

**CONTRIBUTION OF REFRACTIVE ERRORS TO VISION IMPAIRMENT
IN THE ASHANTI REGION, GHANA**

BY

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Declaration

I Clement Afari declare that this thesis is my original work and it has not been tendered in for the award of any Diploma or Degree from any academic institution.

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Abstract

Purpose: To determine the prevalence and causes of vision impairment with particular emphasis on uncorrected refractive error (URE) in Ashanti region, Ghana. A baseline vision impairment study in the Ashanti region is necessary to effectively plan for refractive services and blindness prevention strategies.

Methods: A cross-sectional multistage cluster sampling was conducted in 24 communities in Ashanti region, Ghana. A total of 1420 participants aged 18 years and above were enumerated using a modified Rapid Assessment of Vision impairment (RAVI) protocol. This was limited to unaided visual acuity (VA) using a Snellen chart at a distance of 6 meters, near binocular visual acuity and direct ophthalmoscopy for all participants after obtaining an informed consent. The VA was repeated using a pinhole for participants with $VA \leq 6/12$. A non-cycloplegic refraction was done for those whose pinhole VA improved. Near vision refraction was also assessed for each participant whose near vision was less than N8. Simple proportions were used to compute the prevalence of vision impairment and refractive error in the studied population. The results were analyzed using STATA 11.

Results: One thousand three hundred (1300) of those enumerated (1420), participated in the study, a response rate of 91.5%. The mean age of the participants was 46.29 (CI 95% 45.29-47.29). The minimum age was 18 years and the maximum 99 years. Prevalence of vision impairment was 16.15% (n= 210, 95% CI, 14.15 – 18.16). Refractive error was the leading cause of vision impairment with 47.14% (n = 99, 95% CI of 40.33 - 53.9)

Conclusion: Refractive error was the main cause of visual loss in Ashanti region, Ghana.

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CHAPTER ONE - Introduction

1.1 Introduction

The World Health Organization (WHO) estimates that approximately 285 million people suffer from vision impairment globally, of which 90% live in developing countries, with 39 million being blind and 246 million have low vision (WHO, 2013c, Pascolini and Mariotti, 2012). Vision impairment is defined by the WHO as visual acuity (VA) of worse than 6/18 (WHO, 2013a) but other widely acceptable definitions of vision impairment include VA 6/12 or worse (Naidoo et al., 2003, Kumah et al., 2013) and VA worse than 6/12 (Nangia et al., 2013, Abdull et al., 2009).

In developed countries, the major cause of vision impairment is age-related macular degeneration (Kocur and Resnikoff, 2002), while in developing countries it is uncorrected refractive errors (URE) (43%) (Pascolini and Mariotti, 2012). Cataract continues to be the main cause of blindness in low and middle-income nations (Pascolini and Mariotti, 2012), with the at-risk population being people aged fifty years and above, as they account for 82% of the global blind population (Pascolini and Mariotti, 2012). Fortunately, 80% of vision impairment is preventable or curable, with a global reduction over the past 20 years despite an increasingly ageing population (WHO, 2013c). Much of the reduction in vision impairment is due to the decrease in infectious etiologies, such as the eradication of trachoma in Morocco in 2007 and Ghana in 2008 (WHO, 2013c).

As with other developing countries, vision impairment affects the lives of many people in Ghana, which became a signatory to VISION 2020-THE RIGHT TO SIGHT on 31st October, 2000, thereby committing its government to work towards eliminating avoidable vision impairment and blindness by the year 2020 (National Eye Care Unit, 2013). Despite the advances made in combating the infectious diseases that cause vision impairment, many people are still affected by poor vision and blindness (National Eye Care Unit, 2013). This is particularly true in the Ashanti Region of Ghana, where the adult population living in rural areas have limited access to eye care services, which are mainly provided in urban areas (Amedo, 2014, Gyasi, 2006). Additionally, there has

not been any population-based prevalence study on vision impairment in adult in the Ashanti Region. As a result, Research is therefore needed to identify the prevalence and causes of visual impairment among adults and the proportion of vision impairment attributable to refractive error. This resulted in the aim of this study being to establish the contribution of uncorrected refractive errors to vision impairment in the Ashanti Region, Ghana. The results of the study will provide baseline data for other vision impairment studies in the region, add to the few vision impairment studies in Ghana, as well as assist in planning eye care programmes, and developing policies and strategies to reduce vision impairment locally and possibly nationally.

1.2 Background

Vision Impairment is a condition of the eye that can affect people of all ages, and results in poor vision in one or both eyes. Due to the socio-economic impact of vision impairment on an individual and country, various measures are being put in place to reduce the prevalence of vision impairment globally (Smith et al., 2009). To effectively reduce the prevalence of vision impairment, the various contributing factors and the relative extent to which they each contribute to vision impairment must be well known (Fotouhi et al., 2004). The classification of vision impairment and refractive error will be detailed, followed by an overview of studies in developing countries.

1.2.1 Vision impairment and Refractive Error

The 2006 update of the International Classification of Diseases-10 by the WHO recognizes the following presenting Visual Acuity classification as the levels of vision impairment in either eye (WHO, 2013a):

Mild or No Vision impairment:	6/18 or better
Moderate Vision impairment:	worse than 6/18 but less than and equal to 6/60
Severe Vision impairment:	worse than 6/60 but less than and equal to 3/60
Blindness:	worse than 3/60

Other widely acceptable definitions of vision impairment include VA 6/12 or worse (Kumah et al., 2013, Naidoo et al., 2003) and VA worse than 6/12 (Nangia et al., 2013, Abdull et al., 2009). Full discussion on definition of vision impairment will be presented in Chapter 2 (2.2.2 Visual Acuity range)

Refractive error is a condition of the unaccommodated eye in which parallel rays from infinity are not converged on the retina, causing a blur image. In hyperopia, the refractive power of the eye may be insufficient or the axial length of the eye may be too short, resulting in images forming behind the retina. In myopia, the refractive power of the eye may be higher or the axial length of the eye may be too long, resulting in images forming in front of the retina. In astigmatism, light is focused at different points in different planes (Remington and Remington, 2012). The major cause of vision impairment worldwide is refractive error and is easily corrected with lenses (Bourne et al., 2013, Naidoo et al., 2010, Pascolini and Mariotti, 2012).

1.2.2 Vision impairment and Refractive Error in Developing countries

Uncorrected refractive error can have a significant impact in the life of the affected individual in that it can result in loss of educational and employment opportunities and impact on their quality of life (McIntyre et al., 2000). The paucity of country-specific data regarding the prevalence of blindness and vision impairment in Africa led the WHO in 2004 to recommend that studies be conducted on the prevalence and causes of vision impairment in sub-Saharan Africa (Resnikoff et al., 2004). This is particularly the case in developing countries, where access to eye care services can be difficult where they are available, where schooling facilities for people with disabilities are often limited, and where the family provides the main support network.

Several studies in rural central India have revealed that uncorrected/under corrected refractive error accounts for 33% of vision impairment (Marmamula et al., 2012b, Marmamula et al., 2013c, Nangia et al., 2013, Nangia et al., 2012, Nangia et al., 2010). In Prakasam District (Andhra Pradesh state), south India, 62% of all vision impairment cases were due to refractive error (Marmamula, et al, 2013). A Pakistani national blindness and vision impairment survey uncovered refractive error (43%) as the leading causes of moderate vision impairment (Dineen et al., 2007). In a Bangladesh national eye survey, cataract (74%) was the leading cause of blindness, followed by refractive error (18.7%) and macular degeneration (1.9%) (Dineen et al., 2003).

The Liwan Eye Study, which was conducted in southern China, stated that the incidence of vision impairment was 5.88%, with URE being the main (40.4%) cause (Wang et al., 2013). It was reported that the leading cause of mild, moderate and severe vision impairment in Baoshan District, Shanghai Province, China, was uncorrected refractive error (Zhu et al., 2013). Cheng et al. (2013) reported that various geographical regions in China have different prevalence rates, with a prevalence of 1.4% in east and Central China, and 2.5% in western China. Overall, blindness and vision impairment (after refractive correction) in China was 5.8% (Cheng et al., 2013). It was also reported that optic atrophy, retinitis pigmentosa and diabetic retinopathy are the main causes of serious vision impairment in the working age people in Europe (Kocur and Resnikoff, 2002).

In sub-Saharan Africa, Sherwin et al. (2012) estimated that the proportion of vision impairment due to URE in adults ranged from 12.3% to 57.1%. A Nigerian national blindness and vision impairment survey using a multistage stratified cluster random sampling method found that URE was responsible for 57.1% of moderate (<6/18–6/60) vision impairment (Abdull et al., 2009).

Work done by Naidoo et al. (2014) in a systematic review of 52 published and unpublished population-based surveys indicated that in 2010, age-standardized prevalence of moderate to severe vision impairment was estimated to be 4.0%, with a 95% Confidential Interval of 3.4 – 5.0. The main cause of moderate to severe vision impairment (MSVI) was refractive error (45%) (95% CI 40.8 – 47.7). It was estimated that West Africa had the highest prevalence of MSVI, with 4.1% in men (95% CI 3.3% – 5.4%), while Southern Africa had the lowest at 2.0% in men (95% CI 1.5% - 3.3%) (Naidoo et al., 2014), with similar trends being observed in women (Naidoo et al., 2014).

1.2.3 Vision impairment and Refractive Error in Ghana

Ghana is located in West Africa, and has approximately 25 million inhabitants, with 50.9% being urbanised (Ghana Statistical Service, 2012) . The Ghana Statistical Service (2012), in its report of the 2010 census, stated that vision impairment is the

number one cause of disability in the country. The National Eye Care Unit was established to achieve the aim of Vision 2020 in Ghana. Their aim was to eradicate avoidable blindness/vision impairment by the year 2020. Most of its inhabitants rely on public health services to provide for their health care needs, including optometry (WHO, 2013b). The country has two tertiary institutions that teach optometry, one being located in Kumasi, Ashanti in the central, and the other in southern Ghana, their combined annual output of trainees being an average of 50 (Boadi-Kusi et al., 2014). However, the current ratio optometrist to population ratio is 1:82 000 instead of recommended 1:10 000, severely limiting the accessibility refractive care for those in need (Boadi-Kusi et al., 2014). This is compounded by the fact that most optometrist like other professionals prefer to live in urban areas making it difficult for some people to have access to the care they need (Gyasi, 2006). Additionally, while the current National Health Insurance Scheme does provide eye testing services, it does not make provision for optical devices. This all speaks to the reasons for the refractive error not being corrected, as there are no services, people cannot access them or afford them.

In Ghana, uncorrected refractive error has also been found to be a leading cause of reduced vision. In the Agona-Swedru District of the central region, uncorrected refractive errors was found to account for 85.9% of vision impairment (VA of 6/12 or worse) in 637 children (11- 18 years) (Ovenseri-Ogbomo and Assien, 2010). They reported a prevalence of hyperopia of 5%, myopia 1.7% and astigmatism 6.6 % (Ovenseri-Ogbomo and Assien, 2010). Refractive error has also been reported to be the main cause of vision impairment in Tema, a city in Ghana (Budenz et al., 2012). However, no adult population based studies have been done in the Ashanti Region. The above challenges of skewed distribution of optometrist towards the urban centres, lack of provision of optical aids under NHIS and lack of baseline data also holds true for Ashanti Region.

1.3 Problem Statement

Geographically specific epidemiological research is required to address the problem of vision impairment (Fotouhi et al., 2004) and to enable proper planning of eye care programmes and strategies to reduce vision impairment (Dandona et al., 1999). Reports from rural (Agona Swedru district) and urban (Tema, Accra, Kumasi) studies in

Ghana indicate that uncorrected refractive error is the main reason for vision impairment (Budenz et al., 2012, Kumah et al., 2013, Ovenseri-Ogbomo and Assien, 2010). Among causes of vision impairment, refractive error is known to be most amendable to treatment and providing treatment could make the best public health impact (Resnikoff, 2002). Currently, there is little available data on vision impairment and its causes in Ashanti region.

In the absence of recent research on the contribution of uncorrected refractive errors to vision impairment among adults in the Ashanti Region of Ghana, it not possible to plan appropriate services, know if enough people are being trained, and the right services are being provided in the right places. This study therefore seeks to determine the prevalence of vision impairment in adults aged 18 years and above in the rural Ashanti Region of Ghana.

1.4 Research Questions

1. What is the prevalence of distance and near vision impairment of adults aged 18 years and above in the Ashanti Region?
2. What are the causes of vision impairment in the Ashanti Region?
3. What are the types of uncorrected refractive error that cause vision impairment in the Ashanti Region?

1.5. Aim and Objectives

To establish the contribution of uncorrected refractive errors to vision impairment in the Ashanti Region of Ghana

The study therefore had the following objectives:

1. To determine the prevalence of distance vision impairment of adults aged 18 years and above in the Ashanti Region.
2. To determine the prevalence of near vision impairment of adults aged 18 years and above in the Ashanti Region.
3. To establish the causes of vision impairment in the Ashanti Region.
4. To establish the types of uncorrected refractive errors that cause vision impairment in the Ashanti Region.

1.6 Definitions

The following definitions apply for this study:

Vision impairment (VI): presenting visual acuity of less than or equal to 6/12 in the better eye (Kumah et al., 2013, Naidoo et al., 2003).

Near vision impairment: presenting near vision of N8 or worse in both eyes (Marmamula et al., 2013b).

Myopia: refractive error greater or equal to an equivalent sphere (i.e. sum of the sphere power and half of the cylindrical power) of -0.50 Diopters in the right eye after subjective refraction.

Hypermetropia: refractive error greater or equal to an equivalent sphere of +0.50 Diopters in the right eye after subjective refraction.

Astigmatism: refractive error in the right eye of -0.75 and above of cylindrical power, irrespective of the sphere power.

Refractive error: presenting visual acuity of 6/12 or worse in the better eye which was correctable to 6/9 or better in the better eye as defined by Marmamula et al., (2013c).

Diagnoses of cataract was recorded if presenting VA for that eye was 6/12 or worse and did not improve with pinhole or refraction and lens opacity, as well as poor red reflex were observed during ophthalmoscopy. The cataract definition is similar to the definition used by Marmamula et al. (2013c).

Due to the limited scope of the protocol, all other ocular conditions found among the visually impaired were grouped under 'Other causes'.

