), Dubai (7.0%), RAK (7.0%), Fujairah (3.5%), UAQ (1.3%). Among females, there were less participants reporting to reside in Abu Dhabi (n=1244, 41.2%) and Ajman (n=153, 5.1%) than males, however there were more females residing in other emirates than males (n=1625, 53.9%), including RAK (15.0%), Sharjah (13.4%), Dubai (12.5%), Fujairah (10.0%), UAQ (3.0%).

Regarding socioeconomic factors, 5535 (88.2%) of the students' parents were married, and 742 (11.8%) of the parents were separated/divorced/widowed/other. Both males and females had similar distributions, where among males, 88.6% of the students' parents were married and 11.4% where separated/divorced/widowed/other. Among females, 87.8% of the students' parents were married, and 12.2% were separated/divorced/widowed/other. Regarding education, 2993 (57.8%) of the students' fathers and 2546 (48.9%) of the students' mothers completed a high school education. There was a similar distribution among males and females, where 57.5% of male students' fathers completed high school compared to 58.3% of the female students. With respect to mothers, 49% of the male students' mothers completed high school compared to 48.9% of the female students. In terms of employment, 4457 (83.9%) of the student's fathers were employed (46.9% government, 23.0% private, and 13.9% self-employed) and 867 (16.3%) were not employed or retired. Among males, there was a greater distribution of students whose fathers were employed (85.8%) compared to female students (82.1%), and greater percentage of fathers employed in the government sector (52.1%) compared to female students (42.7%).

Regarding maternal employment, 1073 (19.7%) and of the students' mothers were employed (9.7% government, 7.3% private, 2.7% and self-employed) and 4380 (80.3%) were not employed. There was a similar distribution found amongst male and female students. Moreover, 2936 (74.5%) of the students had a household monthly income of less than 15,000 AED (low-income), where males had a higher percentage in this category of income (76.2%) than females (73.0%). There were 2615 (48.9%) students' whose families did not own their residence. Renting a home was found to be higher among males (51.6%) than females (47.0%). There was an average of 8.74 residents per household.

With respect to screen time, 1543 (25.1%) students spent five or more hours a day watching television. There were 1565 (25.3%) students spending five or more hours playing computer/video-display games. There were 1103 (17.6%) of students spending five or more hours using mobile phones. More females (26.3%) were found to spend five or more hours of television than males (23.7%). There were more males (26.6%) who were found to spend five or more hours playing computer/video games than females (24.3%). There were more males using mobile phones (25.5%) than females (11.4%). The amount of time spent on watching television and playing computer/video games were combined as "screen time" use in hours per day. There were 2071(34.2%) students who reported minimal hours of screen time, 1680 (27.7%) of students noted mild number of hours of screen time, 1552 (25.6%) reported moderate number of hours of screen time, and 758 (12.5%) students reported high number of hours of screen time as noted in Table 5. Both males and females were found to have a similar distribution of screen time use. On a similar trend, 4704 (72.7%) students reported doing at least one outdoor physical activity. This was found to be higher amongst males (81.0%) than females (66.8%).

Regarding health and function, only 754 (12%) students reported to have visited an eye specialist in the past year. This was found to be greater amongst females (15.1%) than males (8.1%). The ability of students to handle daily work/school responsibilities was good to excellent for the majority (5567, 88%), and poor to fair for the rest (705, 11.2%), with a similar distribution amongst males and females.

With respect to missing values for the variables assessed, the highest percentage of missing values included factors in the socioeconomic category pertaining to the participant's household (Table 5a). This included household monthly income (64.2%), maternal educational level (24.2%), paternal educational level (20.6%), maternal employment status (18.7%), paternal employment status (21.5%), and residential ownership (21.0%).

Table 5: Descriptive sociodemographic, lifestyle behaviours and functional capacity of a sample of adolescents living in the UAE (n=6,363)*

Variable	n	Values	Male n (%)	Female n (%)	n total (%)
Biological sex	6359				
		Male			2826 (44.4)
		Female			3533(55.6)
Age	6144				
		(mean/SD)	17 yrs mean ; SD: 1.228	16 yrs mean ; 1.157	17 yrs mean ; SD: 1.195
Nationality	6329				
		UAE	1233 (44.4)	1855 (53.0)	3127 (49.4)
		Other GCC countries	228 (8.2)	127 (3.6)	360 (5.7)
		Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia	864 (31.1)	764 (21.8)	1632 (25.8)

		South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)	366 (13.2)	634 (18.1)	1006 (15.9)
		Europe, Canada, USA, and Australia	30 (1.1)	51 (1.5)	82 (1.3)
		Others and No nationality	54 (1.9)	68 (1.9)	122 (1.9)
Location of Residence (Emirate)	5392	Abu Dhabi	1190 (52.4)	1244 (41.2)	2532 (47.0)
		Ajman	162 (7.1)	153 (5.1)	315 (5.8)
		Dubai	159 (7.0)	378 (12.5)	537 (10.0)
		Fujairah	79 (3.5)	301 (10.0)	380 (7.0)
		Ras Al Khaimah (RAK)	158 (7.0)	452 (15.0)	610 (11.3)
		Sharjah	495 (21.8)	404 (13.4)	899 (16.7)
		Umm Al Quwain (UAQ)	29 (1.3)	90 (3.0)	119 (2.2)
Parental marital status	6277				
		Married	2443 (88.6)	3073 (87.8)	5535 (88.2)
		Separate/Divorced, Widowed, Others	313 (11.4)	426 (12.2)	742 (11.8)
Paternal education level	5,178				
		Did not complete high school	957 (42.5)	1192 (41.7)	2185 (42.2)
		Completed High School	1293 (57.5)	1668 (58.3)	2993 (57.8)
Maternal education level	5,210				
		Did not complete high school	1144 (51.0)	1481 (51.1)	2664 (51.1)
		Completed High School	1097 (49.0)	1420 (48.9)	2546 (48.9)
Paternal employment status	5,324				
		Government employee	1227 (52.1)	1236 (42.7)	2496 (46.9)
		Private employee	510 (21.6)	698 (24.1)	1222 (23.0)
		Self-employed	286 (12.1)	444 (15.3)	739 (13.9)
		Not employed/Retired	334 (14.2)	519 (17.9)	867 (16.3)
Maternal employment status	5,453				
		Government employee	224 (9.4)	292 (9.8)	529 (9.7)
		Private employee	163 (6.8)	230 (7.7)	397 (7.3)
		Self-employed	67 (2.8)	77 (2.6)	147 (2.7)
		Not employed	1940 (81.0)	2388 (79.9)	4380 (80.3)

Residential ownership	5,348				
		Own	1145 (48.4)	1544 (53.0)	2733 (51.1)
		Rent	1223 (51.6)	1371 (47.0)	2615 (48.9)
Number of individuals in residence	5,068				
		(mean/SD)	8.60 (4.54)	8.88 (4.63)	8.74 / 4.59
Household monthly income	3,940				
		Less than 15000	1355 (76.2)	1545 (73.0)	2936 (74.5)
		15000 and Above	423 (23.8)	571 (27.0)	1004 (25.5)
Television - hrs/day	6,145				
		Less than 1 / NA	595 (22.3)	747 (22.0)	1364 (22.2)
		1 to 4	1440 (54.0)	1756 (51.7)	3238 (52.7)
		5 or more	632 (23.7)	891 (26.3)	1543 (25.1)
Computer/Video-display games - hrs/day	6,176				
		Less than 1 / NA	774 (28.9)	1108 (32.4)	1908 (30.9)
		1 to 4	1191 (44.5)	1147 (43.2)	2703 (43.8)
		5 or more	713 (26.6)	831 (24.3)	1565 (25.3)
Mobile phone - hrs/day	6,252				
		Less than 1 / NA	1202 (44.2)	2356 (68.4)	3956 (57.5)
		1 to 4	827 (30.4)	697 (20.2)	1553 (24.8)
		5 or more	693 (25.5)	392 (11.4)	1103 (17.6)
Screen time - hrs/day	6,061				
		Minimal	877 (33.4)	1163 (34.6)	2071 (34.2)
		Mild	758 (28.9)	898 (26.7)	1680 (27.7)
		Moderate	650 (24.8)	890 (26.5)	1552 (25.6)
		High	337 (12.9)	407 (12.1)	758 (12.5)
	6471				

Outdoor physical activity		No outdoor physical activity	536 (19.0)	1173 (33.2)	1767 (27.3)
		At least 1 outdoor physical activity	2290 (81.0)	2360 (66.8)	4704 (72.7)
Visiting an eye specialist in past year	6309				
		No	2496 (91.9)	2983 (84.9)	5555 (88.0)
		Yes	219 (8.1)	529 (15.1)	754 (12.0)
Handling daily work/school responsibilities	6272				
		Good to Excellent	2463 (89.4)	3033 (88.4)	5567 (88.8)
		Poor to Fair	292 (10.6)	399 (11.6)	705 (11.2)
See well enough to read without the use of corrective lenses	6392				
		Yes	2099 (75.2)	2399 (68.3)	4561 (71.4)
		No	694 (24.8)	1112 (31.7)	1831 (28.6)

*All n-values are valid numbers

Table 5a: Missing values of descriptive data of a sample of adolescents living in the UAE (n=6,363)*

Variable	n	Missing values	missing values %
Sex	6359	112	1.8%
Age	6144	327	5.3%
Nationality	6329	142	2.2%
Location of Residence (Emirate)	5392	1079	20.0%
Parental marital status	6277	194	3.1%
Paternal education level	5,178	1293	20.6%
Maternal education level	5,210	1261	24.2%
Paternal employment status	5,324	1147	21.5%
Maternal employment status	5,453	1018	18.7%
Residential ownership	5,348	1123	21.0%
Number of individuals in residence	5,068	102	2.0%
Household monthly income	3,940	2531	64.2%
Television - hrs/day	6,145	326	5.3%
Computer/Video-display games - hrs/day	6,176	295	4.8%
Mobile phone - hrs/day	6,252	219	3.5%
Screen time - hrs/day	6,061	410	6.8%
Outdoor physical activity	6471	0	0.0%
Visiting an eye specialist in past year	6309	162	2.6%
Handling daily work/school responsibilities	6272	199	3.2%
See well enough to read without the use of glasses	6392	79	1.2%

*All n-values are valid numbers

4.2 Bivariate Analysis

To assess associations between each independent variable and self-reported health care needs in relation to vision correction (ability to see well enough to read without use of corrective lenses), bivariate analyses were conducted (Table 6 & Table 7).

Out of the 19 variables, 13 variables were found to have significant associations with the ability to see well enough to read without the use of corrective lenses. Of these, there were 4 demographic factors, 6 socioeconomic factors, 1 behaviour and lifestyle factor, and 2 health and function factors, further described below.

Due to the significant association of biological sex with needing vision correction, biological sex-based bivariate analyses were conducted (Table 7). Out of the 19 variables, 13 variables were found to have significant association with the ability to see well enough to read without the use of corrective lenses. Of these, there were 3 demographic factors, 6 socioeconomic factors, 2 behaviour and lifestyle variables, and 2 health and function factors as outlined below.

Demographic factors

Statistically significant demographic factors included age ($t = -1.72$, $p=0.008$), biological sex ($X^2 = 35.4$, $p <0.001$), location of residence (emirate) ($X^2 = 916.7$, $p<0.001$), and nationality ($X^2 = 58.6$, $p<0.001$). With respect to association, the average age of students who did not see well enough to read without the use of corrective lenses was 17 years of age (birth year noted as 1990 at the time of completing the survey in 2007). Regarding biological sex, 24.8% of males needed vision correction and 31.7% of females needed vision correction. In terms of location of residence (emirate), students from Fujairah reported to need vision correction the most (76.8%), followed by students from UAQ (68.5%), Dubai (52.5%), Abu Dhabi (27.1%), with the lowest prevalence found among students in Ajman (7.6%) and RAK (4.9%). With respect to nationality, the highest percentage was reported by students from South Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia) of needing vision correction (38%), while students

responding as having no nationality or “other” were found to have the lowest percentage of needing vision correction (19%).

In the biological sex-based analysis, statistically significant demographic factors included age (female: t= -0.59, p=0.071), location of residence (emirate) (male: $X^2 = 326.5$, $p<0.001$; female: $X^2 = 914.4$, $p<0.001$), and nationality (male: $X^2 = 11.37$, $p=0.045$; female: $X^2 = 49.75$, $p<0.001$). Both males and females had an average of 16 years of age who needed vision correction. In terms of location of residence (emirate), there were varying differences between female and male distribution of self-reported needs of vision correction between each emirate. There were more females than males reporting to need vision correction who were located in Abu Dhabi (31.1% vs 22.7%) with significantly increased difference in Dubai (74.3% vs 0.6%). However, there were more males reporting to need vision correction than females living in other emirates, including Ajman (11.7% vs 3.0%), Fujairah (94.9% vs 72.1%), UAQ (85.0% vs 65.1%), and significantly higher in RAK (18.4% vs 0.2%) and Sharjah (29.4% vs 10.9%). With respect to nationality, there were more females who reported needing vision correction than males from all categories of nationalities including the UAE, other Middle Eastern countries, South East Asia, European/Western countries, and other/no nationality, with the greatest difference among females from South East Asian countries.

Socioeconomic factors

Among the socioeconomic factors, statistically significant variables included paternal educational level ($X^2 = 24.9$, $p<0.001$), maternal educational level ($X^2 = 24.5$, $p<0.001$), paternal employment status ($X^2 = 21.0$, $p<0.001$), maternal employment status ($X^2 = 9.7$, $p=0.024$), residential ownership ($X^2 = 19.4$, $p<0.001$), and household monthly income ($X^2 = 9.1$, $p=0.003$) (Table 6).There was no significant association between number of people in the residence and

ability to see well enough to read without use of corrective lenses ($t = 5.160$, $p=0.196$). There also was no significant association between parental marital status and seeing well enough to read without the use of corrective lenses ($t = 1.1$, $p = 0.295$). Among the students whose fathers completed high school, 30.5% did not see well enough to read without the use of corrective lenses compared to those whose fathers did not complete high school (24.2%). Among students whose mothers completed high school, 31.2% did not see well enough to read without the use of corrective lenses than those whose mothers did not complete high school (25.0%). Regarding paternal employment status, students needing vision correction had an approximate equal distribution amongst all categories with 26.2% for government employees, 32.9% for private employees, 29.6% for self-employed, and 26.0% for not employed/retired. Similarly, students needing vision correction based on maternal employment status included 30% for government employees, 34.2% for private employees, 26.9% for self-employed, and 27.3% for not-employed. There were 25.3% students whose family owned their home that reported to need vision correction, compared to 30.8% of students whose family rented their home. Regarding household monthly income, 26.8% of students with a household income of less than 15000 AED reported to need vision correction, compared to 31.8% of students with a household income of more than 15000 AED.

