RELATIONSHIP BETWEEN VISUAL ANOMALIES AND HEARING IMPAIRMENT

BY

NWACHUKWU SAMUEL AFIEVAHOL

LSC2007126

FACULTY OF OPTOMETRY

UNIVERSITY OF BENIN

BENIN CITY

NOVEMBER, 2025.

RELATIONSHIP BETWEEN VISUAL ANOMALIES AND HEARING IMPAIRMENT

BY

NWACHUKWU SAMUEL AFIEVAHOL

LSC2007126

A PROJECT WORK SUBMITTED TO THE FACULTY OF OPTOMETRY, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD DOCTOR OF OPTOMETRY (OD) DEGREE IN OPTOMETRY

NOVEMBER, 2025.

CERTIFICATION

This is to certify that this research project titled: **(RELATIONSHIP BETWEEN VISUAL ANOMALIES AND HEARING IMPAIRMENT)** was carried out by **(NWACHUKWU SAMUEL AFIEVAHOL)** in the Faculty of Optometry University of Benin in partial fulfillment of the requirement for the DOCTOR OF OPTOMETRY (OD) degree in the 2024/2025 Academic Session.

……………………………… **……………………………..**

DR. AKPALABA R.U.E (ASSOC. PROFESSOR) **DATE**

(PROJECT SUPERVISOR)

………………………………… **……………………………..**

DR JUNO O. OKUKPON **DATE**

(PROJECT COORDINATOR)

………………………………… **……………………………..**

PROF. (MRS.) EKI OGHRE **DATE**

(DEAN FACULTY OF OPTOMETRY)

………………………………… **……………………………**

EXTERNAL EXAMINER **DATE**

DEDICATION

This work is dedicated to God Almighty for his unconditional love, abundant grace, and unending favour, for giving me the strength, sound mind, wisdom, knowledge and understanding, for His guidance all through my years in the University of Benin and to my wonderful and supportive mother whose sacrifices, love and prayers have helped me thus far and to myself for putting in the long hours despite the challenges and difficulties faced during the course of this project.

ACKNOWLEDGEMENT

First and foremost, I extend my deepest gratitude to my mother, Mrs. Nwachukwu Beauty and my Father Mr. Nwachukwu Precious, whose unwavering love, prayers, and encouragement have been my greatest sources of strength throughout this journey. Their belief in me has been a constant motivation, and I am truly grateful for their endless support. I also express my sincere appreciation to my Aunt, Elizabeth Egware for her kindness.

I am immensely grateful to my supervisor, Assoc. Prof. R.U.E. Akpalaba, for his invaluable assistance, his guidance, patience, and insights have been instrumental in refining my work, and I deeply appreciate his dedication to my academic growth. I also extend my appreciation to the staffs at Izevibigie school of the hearing impaired and Ihogbe college.

A special thank you goes to my research partners, Daniel, Frances, Joel, Daberechi, Favour, Ifeoma, Nosa, Emmanuel, Chinelo, Blessing, Henry, Omosimuwa, Nwaelue, whose collaboration and commitment made this project a rewarding experience. Their support, teamwork, and shared enthusiasm have been invaluable, and I truly appreciate their contributions.