1.7 Scope of Study

The study is a cross-sectional community-based survey design. A modified version of the rapid assessment of vision impairment (RAVI) was adopted (full review of RAVI methodology was discussed in page 11-b. Rapid Assessment Examination). This included visual acuity (VA) testing, pen torch examination, ophthalmoscopy, near vision test and pinhole test for those with VA of 6/12 or worse in the better eye. Refraction was done for those whose pinhole VA improved.

1.8 Study Structure

The thesis is divided into the following Chapters:

Chapter 2. Literature Review: reviews the literature about vision impairment and refractive error.

Chapter 3. Methodology: presents the methods used to achieve the study's objectives and outlines.

Chapter 4. Results: presents the results of the study with respect to the four objectives, with the data being provided in tables and charts.

Chapter 5. Discussion: reviews the study results and discusses them with respect to results found elsewhere.

Chapter 6. Conclusion: answers the research questions, presents the study limitations and recommendations, and indicates future areas of research required.

CHAPTER 2. Literature Review

2.1 Introduction

This chapter is divided into five sections, the first presenting a methodological review, these second outlining the trends in demographic parameters and vision impairment, and the third reviewing the relevance of distance vision impairment. The fourth section identifies the causes of vision Impairment (distant and near), and the last outlines the global burden of vision impairment.

2.2 Methodological Review

A review of the studies done in the area of vision impairment and refractive error revealed a myriad of methodological approaches to collect data. Factors such as age range, visual acuity and the type of examination have an impact on the prevalence of vision impairment, each of which will be reviewed.

2.2.1 Age range

The higher odds of developing vision impairment in old age (Abdull et al., 2009, Freeman et al., 2010, Cheng et al., 2013, Marmamula et al., 2013a) is probably because most of the causes of vision impairment are degenerative conditions which develop overtime. Most vision impairment studies were conducted using adults aged 40 years and above (Abdull et al., 2009, Freeman et al., 2010, Cheng et al., 2013, Marmamula et al., 2013a). Some data do exist for 3-16 year old (Kumah et al., 2013, Naidoo et al., 2003, Woodhouse et al., 2013, Tarczy-Hornoch et al., 2013, Solebo and Rahi, 2013, Schulze Schwering et al., 2013, Heijthuijsen et al., 2013). Nevertheless, the justification for conducting studies in children cannot be over emphasized because a child who is blind or vision impaired will have more disability years and may be hindered in their development (Koberlein et al., 2013, Frick, 2012, Bourne et al., 2012). An assiduous look at the trend of age range used in collecting data on vision impairment caused by URE however, reveals an exclusion of the reproductive age group (18 to 39 years) even though t people in this age group in most regions of the world are in their formative years; in school or among the working populace. Since vision is linked to productivity, it is becoming more common for some current studies on vision impairment and refractive error to include people of this age group (Freeman et al., 2013, Chan et

al., 2013b, Otulana, 2012). In fact some studies include all age groups including children, young adults and adults in their studies (Otulana, 2012, Ntim-Amponsah, 2007).

2.2.2 Visual Acuity range

The essence of conducting vision impairment studies is to find out the proportion of the population, at a given time, that cannot see well. Therefore, a lot depends on the cut off of visual acuity used in the studies. An operational definition of vision impairment as 6/12 VA in the better eye in one study and 6/18 VA in another study of similar population characteristics and same sampling technique would generate different results. It stands to reason that the study involving 6/12 would generate higher prevalence than that which uses 6/18.

It is worth noting that, to the best of the researcher's knowledge, the WHO document made no distinction of what is mild vision impairment from what is normal vision. This created a vacuum with which different researchers in this area chose different limits to classify mild and normal vision impairment. Some define vision impairment as visual acuity less than 6/12 (Chou et al., 2013, Robinson et al., 2013, Budenz et al., 2012, Ezelum et al., 2011, Nangia et al., 2012). Several other researchers use VA equal to or worse than 6/12 (Chan et al., 2013b, Kumah et al., 2013, Naidoo et al., 2013, Abdull et al., 2009). The later classification is much popular in research emanating from Africa and more recent whereas the former classification is much common in studies from North America. In fact, Nangia et al. (2013) in their study, reported visual acuity less than 6/12 threshold as "United States standard" and VA of less than 6/18 as the WHO standard.

2.2.3 Examination

Unlike a recommended standard for classifying vision loss using presenting VA or best corrected VA by the WHO as discussed above; there seem to be no recommended standard for eye examination involving vision impairment studies. The protocol for the eye examination of consenting participants ranges from the comprehensive methodology (Dilated fundus examination, Visual Field Test, Tonometry, full objective and subjective refraction) to a simplified methodology using direct ophthalmoscopy and a pinhole to determine the refractive status of the eye.

a. Comprehensive Examination

All studies provide basic eye examinations. Nonetheless, some protocols go beyond that to provide a full comprehensive eye examination employing dilated eye exams, digital fundus photography, tonometry, gonioscopy, full objective and subjective refraction to diagnose the cause of vision impairment and refractive status of the participants (Marmamula et al., 2012a, Budenz et al., 2012). This type of protocol provides the most accurate and dependable data on vision impairment (Marmamula et al., 2012a). Yet, the ophthalmic instruments and the quality and number of human resources needed to employ this kind of protocols are very expensive and time consuming. It restricts potential researchers who do not have the financial means from conducting these valuable studies (Marmamula et al., 2012a). These types of studies tend to be carried out in the developed world and only a few are carried out in the developing world and are usually funded by non-governmental organizations (NGOs) who may have an interest in specific regions.

b. Rapid Assessment Examination

The Rapid Assessment of Vision impairment (RAVI) is used to estimate the prevalence and common causes of vision impairment; prevalence of presbyopia; spectacle coverage and the barriers to the uptake of eye care services, etc. (Marmamula et al., 2011b). The protocol includes visual acuity assessment with and without a pinhole (if VA is 6/18 or worse) and near vision assessment. A standard Snellen chart is used instead of the simplified Snellen chart with only 6/18 and 6/60 optotypes. The disadvantage of this method is that it has the tendency to overestimate cataract. This is because dilated fundus examination is not done and the proclivity of using ophthalmic technicians (rather than highly skilled ophthalmologist or optometrist) to collect RAVI data. (Marmamula et al., 2012a). Several studies have been undertaken using the RAVI protocol (Dineen et al., 2006, Marmamula et al., 2011b, Nano et al., 2006).

Marmamula et al. (2011a) described a more simplified form of the rapid assessment method which uses improvement of VA with pinhole rather than refraction to determine the refractive state of the eye.

c. Questionnaires

There are several current studies that determined the prevalence rate by administering only validated questionnaires without any eye examination (Freeman et al., 2013, Iliffe et al., 2013, Freeman et al., 2010) including one study conducted in Upper East region of Ghana (Akuamoah-Boateng, 2013). These studies make it clear that their rate are based on self-reported visual loss. Compared to other methods described above, this method is less suitable for planning purposes because some participants tend to over or underestimate their visual difficulty as no visual acuity measurement is done. Moreover, valuable data such as the cause of vision loss is not determined due to the fact that no eye examination is performed (Freeman et al., 2013).

2.3 Prevalence of Distance Vision Impairment

Global causes of vision impairment are uncorrected refractive errors (myopia, hyperopia or astigmatism representing 43 % of all vision impairment); un-operated cataract representing 33% and glaucoma representing 2% (WHO, 2013c).

2.3.1 Global Prevalence Rate

Worldwide, about 285 million people suffer from vision impairment of which 39 million are blind and 246 have low vision (WHO, 2013c). The prevalence of moderate to severe vision impairment (presenting VA worse than 6/18 but equal or better than 3/6) globally as reported by Stevens et al. (2013b) was 10.4% (95% CI, 9.5% - 12.3%) and blindness (presenting VA of worse than 3/60), 1.9%. Several global studies of vision impairment highlighted the wide disparity in the prevalence rate in different geographical regions (Stevens et al., 2013b, Bourne et al., 2013, Pascolini and Mariotti, 2012) and different income level of the world (Freeman et al., 2013). The highest prevalence rate of MSVI in older adults was in South Asia (23.6%) but least (less than 5%) in Europe and North America (Stevens et al., 2013b).

2.3.2 Prevalence of Vision impairment in Asia

Wang et al. (2013) reported an urban Southern China study, which was a prospective 5-year study of the prevalence of blindness and vision impairment after conducting a baseline comprehensive eye examination. Using the WHO and United States of America (USA) definition of blindness (WHO VA < 3/60) and vision loss (WHO VA < 6/18

to 3/60, USA VA < 6/12->6/60), the prevalence of vision impairment and blindness were 5.38% and 0.33% respectively (based on the WHO definition) and 9.85% and 1.42% (based on the United States definition) (Wang et al., 2013). Similarly, Cheng et al. (2013) also reported that prevalence of visual loss (less than 6/18) in mainland China was 5.8%. This result was higher than regional geographical estimates of the prevalence of vision impairment and blindness of 3.6% (95% CI 2.3 to 4.4) and 2.3% (95% CI 1.7 to 2.8) respectively in East Asia (Wong et al., 2014b).

In South India, Marmamula et al. (2011b) reported that, the rural communities in the Prakasam district (Andhra Pradesh state) recorded vision impairment prevalence of 30% (95% CI of 27.6% – 32.2%). The study was conducted among marine fishing populace. Among the weaving communities of the same district however, prevalence rate was 14% (95% CI, 12.8 – 15.3) followed by cataract (Marmamula et al., 2013c). Furthermore, in rural central India, the prevalence of vision impairment or blindness as per the WHO definition was 22% (95% CI 21.1 - 23.5) and 17% when age standardized (Nangia et al., 2013). These high prevalence rates corroborate the regional estimates of 23% in adult population in South Asia (Stevens et al., 2013b).

2.3.3 Prevalence of Vision impairment in Europe and North America

Most European data reports lower rates (less than 5%) compared to the global average prevalence rate (10.4%) of vision impairment (Stevens et al., 2013a).

In a Copenhagen City eye study involving 9980 adults (40 years and above), prevalence rates of vision impairment and blindness were 0.66% and 0.20% respectively (Buch et al., 2004). In a recent study among Spanish adults involving 213, 626 participants aged 15 years and above, the prevalence of vision impairment was 2.43% and 0.17% for blindness (Rius et al., 2013).

In the Reykjavik Eye Study in Iceland, prevalence of vision impairment and blindness was respectively 1.0% and 0.6% and the five-year incidence was respectively 1.1% and 0.4% (Gunnlaugsdottir et al., 2013). The observed lower prevalence rate in Europe was observed in North America. According to Robinson et al. (2013), the prevalence of vision impairment in an urban Canadian town was 2.7% (95% CI, 1.8-4.0). The

prevalence of vision impairment was 7.5% (95% CI, 6.9 - 8.15) in the United States of America. (Chou et al., 2013). These results in this high income region aligns well with estimated prevalence rate of less than 5% as reported by Stevens et al. (2013b).

2.3.4 Prevalence of Vision impairment in Africa

Naidoo et al. (2014) reported that in 2010 the age-standardized prevalence of moderate to severe vision impairment in sub-Saharan Africa population was 4.0% (95% CI: 3.4% – 5.0). Moreover, the report also revealed that 17.1% of the total number of people with MSVI worldwide are in Africa (Naidoo et al., 2014). Furthermore, there are considerable variations in sub-regional MSVI rates with West Africa having the highest rate of 5.5% (95% CI, 4.2 to 7.2) for men and 6.2% (95% CI, 4.7 to 7.9) for women.

2.3.5 Prevalence of Vision impairment in Ghana

Community or population-based studies of adult vision impairment are rare in Ghana. In 1994, Moll et al. (1994), conducted a research in 10 communities in Wenchi, Brong Ahafo region of Ghana and found the prevalence rate of blindness to be 1.7% (using < 3/60 with correction). The researchers did not perform refraction. Guzek et al. (2005) also did some work in Volta Region of Ghana and reported the rate of vision impairment (using WHO definition) and blindness to be 13.4% and 4.4% respectively.

2.3.6 Trend in Age and Prevalence of Vision impairment

Globally, the age-adjusted prevalence of vision impairment has declined over the past 20 years from 1990 to 2010 in spite of the increasing ageing population. The outcome is a slight increment (0.6 million) in the number of the blind population (95% CI: 5.2 - 5.3) as well as moderate to severe vision impairment by 19 million people (95% CI of 8 to 72 million) (Stevens et al., 2013b). The blind population could be visualized as stable over the years (Bakar et al., 2012). Other studies in Liwan, Southern China (Wang et al., 2013); Prakasam district in South India (Marmamula et al., 2013c), Nigeria; (Abdull et al., 2009); Tema, Ghana (Budenz et al., 2012) as well as the developed world (Buch et al., 2004, Gunnlaugsdottir et al., 2013) reported a significant association between vision impairment and increasing age. The Copenhagen eye study for instance recorded a *p* value of 0.001 when they analyzed the relationship between age and vision impairment (Buch et al., 2004). Even in urban populations such as Liwan and Tema, advanced age

remained a risk for vision impairment. The Tema eye study in Ghana and the Nigerian study were done among people adults (40 years and above) and age was an important risk for vision impairment and blindness (Budenzen et al., 2012).

2.3.7 Trends in Gender and Vision Impairment

Generally, females have higher odds of developing vision impairment than males (Bakar et al., 2012). A rather borderline statistical association (p value of 0.06) between gender and vision impairment was recorded in the Prakasam district weaving communities of southern India: females remained more at risk than males (Marmamula et al., 2013c). A recent Spanish adult vision impairment study reported a finding similar to the global picture in that vision impairment prevalence was highest among females (Rius et al., 2013). In Africa, Naidoo et al. (2014) also reported same findings and highlighted the fact that the prevalence rate disparity is getting worse. In Ghana, similar trends have been discussed in population-based studies conducted by Budenz et al. (2012), Guzek et al. (2005) and Moll et al. (1994) but the observed disparity was not statistically significant.

2.4 Causes of Vision Impairment

There are various causes of near and distance vision impairment. Some factors though not causal, are a notable risk. For instance, worldwide climate variation is not only an important risk of presbyopia but also cataract and refractive error (Jaggernath et al., 2013).