In the biological sex-based analysis, statistically significant variables included paternal educational level (male: $X^2 = 7.10$, $p=0.008$; female: $X^2 = 16.89$, $p<0.001$), maternal educational level (male: $X^2 = 8.56$, $p=0.003$; female: $X^2 = 15.72$, $p<0.001$), paternal employment status (male: $X^2 = 6.05$, $p=0.109$; female: $X^2 = 15.98$, $p=0.001$), maternal employment status (female: $X^2 = 9.29$, $p=0.026$), residential ownership (male: $X^2 = 6.89$, $p=0.009$; female: $X^2 = 13.78$, $p<0.001$), and household monthly income (female: $X^2 = 5.72$, $p=0.017$) (Table 7). There was no

significant association between number of people in the residence and needing vision correction (male: t = 2.74, p= 0.264; female: t = 4.59, p= 0.202). There also was no significant association between parental marital status and seeing well enough to read without the use of corrective lenses (male: t = 0.67, p= 0.410; female: t = 0.32, p= 0.574). Significant differences were seen in relation to biological sex and paternal and maternal educational level with higher prevalence of vision correction needs for females than males whose parents did not complete high school (27.0% vs 20.8% for paternal education and 28.3% vs 20.9% for maternal education). Similarly, significant differences were seen in relation to biological sex and paternal and maternal educational level with higher prevalence of vision correction needs for females than males whose parents completed high school (34.2% vs 25.7% for paternal education and 35.2% vs 26.2% for maternal education). In terms of parental employment, significant differences were seen in relation to biological sex and paternal and maternal employment level with higher prevalence of vision correction needs for females whose fathers were government employees (30.0% vs 22.3%), private employees (36.9% vs 27.6%), self-employed (32.4% vs 25.8%), and/or not employed/retired (26.9% vs 24.5%). Similarly, significant differences were seen in relation to biological sex and paternal and maternal employment level with higher prevalence of vision correction needs for females whose mothers were government employees (30.6% vs 29.9%), private employees (40.4% vs 24.8%), self-employed (31.6% vs 22.4%), and/or not employed/retired (30.6% vs 23.4%). Moreover, between both biological sexes, the female association was found to have statistical significance with respect to parental employment. Regarding household monthly income, there were more females with a household income of 15,000 AED and above who reported to need vision correction than males (34.9% vs 27.9%), with only females showcasing statistical significance.

Behaviour and Lifestyle factors

With respect to behaviour and lifestyle variables, the variables of use of near work devices in a day and outdoor activity did not have a significant association with seeing well enough to read without the use of corrective lenses. This included use of television ($X^2 = 2.2$, p=0.341), computer/video-display games ($X^2 = 2.6$, p=0.273), mobile phone ($X^2 = 0.36$, p=0.836), and pursuing at least one outdoor activity ($X^2 = 0.18$, p=0.67) (Table 6). However, the combined use of television and computer/video games per day was associated with needing vision correction and kept in the multi-variate analysis (p=0.116). Participants reported a similar distribution of requiring vision correction between the scaled hours of screen time use. Among students viewing minimal hours of screen time, 27.7% noted requiring vision correction, compared to those viewing mild number of hours (27.2%), moderate number of hours (30.7%), and high number of hours (29.5%) (Table 6).

In the biological sex-based analysis, statistically significant factors included the use of mobile phones per day (female: $X^2 = 9.81$, $p = 0.007$) and outdoor physical activity (female: $X^2 = 2.80$, $p = 0.094$) (Table 7). There was no significant independent association found between use of television per day, use of computer/video games per day, and use of screen time per day and needing vision correction. With respect to mobile phone use per day amongst males, as the number of hours per day increased, the percentage of males needing vision correction decreased. However, for females, as the number of hours per day increased, the percentage of females needing vision correction increased, with an overall higher percentage of females needing vision correction than males in all ranges of hours. Moreover, association within the female demographic in the biological sex-based analysis was found to be statistically significant. With respect to outdoor activity, 25% of males who reported doing no outdoor activity needed vision

correction, and 24.8% of males who did at least one outdoor activity reported needing vision correction. There was a larger and opposite directional difference amongst females, where 29.8% of females who reported doing no outdoor activity needed vision correction, and 32.6% of females who reported doing at least one outdoor activity needed vision correction. Only the female association was found to have statistical significance to be included in the multivariate analysis.

Health and Function factors

Regarding health and function, both variables had statistically signification association (Table 6). Among students who visited an eye specialist in the past year, 59.4%% reported to need vision correction, and among those who did not visit an eye specialist in the past year, 24.5% reported to need vision correction ($X^2 = 394$, $p < 0.001$). 27.5% of students who noted to handle schoolwork / responsibilities on a "good to excellent" scale reported to need vision correction, where 35% of students who noted to handle school work/responsibilities on a "poor to fair" scale reported to need vision correction ($X^2 = 17.5$, $p < 0.001$).

In the biological sex-based analysis, both variables had statistically significant association (Table 7). With respect to visiting an eye specialist, both males and females showed a much higher percentage of needing vision correction if they visited an eye specialist in the past year, with more females noting needing vision correction than males. Among males, 23.8% who reported to handle daily work/school responsibilities on a "good to excellent" scale needed vision correction, whereas 31.8% who reported "poor to fair" needed vision correction. Similarly, amongst females, 30.5% of those who reported "good to excellent" needed vision correction, and 37.8% of those who reported "poor to fair" needed vision correction, with more females needing vision correction in both responses.

The bivariate analyses for continuous variables included the Levene's test to assess the equality of variances among two groups. If the p-value is greater than 0.05, the variances are not significantly different from one another, leading to assumption of equal variance. The p-value for age ($p = 0.008$) is less than 0.05 resulting in an assumption that the variances are not equal, and number of people in residence ($p = 0.196$) is greater than 0.05 resulting in an assumption that the variances were equal across the groups. In the biological sex-based analysis, the p-value for age (male: $p=0.200$; female: $p = 0.071$) is greater than 0.05, and the p-value for number of people in residence (male: $p = 0.264$; female: $p = 0.202$), resulting in an assumption that resulting in an assumption that the variances were equal across the groups.

Table 6: Bivariate analyses to assess associations between independent variables and self-reported health care needs in relation to vision correction

Variable	Reference	Sees well enough to read without use of corrective lenses	Does not see well enough to read without use of corrective lenses/needed vision correction
Biological sex (%)	Male	**75.20*** **	**24.80*** **
	Female	**61.30*** **	**31.70*** **
Age (years)		**Mean: 17 ** **	**Mean: 17 ** **
Nationality (%)	UAE	**73.20*** **	**26.70*** **
	Other GCC countries	**76.30*** **	**23.70*** **
	Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia	**71.90*** **	**28.10*** **
	South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)	**62.00*** **	**38.00*** **
	Europe, Canada, USA, and Australia	**67.90*** **	**32.10*** **
	Others and No nationality	**81.00*** **	**19.00*** **
Location of Residence (Emirate) (%)	Abu Dhabi	**72.90*** **	**27.10*** **
	Ajman	**92.40*** **	**7.60*** **
	Dubai	**47.50*** **	**52.50*** **
	Fujairah	**23.2*** **	**76.80*** **
	Ras Al Khaimah (RAK)	**95.10*** **	**4.90*** **
	Sharjah	**78.90*** **	**21.10*** **
	Umm Al Quwain (UAQ)	**31.50*** **	**68.50*** **
Parental marital status (%)	Married	71.60	28.40
	Separated/Divorced/Widowed, Other	69.70	30.30
Paternal education level (%)	Did not complete high school	**75.80*** **	**24.20*** **
	Completed high school	**69.50*** **	**30.50*** **
Maternal education level (%)	Did not complete high school	**75.00*** **	**25.00*** **
	Completed high school	**68.80*** **	**31.20*** **
Paternal employment status (%)	Government employee	**73.80*** **	**26.20*** **
	Private employee	**67.10*** **	**32.90*** **

	Self employed	**70.20*** **	**29.80*** **
	Not employed/retired	**74.00*** **	**26.00*** **
Maternal employment status (%)	Government employee	**70.00** **	**30.00** **
	Private employee	**65.80** **	**34.20** **
	Self employed	**73.10** **	**26.90** **
	Not employed	**72.70** **	**27.30** **
Residential ownership (%)	Own	**74.70*** **	**25.30*** **
	Rent	**69.20*** **	**30.80*** **
# of people in residence		Mean: 8.94	Mean: 8.24
Household monthly income (%)	Less than 15,000 AED	73.20	26.80
	15,000 AED and above	**68.20** **	**31.80** **
Television - hrs/day (%)	Less than 1/NA	71.70	28.30
	1 to 4	72.00	28.00
	5 or more	70.00	30.00
Computer/Video-display games - hrs/day (%)	Less than 1/NA	72.10	27.90
	1 to 4	71.90	28.10
	5 or more	69.90	30.10
Mobile phone - hrs/day (%)	Less than 1/NA	71.10	28.90
	1 to 4	71.30	28.70
	5 or more	72.10	27.90
Screen time – hrs/day (%)	Minimal	**72.30***	**27.70***
	Mild	**72.80***	**27.20***
	Moderate	**69.30***	**30.70***
	High	**70.50***	**29.50***
Outdoor physical activity (%)	No outdoor physical activity	71.80	28.20
	At least one outdoor physical activity	71.20	28.80
Eye specialist in last year (%)	No	**75.50*** **	**24.50*** **
	Yes	**40.60*** **	**59.40*** **
Handling daily work/school responsibilities (%)	Good to excellent	**72.50*** **	**27.50*** **
	Poor to fair	**65.00*** **	**35.00*** **

Significant association = $p < 0.05$; if 0.000 => $p < 0.001$

* p-value: 0.10
** p -value: <0.05
*** p-value: <0.001

Table 7: Biological sex-based bivariate analyses to assess associations between independent variables and self-reported health care needs in relation to vision correction

Variable	Reference	Male		Female	
		Sees well enough to read without use of corrective lenses	Does not see well enough to read without use of corrective lenses	Sees well enough to read without use of corrective lenses	Does not see well enough to read without use of corrective lenses
Biological sex (%)		75.20	**24.80*****	61.30	**31.70*****
Age (years)		Ave: 16	Ave: 16	Ave: 16	Ave: 16*
# ppl in residence		Ave: 8.71	Ave: 8.12	Ave: 9.13	Ave: 9.13
Nationality (%)	UAE	**77.40****	**22.60****	**70.40*****	**29.60*****
	Other GCC countries	**74.80****	**25.20****	**79.50*****	**20.50*****
	Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia	**74.00****	**26.00****	**69.50*****	**30.50*****
	South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)	**69.40****	**30.60****	**57.80*****	**42.20*****
	Europe, Canada, USA, and Australia	**76.70****	**23.30****	**62.00*****	**38.00*****
	Others and No nationality	**81.50****	**18.50****	**80.60*****	**19.40*****
Location of Residence (Emirate) (%)	Abu Dhabi	**77.30*****	**22.70*****	**68.90*****	**31.10*****
	Ajman	**88.30*****	**11.70*****	**96.70*****	**3.30*****
	Dubai	**99.40*****	**0.60*****	**25.70*****	**74.30*****
	Fujairah	**5.10*****	**94.90*****	**27.90*****	**72.1*****
	Ras Al Khaimah (RAK)	**81.60*****	**18.40*****	**99.80*****	**0.20*****
	Sharjah	**70.60*****	**29.40*****	**89.10*****	**10.90*****
	Umm Al Quwain (UAQ)	**20.00*****	**80.00*****	**34.90*****	**65.10*****
Parental marital status (%)	Married	**75.50*****	**24.50*****	**68.50*****	**31.50*****
	Separated/Divorced/Widowed, Other	73.40	26.60	67.10	32.90
Paternal educational level (%)	Did not complete high school	**79.20****	**20.80****	**73.00*****	**27.00*****
	Completed high school	**74.30****	**25.70****	**65.80*****	**34.20*****

Maternal educational level (%)	Did not complete high school	**79.10****	**20.90****	**71.70*****	**28.30*****
	Completed high school	**73.80****	**26.20****	**64.80*****	**35.20*****
Paternal employment status (%)	Government employee	77.70	22.30	**70.00*****	**30.00*****
	Private employee	72.40	27.60	**63.10*****	**36.90*****
	Self employed	74.20	25.80	**67.60*****	**32.40*****
	Not employed/retired	75.50	24.50	**73.10*****	**26.90*****
Maternal employment status (%)	Government employee	70.10	29.90	**69.40****	**30.60****
	Private employee	75.20	24.80	**59.60****	**40.40****
	Self employed	77.60	22.40	**68.40****	**31.60****
	Not employed	76.60	23.40	**69.40****	**30.60****
Residential Ownership (%)	Own	**78.40****	**21.60****	**71.70*****	**28.30*****
	Rent	**73.70****	**26.30****	**65.30*****	**34.70*****
Household Monthly Income (%)	Less than 15,000 AED	**76.10***	**23.90***	**70.50****	**29.50****
	15,000 AED and above	**72.10***	**27.90***	**65.10****	**34.90****
Television - hrs/day (%)	Less than 1/NA	75.70	24.30	68.70	31.30
	1 to 4	75.10	24.90	69.50	30.50
	5 or more	75.80	24.20	66.10	33.90
Computer/Video games - hrs/day (%)	Less than 1/NA	76.60	23.40	69.10	30.90
	1 to 4	75.00	25.00	69.30	30.70
	5 or more	74.90	25.10	65.90	34.10
Mobile phone - hrs/day (%)	Less than 1/NA	73.30	26.70	**70.00***	**30.00***
	1 to 4	76.10	23.90	**65.50***	**34.50***
	5 or more	77.20	22.80	**63.60***	**36.40***
Screen time - hrs/day (%)	Minimal	75.70	24.30	69.70	30.30
	Mild	76.30	23.70	69.60	30.40
	Moderate	72.80	27.20	66.90	33.10
	High	78.00	22.00	64.90	35.10
Outdoor physical activity (%)	No outdoor physical activity	75.00	25.00	**70.20*****	**29.80*****
	At least one outdoor physical activity	75.20	24.80	**67.40*****	**32.60*****
Eye specialist in last year (%)	No	**77.80*****	**22.20*****	**73.50*****	**26.50*****
	Yes	**45.40*****	**54.60*****	**38.60*****	**61.40*****
Handling daily work/school responsibility (%)	Good to excellent	**76.20****	**23.80****	**69.50****	**30.50****
	Poor to fair	**68.20****	**31.80****	**62.20****	**37.80****

Significant association = $p < 0.05$; if 0.000 => $p < 0.001$

*p-value: 0.1 or less

** p-value: <0.05

*** p-value: <0.001

All statistically significant variables found in the bivariate analysis were included in the multivariate analysis using the binary logistic regression test to examine how well a combination of variables predict the categorical dependent variable, to obtain an odds ratio with more than one independent variable, and to determine the goodness of fit of the model. The included categorical variables are biological sex, location of residence (emirate), nationality, paternal educational level, maternal educational level, paternal employment status, maternal employment status, residential ownership, household monthly income, screen time use per day, visiting an eye specialist in the past year, and handling daily work/school responsibilities. These variables have p-values of 0.1 or less in the chi-square test. The continuous variable included is age, which has a p-value of less than 0.1 in the t-test (Table 8).