2.4.1 Distant Vision Impairment

Distance vision impairment is an issue worldwide because it renders people unable to contribute effectively to the economic growth of their respective countries. There are many causes of VI, the major ones being refractive error, cataract, glaucoma, corneal opacities etc.

2.4.2 Risk Factors for Distance Vision impairment

Risk factors include: being female (Abdull et al., 2009), old age (Freeman et al., 2013, Marmamula et al., 2013c, Chou et al., 2013), diabetes (Freeman et al., 2013, Al Ghamdi

et al., 2012) and poor socio-economic status (Cheng et al., 2013, Marmamula et al., 2013c, Freeman et al., 2013).

2.4.3 Refractive Error

The increasing publication of URE as a major cause of vision impairment has created a greater focus on the need to address issues of URE. In developed countries, there is a shift of the major cause of vision impairment from URE to age-related macular degeneration (Kocur and Resnikoff, 2002). “The Copenhagen eye study outlined the following: Persons between ages 20 to 64 years, had myopia-related retinal disorders, diabetic retinopathy, optic neuropathy, and retinitis pigmentosa as the most common causes of impaired vision, while persons between ages 65 to 84 years, had cataract as the most frequent cause of vision impairment. Age-related macular degeneration was the main cause of blindness.” Thus, causes of vision impairment were dependent on the age group (Buch et al., 2004). Similarly, in the Reykjavik Eye Study in Iceland, age-related macular degeneration accounted for mainly severe vision impairment among the middle and older-aged Icelanders (Gunnlaugsdottir et al., 2013).

Despite the slight shift in the developed world, the major cause (43%) of vision impairment in the world still remains uncorrected/under corrected refractive error (Pascolini and Mariotti, 2012). The prevalence of refractive error among the visually impaired has been earlier addressed (was fully discussed in chapter 1 pages 11 to 14). Global estimates shows that annually, the world economy loses \$269 billion in productivity due to URE (Fricke et al., 2012) and 640 million people are visually impaired due to refractive error (Holden et al., 2008). However there are regional and ethnic variations in the contribution of each type of refractive error to vision impairment. The types of refractive error include myopia, hypermetropia and astigmatism.

a. Myopia

The commonest type of refractive error is myopia and it is a global public health concern (Saw et al., 2005). Complications of myopia include retinal detachment, glaucoma, macular degeneration and choroidal neovascularization. Several theories such as near work (Yeo et al., 2013, Chan et al., 2013a) genetic factors (Hysi et al., 2014, Verhoeven et al., 2013), peripheral refraction (Ip et al., 2007,

Smith et al., 2007), among others, have been espoused as the aetiologies of myopia.

Prevalence of myopia among people with visual loss and blindness in Asia is higher than the global estimate (Wong et al., 2014a) and one in four adults in Europe and North America is myopic (Kempen et al., 2004). In Southern Africa, Naidoo et al. (2003) reported a prevalence of 2.9% in children living in KwaZulu Natal. In Ghana, similar vision impairment and refractive error study conducted in Kumasi revealed that myopia was present in 3.4% of the children (Kumah et al., 2013). The prevalence rate quoted in these studies may be higher in the general population because rate of myopia increases with age (Kempen et al., 2004, Pan et al., 2012, Naidoo et al., 2003). The most comprehensive refractive error study conducted in West Africa, reported by Ezelum et al. (2011), studies reported a crude prevalence of 16.2%. Participation of higher number of older people in the study may account for the high crude prevalence rate.

b. Hypermetropia

Hypermetropia also called far sightedness or hyperopia is an important type of refractive error. It is significantly higher in women than men and prevalence rates seem to increase with age till 50-59 years where the effect of nuclear sclerosis of the crystalline lens decreases the prevalence rate (Haegerstrom-Portnoy et al., 2014, Vincent and Read, 2014). In the most comprehensive population-based adult refractive error study in Africa, Ezelum et al. (2011) revealed that the prevalence of hypermetropia in Nigeria was 50.7% which was higher than rates in Asia but similar to other studies from European population. However, two most comprehensive refractive error and vision impairment studies from the Africa continent were from children population. They reported prevalence of hypermetropia causing vision impairment (in at least one eye) of 0.3% (Kumah et al., 2013) to 2.6% (Naidoo et al., 2003).

c. Astigmatism

Studies reporting prevalence of astigmatism are rare globally and in the Africa continent because of the tendency of authors to report on spherical equivalents. Three studies one from an adult population and two from children. The study report from Ezelum et al. (2011) in National Eye Survey of Nigeria reported that 63% Nigerian adults were astigmatic. Kumah et al. (2013) revealed that prevalence of astigmatism in one or both eyes was 13.7% in a Ghanaian children population.

2.4.4 Cataract

Cataract, a disease of the eye, is the clouding of the clear, natural lens located in the eye which causes it to lose its transparency and prevent sufficient light from reaching the retina with eventual vision impairment (Truscott, 2005). The WHO describes cataract as the second major cause of vision impairment in the world and also the leading cause of blindness (51 %) in the world: It represents about 20 million people (Pascolini and Mariotti, 2012). The majority of those who are blind live in developing countries (Bourne et al., 2013, Stevens et al., 2013b). Cataract together with age-related macular degeneration has been described as the main cause of vision impairment in Sri Lanka (Edussuriya, K, et al, 2009). The situation in Prakasam district of Southern India and Liwan, an urban city in Southern China is similar (Wang et al., 2013, Marmamula et al., 2011b).

Data from Africa and Ghana suggests cataract as the leading cause of blindness (Guzek et al., 2005, Budenz et al., 2012, Pascolini and Mariotti, 2012). A study in Nigeria revealed that cataract (43%) is the foremost cause of blindness (<3/60) (Abdull et al., 2009). In the Tema eye study, cataract ranked high among the leading causes of blindness and vision impairment that did not respond to refractive correction. Irrespective of URE as the major cause of avoidable vision impairment and blindness, cataract remains the foremost cause of vision impairment not correctable by refraction (Budenz et al., 2012). This is reflective of poor cataract service delivery and infrastructure since cataracts can be successfully treated with surgery.

2.4.5 Glaucoma

Glaucoma is a group of conditions that cause progressive optic nerve head damage with characteristic visual field loss (Thylefors and Negrel, 1994). It is the number one cause of irreversible blindness in the world (Freeman et al., 2013, Pascolini and Mariotti, 2012). The condition is more prevalent and severe in the black population worldwide (Budenz et al., 2013, Friedman et al., 2006, Racette et al., 2003). In Ghana, studies conducted by Budenz et al. (2013), shows the prevalence of glaucoma causing vision loss (6.8%, 95% CI 6.2 – 7.4) is higher than that in South Africa - 5.3% (Rotchford et al., 2003) and East Africa - 4.2% (Buhrmann et al., 2000), as well as in non-blacks.

2.4.6 Corneal Opacities

Opacities on the cornea cause the cornea to lose its transparency, thereby causing visual loss through scattering of light rays reaching the retina or by completely blocking it (Singh et al., 2013). It has been estimated that up to 2 million new cases of monocular blindness are caused by this condition. In developing countries like India, it is estimated that it is the fifth biggest cause of visual loss (Gupta et al., 2013, Whitcher et al., 2001). The global estimate of the prevalence of corneal opacity causing vision loss is 1.0% (Pascolini and Mariotti, 2012).

2.4.7 Other causes

Other causes of vision impairment vary geographically. For the developed world it is Age - related Macula Degeneration (AMD), diabetic retinopathies and other retinal disorders. Causes of vision impairment in developing country includes onchocerciasis, uveitis, trauma etc (Pascolini and Mariotti, 2012, Freeman et al., 2013). In the near future, AMD and other retinal conditions contribution to vision loss are likely to increase because of increased life expectancy in the developing world (Bongaarts, 2009, Pascolini and Mariotti, 2012).

2.5 Near Vision Impairment/Presbyopia

The progressive, physiological and age-related loss of the eyes ability to focus on near object is called presbyopia (Remington, 2005, Patel and West, 2007). Currently, there is no cure for the condition but it can be easily corrected by wearing spectacles or contact lenses.

2.5.1 Risk Factors for Developing Near Vision Loss

Literature has identified presbyopia as the main cause of near vision impairment (Holden et al., 2008, He et al., 2014). Risk factors for developing presbyopia such as female gender (Duarte et al., 2003, Hashemi et al., 2012, Ikonne et al., 2010, Morny, 1995) and older age (Morny, 1995, Freeman et al., 2010, Hashemi et al., 2012) have been reported. Studies viz. a multi-continent collaboration (He et al., 2014), from Fiji (Brian et al., 2011) North America (Robinson et al., 2013) reported no relationship between gender and risk of developing presbyopia. Moreover, near vision loss studies conducted using a West Africa population seems to show that females develop presbyopia earlier and have higher risk than men (Ikonne et al., 2010, Morny, 1995).

Older people have a higher risk of developing near vision problems because the crystalline lens loses its elasticity over time (Truscott and Zhu, 2010). Some studies report a strong relationship between heat and risk of developing presbyopia (Truscott and Zhu, 2010, Weale, 2003, Jaggernath et al., 2013). Women's excessive exposure to heat might explain the observed higher risk because in West African cultural settings women are disproportionally involved in activities such cooking and farming which expose them to excessive heat.

In Ghana, little work had been done on near vision impairment. Kumah et al. (2011) reported that out of 298 teachers (age 36 - 50 years) sampled in Kumasi metropolis, 68% of them had presbyopia. This data unfortunately cannot be extrapolated to the adult population.

2.5.2 Prevalence of Near Vision impairment

The exact prevalence of this condition globally is not known but it has been estimated that 1.04 billion are presbyopic (Holden et al., 2008) and it is projected to significantly increase by 2020 (Ortner C., 2002). Globally, population-based studies of adults above 39 years and using a near VA cut-off of 20/40 revealed that the prevalence of presbyopia ranges from 68.1% to 61.8%. In Oceania continent, data collected from 1223 individuals in Fiji, aged forty years and above reported a prevalence rate of 68.1 (Brian et al., 2011). In India, Marmamula et al. (2013b), reported the prevalence of

presbyopia to be 61.8%. In China, Lu et al. (2011) reported prevalence of 67.3%. Similar high prevalence was reported in North America. It was reported from a Canadian urban population-based study that the prevalence of presbyopia was 69.1% (Robinson et al., 2013). In Africa, it was reported in Tanzania, East Africa that the prevalence was 62% (Patel, et al., 2007).

Due to the positive link between age and the risk of developing presbyopia, it is expected that studies conducted in a younger population would yield lower prevalence. For instance a report from a study conducted among 15-50 years old in Zoba Ma'ekel, Eritrea shows that prevalence of near vision impairment was 32.9% (Chan et al., 2013b). But multi-continent population-based studies of adults 35 years and older reported highest prevalence of 83% (from India, Asia and Durban, South Africa) and lowest prevalence rate of 49% (from Niger, West Africa) (He et al., 2012). The disparity in the rate may be due to the Niger study having a higher proportion of younger participants.

2.6 Global Burden of Vision Impairment

As per studies conducted in over 70 countries, the burden of vision impairment differs globally across low, middle and high income countries. Freeman et al. (2013) revealed in their work that low income countries have a higher prevalence of vision impairment as compared to high income countries. Freeman et al. (2013) also revealed that whereas 6% of people living in low income countries had some form of visual loss only 2% of people in high income countries had visual loss.

Worldwide, it has been reported that vision impairment and blindness causes loss of productivity and hence economic stagnation (Wittenborn et al., 2013) early mortality, loss of weight (Koberlein et al., 2013), loss of earnings, poor quality of life (Tahhan et al., 2013) and cognitive dysfunction (Ong et al., 2012). Wittenborn et al. (2013) also reported more young people have visual loss than previously thought or reported and that more than one third of total cost of eye disorders and vision impairment could be incurred in young people less than 40 years.

Fricke et al. (2012) reported that in 2007, there were 158 million people who had distance vision impairment. Fricke et al. (2012) also suggested that 28 billion –US dollars will be required to train the needed manpower, constructing and maintaining refractive error programmes. Additionally, the estimated loss in global gross domestic product due to refractive error was 269-billion US dollars (Fricke et al., 2012). Holden et al. (2008) also revealed that 410 million people in the world could not perform optimum near vision tasks due to presbyopia. They concluded that ameliorating the prevalence of presbyopia in the world will require significant increase in resources targeted at primary eye care service providers who in addition to having knowledge of refraction, could also detect or diagnose permanent blinding conditions such glaucoma and diabetic retinopathy.

Koberlein et al. (2013) reviewed 22 published articles on the global cost of vision impairment and highlighted that the “mean annual expense” (MAE) cost of handling blind people was two times higher than that of non-blind people. They also reported that apart from the cost of admission, diagnoses and treatment; the cost of productivity loss of caregivers is very high (US\$ purchasing power parities 263 per week). Given that there has been a yearly increase in cost of blindness and vision impairment worldwide; the economic implications of vision impairment and blindness make this an urgent public health matter (Frick, 2012).

CHAPTER 3. Methodology

3.1 Introduction

This chapter discusses mainly the operational definition of visual impairment and blindness together with the method that was used for the collection of data and its analysis.

3.2 Study Design

The study is a cross-sectional community-based survey design.

3.3 Study Area/Population

Multistage cluster random sampling was employed. Simple random method was employed in the selection of three (3) districts and for each district, eight (8) villages/towns were also selected through simple random method. The list of towns/villages were obtained from the local district assemblies.

Ghana, located in West Africa, has approximately 25 million inhabitants, with 50.9% being urbanized (Ghana Statistical Service, 2012) . The Ghana Statistical Service (2012), in its report of the 2010 census stated that vision impairment is the number one cause of disability in the country. There are two optometry schools, one ophthalmic nursing school and one postgraduate college training in ophthalmology. All producing an average of 50 optometrist, 10 ophthalmic nurses and 2 ophthalmologist a year. The current optometrist to population ratio is 1:82 000 (Boadi-Kusi et al., 2014) and only 74 ophthalmologist in the country with 50% being in Accra, capital city of Ghana (Ministry of Health, 2014) . About 40% of inhabitants assess medical care using national health insurance scheme (NHIS) which in eye care covers refraction, visual field test, cataract surgery, eyelid surgery, A- scan and keratometry (National Health Insurance Authority, 2014) .

The Ashanti Region of Ghana is the third largest administrative region in Ghana, and lies between longitude 0.15W and 2.25W, latitude 5.5N and 7.6 N. It is made up of 27 districts, and according to the 2010 census, had a population of 4,725,046, constituting 19.5% of the national population, with females constituting 51.6%. The region covers a land area of 24,389 kilometers square (km²) and has a population density of 194 per sq.km (Ghana Statistical Service, 2012). Most of the inhabitants access health care

including eye care services using the NHIS making the region the number one user of NHIS (National Health Insurance Authority, 2014). This study took place in three Districts within the Ashanti Region, namely the rural Bosomtwe Atwima Kwanhuma District, the Ejura–Sekyedumase and Ejisu-Juaben Municipalities.

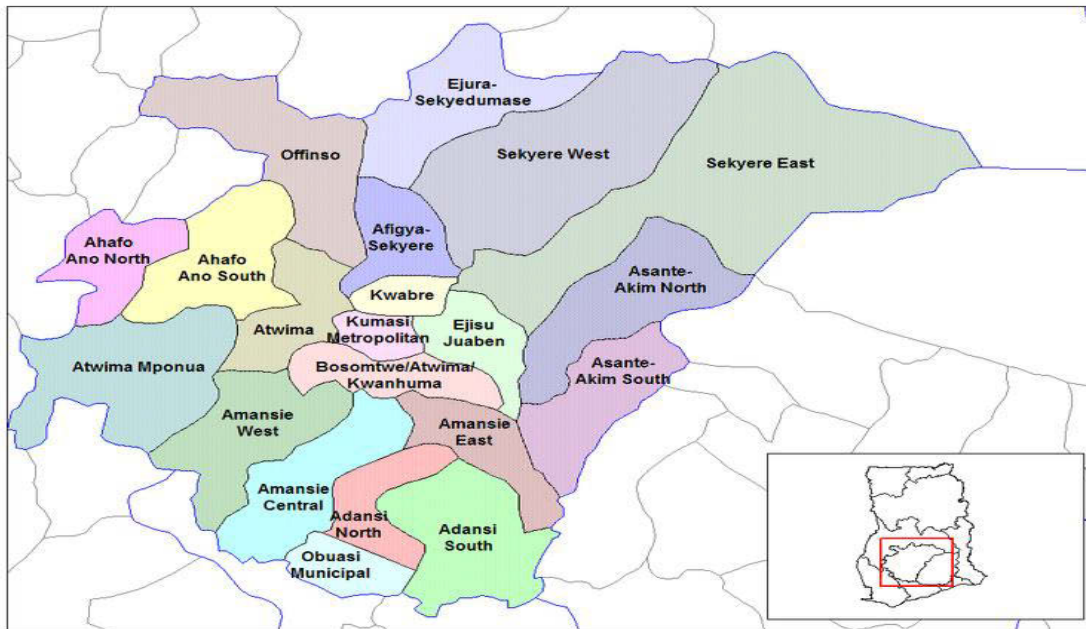


Figure 3. 1 Districts in Ashanti Region. Source: Wikipedia (2013)

a. Bosomtwe Atwima Kwanhuma District

The central Bosomtwe Atwima Kwanhuma District's capital is located in the city of Kuntanase, has a population of 93,910, of whom 44,793 (47.7%) are men. It lies within latitudes 6° 43' North and longitudes 1° 46' West, and covers a land area of 718 km². The district is bounded on the North by Atwima Nwabiagya and Kumasi Metropolis and on the East by Ejisu-Juaben District. The southern section is bounded by Amansie West, Central and East Districts. Currently, the projected population for 2010 reveals a total of 83,165. The only natural lake in Ghana, Lake Bosomtwe, covers the south eastern end of the district. The district is mostly rural but towns/villages are a few

kilometres apart. According to Ghana Statistical Service, (2012) most of the inhabitants are farmers.

The District has 3 Health Centers; 3 Maternity Homes and 30 Clinics, which are inequitably distributed (Ghana-Districts, 2013a). The biggest hospital in the district is the St. Michael's Hospital, which has a secondary level eye care facility. The facility has one ophthalmologist, three optometrist and three ophthalmic nurses.

b. Ejura–Sekyedumase Municipality

The Ejura–Sekyedumase Municipality is located in the northern part of the Ashanti region and is bounded in the north by Atebubu and Nkoranza districts (both in the Brong Ahafo Region), on the west by Offinso district, on the East by Sekyere East district and the South by Sekyere West and Afigya Sekyere District. The district is located within longitudes 1°5'W and 1°39' W and latitudes 7°9' N and 7°36'N, covers an area of approximately 1,782.2 km² (690.78 square miles) and is the fifth largest district in the Ashanti Region's. Its land size constitutes about 7.3% of the region's total land (Ghana-Districts, 2013b) and has a population of approximately 85, 446 (Ghana Statistical Service, 2012). Apart from the district capital Ejura and the second largest town Sekyedumase which are semi urban towns, the rest are rural. The district is characterized by scattered settlements with each villages far apart. The district have two hospitals including the district hospital that has an eye clinic manned by one optometrist and two ophthalmic nurses.

c. Ejisu-Juaben Municipality

Ejisu-Juaben municipal is one of the 30 administrative and political districts in the Ashanti region of Ghana. The municipality is known globally for its rich cultural heritage and tourists attractions notably the booming kente weaving industry. It covers an area of 637.2 km², constituting about 10% of the entire Ashanti Region and with Ejisu as its capital. Currently it has four urban settlements namely, Ejisu, Juaben, Besease and Bonwire. The total population is 143,762; made up of 68,648 males and 75,114 females. The municipality is located in the central part of the Ashanti Region and provides enormous opportunity for creating an inland port for Ghana to serve the northern section of the country. It lies within Latitude 1° 15'

N and 1 ° 45' N and Longitude 6° 15'W and 7° 00'W. Ejisu-Juaben municipality shares boundaries with six (6) other districts in the Region (Ghana-Districts, 2013c). The eye unit of Juaben hospital has one ophthalmologist, one optometrist and three ophthalmic nurses.

3.4 Study Sample and Size

With a population of 4,725, 046 in the Ashanti region, vision impairment prevalence rate of 3.75% from a published work by Kumah. et. al, (2013) in Children in Kumasi, Ashanti region; 1.25% error margin, design effect of 1.5 and 90% enrolment rate the calculated sample size was 1420. The prevalence rate from Kumah, et al, (2013) work was used because it was the only available vision impairment study in the area and since prevalence rate of vision impairment increases with age, using child eye health prevalence would ensure that the lowest prevalence group is detected by the sample size. The equation used was developed by Minassian (1997) in an article titled “Epidemiology in practice: Sample Size Calculation for Eye Surveys”

Formula for calculating the sample size

$$n = A / (E^2 + (A/N))$$

Where:

$$A = 3.8416 PQW$$

n = minimum sample size required (approximate)

P = assumed population prevalence, in % (which was 3.75%)

$$Q = 100 - P$$

E = maximum acceptable random sampling error, in % (which was 1.25%)

W = the likely design effect (1.5)

N = population size (4,725, 046)

3.5 Inclusion and exclusion criteria

Male and female inhabitants of the study area who were 18 years or more were enumerated. Each participant's age was confirmed using the Ghana national voters' identification card. Those younger than 18 years were excluded.

3.6 Data Collection Instrument

A designed questionnaire (Appendix A) was used to collect data on demographic characteristics such as:

- Demographic details: age, gender, occupation and address
- Occupation was categorized as farmers, public servants, artisans, students, unemployed and others

Six pieces of equipment were used to obtain the data needed to meet objectives 1, 2, 3 and 4, these being to determine the prevalence of distance and near vision impairment of adults aged 18 years and older. These are:

- Snellen Visual Acuity Chart
- Pinhole
- Near acuity chart
- Welch Allyn Ophthalmoscope
- Energizer pen touch
- Head loupe magnifier

Details of how they were used to achieve the specific objectives are discussed below:

a. In determining the prevalence of distance vision impairment of adults aged 18 years and older in the Ashanti Region, three tests were done on all the study participants, namely distance VA, and pen touch examination and ophthalmoscopy. For those with VA equal or worse than 6/12, additional tests such as pinhole VA and refraction were done. The test were done as described below:

- Visual Acuity (Test 1): a safe, confidential and well illuminated area of the house was identified. The Snellen chart was securely fixed on wall and a six meter precut robe used to demarcate the distance of the participant from the chart. The visual acuity of the right was always tested first. The participants read tumbling “E” letters of decreasing sizes. The VA was retested with a pinhole if the VA was 6/12 or worse.
- Refraction (Test 2): An objective refraction was assessed using Welch Allyn retinoscope with the patient fixating on the 6/60 optotype of the Snellen chat. The

retinoscopy was followed by a non cycloplegic subjective refraction using Shin Nippon trial frame and trial lens set. Jackson's cross cylinder was used to refine the cylinders. Refraction was done monocularly with the right eye tested first.

- Pen touch examination (Test 5): An energizer pen touch was used together with the head loupe magnifier to examine the ocular adnexa. The eye lashes, eyelid margins, cornea as well as the lens, were checked in that order for signs of trachoma, trichiasis, corneal opacity or cataract.
- Ophthalmoscopy (Test 6): A Welch Allyn Ophthalmoscope was used to examine the anterior chamber, the lens, the vitreous chamber and the fundus for uveitis, cataract or posterior segment eye disease through undilated pupil.

b. To determine the prevalence of near vision impairment of adults aged 18 years and older in the Ashanti Region, two tests were done: near VA and near refraction.

- Near vision assessment (Test 3): Near vision assessment was done binocularly using near chart (with tumbling "E") placed at 40cm away from the patient.
- Near Refraction (Test 4): Near refraction was done for only participants with near VA worse than N8. For this test, age appropriate lens addition was used as starting point with +0.25 Diopter lenses added until the participant could read better than N8.

c. To establish the causes of vision impairment, two test were done and they are:

- Pen touch examination (Test 5): An energizer pen touch was used together with the head loupe magnifier to examine the ocular adnexa. The eye lashes, eyelid margins, cornea as well as the lens, were checked in that order for signs of trachoma, trichiasis, corneal opacity or cataract.
- Ophthalmoscopy (Test 6): A Welch Allyn Ophthalmoscope was used to examine the aqueous chamber, the lens, the vitreous chamber and the fundus for uveitis, cataract or posterior segment eye disease through undilated pupil.

d. To establish types of URE that causes vision impairment in the Ashanti Region of Ghana, the following tests were done:

- Pinhole: the VA was retested with pinhole for all participants who read 6/12 or worse
- Refraction (Test 2): An objective refraction was assessed using Welch Allyn retinoscope with the patient fixating on the 6/60 optotype of the Snellen chart. The retinoscopy was followed by a subjective refraction using Shin Nippon trial frame and trial lens set. Jackson's cross cylinder was used to refine the cylinders. Refraction was done monocularly with the right eye tested first.

3.7 Research Team and Pilot Study

The research team included one enumerator, two research assistants and a fully registered Optometrist as principal investigator (researcher). Prior to the survey, a five-day rigorous training of the research team was conducted.

A pilot study was conducted in the Kwabere District of Ashanti Region, in a community which was not part of the study area. The sample size for the pilot study was 200, with the procedure for enumeration, recruitment (process of taking informed consent from participants) and field examinations being done as per the main study protocol, with the data obtained was not included in the main study result. Any challenges encountered, as well as inter-observer variability in visual acuity measurement taken by the research assistants and the principal investigator (PI) were noted. A kappa statistic of at least 0.7 was considered appropriate for the study. Only the researcher performed the main examination as described in Fig 2 during the pilot study.

3.8 Data Collection Process

The study took place from 15th November, 2013 to 24th December, 2013. Households were randomly selected by spinning a bottle at one end of the village to choose which side of the village to begin enumeration. The households were then selected consecutively. All eligible (18 years and above) people living in a selected households were enumerated by the enumerator of the team. Age eligibility was confirmed by participants showing their voters identity card. Each enumerated individual was taken through the information sheet and all concerns addressed before eventual enrollment as

a study participant by the principal investigator. The consenting participants were examined in their homes. The best illuminated area of the house was identified. Preformed six meter rope was used in determining the distance of the participants from the chart. Those who chose not to consent to participation in the study but wanted to have the free eye examination were examined free of charge. But such data was not included in the study.

The research protocol is similar to the one implemented by Marmamula et al. (2011b) and Oye et al. (2006). Once their personal details had been taken, each participant was examined by the principal investigator using a modified Rapid Assessment of Vision impairment (RAVI) protocol to correct the inherent drawback of the RAVI protocol described earlier. The modification included performing ophthalmoscopy for all participants and including young participants. This protocol involved taking informed consent; demographic data; Unaided monocular VA using a Tumbling “E” Snellen chart at a distance of 6 meters; near binocular visual acuity (the near acuity chart was placed 40cm from the participant) by the research assistants, pen torch examination and direct ophthalmoscopy for all participants by the researcher. The VA was repeated using a pinhole for participants with VA 6/12 or worse and a non-cycloplegic refraction was done for those whose pinhole VA improved. Near vision refraction was performed for each participant whose near vision was less than N8. The primary cause of vision impairment was assigned for each participant with uncorrected visual acuity of 6/12 or worse by the researcher. Moreover, the primary cause of vision impairment for each participant was based on the World Health Organization (WHO) recommendation that the primary cause should be the ocular condition that is most amenable to treatment (WHO, 1988). Each form was checked for completeness by the researcher before the participant left.