In the biological sex-based bivariate analysis, the categorical variables included in the multivariate analysis with a p-value of 0.1 or less amongst both biological sexes include location of residence (emirate), nationality, paternal educational level, maternal educational level, paternal employment status, maternal employment status, residential ownership, household monthly income, mobile phone use per day, visiting an eye specialist in the past year, and handling daily work/school responsibilities. The continuous variable includes age which has a p-value of 0.1 or less in the t-test. (Table 9).

4.3 Multivariate Analysis

The significant determinants found in the binary logistic regression analysis were nationality, location of residence (emirate), screen time use, and visiting an eye specialist in the past 12 months (Table 8). The significant determinants found in the biological sex-based binary

logistic regression analysis were age, location of residence (emirate), nationality, visiting an eye specialist in the past 12 months, and handling daily school/work responsibilities for the male analysis and location of residence (emirate), nationality, maternal education, and visiting an eye specialist in the past 12 months for the female analysis (Table 9). In the binary logistic regression test (enter method), the model coefficients showed that the full model represents significant improvement in fit relative to the null (intercept only) model, with a p-value of less than 0.001. The Hosmer and Lemeshow test, which is another index of overall model fit, had a p-value of 0.386, representing a non-significant value as a good fit.

In the classification table, among the total number of participants who were identified to able to see well enough to read without the use of corrective lenses, 93.0% was correctly predicted by the model, indicating the specificity of the model. Among the individuals who were identified as not being able to see well enough to read without the use of corrective lenses, 45.0% were predicted by the model for the response, indicating the sensitivity of the model. The overall classification accuracy was 79.4%, where the model is better able to predict those who see well enough to read without the use of corrective lenses.

Among the twelve variables entered in the multivariate analysis, the results of the binary logistic regression analysis showed four statistically significant determinants with vision correction needs (Table 8). This included nationality, location of residence (emirate), screen time use, and visiting an eye specialist in the past 12 months. A separate binary logistic regression analysis with the statistically significant factors as interactions along with the independent four factors. This resulted in the model coefficients presenting a p-value of less than 0.001, and a Hosmer and Lemeshow test showcasing a p-value of 0.999. However, there were no additional factors that were statistically significant in association with needing vision correction as

interaction variables. Therefore, the best fit model for the binary logistic regression analysis was found to be using the twelve variables with no interactions.

Students residing in Ajman were 0.181 times as likely to report needing vision correction than those from Abu Dhabi (95% CI: 0.087, 0.379, $p<0.001$). Student residing in Dubai were 2.746 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 2.045, 3.689, $p<0.001$). Students living in Fujairah were 9.533 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 6.307, 14.410, $p<0.001$). Students living in RAK were 0.129 times as likely to report needing vision correction as those from Abu Dhabi (95% CI: 0.070, 0.236, $p<0.001$). Students living in Sharjah were 0.711 times as likely to report needing vision correction as those from Abu Dhabi (95% CI: 0.536, 0.944, $p=0.018$). Students living in UAQ were 7.570 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 3.779, 15.163, $p<0.001$). Students noting their nationality from South East Asia were 1.996 times more likely to report not seeing well enough to read without the use of corrective lenses than those of UAE nationality, which was the only statistically significant classification among other listed nationalities (95% CI: 1.303, 3.058, $p=0.002$). Students who noted spending moderate number of hours of screen time in a day were 1.401 times more likely to report needing vision correction than those who reported spending minimal hours of screen time in a day (95% CI: 1.068, 1.838, $p=0.015$). This classification was the only statistically significant category among other listed hours. Students who responded visiting an eye specialist in the past 12 months were 4.038 times more likely to report not seeing well enough to read without the use of corrective lenses (95% CI: 3.051, 5.346, $p<0.001$).

Table 8: Multivariate analysis – Binary Logistic Regression Results for Self-Reported Vision Correction Needs

Category	Variable (Reference)	Classification	Do not see well enough to read without the use of corrective lenses	
			OR (Exp(B))	95% CI
Demographic				
	Biological sex (Male)	Female	1.042	(0.836, 1.300)
	Age		0.923	(0.834, 1.022)
	Emirate (Abu Dhabi)	Ajman	**0.181****	(0.087, 0.379)
		Dubai	**2.746****	(2.045, 3.689)
		Fujairah	**9.533****	(6.307, 14.410)
		Ras Al Khaimah (RAK)	**0.129****	(0.070, 0.236)
		Sharjah	**0.711***	(0.536, 0.944)
		Umm Al Quwain (UAQ)	**7.570****	(3.779, 15.163)
	Nationality (UAE)	Other GCC countries	**1.681***	(1.020, 2.771)
		Other Middle Eastern countries (Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia)	1.045	(0.701, 1.559)
		South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, Indonesia)	**1.996***	(1.303, 3.058)
		Europe, Canada, USA and Australia	1.864	(0.747, 4.648)
		Others and no nationality	0.584	(0.235, 1.456)

Socioeconomic	Paternal education (did not complete high school)	Completed high school	1.007	(0.775, 1.343)
	Maternal education (did not complete high school)	Completed high school	1.259	(0.946, 1.675)
	Paternal employment status (Not employed/retired)	Government employee	0.841	(0.609, 1.159)
		Private employee	0.928	(0.625, 1.378)
		Self-employed	0.853	(0.558, 1.302)
	Maternal employment status (not employed)	Government employee	1.317	(0.936, 1.854)
		Private employee	1.107	(0.752, 1.630)
		Self-employed	0.680	(0.338, 1.367)
	Home ownership (own)	Rent	0.991	(0.714, 1.376)
	Household income (less than 15,000 AED)	15,000 AED and above	1.186	(0.925, 1.522)
Behaviour and Lifestyle	Screen time (hrs/day) (Minimal))	Mild	1.146	(0.878, 1.495)
		Moderate	**1.401***	(1.068, 1.838)
		High	1.230	(0.876, 1.727)
Health and Function	Visiting an eye specialist in the past 12 months (No)	Yes	**4.038****	(3.051, 5.346)
	Ability to handle day to day work/school responsibilities (Good to excellent)	Poor to Fair	1.254	(0.919, 1.710)
Specificity (%)/Sensitivity (%)			93.0/45.0	
Model				
Chi-square			657.17	
p-value			<0.001	
Hosmer and Lemeshow test				
Chi-square			8.503	
p-value			0.386	

* p-value: <0.05
** p-value: <0.001

In the biological sex-based binary logistic regression analysis, the male and female multivariate analysis were conducted separately, resulting in differing model of coefficients, specificity and sensitivity, and Hosmer and Lemeshow test (Table 9). In both the male and female analysis, the model coefficients showed that the full model represents significant improvement in fit relative to the null (intercept only) model, with a p-value of less than 0.001. The Hosmer and Lemeshow test resulted in a p-value of 0.471 for the male analysis versus a p-value of 0.918 for the female analysis, thereby showcasing the female analysis as a better fit than the male analysis due to its non-significant value. In the classification table, among the total number of participants who were identified to able to see well enough to read without the use of corrective lenses, 97.2% was correctly predicted by the model for males and 86.7% was correctly predicted for females, indicating the specificity of the model. Among the individuals who were identified as not being able to see well enough to read without the use of corrective lenses, 32.1% was predicted by the model for the response for males and 67.9% was predicted by the model for females, indicating the sensitivity of the model. The overall classification accuracy was 81.9% for males and 80.6% for females, where the model is better able to predict those who see well enough to read without the use of corrective lenses.

The results of the binary logistic regression analysis showed five statistically significant factors associated with vision correction needs in the male analysis. This included age, location of residence (emirate), nationality, visiting an eye specialist in the past 12 months, and handling daily school/work responsibilities. Among the female group, four statistically significant factors were found, including location of residence (emirate), nationality, maternal education, and visiting an eye specialist in the past 12 months.

For males, students with increasing age reported being 0.796 times as likely to report needing vision correction (95% CI: 0.683, 0.928, p=0.003). Students residing in Ajman were 0.483 times as likely to report needing vision correction than those from Abu Dhabi (95% CI: 0.235, 0.995, p=0.048). Student residing in Dubai were 0.045 times as likely to report needing vision correction than those from Abu Dhabi (95% CI: 0.006, 0.332, p=0.002). Students living in Fujairah were 82.833 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 18.849, 364.023, p<0.001). Students living in Sharjah were 1.471 times more likely to report needing vision correction as those from Abu Dhabi (95% CI: 1.013, 2.138, p=0.043). Students living in UAQ were 17.222 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 3.348, 88.600, p<0.001). Students from a nationality of other GCC countries were 2.154 times more likely to report needing vision correction than those from the UAE (95% CI: 1.111, 4.175, p=0.023). Students who responded visiting an eye specialist in the past 12 months were 4.091 times more likely to report needing vision correction than those who did not visit an eye specialist in the past 12 months (95% CI: 2.529, 6.620, p<0.001). Students noting poor to fair ability to handle daily school/work responsibilities were 0.441 times as likely to report needing vision correction than those noting good to excellent in handling daily responsibilities (95% CI: 0.264, 0.737, p=0.002).

In the female analysis, students residing in Dubai were 6.34 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 4.305, 9.356, p<0.001). Students living in Fujairah were 6.683 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 4.161, 10.734, p<0.001). Students living in RAK were 0.010 times as likely to report needing vision correction than those from Abu Dhabi (95% CI: 0.001, 0.071, p<0.001). Students living in Sharjah were 0.274 times as likely to report needing vision

correction as those from Abu Dhabi (95% CI: 0.168, 0.449, p<0.001). Students living in UAQ were 6.165 times more likely to report needing vision correction than those from Abu Dhabi (95% CI: 2.817, 13.493, p<0.001). Students having a nationality from South East Asia were 1.860 times more likely to report needing vision correction than students from the UAE (95% CI: 1.027, 3.368, p=0.041). Moreover, students who noted having another nationality or no nationality were 0.249 times as likely to report needing vision correction than those from the UAE (95% CI: 0.070, 0.891, p=0.033). Students whose mothers completed high school were 1.503 times more likely to report needing vision correction than those whose mothers did not complete high school (95% CI: 1.015, 2.224, p=0.042). Students who responded visiting an eye specialist in the past 12 months were 3.742 times more likely to report needing vision correction than those who did not visit an eye specialist in the past 12 months (95% CI: 2.577, 5.434, p<0.001).

4.4 Assessing the daily functional capacity – Flow chart

Among students reporting the need for vision correction, the majority did not report visiting an eye specialist in the past 12 months (Figure 3). This was found to be highest among students from RAK (86.7%), followed by UAQ (78.4%), Abu Dhabi (77.3%), Fujairah (73.0%), Sharjah (72.1%), Ajman (69.6%) and Dubai (68.0%). There were five emirates where the percentage of participants who report poor to fair daily functional capacity was greater among those who did not visit an eye specialist in the past year compared to those who visited an eye specialist in the past year, with a significant association found within the emirate of Dubai (18.2% vs 6.8%) (X^2 = 6.22, p = 0.013).

Table 9: Biological sex-based multivariate analyses – Binary Logistic Regression Results for Self-Reported Vision Correction Needs

Category	Variable (Reference)	Classification	Male		Female	
			Do not see well enough to read without the use of corrective lenses			
			OR (Exp(B))	95% CI	OR (Exp(B))	95% CI
Demographic	Age		**0.796***	(0.683, 0.928)	0.994	(0.868, 1.151)
	Emirate (Abu Dhabi)	Ajman	**0.483***	(0.235, 0.995)	0.000	(0.000, 0.000)
		Dubai	**0.045***	(0.006, 0.332)	**6.346****	(4.305, 9.356)
		Fujairah	**82.833****	(18.849, 364.023)	**6.683****	(4.161, 10.734)
		Ras Al Khaimah (RAK)	0.844	(0.420, 1.696)	**0.010****	(0.001, 0.071)
		Sharjah	**1.471***	(1.013, 2.138)	**0.274****	(0.168, 0.449)
		Umm Al Quwain (UAQ)	**17.222****	(3.348, 88.600)	**6.165****	(2.817, 13.493)
	Nationality (UAE)	Other GCC countries	**2.154***	(1.111, 4.175)	1.165	(0.439, 3.093)
		Other Middle Eastern countries (Lebanon, Syria, Jordan, Palestine, Iraq, North Africa, Yemen, Somalia)	1.139	(0.611, 2.123)	0.908	(0.512, 1.609)
		South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, Indonesia)	1.889	(0.952, 3.746)	**1.860***	(1.027, 3.368)

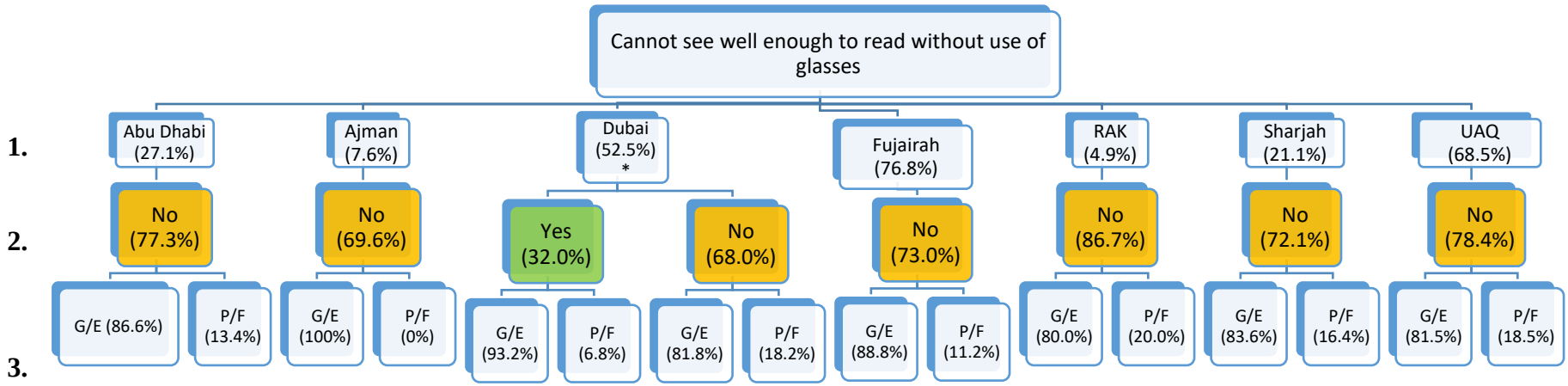
		Europe, Canada, USA and Australia	2.305	(0.463, 11.473)	1.861	(0.535, 6.467)
		Others and no nationality	1.386	(0.392, 4.903)	**0.249***	(0.070, 0.891)
Socioeconomic	Paternal education (did not complete high school)	Completed high school	1.073	(0.683, 1.684)	0.833	(0.556, 1.246)
	Maternal education (did not complete high school)	Completed high school	1.348	(0.850, 2.139)	**1.503***	(1.015, 2.224)
	Paternal employment status (Not employed/retired)	Government employee	0.917	(0.521, 1.613)	0.877	(0.567, 1.357)
		Private employee	1.215	(0.634, 2.332)	0.766	(0.439, 1.336)
		Self-employed	1.027	(0.495, 2.131)	0.761	(0.426, 1.360)
	Maternal employment status (not employed)	Government employee	1.388	(0.832, 2.316)	1.414	(0.854, 2.342)
		Private employee	0.930	(0.490, 1.767)	1.016	(0.599, 1.725)
		Self-employed	0.345	(0.084, 1.410)	1.025	(0.422, 2.493)
	Home ownership (own)	Rent	1.044	(0.634, 1.719)	0.981	(0.610, 1.578)
	Household income (less than 15,000 AED)	15,000 AED and above	1.428	(0.952, 2.141)	1.051	(0.747, 1.479)
Behaviour and Lifestyle	Mobile use (hrs/day) (less than 1/NA)	1 to 4	0.647	(0.410, 1.021)	0.983	(0.619, 1.563)
		5 or more	0.947	(0.651, 1.377)	1.060	(0.752, 1.493)
Health and Function	Visiting an eye specialist in the past 12 months (No)	Yes	**4.091****	(2.529, 6.620)	**3.742****	(2.577, 5.434)

	Ability to handle day to day work/school responsibilities (Good to excellent)	Poor to Fair	**0.441***	(0.264, 0.737)	0.987	(0.652, 1.492)

	Male	**Female**
Specificity (%)/Sensitivity (%)	97.2/32.1	86.7/67.9
Model		
Chi-square	241.661	651.190
p-value	<0.001	<0.001
Hosmer and Lemeshow test		
Chi-square	7.625	3.242
p-value	0.471	0.918

Significant association = $p < 0.05$; if 0.000 => $p < 0.001$
* p-value: <0.05
** p-value: < 0.001

Figure 3. Emirate-based analysis of vision correction needs with healthcare access and functional capacity



Legend:

1. Emirate-based prevalence of adolescents reporting to need vision correction
2. Visiting an eye specialist in the past 12 months
3. Handling daily work
   - G/E = good to excellent
   - P/F = poor to fair

   *P<0.05

Chapter 5: Discussion

This thesis examined the prevalence and determinants of self-reported need to see well enough to read without the use of corrective lenses among high school students in the UAE based on a cross-sectional survey (2007-2009) that was administered on 6363 adolescents. The primary research objectives of this study were to assess the prevalence of self-reported health care needs in relation to vision correction among high school students in the UAE, and to assess if there are significant associations between vision correction needs and each of following factors: demographic, socioeconomic status, physical and lifestyle behaviours, and affecting the daily functional capacity among the UAE adolescent population. The third objective was to identify the most significant determinants of vision correction needs among the UAE adolescent population.

5.1 Prevalence of self-reported health care needs in relation to vision correction

Results indicate that 28.6% of the students responded that they could not "see well enough to read without the use of corrective lenses", indicating needing vision correction. These results are lower than the global prevalence of VI ascribed to refractive errors as 43% (Pascolini & Mariotti, 2012). Of the five studies in the literature review in Chapter 2 that assessed prevalence of myopia, two studies presented similar prevalence of myopia compared to findings of this study, where the other three presented lower prevalence of myopia. All studies included in the literature review reported lower prevalence of hyperopia. The relatively higher percentage of students with the self-reported health care need of vision correction among students in this study may be due to various environmental and academic factors. While the Ministry of Health (MoH) oversees public-school health services and the Dubai Health Authority (DHA) oversees the

private schools, the DHA was only launched in March 2008, including the Schools and Educational Institutions Health Unit (SEIHU) from the Primary Health Care Services Sector (PHCSS) of DHA that help conduct health assessments and support (Taryam et al., 2017). In Abu Dhabi, the Comprehensive School Screening Program, part of the Preventative Screening for children, was launched by Health Authority of Abu Dhabi (HAAD) in 2010 (Al Hajeri, 2020). Therefore, the DHA for private schools and Comprehensive School Screening Program was not active at the time of conducting the questionnaire. Lack of timely screening of VI-RE among students in the UAE may have resulted in a significant percentage of students reporting to need vision correction in the adolescent years. Moreover, as majority of the students noted to have a household monthly income of less than 15,000 AED (76.2%), and vision care requires an employment insurance plan dependent on an employee's salary and designation (Health Insurance Law of Dubai – ISAHD, 2015), families falling under the low-income category may not be able to provide access or continued access to vision care for their children in their childhood and/or adolescent years. This finding is consistent with 91.9% of students reporting to not visit an eye specialist in the past year. In addition, engaging in outdoor activity has been associated with lower prevalence of VI-RE in the literature review, where children pursuing outdoor activities had significantly less odds of having an RE compared to children who did not pursue outdoor activities. While pursuing at least one outdoor activity was not shown to be significantly associated with self-reported needs of vision correction in this study, the warmer climate in the UAE may pose contextual barriers to pursuing outdoor activities. The findings from this study noted 19.0% of the students did not pursue at least one outdoor physical activity. The temperature in the UAE is known to reach up to 40 degrees Celsius in the summer, which was shown to be a common barrier for outdoor activity participation among students in a study conducted among female Emirati university students, and among women in a Qatari study who

had a significant decrease in physical activity participation in the summer months (Burton et al., 2021; Sayegh et al., 2016). Therefore, lack of prior academic health screening, low socioeconomic status in the form of household monthly income, and reduced outdoor activity due to weather conditions may play a role in the prevalence of students reporting to need vision correction.

5.2 Determinants of health care needs in relation to vision correction

Demographic factors

Age was found to be significantly associated with self-reported needs of vision correction among the sample population of 13 to 20 years of age with an average age of 17 years, both as a whole sample ($p=0.008$) and amongst females in the biological sex-based analysis (average of 16 years of age) ($p=0.071$). This finding is consistent with the results of the literature review. In the review, older participants presented with hyperopic astigmatism and a gradual increase in myopia, and increased burden was found with increasing age among both biological sexes (Ebri et al., 2019; Kandi et al., 2021; Galvis et al., 2017; Yang et al., 2021). The increasing self-reported need of vision correction with increasing age may be a result of the academic setting. While the schools in the UAE are categorized into governmental, which are only for the UAE nationals, and private, which are for both UAE nationals and expatriates, most of the UAE nationals also include their children in the private schools (Mahir Ali et al., 2019). As private schools are in English, students from other nationalities and UAE nationals need to know English in addition to their native language to study in these schools. To keep up with the academic demands reflecting the modernization process of the western world, the students are

placed in pressurizing academic settings especially in the adolescent years impacting their lifestyle, diet, and physical activity as they aim to achieve high grades to enter one of UAE's prominent universities known to guarantee lucrative employment opportunities. Increasing academic work falls under near work, where studies have shown a positive association between near work and myopia and astigmatism, predominantly seen increasing among adolescents from Asian countries in the past three decades (Mutti et al., 2002; Buehren et al., 2003; Yasuda & Yamaguchi, 2005; Dolgin, 2015; Hashemi et al., 2017). A study based in Riyadh, Saudi Arabia using a questionnaire presented to parents of students aged 6 – 15 years of age found no association between number of hours spent on homework and RE, however this questionnaire was not presented to the students themselves (Alomair et al., 2021). The results from the current study found screen time (television and computer/video games) to be significantly associated with self-reported vision correction needs, suggesting further research on increasing near work in an academic setting amongst a diverse age group.

Biological sex was found to be significantly associated with self-reported vision correction needs, where 24.8% of males needed vision correction and 31.7% of females needed vision correction ($p<0.001$). The higher percentage of females reporting needing vision correction is consistent with five studies included in the literature review noting significant differences between biological sex where female participants appeared to have a higher association with refractive error with respect to myopia and higher disease burden due to uncorrected refractive error (URE) (Teran et al., 2021; Ebri et al., 2019; Kandi et al., 2021; Galvis et al., 2017; Yang et al., 2021). It is not clear if there are genetic predispositions between males and females for vision impairment due to refractive error and/or social and environmental factors. In the current study, females had a lower distribution of paternal employment than

males, however with a lower distribution of low household monthly income and higher distribution of owning their residence. More females were found to spend 5 or more hours in a day watching television, but more males were found to spend 5 or more hours in a day playing video/computer games and using mobile phone. However, significantly more females were found to visit an eye specialist than males in the past year, which may be a factor in their self-reported vision correction needs.

The current study also presents a strong association between location of residence (emirate) and self-reported needs of vision correction, both as a whole ($p<0.001$) and in the biological-sex based analysis ($p<0.001$ for males and females). Students residing in Fujairah had the highest percentage who noted to need vision correction, followed by UAQ, Dubai, Abu Dhabi, Sharjah, and lowest percentage in Ajman and RAK. This was similar among both males and females, however with varying distributions among both biological sexes for each emirate, where there were more females reporting to need vision correction residing in Abu Dhabi and Dubai, and more males reporting to need vision correction residing in other emirates. Fujairah and UAQ were the lowest percentage of the population distribution of residence (7.0% and 2.2% respectively), and Abu Dhabi was found to have the highest percentage of population distribution of residence (47.0%) (About Fujairah, 2022; About UAQ, 2022). This may have a potential correlation with the fact that as of 2018, Abu Dhabi has the highest distribution of government and private hospitals, with 14 government and 25 private hospitals, while Fujairah and UAQ have the lowest distribution of government and private hospitals, with Fujairah having 2 government and 1 private hospital, and UAQ having 1 governmental and 0 private hospitals (Health Insurance and the Healthcare System in the UAE Explained, 2021). However, a collection of 105 government-funded primary health care (PHC) clinics have also been built

across the UAE as of 2001 (Health Service Report, 1999). These centers are funded by the Federal Ministry of Health and by the state Dubai Ministry of Health, however with a relatively similar low means of infrastructure and service provided with no ophthalmic services for expatriates. Therefore, with limited access to a hospital and/or PHC that provides eye examination services due to a relatively lower population size, students living in Fujairah and UAQ may be at a disadvantage in timely vision screening than those living in other emirates.

In the current study, nationality was found to be significantly associated with self-reported vision correction needs as a whole ($p<0.001$) and in the biological sex-based analysis (male: $p=0.045$; female: $p<0.001$). Students from South East Asia had the highest number of students needing vision correction (38%), followed by students from the Western countries (32.1%), Middle East countries (28.1%), other GCC countries (23.7%), and lastly those noting no nationality or "other" (19%). There were more females who reported needing vision correction than males from all categories of nationalities with the greatest difference among females from South East Asian countries. The findings are consistent with studies conducted in South East Asian countries noting a high prevalence of myopia among children and adolescents in the literature (He, 2004; Lin, 1999; Powell, 2004; Yang et al., 2021), while contrasting with the low prevalence of hyperopia and astigmatism found in studies comparing different nationalities/ethnicities, where the lowest prevalence was found among students from South East Asian nationalities (Hashemi et al., 2017). This may suggest a higher prevalence of myopic self-reported vision correction needs among students in the UAE as it is consistent with the ethnic differences shown in the literature leading to higher prevalence of myopia and lower prevalence of hyperopia among adolescents in studies from South East Asian countries. The review by Yang et al. (2021) noted India to have the highest DALYs number due to a large population size, but

with standardization in relation to population size, it was found that the Middle Eastern region to have the highest disease burden over the past 30 years compared to other WHO regions. A limitation in the findings of this study is not including the Latin American nationalities that were noted in the literature to have a significant prevalence of myopia including studies from Mexico and Columbia (Teran et al., 2021; Galvis et al., 2017). This may be due to a low frequency of students presenting from a nationality in the Latin Americas, thus categorized into the "other/no nationality". Among students from South East Asian countries, adolescents having parents with higher educational levels resulting in aiming to strive further in an intense academic setting with increased near work and decreased outdoor activity may be positively associated with vision impairment due to refractive error especially in terms of myopia (Pan et al., 2012). It is unclear whether differences between our results and existing literature are due by ethnic predisposition to certain forms of VI-RE or sociocultural-dependent environmental factors resulting in increased prevalence of VI-RE.