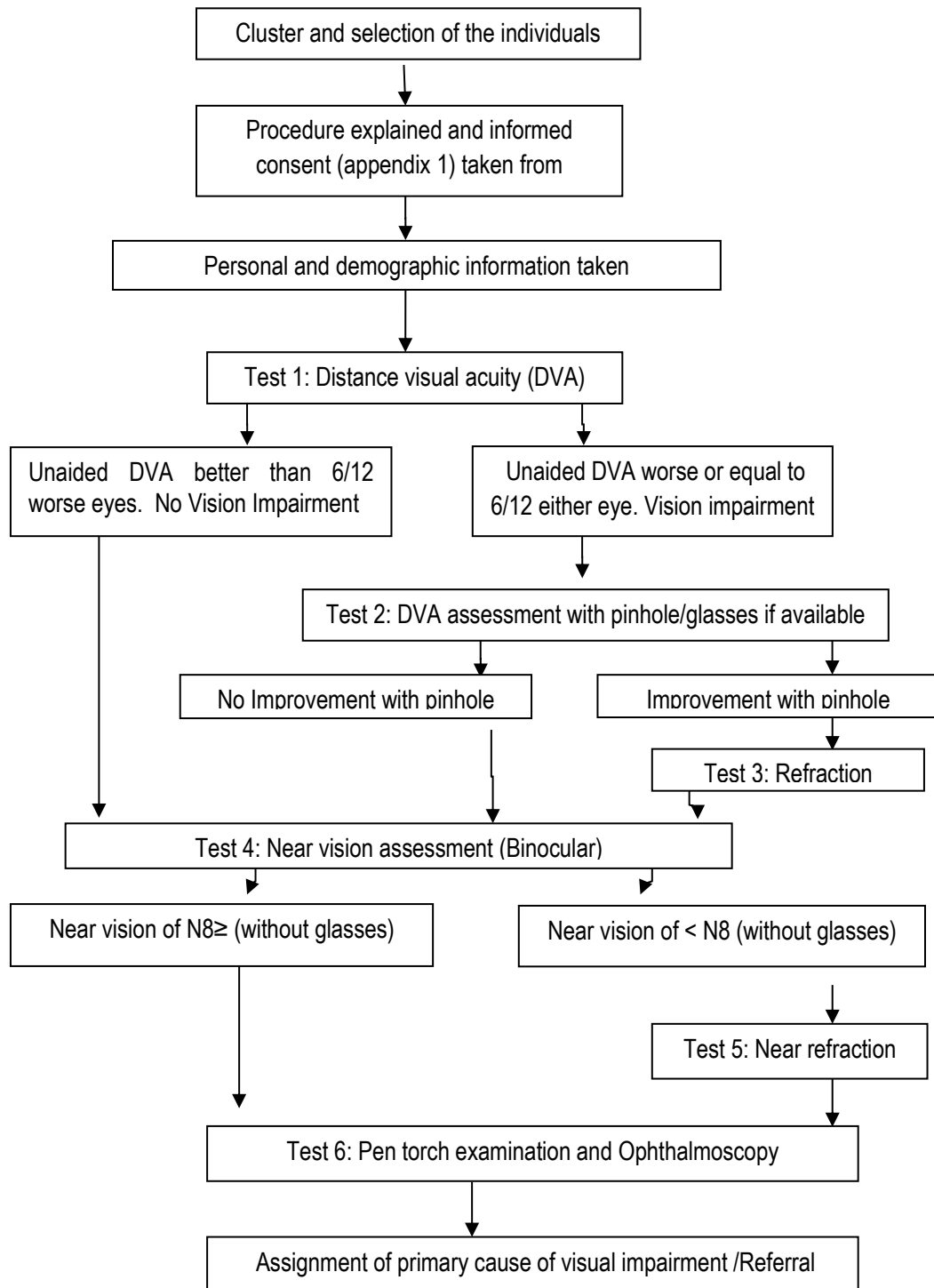


Figure 3. 2 Flow Chart of examination process

3.9 Data Management

Once the forms had been completed, they were collected and stored in locked briefcase by the principal investigator and only the principal investigator had access to it. At the

end of each day, the data was entered using Microsoft Access by the principal investigator and the digital data stored on a password protected laptop of which only the principal investigator had access to. Once the data was entered, the hard copy of the forms were locked in the cabinet of Department of Optometry and Visual Science. The hard copies will be locked for five years after which they will be machine shredded.

3.10 Data Analysis

The data was entered using Microsoft Access version 2013 by the principal investigator and the file was converted into Microsoft Excel version 2013 which was to clean the data. The completed and clean data was exported to STATA version 11 software which was used to analyze the data.

The criteria identified in Chapter 1 were used to determine whether or not the participants had distance, near vision impairments, cataract and/or refractive error. Simple proportions were used to analyze the prevalence of vision impairment and refractive error in the studied population. Fisher's exact test was used to compare the prevalence of vision impairment due to refractive errors with the demographic characteristics of respondents. Microsoft Excel version 2013 software was used to draw the graphs and charts. Prevalence rates were calculated using simple proportion as done by others (Kumah et al., 2013, Naidoo et al., 2003)

3.11 Reliability and Validity

The co-supervisor of the project visited the field to monitor and ensure reliability and validity of the data. Data was entered in duplicate and accuracy of data was checked using the append tool of STATA version 11.

3.12 Ethical Consideration

The following ethical considerations were observed:

- Ethical clearance (BE 331/13) was obtained from the University of KwaZulu Natal's Biomedical Research Ethics Committee (BREC) (Appendix B), and Ghana Health Service Ethics Review Committee (GHS-ERC 14/09/13) (Appendix C).
- Permission was sought from the health directorates of the districts that were involved in the research (Appendices D, E and G).
- The political heads of a specific study area were informed and involved.

- Members of the household were properly educated on the detailed examination procedures that were to be carried out. Informed consent was then obtained from each participant before enrollment. Thereafter, the details on the consent form was also read to consenting participants in the language they understood best. For every participant, the information sheet was read in the language (mostly in English or the local language in Ashanti Region, “twi”) he/she best understood. Once informed, the participants were allowed to voluntarily sign or thumb print the consent form. A copy of the information sheet was given to each participant. During consent process, it was made known to the participants that they could voluntarily withdraw from the study at any time.
- In gathering the data, none of the participants were identified by name and all data gathered was kept under lock and key at Department of Optometry and Visual Science (DOVS), Kwame Nkrumah University of Science and Technology (KNUST), where they would be kept for five years after which they would be machine shredded.
- All participants with eye conditions were referred to the nearest eye clinic.

CHAPTER 4. RESULTS

4.1 Introduction

This chapter describes the results obtained after the various procedure described above were carried out. The results are presented with respect to the four objectives after the demographic details: demographic parameters of participants, prevalence of distance vision impairment, prevalence of near vision impairment, causes of vision impairment and refractive error in visually impaired. Most of the results were cross tabulated with the participants' demographic parameters of age, gender and occupation.

4.2 Demographic Characteristics

Of the 1,420 people who were enumerated, 1,300 were examined, providing a 91.5% response rate. The mean age of participants was 46.29 (95% CI 45.29 - 47.29, Standard Deviation (SD) ± 0.51). The minimum age was 18 years and the maximum was 99 years. Completed data for all 1300 participants was available for analyses.

4.2.1 Age Distribution

In figure 4.1 below most of the participants were in the 18-39 year age group of (n=486, 37.38%) with slightly fewer (n=485, 37.31%) in the 40-59 age group and 20.85% (n=271) in the 60-79 group with. The least represented group was the 80-99 group (n=58).

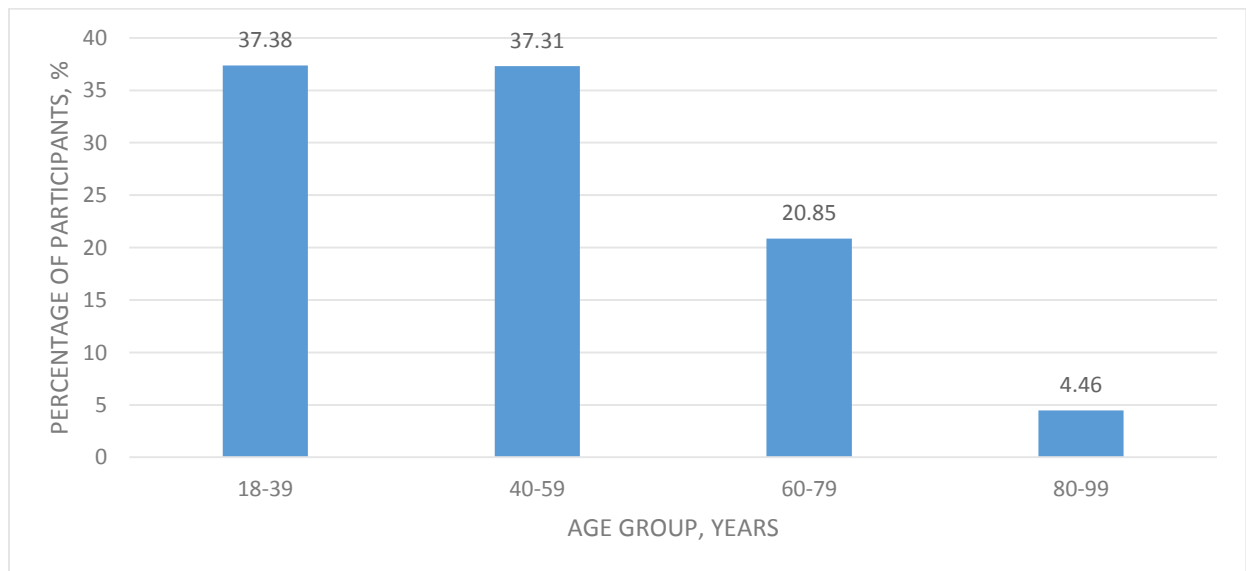


Figure 4. 1 Age distribution of participants

4.2.2 Sex Distribution of Participants

There were more female participants as compared to males in all age range (Fisher's exact value, $p = 0.026$). The females accounted for 61.4% of the respondents while the males made up 31.46% of the total number of participants (**Figure 4.2**).

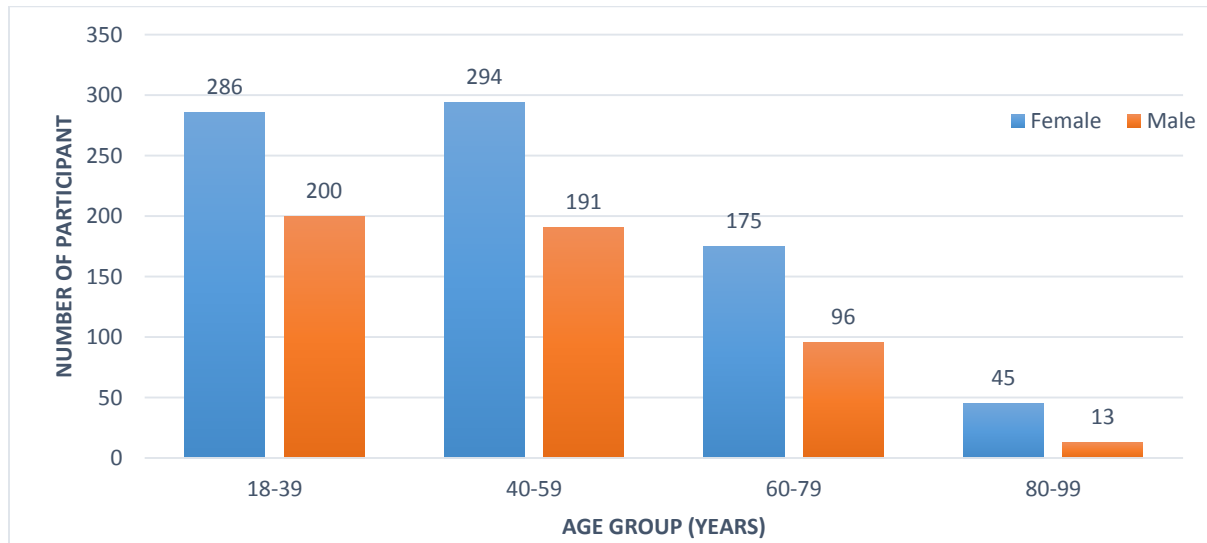


Figure 4. 2 Sex distribution of participants.

4.2.3 Occupational Distribution of Participants

Almost half of the participants were farmers (46.62%) and less than 10% indicated that they were unemployed (6.93%) (**Figure 4.3**). Of the 1300 people who participated, only 16.15% had any visual impairment.

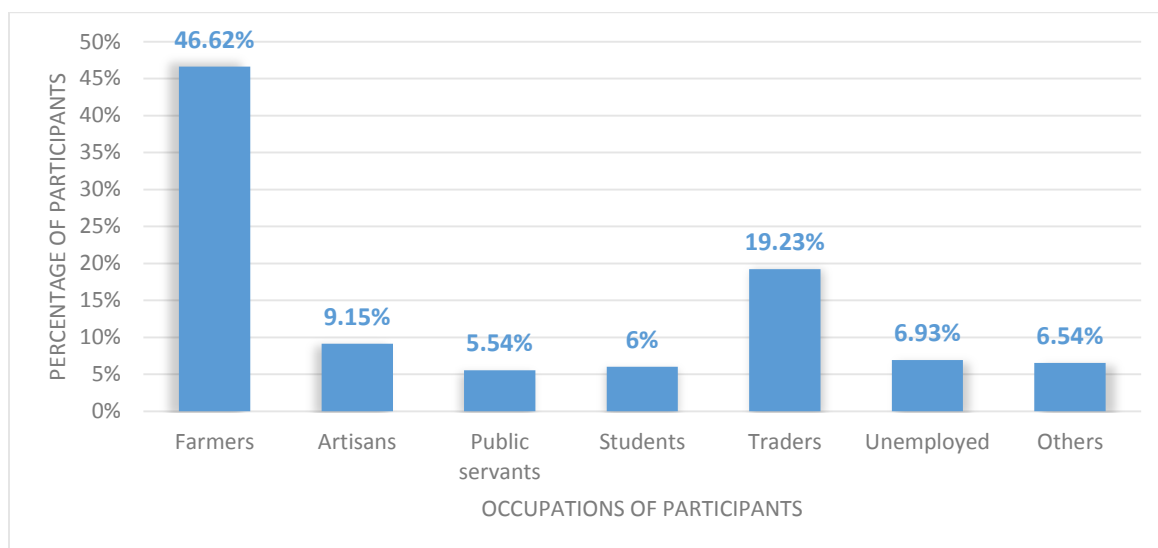


Figure 4. 3 Occupational distribution of the respondents.

4.3 Prevalence of Distance Vision Impairment of Adults Aged 18 Years and above in the Ashanti Region (Objective 1).

The prevalence of distance vision impairment in Ashanti Region based on presenting Visual acuity of 6/12 or worse in the better eye was 16.15% (n= 210, 95% CI,14.15% – 18.16%). The prevalence rate of vision impairment after refraction dropped to 8.40%, and the rate for using the 6/18 cut off (WHO standard) was 7.08%.