Socioeconomic factors

Higher paternal educational levels ($p<0.001$) and maternal educational levels ($p<0.001$) were found to be significantly associated with higher self-reported vision correction needs. This was also consistent in the biological sex-based analysis for paternal educational levels (male: $p=0.008$, female: $p<0.001$) and maternal educational levels (male: $p=0.003$; female: $p<0.001$). In the total sample, among students who had both parents complete high school, more students reported needing vision correction than those whose parents did not complete high school, with a higher distribution among females. Consistent with previous preliminary literature search findings, higher levels of parental education have been reported to have a positive correlation with prevalence of VI-RE among children and adolescents (Chong et al., 2005; Sapkota et al.,

2008; Hashim et al., 2008; Rudnicka et al., 2008). The following findings may be attributed to the parental pressure of attaining a high educational level similar to that of the parents by focusing on improving their academic performance. This may be further emphasized in an urban learning environment where employment level may be majorly dependent on one's educational status, thus increasing academic near work and decreased outdoor activity, as described in the study based in Bhutan of adolescents aged 10-15 years (Sharma et al., 2020). In terms of biological sex differences, the current study finds more males reporting to pursue at least one outdoor activity (81.0%) than females (66.8%). A systematic review by Xiong et al. (2017) extends this finding suggesting that boys have more outdoor activities than girls. The parental pressure of pursuing academic work and decreased outdoor activity for females may be a potential factor in more females reporting vision correction needs than males of parents who have completed high school. Certain cultural differences may exist where parents believe that higher educational level is a means of attaining a successful career, thus guiding their children, in particular females, to also partake in more indoor academic work to pursue an equal or higher educational level to obtain a stable career suitable for females. This cultural outlook may also be a potential factor in adolescents, especially females, in reporting greater vision correction needs than males.

Paternal employment status ($p<0.001$) and maternal employment status ($p=0.024$) were found to be significantly associated with self-reported vision correction needs. This was also consistent in the biological sex-based analysis for paternal employment status (male: $p=0.109$, female: $p=0.001$) and maternal employment status for females ($p=0.026$). There was an approximate equal distribution among the four categories of employment (government, private, self-employed, not employed/retired) and the student's reported vision correction needs for

paternal employment status and maternal employment status, with a mild increased percentage for students whose parents who were private employees. There was a higher distribution among females than males with respect to both paternal and maternal employment status. The increased percentage among those whose parents were private employees appears consistent with the previous literature showcasing higher prevalence of myopia among adolescents of parents with professional occupations, suggesting employment status to be positively associated with prevalence of visual impairment (Xiang, He, & Morgan, 2012; Robaei et al., 2005). However, the overall similar distribution of self-reported vision correction needs between different types of employment categories potentially demonstrates a fairly uniform educational system and curriculum amongst public and private schools in the UAE. This rationale is seconded by the results from a cross-sectional study conducted in Ghana among schoolchildren aged 5-19 years that did not show SES (in the form of parental employment status) to influence the distribution of the types of refractive error (Ovenseri-Ogbomo & Omuemu, 2010). Both public and private schools in the UAE may require similar amount of academic near work from all students to successfully complete high school for all high school students.

Household financial status in terms of residential ownership ($p<0.001$) and household monthly income ($p=0003$) was found to be significantly associated with self-reported vision correction needs. This was also statistically significant in the biological sex-based analysis for residential ownership (male: $p=0.009$, female: $p<0.001$) and household monthly income for females ($p=0.017$). There was a higher percentage of students that reported needing vision correction whose parents did not own their home than of those who owned there home, with a higher distribution among females. On the contrary, more students reported needing vision correction with a household income of 15,000 AED or above than students with a household

income of less than 15,000 AED, with a higher distribution among females in both income categories. Therefore, higher SES in terms of household income, yet lower SES in the form of lack of property ownership was associated with increased self-reported vision correction needs. This finding coincides with the previous results of SES in the form of parental employment status which had a similar distribution of self-reported vision correction needs among all employment types. These findings are also consistent with those from the literature review, including the study based in Australia where children with parental home ownership were less likely to have visual impairment than those with parental home ownership (Robaei et al., 2005) and the studies based in Korea and Guangzhou, China with increased prevalence of myopia among children from higher family income (Lim et al., 2012; Xiang, He, & Morgan, 2012). Moreover, the current findings align with the review by Yang et al. (2021) that found the DALY rates, or global disease burden of uncorrected refractive error (URE) to be highest in high income regions.

Lifestyle and Behaviour

Screen time use (combined use of television and video/computer games) was found to be significantly associated with self-reported needs of vision correction (p=0.116), however was not found to be statistically significant in the biological sex-based analysis. There was an overall similar distribution of students reporting vision correction needs with the highest among those using moderate number of screen time hours (5-9 hours). Among females, use of mobile phones per day was found to be significantly associated with self-reported vision correction needs (p=0.007), with increased reports of vision correction needs with increasing number of hours using mobile phones. The similar distribution of prevalence of self-reported vision correction needs with minimally increasing trend with increasing number of hours may not be significantly

consistent with the preliminary literature, which shows a positive correlation between near work and vision impairment with respect to amblyopia and myopia especially among those from Asian countries (Buehren et al., 2003; Yasuda & Yamaguchi, 2005; Dolgin, 2015). However, these findings coincide with the literature review, where a study based in Riyadh, Saudi Arabia found no significant association between hours spent on homework and/or electronic devices and having a refractive error (Alomair et al., 2021). While use of mobile phones was found to be significant among females, the type of mobile phones around 2007-2009 that were commonly used among the adolescent population included basic functions such as calling, texting with limited space count, games, and limited storage for images. The introduction of iphone smartphone in 2007 was still new and highly priced to be easily attainable for the general population and in particular high school students. Therefore, use of the mobile phone during 2007-2009 with increasing report of self-reported vision correction needs with increasing use of mobile phone may not be solely associated with visual use of the phone as a near task.

Health and Function

Visiting an eye specialist in the past 12 months was found to be significantly associated with self-reported vision correction needs for the overall sample ($p<0.001$) and among males and females separately ($p<0.001$). A higher prevalence of self-reported vision correction needs was found among those visiting an eye specialist in the past year, with a higher distribution among females. This finding may be indicative that students visiting an eye specialist may be addressing their self-reported vision correction needs and potentially be finding solutions through spectacles, contact lenses or other means of treating their visual impairment. The increased distribution of females is in contrast with the study based in United States finding that among those with similar healthcare needs, women were found to have fewer physician visits than males

in the older population (Cameron et al., 2010). However, the results are consistent with the findings in the Portugal-based study where women above 18 years of age had higher health care use than men including specialist visits even when aligning for similar morbidity and socioeconomic differences. Further research assessing interactions between factors impacting accessing health care and biological sex to further understand potential biological sex-based differences among adolescents accessing vision care services in the UAE.

Among students reporting to need vision correction, there were more students reporting to not visit an eye specialist in the past year than visiting an eye specialist in all emirates, where the majority was found to be highest in the emirates of RAK, UAQ, Abu Dhabi, Fujairah, Sharjah, Ajman and Dubai. There was a higher percentage of these students reporting poor to fair daily functional capacity in handling daily academic tasks than those visiting an eye specialist in UAQ followed by Dubai, Sharjah, Abu Dhabi and Fujairah. While the findings from the literature review in this study have not assessed daily functional capacity as a health determinant, the results of this study coincide with the suggestions by WHO and the study by Rudnicka et al (2008) suggesting impaired vision to be affecting children's educational performance due to increased visual tasks with academic progression as well as sociodemographic differences potentially impacting their daily vision-dependent activities (World Health Organization, 2000; Rudnicka et al., 2008). As the emirates with a lower population demographic were shown to have relatively higher percentage of students not visiting an eye specialist in the past year who reported needing vision correction, and as a result noting a higher percentage of reporting poor to fair daily functional capacity than those visiting an eye specialist, further research on exploring the number of vision care services in these emirates, affordability and accessibility to access these services, and other potential barriers for these students to not visit an eye specialist need to

be explored to further understand the reasoning behind their relatively lower daily functional capacity.

5.3 Significant Determinants found in Multivariate analysis of self-reported health care needs in relation to vision correction

Demographic factors

Age

For males, students with increasing age were less likely to report needing vision correction (p=0.003). This finding presents the direction of association for males after controlling for confounding factors through a binary logistic regression. The findings suggest an older age group to have a lower likelihood of reporting to need vision correction than a younger age group within the adolescent years. While two previous studies in the literature review suggested increased hyperopic astigmatism and gradual increase in myopia with increasing age in both sexes, two studies also found decreased rate of hyperopia and slower rise in global DALY rates with increasing age (Ebri et al., 2019; Kandi et al., 2021; Galvis et al., 2017; Yang et al., 2021). Further research in incorporating the type of VI-RE using an ophthalmic examination along with self-reported vision correction needs may help better understand if there are differences in the prevalence of myopia, hyperopia, and astigmatism between males and females between younger and older adolescents and how many report needing vision correction. Assessing the trend found between the three group in both biological sexes may further showcase if males of a specific type of VI-RE are less likely to report needing vision correction with increasing age.

Nationality

Similar to the bivariate analysis, students reporting a nationality from South East Asia as a whole (p=0.002) and in particular among females (p=0.041), while males reporting to be from other GCC countries (p=0.023), were found to be more likely to report needing vision correction than those of UAE nationality. These findings are in contrast with the findings found by Hashemi et al. (2017) within the WHO regions assessing the visual status of children, showcasing a lower relative prevalence of myopia, hyperopia and astigmatism in South East Asia compared to other WHO regions. However, studies based in China and Taiwan for adolescents indicated a high distribution of myopia in East Asia (Powell, 2004). In comparison with the literature review, the findings from this study are similar to the review by Yang et al. (2021) that noted to present the highest disease burden for uncorrected refractive error among the East Mediterranean region compared to other WHO regions as seen in the male multivariate analysis, as well as a high prevalence of myopia among adolescents in urban areas of East Asian countries. A review conducted by Foster & Jiang (2014) to assess the global epidemiology of myopia found greater differences in the prevalence of myopia among older-aged children of varying ethnicities, where prevalence rates of myopia among students from East Asian and South East Asian countries were found to be generally higher than students from other countries, with a higher prevalence in urban areas than rural areas.

A potential factor in an increased odds ratio of students from South East Asian countries to report needing vision correction may be sociocultural expectations of students from these countries. Parents from South East Asian countries who immigrate to the UAE may fall under the higher educational level and employment level based on immigration requirements for applicants from these countries, and thus may reinforce the importance of excelling in education

to obtain a successful career to their children, resulting in the student using more screen time for academic purposes and reducing the time spend outdoors on recreational activity. Moreover, identifying parental vision correction needs may help identify potential genetic components to students of South East Asia presenting with more vision correction needs than students from the UAE. It may also add to the parental educational level, employment level (and type of employment based on indoor or outdoor work) and the student's vision correction needs.

Another potential factor to further assess based on the current findings is the accessibility of vision care services between students of the South East Asian nationality and students from the UAE. Parents immigrating from South East Asian countries to the UAE may be applying for employment positions varying from manual labour to occupations related to science, technology, education and finance, which may provide varying levels of health care benefits. As health care is covered for Emiratis, students noting a nationality of UAE may have a higher advantage in accessing the required vision care services. Further research in this area to identify the main areas of employment among South East Asians and the overall scope of health care benefits in those occupations may help distinguish ethnic/nationality-based differences in prevalence of vision correction needs and socioeconomic differences leading to unequal access to vision care. Identifying these components in addition to the findings of vision correction needs among adolescents of the South East Asian nationality may help assess the combination of genetic predisposition and environmental exposures that may be determinants of vision correction needs.

Location of residence (Emirate)

Students residing in Ajman as a whole ($p<0.001$) and among males, RAK as a whole ($p<0.001$) and among females, and Sharjah as a whole ($p=0.018$) and among females were less likely to report needing vision correction than those from Abu Dhabi. Students residing in

Fujairah as a whole ($p<0.001$) and among males ($p<0.001$) and females ($p<0.001$), Dubai ($p<0.001$) as a whole and among females ($p<0.001$), and UAQ as a whole ($p<0.001$) and among males ($p<0.001$) and females ($p<0.001$) were more likely to report needing vision correction than those from Abu Dhabi.

As the UAE population has increased primarily due to expatriate employment recruitment catering towards industrial occupations, there are more males than females in the general population (including nationals and non-nationals) with a 3:1 ratio, however with an approximate equal ratio of male to female UAE nationals (Blair & Sharif, 2012). The emirate of Abu Dhabi hosts the capital city of Abu Dhabi (SCAD Statistics, 2021). This emirate is also the largest emirate covering 87% of the country's total area and is the second largest populated emirate after Dubai. (Statistics Centre – Abu Dhabi, 2020). It is used as the primary reference against other emirates in this study. In comparison, Ajman is the known to be the smallest in size of the seven emirates, whereas RAK is known as the fourth largest Emirate, and Sharjah is the third largest emirate (About Ajman, 2022; RAK Centre for Statistics and Studies, 2019; About Sharjah, 2020). In comparison to the number of hospitals in Abu Dhabi indicated in Table 1, there are relatively a smaller number of public and private hospitals in Ajman, RAK, and Sharjah as of 2018 (Health Insurance and the Healthcare System in the UAE Explained, 2021). Given these statistics, all three emirates of Ajman, RAK, and Sharjah are smaller in size and provide less hospitals to access for vision care. The fact that Abu Dhabi has a higher population demographic, larger size, and more hospitals may result in a large sample size from this region, and higher number of hospitals with vision care leading to more screening of vision correction. However, it is unclear if the vision care services are easily accessible to the population of Emiratis vs non-Emiratis, and the urban and rural demographics of the students in this study.

Therefore, further research on potential factors resulting in students from these three emirates reporting less vision correction needs than those from Abu Dhabi.

Fujairah is the second smallest emirate found in the complete eastern coast bordering the neighbouring country of Oman, whereas Dubai is the second largest emirate, however with a high proportion of male adults (229 males per 100 females) partially due to the high number of expatriate workers unaccompanied by their families (About Fujairah, 2022; About Dubai, 2020). UAQ is the second smallest emirate with the lowest population (About UAQ, 2022). As both Fujairah and UAQ fall under the second smallest and smallest emirates respectively, it is helpful to further inquire on the relative vision care resources, socioeconomic levels of the students' households to assess accessibility to these vision care resources within the small population and area relative to Abu Dhabi and other large emirates to identify potential gaps in providing the required assistance to students needing vision correction in these areas. These findings also identify with the bivariate analysis where Fujairah and UAQ were noted to have the highest prevalence of students reporting to need vision correction, where these two emirates also had the lowest population size in the study sample. While Dubai is the second largest emirate (after Abu Dhabi) and the most populated emirate, the finding that students were more likely to report needing vision correction than those from Abu Dhabi may not be associated with size and population. As a significant association was found among females being more likely to report needing vision correction than females from Abu Dhabi, further research on biological sex-based gaps in females presenting with greater vision correction needs such as socioeconomic, cultural, academic factors potentially impacting their vision more than males, and biological sex-based differences in their ability to access required vision care needs.

Socioeconomic factors

Maternal education

Among females, students whose mothers completed high school were more likely to report needing vision correction than those whose mothers did not complete high school (p=0.042). These results are consistent with the preliminary literature findings of studies reporting a positive correlation between higher parental education and VI-RE among children and adolescents (Chong et al., 2005; Xian, He & Morgan, 2012; Hashim et al., 2008; Rudnicka et al., 2008). However, these studies did not showcase biological-sex based differences in VI-RE based on parental education or differences between maternal and paternal education. Female students with mothers who have completed high school may gain influence from their mothers to value higher education, and have their mothers assist them with academic work, thus dedicating time towards academic work than outdoor activities, compared to female students whose mothers did not complete high school. Biological sex-based analysis to assess the amount of near work, time spent outdoors and paternal education for males and maternal education for females respectively may help distinguish any biological sex-based differences in the students' time spent on academic work based on paternal and maternal education separately.

Lifestyle factors

Screen time use

Students who noted spending moderate number of hours of screen time in a day (5 to 9 hours) were more likely to report needing vision correction than those who reported spending minimal hours of screen time in a day (0 to 5 hours) (p=0.015). This finding is similar to the bivariate analysis where the highest distribution of vision correction needs was found among

students spending a moderate number of hours in screen time. While these results are in contrast to the study based in Riyadh, Saudi Arabia from the literature review that did not find a significant association between frequency and time spent on homework or electronic devices and having an RE (Alomair et al., 2021), they coincide with studies from the preliminary literature suggesting a positive association between near work and myopia, astigmatism, and higher prevalence of near work and VI-RE among children and adolescents from South Asian countries than those from UK and USA (Mutti et al., 2002; Buehren et al., 2003; Yasuda & Yamaguchi, 2005; Hashemi et al., 2017). However, screen time in this study is a combination of the number of hours for television and video/computer display games, therefore these findings cater to more recreational near work than the academic near work found in the preliminary literature and literature review. While the optical changes are the same for this form of near work, further quality improvement studies can be done at the school level to identify ways to have the students involved in more outdoor and/or recreational activities that are not near-task based, thus helping reduce the number of screen time spent on television and video/computer display games and help reduce the likelihood of these students to report needing vision correction.

Health and Function

Visiting an eye specialist and daily functional capacity

Similar to the bivariate analysis, students who responded visiting an eye specialist in the past 12 months were more likely to report not seeing well enough to read without the use of corrective lenses as a whole sample ($p<0.001$) and among males ($p<0.001$) and females ($p<0.001$) respectively. However, male students noting poor to fair ability to handle daily school/work responsibilities were less likely to report needing vision correction ($p=0.002$), contrary to the bivariate analysed that found more students needing vision correction to report

poor to fair academic performance than those with vision correction needs reporting good to excellent academic performance. While more students may be identifying their needs of vision correction by visiting an eye specialist in the past year, there is more research to be done to understand the potential reasoning behind male students with poor to fair ability to handle academic responsibilities to report less likelihood of vision correction needs.

5.4 Strengths, Limitations and Future Research

Strengths

This study is among the first to assess the self-reported vision correction needs among the adolescent population in the UAE, along with self-reported daily functional capacity and visiting an eye specialist in the past year among those needing vision correction and those not needing vision correction as a whole and biological-sex specific analysis. At a time when the DHA was not formed to further screen and assist those needing vision correction, these findings hold increased relevance in identifying the impact of lack of adequate screening measures in high schools in relation to vision correction requirements.

The dataset used included a wide range of components surveyed in the categories of demographic and socioeconomic data, medical conditions, smoking behaviours, physical activity, and lifestyle behaviours in the first component, followed by residential, financial and neighborhood information in the second component. The factors used in this study from the dataset demonstrated the prevalence of self-reported vision correction needs as well as a variety of socioeconomic, demographic, environmental, and behavioural variables, thus assisting in identifying potential limiting factors resulting in the participants reporting to need vision

correction. This has additionally helped in identifying if those reporting to need vision correction have accessed an eye specialist in the past year, and how their health care needs affected their daily functional capacity in comparison to those not reporting to need vision correction, which has also not been assessed in previous studies. As the original survey included a component filled by the student and a component filled by the parents, this allowed for autonomous responses by the participant themselves resulting in better understanding of their health care needs and lifestyle responses as opposed to the limiting studies using questionnaires responded by the parents and/or school representatives.

The findings in this study have been analyzed as a whole sample as well as categorized into biological sex-based analysis. This has helped provide a deeper understanding of the biological sex-based differences for the independent variables assessed such as socioeconomic, demographic, screen time use, lifestyle behaviours and functional capacity. In addition, this categorization has been analyzed between each emirate, which helps in assessing biological-sex based differences between each emirate to identify potential modifiable barriers for each biological sex that may be further assessed and mitigated at the school, in the vision care services in the region, and at residence for adolescents as a whole and specific to biological-sex.

Limitations

One of the limitations of this study is conducting a retrospective analysis of a dataset based on a cross-sectional survey conducted between 2007-2009. While the literature review included articles published in the past 10 years, the end year of the dataset used for this study surpasses the timeframe used for the literature review. The findings from this study reflect the prevalence and determinants of vision correction needs during those years, which can assist in comparing with further research on the current situation among adolescents in the UAE. With the

addition of DHA, economic changes and updates to the ability to access vision care, this comparison may help identify any remaining gaps that need to be addressed with action items to assist with the vision-related health of adolescents.

As the questionnaire conducted was using self-reported responses, there is risk of low response, subjective recall bias, and inability to verify their responses. The relatively higher levels of missing values noted in Table 5a for the parental education levels, parental employment status, household monthly income, location of residence (emirate) and residential ownership indicate gaps in completion of various socioeconomic household-based sections of the questionnaire by the participants that may be due to inability to recall the appropriate response or unwillingness to share the information. Moreover, participants may have recall bias as they may respond to what they believe is the accurate response or what they believe is expected of them to respond. For example, they may have subjective inaccurate recall of ability to see well enough to read without use of glasses, how many hours a day they view television, mobile phone, or video/computer games, pursuing at least one outdoor activity, visiting an eye specialist in the past year, and/or handling daily school/work responsibilities. As these are self-reported responses, one is not able to cross-verify the accuracy of the responses, and/or refer to medical charts indicating the diagnosis of VI-RE, thus needing glasses to read.

Another limitation of the study is that it's based on a cross-sectional survey. As the exposure and outcome are analyzed at the same time, the temporal association is not measurable. For example, the ability to see well enough to read without use of glasses is not followed through a period of time that explores changes in age, academic tasks, change in location of residence and other socioeconomic components, and updates to screening of vision health in schools, etc. Therefore, further research using a longitudinal study exploring such factors or a cross-sectional

study comparing the current associations between the analyzed factors and dependent outcome with the findings of this study.

The dependent variable in this study is asking the participant to self-report their ability to see well enough to read without the use of glasses. While this provides a direct indication of the participant's need for vision correction, it does not indicate if they have glasses or other forms of vision correction. Moreover, as other studies in the literature review measure the VI-RE through an ophthalmic examination to measure the type and level of RE such as myopia, hyperopia and astigmatism, this study does not include a measure of their RE to use as reference with their response. Thus, the findings in this study are not comparable with the previous studies reviewed using objective measures of VI-RE with categories in types of RE. Further research in obtaining data on needing vision correction and having glasses along with frequency of visiting an eye specialist to ensure validity of the glasses prescription examination will help provide a more thorough understanding of the participant's vision correction needs.

The location of residence for the participant is based on the emirate. While each emirate has a certain number of hospitals, it is unclear as to which hospitals have ophthalmic services and if they are public or private services for the participant. The number of non-hospital, independent eye clinics within each Emirate is also unknown as a statistic. In addition, while the emirate that the participant resides in is identified, the distance between the participant's residence to the vision care service is unknown and may differ between one participant to another within the same emirate, including their method of transportation to access the vision care services.

This cross-sectional study also contains potential confounding variables that may involve interference between independent variables thus creating a false interpretation between the

independent and dependent variable. Socioeconomic and demographic variables such as nationality, household income, parental education and employment level, and location of residence may impact the participant's ability to access vision care services based on where he/she resides, the financial capacity to utilize vision care services, and to purchase glasses. For example, conducting bivariate analysis between nationality and self-reported needs of vision correction may have additional determinants of socioeconomic status of the general population of the noted nationality in terms of financial status, education and employment, and/or the common location of residence of a particular nationality in the UAE thus indicating proximity to accessing vision care services. While a stratified randomized sampling strategy was originally used to mitigate confounding variables, this is a retrospective study with no other means to control the confounding variables at the analysis stage. Therefore, a binary logistic regression as an alternative to using a stratification method to control confounding variables.

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6.0 - Conclusions

VI-RE has been suggested to negatively affect academic performance, economic advantages, physical safety and overall quality of life, in particular among the adolescent age group where academic visual tasks increase with age, requiring early screening and assistance in accessing the vision correction resources in terms of vision care and corrective lenses, where detection and access may be influenced by environmental factors such as socioeconomic, demographic factors (Dandona & Dandona, 2001; Sherwin et al., 2011; Naidoo & Jaggernath, 2012). Previous literature pertaining to VI-RE have identified sociodemographic, environmental and behavioural determinants of visual impairment however with conflicting methods of defining VI-RE, income and education level, varying age groups that lack focus on the adolescent age group, and limited studies on self-reported health care needs which provide inconsistent evidence in identifying individuals in the adolescent group that need vision correction.

The UAE comprising of seven emirates has a population structure of 11% nationals (Emiratis) and the rest expatriates of different nationalities of various socioeconomic, academic, ethnic and cultural backgrounds that provide a diverse population to assess various health outcomes (United Arab Emirates National Bureau of Statistics, 2011; Dhabi, 2011). The disproportionate structure of the number of hospitals across the seven emirates, disparity in access and resulting utilization of health care between nationals and non-nationals, and vision screening formed only for private schools in Dubai and public schools in Abu Dhabi (based on 2007-2009 period) present potential sociodemographic, environmental and behavioural health determinants of vision correction needs among the adolescent population in the UAE.

This study aimed to review the prevalence of vision correction needs among adolescents on a global scale, assess the prevalence of self-reported vision correction needs among high school students in the UAE, assess significant determinants of self-reported vision correction needs and its affects on daily functional capacity, and compare the findings with the literature.

The literature review found prevalence of myopia reported in several national-based studies consistent with the prevalence of myopia at the global level, however with varying measures to assess VI-RE. Increased myopia was found with increased age, higher prevalence among females, higher SES. Pursuing outdoor activity was seen as prophylactic measures of progression of myopia, however near work was not found to be significantly associated with VI-RE contrary to the preliminary literature search. Limitations in the review include a wide range of age groups that included the adolescent population, studies that were school-based and population-based, varying measures to assess VI-RE, urban vs rural settings, limited studies surveying self-reported vision correction needs and only one publication regarding RE among schoolchildren in the UAE. Moreover, there were limited studies assessing the potential risk factors of VI-RE among adolescents self-reporting vision correction needs.

The current study conducted retrospective quantitative data analysis to assess the prevalence and self-reported health care needs and its determinants for a sample of adolescents (n=6363) from the United Arab Emirates, aged 13 to 20 years between 2007-2009.

Prevalence of self-reported vision correction needs was found to be lower than the global prevalence of VI-RE, however similar and above some of the findings in the literature review. Lack of adequate vision-screening programs in place at the time, which are in place today such as the DHA, HAAD, along with a majority of the sample noting to fall under the low-income category and not visiting an eye specialist in the past year, and reduced outdoor activity may play

a role in the prevalence of students reporting to need vision correction. Further research on comparing the current prevalence and determinants among the same age group in the UAE with the addition of these screening services may help identify remaining modifiable barriers in providing the required vision care for those reporting to need vision correction.

Increasing age was found to be significantly associated with higher self-reported vision correction needs, consistent with the literature review, potentially due to increased academic demands and screen work with age in particular in the urban setting among the expatriates. However, upon controlling confounding factors, male students were less likely to report needing vision correction with increasing age. Further research in assessing the type of VI-RE through an ophthalmic examination with self-reported vision correction needs may help identify more specific trends of VI-RE based on myopia, hyperopia, and astigmatism between both biological-sexes.

Biological sex was found to be significantly associated with self-reported vision correction needs with higher prevalence among females, consistent with the literature review. Further research assessing parental VI-RE may help identify potential genetic predispositions, identifying biological-sex based differences in SES, screen-time use and accessing vision care services among those needing vision correction may help identify potential biological-sex based determinants of vision correction needs.

There was a strong association between location of residence (emirate) and self-reported needs of vision correction as a whole sample and in the biological sex-based analysis, which was sustained in the multivariate analysis. Highest prevalence was found in Fujairah and UAQ hosting limited access to hospitals, primary health clinics providing vision care, relatively lower population size and infrastructure, which may provide students living in Fujairah and UAQ may

be at a disadvantage in timely vision screening than those living in other emirates. Further research is needed on biological-sex based analysis to identify the potential reasoning of females in these emirates presenting with greater vision correction needs such as socioeconomic, cultural, academic factors potentially impacting their vision more than males.

Nationality was found to be significantly associated with self-reported vision correction needs as a whole and in the biological sex-based analysis, sustaining in the multivariate analysis. Students, and in particular female students, from South East Asia were found to have to highest prevalence of vision correction, consistent with the literature review. Identifying any ethnic predispositions to VI-RE, sociocultural dependent environmental factors in addition to the self-reported findings of vision correction needs among adolescents of the South East Asian nationality may help assess the combination of these components that may be determinants of vision correction needs.