4.3.1 Age Distribution of Participants with Distance Vision Impairment

The prevalence of vision impairment among the 18-39 years group was 1%. The number with vision impairment (VI) in this age group was six (6) and the total number of participant in this age group was 486; for the 40-59 year group it was 7.45% (participants with VI = 41); 60-79 year group was 43% (119, N=271) and 80-99 year group (44, N = 58). Additionally, the mean age (67.97, standard deviation (SD) of ± 13.50) of those with VI was statistically significant (Fisher's exact value = 0.000) than those without VI (42.11, SD ± 16.16).

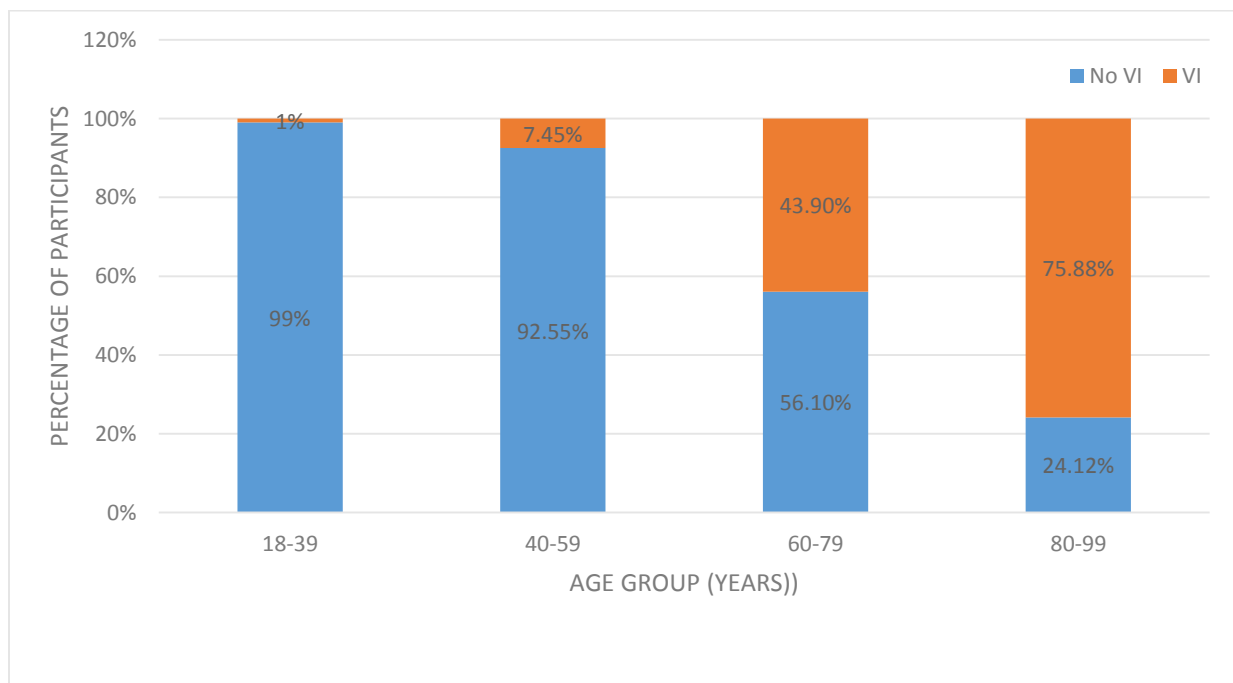


Figure 4. 4 Age distribution of participants with and without distance vision impairment.

4.3.2 Sex Distribution of Participants with Vision Impairment

The total number of participants with vision impairment was 210 of which majority, 137 (65.2%), were females (**Table 4. 1**).

Table 4. 1 Sex distribution of participants with vision impairment.

Gender	Prevalence in population with vision impairment, %	Prevalence in population, % (n)	Odd ratio (95% CI)	P value
Male	34.8	5.61 (73)	Reference	0.089
Female	65.2	10.54 (137)	0.8273 (0.60 -1.13)	

4.3.3 Occupational Distribution of Participants with Vision Impairment

Of all occupations of the respondents the unemployed had higher proportion (42.22%) of visually impaired individuals (**Figure 4.5**).

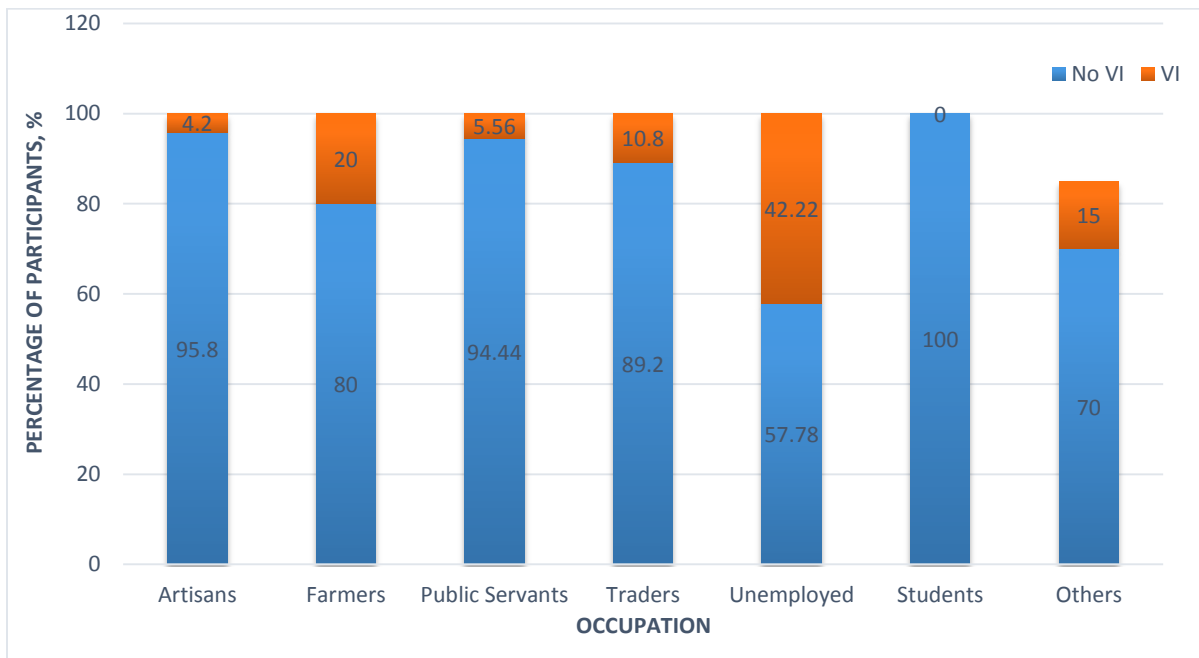


Figure 4. 5 Occupation of participants with and without vision impairment.

4.4 Prevalence of Near Vision Impairment of Adults Aged 18 years and above in the Ashanti Region of Ghana (Objectives 2).

The prevalence of near vision impairment was 59.92% (95% CI 57.26 – 62.59) of which 87.93% were correctable with spectacles.

4.4.1 Age Distribution of Near Vision Impairment

Age was significantly associated with near vision impairment with Fisher's exact test value of 0.000. The mean age of those with near vision impairment was 58.45, standard deviation of ± 12.73 (Table 4.2).

Table 4. 2 Age distribution of near vision impairment.

Age group, years	Participants with near vision impairment, n (%)		Prevalence of near VI in the studied population, %
	Correctable with glasses	Uncorrectable with glasses	
18-39	9 (0.69)	1 (0.08)	0.77
40-59	420 (32.31)	20 (1.53)	33.85
60-79	226 (17.38)	45 (3.46)	20.85
80-99	30 (2.31)	28 (2.15)	4.46
All ages	685 (52.69)	94 (7.23)	59.92

4.4.2 Sex Distribution of Near Vision Impairment.

The risk of females developing near vision loss is higher than males (Table 4.3) but the observation was not statistically significant.

Table 4. 3 Sex distribution of near vision impairment.

Gender	Prevalence	95% Confidence Interval	
		Odd ratio	P value
Male	57.00%	Reference	0.089
Female	61.75%	1.10 (0.99-1.24)	

4.5 Causes of Vision Impairment in the Ashanti Region (Objective 3)

Refractive error was the leading cause of vision impairment with 47.14% (n = 99, 95% CI of 40.33 - 53.9). Cataract was the second leading cause of vision impairment with 42.86% (n = 90, 95% CI of 36.10 - 49.61). Other causes of vision impairment prevalence was 10.00% (n= 21, 95% CI of 5.90 – 14.09) (**Figure 4.6**).

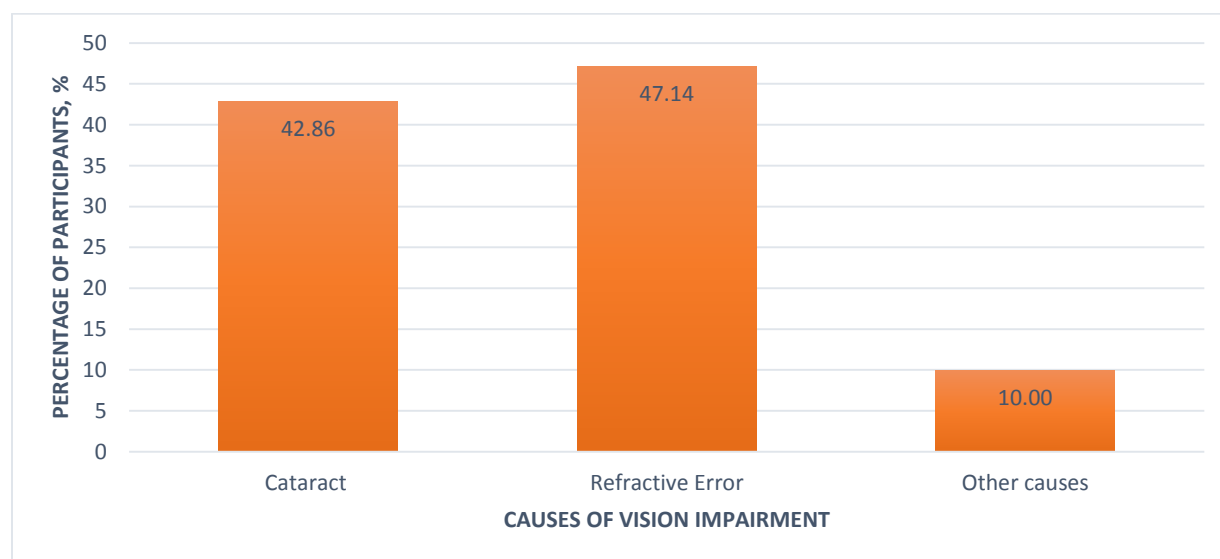


Figure 4. 6 Distribution of causes of vision impairment.

4.5.1 Age and Causes of Vision Impairment

There was a strong (Fisher's exact, p = 0.000) link between the cause of vision impairment and the age group of the participants (**Table 4.4**).

Table 4. 4 Age distribution of causes of vision impairment

Age group, years	Causes of Vision impairment, n (%)				Prevalence of vision impairment in the studied population, %
	Cataract	Refractive error	Other causes	All causes	
18-39	0 (0)	2 (0.95)	4 (1.90)	6 (2.86)	0.46
40-59	6 (2.86)	31 (14.76)	4 (1.90)	41 (19.52)	3.15
60-79	56 (26.67)	55 (26.19)	8 (3.81)	119 (56.67)	9.15
80-99	28 (13.33)	11 (5.54)	5 (2.38)	44 (20.95)	3.38
All ages	90 (42.86)	99 (47.14)	21 (10)	210 (100.00)	16.15

4.5.2 Sex Distribution of Causes of Vision Impairment.

More females had vision impairment than males in each of the causes but the observed difference was not statistically significant (Fisher's exact = 0.312) (**Figure 4.7**).

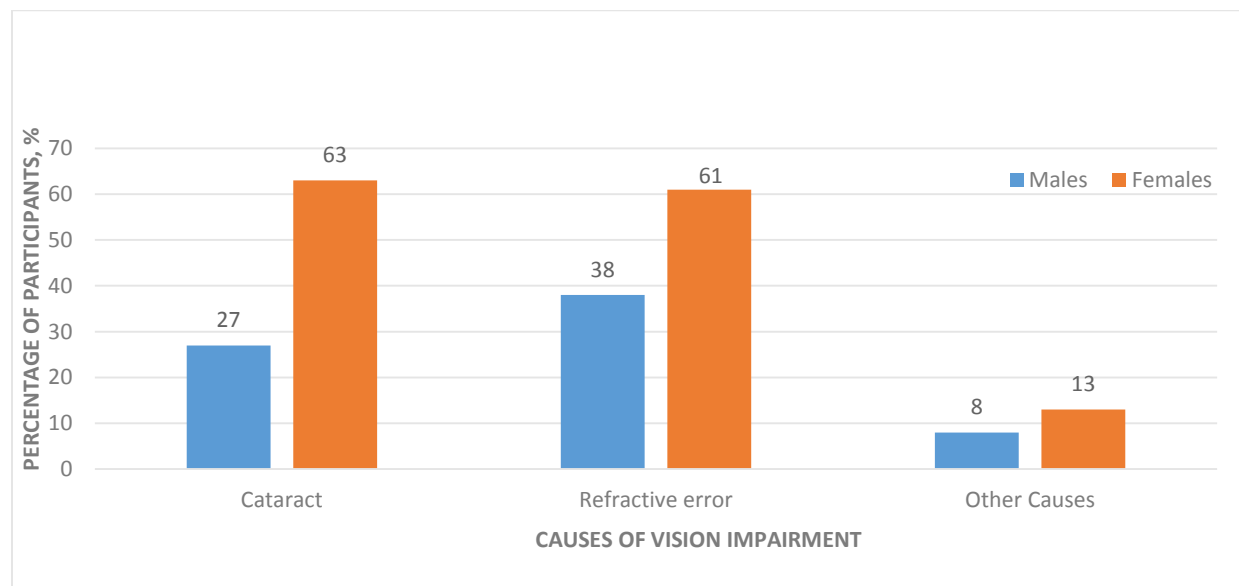


Figure 4. 7 Sex distribution of causes of vision impairment.

4.5.3 Participants' Occupation and Causes of Vision Impairment.

Sixty five percent of the visually impaired were farmers.

Table 4. 5 Occupation with respect to the causes of vision impairment.

Occupation (% in that category)	Causes of vision impairment, n (%)				Prevalence of vision impairment in the studied population
	Cataract	Refractive error	Other causes	All causes	
Artisans	2 (0.95)	2 (0.95)	2 (0.95)	6 (2.86)	0.46
Farmers	59 (28.1)	67 (31.90)	10 (4.76)	136 (64.76)	10.46
Public servants	2 (0.95)	2 (0.95)	1 (0.48)	5 (2.38)	0.38
Traders	4 (1.90)	12 (5.71)	3 (1.43)	19 (9.05)	1.46
Unemployed	21 (10.00)	9 (4.29)	3 (1.43)	33 (15.71)	2.5
Others	2 (0.95)	67 (31.90)	2 (0.95)	11 (5.23)	0.84

4.6 Types of URE that Cause Vision Impairment in the Ashanti Region (Objective 4)

The refractive error agreement (correlation) between the two eyes was very high (Pearson's correlation = 0.8483 Fisher's exact score, $p=0.000$), therefore the refractive power of the right eye of the participants was used for this part of the result. To compute the refractive error that has the astigmatism component, the cylindrical power of the right eye was halved to get the equivalent sphere power (S). A similar method of only using the right eye was used by Ezelum et al. (2011).

The mean refractive power among the participants with refractive error was -0.45, standard deviation of ± 0.15 . The mean myopic power was -1.57DS with standard deviation of ± 0.65 . The mean hypermetropic power was +1.07 with standard deviation of ± 0.99 . Astigmatism was defined as refractive errors of the right eye which had -0.75 and above cylinder power component irrespective of the sphere power. More Females than males were astigmatic but the perceived relationship was not statistically significant (Fisher's exact = 0.350). Crude prevalence of astigmatism in the visual impaired group was 18.10% (95% CI, 12.86 -23.34) and in the studied population, 2.92%. The mean astigmatic power was -0.24 (95% CI, -0.31 - 0.15).

Table 1.6 Prevalence of refractive error

Prevalence of refractive error	Prevalence	95% Confidence Interval
Among participant who have vision impairment	47.14%	40.34 - 53.95
Among population	7.61%	95% CI, 6.17 - 9.06

4.6.1 Types of Refractive Error

It was observed generally that the older participants, the higher the prevalence of refractive error (Table 4.6), this relationship being statistically significant (Fisher's exact, $P= 0.000$). The age group with most number of participants with refractive error was the 60-69 years group followed by the 40-59 years group and then the 80-99 years group. The group with the least number of participants with refractive error was 18-39 years group.

Additionally, there were more myopes (57.57%) than hypermetropes (42.42%).

Table 4. 6 Age group distribution of refractive error.

Age Range, years	No. in age range	Types of vision impairment, n (%)			Percentage of refractive error in age group
		Myopes	Hypermetropes	Total	
18-39	486	2 (2.02)	0 (0.0)	2 (2.02)	0.4
40-59	485	16 (1.6.16)	15 (15.15)	31 (31.31)	6.39
60-79	271	32 (32.32)	23 (23.23)	55 (55.55)	20.3
80-99	58	7 (7.07)	4 (4.04)	11 (11.11)	18.97
All age	1300	57 (57.57)	42 (42.42)	99 (100)	7.6

4.6.2 Gender Distribution of Participants with Refractive Errors

The odds ratio of female having refractive error was 1.19 (95% CI, 0.62 – 2.29) with males being the reference but the OR observed was not statistically significant (p value of 0.596).

Table 4. 7 Gender distribution of participants with refractive errors

Type of refractive error	Gender Distribution, n (%)	
	Males,	Females,
Myopia	22 (22.22)	35 (35.35)
Hyperopia	16 (16.16)	26 (26.26)
All refractive error types	38 (38.38)	61 (61.61)

4.6.3 Occupational Distribution of Participants with Refractive Errors

Farmers were most (67.67%) affected by refractive error followed by the traders (12.12%).

Table 4. 8 Occupational distribution of refractive error among visually impaired.

Types of refractive error	Occupation of participants with vision impairment, n (%)					
	Artisan	Farmer	Other	Public Servant	Trader	Unemployed
Myopes	2 (2.02)	38 (38.38)	4 (4.04)	2 (2.02)	6 (6.06)	5 (5.05)
Hypermetropes	0 (0.00)	29 (29.29)	3 (1.43)	0 (0.00)	6 (6.06)	4 (4.04)
All refractive error types	6 (2.86)	67 (67.67)	7 (7.07)	2 (2.02)	12 (12.12)	9 (9.09)

4.6.4 Distribution of Visually Impaired Participants Who had Refractive Error.

Only two (2) individuals had severe to blind vision impairment caused by refractive error and forty seven percent (47%) of the visually impaired, could have their vision restored to normal by wearing the appropriate glasses.

Table 4. 9 Distribution of visually impaired participants who had refractive error.

Types of refractive error	Categories of Vision impairment, n (%)			
	Mild	Moderate	Severe	Blind
Myopia	38 (38.38)	17 (17.17)	1 (1.01)	1 (1.01)
Hypermetropia	30 (30.30)	12 (10.10)	0(0)	0 (0)
All refractive error types	68 (68.38)	29 (29.29)	1 (1.01)	1 (1.01)

CHAPTER 5. DISCUSSIONS

5.1 Introduction

This cross-sectional study has provided data on vision impairment prevalence and causes as well as the statistical relationship between age, gender, occupation and vision impairment. The results are discussed with respect to the demographic characteristics and the four objectives of the study.

5.2 Demographic characteristics

There were more female participants as compared to males in all age range (Figure 4. 2). The females made up 61.4% of the respondents whilst the males were 31.46% of the total number of participants (Fisher's exact value = 0.026). The female to male ratio for this study was similar to the age adjusted national census female to male ratio for Ashanti region (Ghana Statistical Service, 2012) which also reported higher female population. This trend is consistent with population based vision impairment studies in Ghana (Kumah et al., 2013, Guzek et al., 2005, Budenz et al., 2012). The sampled population is therefore an appropriate representation of the Ashanti region.

5.3 Prevalence of distance vision impairment of adults aged 18 years and above in the Ashanti Region (Objective 1).

The prevalence of distance vision impairment in the Ashanti region based on presenting Visual acuity of 6/12 or worse in the better is 16.15% (n= 210, 95% CI, 14.15% – 18.16%). This result is much lower than similar studies from the India subcontinent where rates varied between 30% to 17.1% (Marmamula et al., 2011b, Nangia et al., 2013). But the rate is higher in studies from the developed world such North America by Robinson et al. (2013); Chou et al. (2013) and also in Europe (Rius et al., 2013, Reidy et al., 1998, Gunnlaugsdottir et al., 2013). It is very similar to studies from Africa by Oye et al. (2006) (16.7%) as well as in Ghana (17%) - Budenz et al. (2012).

The number of people with vision impairment was significantly higher in older age groups (Figure 4. 1). This trend is generally seen in all global estimates of vision impairment (Resnikoff et al., 2004, Pascolini and Mariotti, 2012, Freeman et al., 2013) and studies conducted in Ghana (Ntim-Amponsah, 2007, Guzek et al., 2005, Budenz et

al., 2012). Studies from the developed world had similar results (Buch et al., 2004, Gunnlaugsdottir et al., 2013).

The reason for the observed relationship may be due to the fact that most eye diseases such cataract glaucoma, hypertensive and diabetic retinopathy tend to be higher in prevalence in later years. Therefore with advanced age, the prevalence rate is expected to increase.

This study shows that females were more vision impaired than males (Table 4. 1). The observed trend of more women being vision impaired than men may be because in developing country like Ghana, women are less likely to seek eye care services because they are economically disadvantaged than their male counterparts (Lewallen and Courtright, 2002). Other cultural barrier, such as asking permission from a male counterpart before accessing eye care services (as reported especially in rural Ghana) may have played a role in the observed disparity (Asenso-Okyere et al., 1998). Moreover the result is not surprising as it corroborates other studies conducted in almost every continent (Zhu et al., 2013, Marmamula et al., 2013c, Hashemi et al., 2012, Freeman et al., 2013, Abdull et al., 2009). The gap may widen if no initiatives are rolled out to narrow or eliminate this disparity because women are more than men and have higher life expectancy than men in the region (Ghana Statistical Service, 2012).

5.4 Prevalence of near vision impairment of adults aged 18 years and above in the Ashanti Region (Objective 2).

Near vision problem is known to occur in old age. This study shows prevalence of 59.92 (95% CI 57.26 – 62.59) which is low compared to other studies possibly because this study included young adults (18 – 35 years) whilst others from Prakasam District, India; reported 61.8% (Marmamula et al., 2013b) and Durban, South Africa, reported 77% (Naidoo et al., 2013).

5.5 Causes of vision impairment of adults aged 18 years and above in the Ashanti Region (Objective 3).

The current study showed that refractive error is the major cause of vision impairment accounting for 47.14% of the visually impaired but 7.62% of the total participants. This is slightly higher than the global picture (43.3%) (Bakar et al., 2012, WHO, 2013c) but similar to findings from various studies around the continent: Asia; (Marmamula et al., 2012b, Marmamula et al., 2013c, Nangia et al., 2013, Nangia et al., 2012, Nangia et al., 2010) and Africa (Abdull et al., 2009, Sherwin et al., 2012).

Even in Ghana, the situation is no different, judging from the existing adult population based study - Budenz et al. (2012) reported 60%. This result does not compare however, with results from various studies in the developed world (Kocur and Resnikoff, 2002, Bakar et al., 2012, Gunnlaugsdottir et al., 2013); a finding already established by the WHO (WHO 2013b). In the developed countries, there is a shift of the major cause of vision impairment from URE to age related macular degeneration (Kocur and Resnikoff, 2002) possibly due to the availability of optometrists and refraction services.

5.5.1 Refractive error

Despite the slight shift in the developed world, the major (43%) cause of vision impairment in the world still remains uncorrected/ under corrected refractive error (Pascolini and Mariotti, 2012). The observed high rate of refractive error in this study underscore the need for revamping the refractive components of eye care programmes in the region and the provision of basic spectacles under the national health insurance scheme.

5.5.2 Cataract

Cataract was the second highest (42.86%) condition causing vision impairment (**Error! Reference source not found.**). This is similar to the global causes of vision impairment (Pascolini and Mariotti, 2012) as well as findings from other studies (Wang et al., 2013, Marmamula et al., 2011b, Edussuriya et al., 2009, Pascolini and Mariotti, 2012). This result demonstrates the need for upscaling of cataract surgical services if the goal of VISION 2020 are to be met in the region.

5.5.3 Other causes

Other causes of vision impairment such as diabetic retinopathy and other retinal disorders, age related macular degeneration etc. may exist but due to the limited scope of the protocol used in this study, differentiation of such conditions were not made. There is a need for future research with sufficient funding to quantify this. Other ocular diseases grouped under other causes includes two corneal scars and 1 phtisis bulbi.

Nonetheless, during the house to house data collection 10 (4.76%) visual impaired individuals self-reported being glaucoma patients. They substantiated this by showing prescribed anti-glaucoma medication.

The proportion of glaucoma may be underestimated in this study since gonioscopy, visual field assessment and tonometry were not done.

5.6 Types of uncorrected refractive errors that cause vision impairment in the Ashanti Region (Objective 4).

Most of the visually impaired participants with refractive error were myopes (57%) (4.6.1 Types of Refractive Error

It was observed generally that the older participants, the higher the prevalence of refractive error (Table 4.6), this relationship being statistically significant (Fisher's exact, $P= 0.000$). The age group with most number of participants with refractive error was the 60-69 years group followed by the 40-59 years group and then the 80-99 years group. The group with the least number of participants with refractive error was 18-39 years group.

Additionally, there were more myopes (57.57%) than hypermetropes (42.42%).

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). This result is not surprising because majority (64%) of the visually impaired were farmers. This result corroborates national and regional statistics that most workers in Ghana are agricultural workers (Ghana-Statistical-Service, 2012). It was observed that although not statistically significant, farmers had more refractive errors than other workers. Because farming in Ashanti region is largely an outdoor activity, perhaps, the relatively higher exposure to ultra violet (UV) light might explain the high rate. A review of articles done on the effect climate change on eye health concluded that worldwide climate variation is not only an important risk of presbyopia but also cataract and refractive error (Jaggernath et al., 2013). Work by Saari and Aine (1984) also reported a high prevalence of refractive error in agricultural workers in a Scandinavian population. Ultra violet radiation from the sun may denature the delicate crystalline lens proteins, resulting in lens nuclear sclerosis which consequently may lead to myopia (Jaggernath et al., 2013, Truscott and Zhu, 2010). The observed lower rate of hypermetropia was because most of participants with refractive error were more than sixty years old. It is a well-known fact, that hyperopia prevalence rate seems to increase with age till 50-59 years (Haegerstrom-Portnoy et al., 2014, Vincent and Read, 2014). After age sixty, nuclear sclerosis of the crystalline lens, causes the crystalline lens power to become more negative and thereby decreasing the net hyperopic power of the eye.

5.6.1 Refractive Error in Visually Impaired Participants

Prevalence of refractive error in the general population was 7.6%.

Chan et al. (2013b), conducted a population based study in Eritrea with 3200 participants 15 to 50 years and found the prevalence rate of refractive error in the population to be 6.4%. The work used the same 6/12 threshold but found lower rate. This is probably due to the differences in population demographic characteristics and the lower age of their respondents. Ntim-Amponsah (2007), did hospital based work in Greater Accra, Ghana in subjects 6 years and older and found vision impairment prevalence due to URE to be 4.8%. The lower rate found by (Ntim-Amponsah, 2007) may be due to the hospital based nature of the study. Hospital based studies cannot be reflective of the trend in the general population.

Ezelum et al. (2011) conducted a national eye survey in Nigeria and a crude prevalence rate of refractive error of 9.4% was found in visually impaired. This is higher than what was found in this study. The difference may be due to older age group used in the study by Ezelum et al. (2011). Higher prevalence of refractive error had been reported in the Indian population by Nangia et al. (2012) and Marmamula et al. (2013c) with prevalence rate of 17.42% and 15.73% respectively. Robinson et al. (2013) also found a higher prevalence in a Canadian population. These studies from North America and Asia reported higher rates because people from this geographical regions tend to do more near work (Yeo et al., 2013, Chan et al., 2013a), stay more indoors (Rose et al., 2008) and have genetic (Hysi et al., 2014, Verhoeven et al., 2013) propensity to develop myopia.