Higher parental educational levels, similar distribution of type of employment status, lack of residential ownership and high-income household monthly income were found to be significantly associated with higher self-reported vision correction needs as a whole in the biological-sex based analysis with a higher distribution among females, consistent with the literature findings. Multivariate analysis found higher maternal educational levels among female students with higher self-reported vision correction needs. To identify the influence of paternal and maternal education on males and females separately, biological sex-based analysis to assess the amount of time spent on near work and outdoor activity, and paternal education for males and maternal education for females respectively may help distinguish any biological sex-based differences the students vision correction needs.

Screen time use of moderate number of hours (5 to 9 hours) was found to be significantly associated with higher self-reported vision correction needs than other levels of hours, sustaining in the multivariate analysis and coinciding with the literature. As screen time in this study is a combination of the number of hours for television and video/computer display games, further quality improvement studies at the school level to create more opportunities for outdoor recreational activities may help reduce the number of screen time spent on television and video/computer display games and help reduce the likelihood of these students to report needing vision correction.

Visiting an eye specialist in the past 12 months was found to be significantly associated with self-reported vision correction needs for the overall sample and in the biological sex-based analysis, also found to be significant in the multivariate analysis with a higher distribution among females. Further research is needed to understand potential biological sex-based differences among adolescents accessing vision care services in the UAE. However, among those needing vision correction, majority did not visit an eye specialist in the past 12 months across all emirates with the highest in RAK and UAQ, which resulted in more students reporting poor to fair daily functional capacity than those who visited an eye specialist especially in UAQ. This finding is consistent with the global preliminary literature suggesting vision impairment to negatively affect children's educational performance especially in increasingly demanding visual tasks. Further research on exploring the number of vision care services in these emirates, affordability and accessibility to access these services, and other potential barriers for these students to not visit an eye specialist need to be explored to further understand the reasoning behind their relatively lower daily functional capacity.

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Appendix A - Questionnaire – First Component

In this section, we would like to ask you a few questions about your lifestyle activities. Please put a check mark beside the response that most accurately reflects your answer to each question and fill in the blanks when applicable.

1. Did you ever smoke cigarettes or any form of tobacco such as shisha or midwakh?
   - ☐ Yes
   - ☐ No; **IF 'NO', GOT TO QUESTION 5.**
   - ☐ Do not know

2. During the past 30 days, how often did you smoke cigarettes?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

3. During the past 30 days, on how many days did you use midwakh?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

5. During the past 30 days, on how many days did you use any form of tobacco products (other than cigarettes, shisha or midwakh), for example: cigars, pipe, little cigars, chewing tobacco, snuff, dip?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

6. How old were you when you first used any form of tobacco?
   _____age in years

7. How often are you exposed to tobacco smoke at home or with friends?
   - ☐Daily
   - ☐Occasionally
   - ☐Not at all; **PLEASE GO TO QUESTION 9.**
   - ☐Do not know; **PLEASE GO TO QUESTION 9.**

8. How old were you when you first started being regularly (at least twice a week, every week of the year) exposed to tobacco smoke at home or with friends?
   _____age in years

9. During your life, have you ever used illegal drugs such as marijuana (hashish) or cocaine?
   - ☐Yes
   - ☐No
   - ☐Do not know

4. During the past 30 days, on how many days did you use shisha?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

10. During your life, have you ever purposely smelled gasoline fumes, glue, correctors, car exhaust, or burning black ants?
    - ☐Yes
    - ☐No
    - ☐Do not know

Next, we would like to ask you a few questions about your day to day activities. Please put a check mark beside the response that most accurately reflects your answer to each question and fill in the blanks when applicable.

11. During the past 30 days, how often did you wash your hands with soap before eating?
    - ☐ Always
    - ☐ Most of the time
    - ☐ Sometimes
    - ☐ Rarely
    - ☐ Never

12. On average, how many days do you eat fish or seafood per month? Please circle the number of days.

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29

16. How often do you use any of the following when you spend time outdoors?

Sunscreen	☐ Always ☐ Sometimes ☐ Rarely ☐ Never
Sunglasses	☐ Always ☐ Sometimes ☐ Rarely ☐ Never
Shade or umbrella	☐ Always ☐ Sometimes ☐ Rarely ☐ Never
Hat	☐ Always ☐ Sometimes ☐ Rarely ☐ Never

17. Which of the following practices do you do in order to maintain your health? **You can select more than one from the list below.**
    - ☐ I eat good food
    - ☐ I do physical exercise
    - ☐ I care for my personal hygiene
    - ☐ I sleep sufficiently
    - ☐ I take iron tablets
    - ☐ I take care of my psychological health
    - ☐ I avoid smoking

13. Do you eat a specific type of fish on a regular basis?
☐Yes; **Specify TYPE OF FISH _____**
☐No
☐Do not know

14. In the past 12 months, have you experienced painful sunburn on any part of your body?
☐Yes
☐No
☐Do not know

15. If you use sunscreen products, is the SPF value greater or equal to 15?
☐Yes
☐No
☐Do not know

☐ I take vitamins
☐ I avoid drugs
☐ I use medicine
☐ I consult a doctor
☐ I avoid alcohol
☐ I have good eating and drinking habits
☐ Other (specify) _____
☐ I do nothing

18. Please fill the table below by moving across each row:

i) Do you have any of the following?			**ii) In a typical or usual day, how many hours do you use it?**		
a. Mobile phone	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more
b. Cordless phone	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more
c. Wireless local area networks	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more
d. Bluetooth	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more
e. Television	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more
f. Computer(s) / Video display games	☐ YES	☐ NO	☐ Less than 1	☐1 to 4	☐5 or more

19. Which of the following physical activities have you practiced **in the past year** during your leisure time?

Type of activity	On average, how many hours per week did you practice this activity?	For how many weeks did this program run?	Was the activity held indoors or outdoors?
☐ walking for exercise	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ swimming	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ bicycling	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ popular or social dance	_____ hours / week	_____	☐ Indoors ☐ Outdoors

☐ home exercises	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ skating or rollerblading	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ jogging or running	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ golfing	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ exercise class or aerobics	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ bowling	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ tennis	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ weight-training	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ fishing	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ volleyball	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ basketball	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ soccer	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ Other, please specify	_____ hours / week	_____	☐ Indoors ☐ Outdoors

The following section asks you some general questions about your health. Please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

20. Do you take any over-the-counter medication on a regular basis (such as Panadol, Tylenol, Advil etc..)?
    - ☐ Yes; **SPECIFY MEDICATION USED** _____
    - ☐ No
    - ☐ Do not know

21. Are you <u>usually</u> able to see well enough or read your books <u>without</u> glasses or contact lenses?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

22. Are you <u>usually</u> able to hear what is said in a group conversation with at least three other people <u>without</u> a hearing aid?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

23. Are you <u>usually</u> able to hear what is said in a conversation with one other person in a quiet room <u>without</u> a hearing aid?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

24. During the past year, on how many occasions did you have severe stomach pain that could have resulted from an upset stomach or food poisoning? Please circle the appropriate answer.

0	1	2	3	4	5	6	7	8	9	10	> 10

25. During the past 30 days, how many days did you miss classes or school **due to a particular health problem?**

0	1	2	3	4	5	6	7	8	9	10	> 10

26. During the past 30 days, how many days did you miss classes or school **due to injury**?

0	1	2	3	4	5	6	7	8	9	10	> 10

27. How many school days did you miss in the previous academic year?
- ☐ 0 days
- ☐ 1 or 2 days
- ☐ 3 to 5 days
- ☐ 6 to 9 days
- ☐ 10 or more days

28. How would you rate your ability to handle the day-to-day demands in your life, like work or school or family responsibilities?
- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ Do not know

30. Please indicate by circling the appropriate box, the feelings you have now taking into account what has happened in the last 5 years and what you expect in the near future.

a) How do you feel about your school results?

I feel:

7	6	5	4	3	2	1
Delighted	Pleased	Mostly Satisfied	Mixed (About equally Satisfied and Dissatisfied)	Mostly dissatisfied	Unhappy	Terrible

b) How do you feel about your life in general?

I feel:

7	6	5	4	3	2	1
Delighted	Pleased	Mostly Satisfied	Mixed (About equally Satisfied and Dissatisfied)	Mostly dissatisfied	Unhappy	Terrible

31. Were you ever told by a doctor or health professional that you have any of the following conditions? **PLEASE CHECK ALL THAT APPLY.**
- ☐ Chronic Bronchitis
- ☐ Emphysema
- ☐ Asthma
- ☐ Other chest conditions**;**
  SPECIFY_____
- ☐ Any long-term skin conditions
  SPECIFY_____
- ☐ Hay fever / other allergies
  SPECIFY_____
- ☐ Arthritis / rheumatism
- ☐ Any respiratory problems
  SPECIFY_____
- ☐ High blood pressure / hypertension
- ☐ Heart disease
  SPECIFY_____
- ☐ Thalassemia;

29. How would you rate your ability to handle unexpected or difficult problems, like a family or personal crisis?
    - ☐ Excellent
    - ☐ Very good
    - ☐ Good
    - ☐ Fair
    - ☐ Poor
    - ☐ Do not know

32. If you select any condition from above, please specify any type of medication prescribed:
    _____

33. Do you or any direct family member (parent or sibling) suffer from any of the following conditions?
    - ☐ Headaches
    - ☐ Fatigue
    - ☐ Unexplained pain
    - ☐ Blurring vision
    - ☐ Dizziness
    - ☐ Memory loss
    - ☐ Learning and/or reading disability

34. In the past 12 months, have you seen or talked on the phone about your health with any of the following**?** **PLEASE CHECK ALL THAT APPLY.**
    - ☐ Family doctor or general practitioner (GP)
    - ☐ Eye specialist (ophthalmologist or optometrist)
    - ☐ Other medical doctors (surgeon, allergist, psychiatric)
    - ☐ A nurse for care or advise / Pharmacist
    - ☐ Dentist or orthodontist
    - ☐ Chiropractor / physiotherapist
    - ☐ Social worker / counsellor / psychologist
    - ☐ Nutritionist

35. Where do you often go when you need health care?
    - ☐ Private clinic / hospital
    - ☐ Public clinic / hospital

SPECIFY_____

- ☐ Sickle Cell Anemia
- ☐ Any type of Anemia
  SPECIFY_____

- ☐ Diabetes**;**
  SPECIFY_____

- ☐ Kidney Problem;
  SPECIFY_____

- ☐ Ulcer**;** **SPECIFY**_____
- ☐ Any type of cancer**;**
  SPECIFY_____

- ☐ Migraine Headache
- ☐ Thyroid condition**;**
  SPECIFY_____

- ☐ Any food allergies**;** **SPECIFY**_____
- ☐ Other major health diagnosis**;**
  SPECIFY_____

37. Thinking of the most recent time, why didn't you get care?
    - ☐ None available in the area
    - ☐ Not available at the time required
    - ☐ Waiting time too long
    - ☐ Cost
    - ☐ Too busy
    - ☐ Didn't know where to go
    - ☐ Transportation problem
    - ☐ Language problems
    - ☐ Dislike/afraid of Doctors
    - ☐ Other; **PLEASE SPECIFY** _____

38. In the past two years, have you had a routine physical check up without having a specific problem?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

39. Have you ever traveled for medication to other countries?
    - ☐ Yes; **if 'yes' please fill in the table below**
    - ☐ No

Country	Medical Condition

☐ School clinic
☐ Telephone consultation only
☐ Internet
☐ Other; **PLEASE SPECIFY** _____

36. During the past 12 months, was there ever time when you felt that you needed health care but did not receive it?
☐ Yes
☐ No; **IF 'NO', PLEASE GOT TO QUESTION 38.**
☐ Do not know

42. Have you <u>ever</u> had wheezing or whistling in the chest at any time in the past?
☐ Yes
☐ No; **IF 'NO' SKIP TO QUESTION 47.**

43. Have you had wheezing or whistling in the chest <u>in the last 12 months?</u>
☐ Yes
☐ No; **IF 'NO' SKIP TO QUESTION 47.**

44. How many attacks of wheezing have you had <u>in the last 12 months?</u>
☐ 1 to 3
☐ 4 to 12
☐ More than 12

45. In the last 12 months, how often, on average, has your sleep been disturbed due to wheezing?
☐ Never woken with wheezing
☐ Less than one night per week
☐ One or more nights per week

40. Have you ever had an in-patient surgical operation?
☐ Yes; **if 'yes' please fill in the table below**
☐ No

Country	Hospital	Medical Condition

The following section contains questions about your respiratory health. <u>All questions are about problems that occur when you *DO NOT* have a cold or the flu.</u>

41. Have you recently spent any nights as an in-patient in a hospital for asthma or any respiratory health illness?
☐ Yes
☐ No
☐ Do not know

52. <u>In the past 12 months</u>, has this nose problem been accompanied by itchy-watery eyes?
☐ Yes
☐ No

53. In which of the <u>past 12 months</u> did this nose problem occur? (Please tick any which apply).

January	☐	May	☐	September	☐
February	☐	June	☐	October	☐
March	☐	July	☐	November	☐
April	☐	August	☐	December	☐

46. In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words at a time between breaths?
    - ☐ Yes
    - ☐ No

47. Have you ever had asthma?
    - ☐ Yes
    - ☐ No

48. In the last 12 months, has your chest sounded wheezy during or after exercise?
    - ☐ Yes
    - ☐ No

49. In the last 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection?
    - ☐ Yes
    - ☐ No

50. Have you ever had a problem with sneezing, or a runny, or blocked nose when you DID NOT have a cold or the flu?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 55.**

51. In the past 12 months, have you had a problem with sneezing, or a runny, or blocked nose when you DID NOT have a cold or the flu?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 55.**

Now some questions about injuries which occurred in the past 12 months, and were serious enough to limit your normal activities. For examples: multiple injuries, broken or fractured bones, burn, dislocation, sprain or strain, cut or scrape, bruise or abrasion, concussion, poisoning, or internal injury.