It was also noted that of the ninety nine (99) subjects who had refractive error and vision impairment only three (3) had their spectacles on during the data collection. This low spectacle coverage may be because limited refractive services are available, prescribed spectacles are too expensive (since the Ghana National Health Insurance does not cover optical corrections) or people may have poor perceptions about spectacle wear. Similar trends of poor spectacle coverage (3.3%) was reported by (Kumah et al., 2013) in Ghanaian children living in Kumasi, Ashanti region. Same trend had been reported in almost every continent in the world (Chan et al., 2013b, Shah et al., 2008, O'Donoghue et al., 2010). Admittedly, further studies on spectacle coverage and barriers to the uptake of refractive services need to be carried out in the region.

5.6.2 Refractive Error and Age

It was observed generally that, the older participants had a higher prevalence of refractive error (

Table 4. 6). This relation was statistically significant (Fisher's exact, $P = 0.000$). This finding is consistent with other studies conducted by (Robinson et al., 2013, Ezelum et al., 2011, Marmamula et al., 2013c) that found a positive relation with age and refractive error. More people in the age group of 60-79 years had myopia than the other age groups probably because of nuclear cataracts. The observed relationship between myopia and age had also been described in other studies in West Africa (Bekibele et al., 2007, Ezelum et al., 2011), Asia (Dandona et al., 1999), Americas (Wu et al., 2005) and in Ghana (Kumah et al., 2013). It was also noted that prevalence of hypermetropia increased with age up to age group 60-79. This trend is consistent with studies done in Asia (Saw et al., 2008, Shah et al., 2008); in Black Americans (Wu et al., 1999) and in West Africa (Ezelum et al., 2011).

5.6.3 Refractive Error and Categories of Vision impairment

Only two (2) individuals had severe to blind vision impairment caused by refractive error (Table 4. 9). However, 47.14% of the visually impaired could have their vision restored to normal by wearing the appropriate glasses. This result corroborates the findings in other studies done in Ghana (Ovenseri-Ogomo and Adofo, 2011, Ntim-Amponsah, 2007, Kumah et al., 2013, Budenz et al., 2012) that concluded that refractive error is the leading cause of vision impairment in Ghana. The authors suggested that more Optometrists were needed to be deployed in the public health system to prevent this avoidable visual loss.

CHAPTER 6. CONCLUSION

6.1 Introduction

This study sought to assess the contribution of URE to Vision impairment in Ashanti Region, Ghana. The study specifically determined the prevalence of distance and near vision impairment of adults aged 18 years and above in the Ashanti region of Ghana; the causes of vision impairment in the Ashanti region of Ghana; types of uncorrected refractive errors that causes vision impairment in the Ashanti region of Ghana as well as the relationship between age, gender and vision impairment. The following limitations, conclusions and recommendations were made.

The prevalence of distance vision impairment in Ashanti region based on presenting visual acuity of 6/12 or worse in the better is 16.15% (n= 210, 95% CI, 14.15% – 18.16%). The number of people with vision impairment was significantly higher in older age groups. This study shows that females were more vision impaired than males and most of the visually impaired were farmers.

The prevalence of near vision impairment was 59.92% (95% CI 57.26 – 62.59) of which 87.93% were correctable with spectacles. Age was significantly associated with near vision impairment with Fisher's exact test value of 0.000 and the mean age of those with near vision impairment was 58.45, standard deviation of ± 12.73 . The risk of females developing near vision loss was higher than males but the observation was not statistically significant.

Refractive error was the leading cause of vision impairment with 47.14% (n = 99, 95% CI of 40.33 - 53.9). Cataract was the second leading cause of vision impairment with 42.86% (n = 90, 95% CI of 36.10 - 49.61) and other causes of vision impairment prevalence was 10.00% (n= 21, 95% CI of 5.90 – 14.09). More females had vision impairment than males in each of the causes but the observed difference was not statistically significant (Fisher's exact, p = 0.312).

This study showed that refractive error is the major cause of vision impairment accounting for 47.14% of the visually impaired but 7.62% of the total participants.

Majority of participants with refractive error were myopes (58%). Forty two percent (42%) were hyperopes and 18% had astigmatism. The mean myopic power was -1.57DS with standard deviation of ± 0.65 and the mean hypermetropic power was +1.07 with standard deviation of ± 0.99 . It was observed generally that the older participants, the higher the prevalence of refractive error (Fisher's exact, $P= 0.000$) and most participants with refractive errors were farmers. The age group with most refractive errors was the 60-69 years group followed by the 40-59 years group. The odds ratio of female having refractive error was 1.19 (95% CI, 0.62 – 2.29) with males being the reference but the odd ratio observed was not statistically significant (p value of 0.596). Only two (2) individuals had severe to blind vision impairment caused by refractive error and forty seven percent (47%) of the visually impaired, could have their vision restored to normal by wearing the appropriate glasses.

6.2 Limitations

A number of limitations may have affected the study results. The eye examination was limited to visual acuity, pen torch exam, pinhole examination, near and distance refraction and undilated fundus examination. Therefore posterior segment diseases, such as age-related macular degeneration, retinal problems, etc. were not objectively captured and was classified as 'others causes'. Additionally, due to financial constraints, visual field test, gonioscopy, tonometry and dilated fundus examination, which would have increased the accuracy of diagnosing glaucoma, were not done. As the objective diagnoses of glaucoma was not done, any suspicion of the condition was also reported as 'other causes' of vision impairment. However, the RAVI protocol used in this study had been fully validated and many studies reported the causes of vision impairment as was done in this study (Marmamula et. al., 2010, Marmamula et. al., 2013).

The uncorrected refractive error that causes vision impairment results in the 18 to 39 year group may not be a true representative as cycloplegic refraction was not done for the participants of age 18-25 years as suggested by some studies such as Sanfilippo et al., (2014). However, their representation in the whole study was minimal and the standard refraction protocol employed in this study may minimize the overall effect of not doing cyclo-refraction on this group

6.3 Recommendations

As a result of the study, the following recommendations are made:

1. More Optometrist need to be trained and deployed in public health system to prevent avoidable visual loss from uncorrected vision impairment correctable with spectacle usage.
2. There should be further studies into the barriers to the use spectacles and spectacle coverage among individuals with refractive error in Ashanti region of Ghana. This is to obtain specific proportions of individual with uncorrected refractive error who could benefit from spectacle usage as well as the factors that prevent spectacle wear so that this can inform refractive error programs.
3. There should be the inclusion of spectacle provision in the National Health Insurance Scheme.
4. Access to affordable spectacles should be increased in both the private and public sector.

6.4 Significance of Study

The results of the study can contribute to a number of issues, including the following:

- add to the few vision impairment studies in Ghana,
- provide baseline data for other studies of vision impairment in the Ashanti Region,
- planning eye care programmes,
- developing policies and strategies to reduce vision impairment in the Ashanti Region and possibly other areas of Ghana.

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APPENDIX

APPENDIX A

University of KwaZulu-Natal

Africa Vision Research Institute/ Brien Holden Vision Institute

Contribution of Refractive Errors to Visual Impairment in Ashanti Region, Ghana

Data forms

Cluster No:.....

Case No:

Date: 20...

Age:yrs

Gender: M / F

Add/Location: Occupation:

History:

VA Pd:/.....mm

	WoRx	WRx	PH	NVA
OD				
OS				

OU				
----	--	--	--	--

For VA < 6/12: Do you wear spectacles? Y/ N

Examination

RIGHT EYE

LEFT EYE

.....	Lids/Lashes
.....	Cornea/Conj.
.....	A/C
.....	Pupils
.....	Vitreous
.....	Disc Margins
.....	C/D
.....	Neuroretinal Rim.....
.....	Peripapillary Region.....
.....	Nerve Fibre Layer
.....	Peripheral Retina.....
.....	Arteries/Veins
.....	Macular Area

Diagnosis:.....

Primary cause of visual impairment: Right eye:.....

Left eye:.....

Refraction results

	Sphere	Cyl	Axis	DxVA	ADD	NxVA
OD						
OS						

Plan

Comments

Signature.....

(Clement Afari, OD)

APPENDIX B



13 November 2013

Dr C Afari
Dep of Optometry and Visual Science
KNUST.PMB
Kumasi,
Ghana
clmafari@gmail.com

PROTOCOL: Contribution of Refractive Error to Visual Impairment in Ashanti Region, Ghana: BE331/13

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 02 September 2013.

The study was provisionally approved pending appropriate responses to queries raised. Your responses received on 31 October 2013 to queries raised on 18 October 2013 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 13 November 2013.

This approval is valid for one year from **13 November 2013**. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its next meeting taking place on **10 December 2013**.

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely


Professor D.R. Wassenaar
Chair: Biomedical Research Ethics Committee

Professor D Wassenaar (Chair)
Biomedical Research Ethics Committee
Westville Campus, Govan Mbeki Building

Postal Address: Private Bag X54001, Durban, 4000, South Africa

Telephone: +27 (0)31 260 2384 Facsimile: +27 (0)31 260 4609 Email: brec@ukzn.ac.za

Website: <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>

Founding Campuses:  Edgewood  Howard College  Medical School  Pietermaritzburg  Westville

INSPIRING GREATNESS



APPENDIX C

GHANA HEALTH SERVICE ETHICAL REVIEW COMMITTEE

*In case of reply the
number and date of this
letter should be quoted.*

My Ref. :GHS-ERC: 3
Your Ref. No.



Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: nanatuesdaykad@yahoo.com

29th October, 2013

Clement Afari,
Department of Optometry and Visual Science
KNUST, Kumasi

ETHICAL APPROVAL - ID NO: GHS-ERC: 14/09/13

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol titled:

"Contribution of Refractive error to Visual Impairment in Ashanti Region, Ghana"

This approval requires that you inform the Ethical Review Committee (ERC) when the study begins and provide Mid-term reports of the study to the Ethical Review Committee (ERC) for continuous review. The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Please note that any modification without ERC approval is rendered invalid.

You are also required to report all serious adverse events related to this study to the ERC within seven days verbally and fourteen days in writing.

You are requested to submit a final report on the study to assure the ERC that the project was implemented as per approved protocol. You are also to inform the ERC and your sponsor before any publication of the research findings.



Please always quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....

DR. CYNTHIA BANNERMAN
(GHS-ERC VICE-CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

APPENDIX D

 Service and Development	BOSOMTWE DISTRICT ASSEMBLY <small>In case of reply the number and date of this letter should be quoted</small> Tel: 20146 / Fax: 051-20142	 Office of the District Administration Post Office Box 24 Kuntanase, Ashanti Ghana-West Africa
Our Ref: AB. 1/4/02		9TH SEPTEMBER, 2013
Your Ref:		Date:

**RESEARCH AND ETHICAL COMMITTEE
GHANA HEALTH SERVICE
ACCRA**



PERMISSION: CLEMENT AFARI

I write to grant permission to Clement Afari from the department of Optometry and Visual Science, Kwame Nkrumah University of Science and Technology (KNUST) to collect data in Bosomtwe District. His research title is contribution of refractive error to visual impairment in Ashanti Region Ghana.

Counting on your co-operation.


for: **DISTRICT CHIEF EXECUTIVE
(JOHN K. ADOMAKO)
DISTRICT CO-ORD DIRECTOR**

APPENDIX E


 <p>In case of reply the number and date of this letter should be quoted Tel: 0322-195674 0322-195675 Email: ejisujuabenassembly@yahoo.com Our Ref: EJMA/LI/Vol.2/85 Your Ref:</p>	 <p>REPUBLIC OF GHANA</p>	<p>Office of the Municipal Administration P. O. BOX 12 Ejisu-Ashanti Ghana</p>
		Date: 10 th Sept, 2013.

PERMISSION TO UNDERTAKE RESEARCH
DR. CLEMENT AFARI

We wish to inform you that Dr. Clement Afari, a staff of the Department of Optometry and Visual Science, College of Science, Kwame Nkrumah University of Science and Technology (KNUST), has been granted permission by this Assembly to undertake his research work on the Contribution of Refractive Error to Visual Impairment, in this municipality.

This is for your kind information and necessary action, please.



Thank you.


FOR: MUNICIPAL CHIEF EXECUTIVE
(OWUSU FREMPONG-BOADU)
MUNICIPAL CO-ORD. DIRECTOR

THE CHAIRMAN
ETHICAL COMMITTEE
GHANA HEALTH SERVICE
ACCRA

Cc:- Dr. Clement Afari ✓
KNUST, Kumasi

APPENDIX F

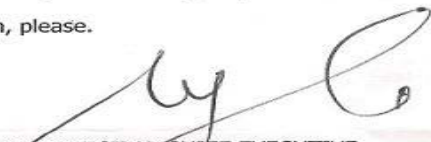
	EJISU-JUABEN MUNICIPAL ASSEMBLY	
In case of reply the number and date of this letter should be quoted Tel: 0322-195674 0322-195675 Email: ejisujuabenassembly@yahoo.com Our Ref: EJMA/LI/Vol.2/85	 REPUBLIC OF GHANA	Office of the Municipal Administration P. O. BOX 12 Ejisu-Ashanti Ghana
Your Ref:		Date: 10 th Sept, 2013.

PERMISSION TO UNDERTAKE RESEARCH
DR. CLEMENT AFARI

We wish to inform you that Dr. Clement Afari, a staff of the Department of Optometry and Visual Science, College of Science, Kwame Nkrumah University of Science and Technology (KNUST), has been granted permission by this Assembly to undertake his research work on the Contribution of Refractive Error to Visual Impairment, in this municipality.

This is for your kind information and necessary action, please.

Thank you.


FOR. MUNICIPAL CHIEF EXECUTIVE
(OWUSU FREMPONG-BOADU)
MUNICIPAL CO-ORD. DIRECTOR

THE CHAIRMAN
ETHICAL COMMITTEE
GHANA HEALTH SERVICE
ACCRA

Cc:- Dr. Clement Afari ✓
KNUST, Kumasi