60. In the past 12 months, did you have any injuries that were serious enough to limit your normal activities?
    - ☐ Yes; **PLEASE SPECIFY TYPE _____**
    - ☐ No; **PLEASE GO TO QUESTION 63.**
    - ☐ Do not know

61. Where did your most recent injury happen?
    - ☐ In a home or surrounding area
    - ☐ Recreation or sport place
    - ☐ Street or highway

54. In the past 12 months, how much did this nose problem interfere with your daily activities?
    - ☐ Not at all
    - ☐ A little
    - ☐ A moderate amount
    - ☐ A lot

55. Have you ever had an itchy rash which was coming and going for at least six month?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 60.**

56. Have you had this itchy rash at any time in the last 12 months?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 60.**

57. Has this itchy rash at any time affected any of the following places: the folds of the elbow, behind the knees, in front the ankles, under the buttocks, or around the neck, ears, or eyes?
    - ☐ Yes
    - ☐ No

58. Has this rash cleared completely at any time during the last 12 months?
    - ☐ Yes
    - ☐ No

59. In the last 12 months, how often, on average, have you been kept awake at night by this itchy rash?
    - ☐ Never in the last 12 months
    - ☐ Less than one night per week
    - ☐ One or more nights per week

65. As a driver or passenger, how often does the vehicle you are in exceed the posted speed limit?
    - ☐ Always
    - ☐ Most of the time

- ☐ Building used by general public (hotel, mall, restaurant)
- ☐ School
- ☐ Other; **PLEASE SPECIFY _____**

62. What were the main causes of injuries occurred to you during the past 12 months? **PLEASE SELECT ALL THAT APPLY.**
    - ☐ Motor Vehicle accident
    - ☐ Accidental fall
    - ☐ Fire, flame and resulting fumes
    - ☐ Accidentally struck by an object or person
    - ☐ Accidental injury caused by natural or environmental factors (weather conditions, animal bites, stings)
    - ☐ Accidental suffocation
    - ☐ Accidental near drowning
    - ☐ Caused by machinery
    - ☐ Caused by cutting or piercing instruments (knife, stapler etc.)
    - ☐ Accidental poisoning
    - ☐ Other; **PLEASE SPECIFY _____**

63. In the past 12 months, have you been a passenger with a driver who had an accident?
    - ☐ Yes **If 'Yes', were you wearing a seatbelt?** ☐ Yes ☐ No
    - ☐ No
    - ☐ Do not know

64. In the past 12 months, have you had an accident while driving a motor vehicle?
    - ☐ Yes **If 'Yes', were you wearing a seatbelt?** ☐ Yes ☐ No
    - ☐ No
    - ☐ Do not know
    - ☐ Sometimes
    - ☐ Rarely or never

66. As a driver or passenger, how often do you ensure that all passengers in the car have their seatbelts fastened and that young children are in car seats?
    - ☐ Always
    - ☐ Most of the time
    - ☐ Sometimes
    - ☐ Rarely or never

Next, we would like to ask a few questions about you.

67. In what year where you born? _____

68. What is your sex:
    - ☐ Male
    - ☐ Female

69. How tall are you without shoes on?
    _____ m □ / cm □ / ft □ / in □

70. How much do you weigh? _____kg □ / lb □

71. What is your parents' marital status?
    - ☐ Married
    - ☐ Widowed
    - ☐ Separated / Divorced
    - ☐ Other

72. Does your family have at least one housekeeper (maid or servant)?
    - ☐ Yes **IF YES, HOW MANY? _____**
    - ☐ No
    - ☐ Do not know

73. From the list below, select the duties that your housekeeper(s) is / are responsible for. **PLEASE SELECT ALL THAT APPLY**
    - ☐ Cleaning
    - ☐ Cooking
    - ☐ Washing dishes
    - ☐ Laundry
    - ☐ Preparing meals
    - ☐ Grocery shopping
    - ☐ House shopping
    - ☐ Helps with school homework
    - ☐ Other; **PLEASE LIST _____**

74. What is your nationality?
    - ☐ UAE
    - ☐ Other GCC countries (Kuwait, KSA, Oman, Qatar, Bahrain, and Yemen)
    - ☐ Lebanon, Syria, Jordan, Palestine, and Iraq
    - ☐ North Africa (Egypt, Tunisia, Morocco, Algeria, Libya, and Mauritania
    - ☐ South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia
    - ☐ Europe, USA, and Australia
    - ☐ Other country; **PLEASE SPECIFY** _____

75. What is the primary language spoken in your home?
    - ☐ Arabic
    - ☐ English
    - ☐ Indian
    - ☐ Persian
    - ☐ Other; **PLEASE SPECIFY _____**

76. Were you born in the UAE?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

77. How many of each do you have in your home?

PLEASE CIRCLE THE APPROPRIATE ANSWER.

Bedrooms	0 1 2 3 4 5 6 7 8 9 10+
Washrooms	0 1 2 3 4 5 6 7 8 9 10+
Cars	0 1 2 3 4 5 6 7 8 9 10+
Televisions	0 1 2 3 4 5 6 7 8 9 10+
Computers	0 1 2 3 4 5 6 7 8 9 10+
Bicycles	0 1 2 3 4 5 6 7 8 9 10+

The following section is optional. We will be requesting contact information for yourself. This information may be used in the future for follow-up studies. Choosing to provide your contact information does not necessarily include you in follow-up studies. You will have the option to refuse or accept participation at that point.

Please enter any or all of the information below.

Mobile number: _____

House number: _____

e-mail address: _____

Thank You for Taking the Time to

Complete this Survey!

ID Number _____

Appendix B – Questionnaire (Second Component)

First, we would like to ask you a few questions about the neighborhood and the residence that you live in.

For each question, please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

1. How long have you lived at your current address? Number of years_____

2. Please enter your current address: Emirate _____ Area _____

3. Does your family own □ or rent □ this property

4. How many people live in your household including yourself, relatives, and staff? _____

5. What is the approximate age of this property: _____ years

6. Please fill in the table below by moving across each row:

Do you have any of the following?	**How often do you use it?**
6a) Air conditioner ❑ Yes ❑ No	☐ always in hot weather ☐ almost always ☐ sometimes ☐ never
6b) Air filter / purifier / cleaner ❑ Yes ❑ No	☐ always ☐ almost always ☐ sometimes ☐ never

7. Which best describes the type of air conditioning in this property?
   - ☐ Separate units
   - ☐ central
   - ☐ other; **PLEASE SPECIFY** _____

10. Which best describes your family's most frequently used cooking method? Please check all that apply.
    - ☐ Electricity
    - ☐ Gas
    - ☐ Microwave
    - ☐ Other; **PLEASE SPECIFY**_____
    - ☐ Do not know

11. Which best describes the source of tap water where you live? Please check all that apply.
    - ☐ Tanker-truck, vendor
    - ☐ Piped into your house by the municipality (DEWA, ADWEA etc.)
    - ☐ Water well
    - ☐ Other; **PLEASE SPECIFY**_____
    - ☐ Do not know

12. Which best describes the source of drinking water where you live?
    - ☐ Bottled water; **PLEASE SPECIFY THE BRAND CONSUMED**_____
    - ☐ Tap water
    - ☐ Boiled tap water
    - ☐ Other; **PLEASE SPECIFY**_____
    - ☐ Do not know

13. Do you currently have any pets living in your home?
    - ☐ Yes**; PLEASE SPECIFY**_____
    - ☐ No

14. Do you live in a house that was recently (in the last 12 months) renovated or repaired?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

8. If applicable, how often is your home maintained in terms of cooling equipments, air filtration and/ or air duct cleaning?
   - ☐ Yearly
   - ☐ As needed
   - ☐ Rarely
   - ☐ Do not Know

9. What types of flooring are in the main living areas (TV room, living room, bedrooms) of your house/apartment?
   - ☐ Wall-to-wall carpet; **ENTER AGE:_____years**
   - ☐ Ceramic tiles
   - ☐ Wooden floors
   - ☐ Heavy rugs
   - ☐ Other; **PLEASE SPECIFY_____**

17. Do you feel that the temperature in your home is comfortable?
   - ☐ Yes always
   - ☐ Most of the time
   - ☐ No; **SPECIFY if temperature is: Too Hot ☐ OR Too Cold ☐**
   - ☐ Do not know

18. Do you feel that your home is too humid? **Answer 'Yes' if you see moisture on windows, walls or ceilings.**
   - ☐ Yes
   - ☐ No
   - ☐ Do not know

19. Are pesticides or insecticides <u>ever</u> used in your home, garden, or on your pet (s)?
   - ☐ Yes
   - ☐ Sometimes
   - ☐ No
   - ☐ Do not know

20. Do you or anyone in your household do arts, crafts, ceramics, stained glass work or similar hobbies <u>on a regular basis</u>?
   - ☐Yes
   - ☐No
   - ☐Do not know

21. Does your home have any pests (e.g. cockroaches, rodents)?
   - ☐Yes
   - ☐Sometimes
   - ☐No
   - ☐Do not know

15. During the last 12 months, were any areas inside your home painted, such as wall, trims or ceiling?
   - ☐ Yes
   - ☐ No
   - ☐ Do not know

16. Are there any rooms in your home where you can see paint that is peeling, flaking or chipping off the walls, ceilings, doors or windows?
   - ☐ Yes
   - ☐ No
   - ☐ Do not know

22. Do you currently live near an industrial plant, gas station, dump site, or major construction area?
   - ☐ Yes
   - ☐ No
   - ☐ Do not know

23. Do you currently live close to overhead power lines and /or plants (hydroelectric power plant, radio stations, etc.)?
   - ☐ Yes
   - ☐ No; **IF 'NO', GO TO QUESTION 25.**
   - ☐ Do not know

24. Which of the following is the best estimate of the walking distance to the overhead power lines or plants?
   - ☐ Less than 5 minutes
   - ☐ Between 5 and 15 minutes
   - ☐ More than 15 minutes

25. How concerned are you about air pollution in your neighborhood?
   - ☐ Extremely concerned
   - ☐ Moderately concerned
   - ☐ Slightly concerned
   - ☐ Not at all concerned

26. Do you have a previous place of residence?
    - ☐ Yes
    - ☐ No**; IF 'NO', SKIP TO QUESTION 28.**

27. Please describe your previous places of residence. Residence A represents the most recent residence before your current residence.

	Residence A	Residence B	Residence C	Residence D
a) Duration of residence From	_____ Enter Year	_____ Enter Year	_____ Enter Year	_____ Enter Year
To	_____ Enter Year	_____ Enter Year	_____ Enter Year	_____ Enter Year
b) Location City	_____	_____	_____	_____
Country	_____	_____	_____	_____

c) How many people lived in this household including yourself?	_____	_____	_____	_____
d) How many bedrooms did this property have?	_____	_____	_____	_____
e) What was the approximate age of the property at the time of residence?	_____years	_____years	_____years	_____years

28. What is your father's highest level of education?
    - ☐ Did not attend school
    - ☐ Completed primary school
    - ☐ Some intermediate school
    - ☐ Completed intermediate school
    - ☐ Some secondary school
    - ☐ Completed secondary school
    - ☐ Some community college, technical school, or university
    - ☐ Completed college or university
    - ☐ Completed post graduate training
    - ☐ Do not know

29. What is your mother's highest level of education?
    - ☐ Did not attend school
    - ☐ Completed primary school
    - ☐ Some intermediate school
    - ☐ Completed intermediate school
    - ☐ Some secondary school
    - ☐ Completed secondary school
    - ☐ Some community college, technical school, or university
    - ☐ Completed college or university
    - ☐ Completed post graduate training
    - ☐ Do not know

30. Which best describes your father's employment?
    - ☐ Government employee
    - ☐ Private employee
    - ☐ Self-employed
    - ☐ Not employed

31. Which best describes your mother's employment?
    - ☐ Government employee
    - ☐ Private employee
    - ☐ Self-employed
    - ☐ Not employed

32. Could you please tell me how much income all members of your household receive <u>every month</u>? Be sure to include FROM ALL SOURCES such as savings, pensions, rent, and unemployment insurance as well as wages.
    - ☐ Less than 2000
    - ☐ Between 2000- 5000 DHS
    - ☐ More than 5000 - 8000 DHS
    - ☐ More than 8000 and 10,000 DHS
    - ☐ More than 10,000 and 12,000 DHS
    - ☐ More than 12,000 and 15,000 DHS
    - ☐ More tan 15,000 and 20,000 DHS

<u>Finally</u>, in the next three pages, we will ask you questions about the health of your biological parents and siblings. For each question, please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

- ☐ more than 20,000 DHS
- ☐ Do not know

33. Please provide information on **ALL** your family members.

Family member	Age	Sex	Status	Reason
Father		Male	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Mother		Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 1		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 2		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 3		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 4		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 5		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 6		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 7		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 8		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 9		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 10		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	

34. Were either of your natural parents or siblings ever been told by a doctor / health professional that they had the following conditions?(DNK= Do not know)

Medical Condition	Mother	Father	Sibling 1	Sibling 2	Sibling 3	Sibling 4	Sibling 5	Sibling 6	Sibling 7	Sibling 8	Sibling 9	Sibling 10
i)Chronic Bronchitis?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
ii) Emphysema?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
iii) Asthma?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
iv) Lung cancer?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
v) Other chest	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
vi) Any long-term skin conditions?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
vii) Arthritis /	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
viii) Any respiratory	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
ix) High blood	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
x) Heart disease?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK

xi) Thalassemia?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
Medical Condition	Mother	Father	Sibling A	Sibling B	Sibling C	Sibling D	Sibling E	Sibling F	Sibling G	Sibling H	Sibling I	Sibling J
xii) Sickle cell	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xiii) Diabetes?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xiv) Any type of	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xv) Any type of	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xvi)Thyroid condition	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xvii) Any food allergies	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xviii) Kidney	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xix) Ulcer?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xx) Autism	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xxi) Developmental Delay	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xxii) Any hearing problem	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK

xxiii) Other major health diagnosis? **If yes, SPECIFY**	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____

The following section is optional. We will be requesting contact information for yourself. This information may be used in the future for follow-up studies. Choosing to provide your contact information does not necessarily include you in follow-up studies. You will have the option to refuse or accept participation at that point.

Please enter any or all of the information below.

Mobile number: _____

House number: _____

e-mail address: _____

Parental contact name: _____

Relationship to student: _____

Thank You for Taking the Time to Complete this Survey!