To everyone who has supported me throughout this journey, directly or indirectly, I offer my sincere gratitude. This accomplishment would not have been possible without your encouragement, generosity, and belief in me.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Background: Dual sensory impairment, involving both visual and auditory deficiencies, significantly impacts an individual's ability to communicate, learn, and navigate their environment. Research suggested that hearing-impaired individuals were at a higher risk of developing ocular abnormalities, including refractive errors and contrast sensitivity deficits. Given their reliance on vision for communication, understanding the prevalence and nature of visual impairment in this population was crucial for effective healthcare interventions. **Purpose:** To determine the relationship between visual and hearing impairment in affected individuals. **Method:** A cross-sectional study was conducted at the school for the hearing impaired in Benin City using purposive sampling. Participants were selected based on inclusion criteria, with demographic and hearing-impairment data obtained from school records and teachers. Visual assessments included Tumbling E visual acuity testing, ophthalmoscopy, retinoscopy, subjective refraction, contrast sensitivity testing using the Pelli-Robson chart, and cover test. Data were collected using structured forms and analyzed using SPSS Version 25.0. **Data Analysis:** Descriptive and inferential statistical methods were employed. The prevalence of visual impairment and contrast sensitivity abnormalities was determined. Chi-square tests assessed associations between age, gender, and dual sensory impairment. **Results:** Among the 100 hearing-impaired participants examined, hyperopia (34%) was the most common refractive anomaly, followed by compound hyperopic astigmatism (15%), while mixed astigmatism (4%) was the least. Visual impairment before correction was 6%, and after refraction, normal vision increased to 96% with 2% impaired. Contrast sensitivity was normal in 96% of participants, with 2% showing mild reduction. No severe visual impairment, blindness, or significant association with age or gender was found. **Conclusion:** Hearing-impaired individuals showed a high prevalence of correctable refractive errors. Most visual deficits improved with refraction, underscoring the importance of routine vision screening and timely optical correction in schools for the hearing impaired. **Contribution to Optometry:** This study provided valuable insights into the relationship between visual and auditory impairments, supporting improved screening and management strategies for individuals with dual sensory impairment.

Keywords: Dual sensory impairment, visual impairment, visual anomalies, hearing impairment, refractive errors, contrast sensitivity, optometry, deaf school, vision screening.

CHAPTER ONE

1.0 INTRODUCTION

Visual and auditory impairments were widespread public-health issues that significantly affected communication, learning, and independent functioning. Across the globe, disorders involving vision and hearing impacted millions of individuals and placed considerable strain on health and rehabilitation systems (World Health Organization, 2019; World Health Organization, 2021). Visual problems ranged from refractive errors that were correctable to more complex conditions that diminished visual acuity or field even after correction. They also encompassed subtle functional limitations—such as reduced contrast sensitivity—that impaired visual performance despite apparently normal acuity (Resnikoff et al., 2008; Radhakrishnan et al., 2004).

Within the context of this study, visual anomalies referred to departures from normal visual function that reduced efficiency or comfort. These included uncorrected or under-corrected refractive errors, amblyopia, binocular vision anomalies, diminished contrast sensitivity, and observable anterior or posterior segment changes. Together, these parameters were evaluated to determine the extent of visual disorders among individuals with hearing impairment (Benjamin, 2006; Bennett & Rabbetts, 2007; Salmon, 2024).

Hearing impairment was described as a partial or total loss of the ability to perceive sound in one or both ears. Participants were identified as hearing-impaired based on available school health documentation or previous audiological assessments (World Health Organization, 2021). When both vision and hearing deficits coexisted—an occurrence termed dual sensory impairment (DSI)—the combined effects were more severe than those of either condition alone. Such individuals often experienced poorer functional outcomes, increased social withdrawal, cognitive decline, and greater dependency compared with those who had only one sensory loss (Gopinath et al., 2013; Swenor et al., 2013; Bright et al., 2023). For operational clarity, DSI was defined as the coexistence of a documented hearing impairment with a visual impairment classified in line with WHO/ICD-11 visual acuity standards (World Health Organization, 2019).

In this study, visual impairment denoted a functional limitation in vision that could not be fully corrected by optical, medical, or surgical intervention and which interfered with normal daily tasks. Earlier epidemiological and clinic-based research had shown a higher prevalence of ocular disorders among people with hearing loss, with uncorrected refractive errors, allergic and conjunctival conditions, and other manageable ocular abnormalities being particularly frequent (Abah et al., 2011; Gogate et al., 2009; Pehere et al., 2019).

Reports from sub-Saharan Africa and other low- and middle-income regions further revealed limited access to routine eye examinations for deaf and hard-of-hearing schoolchildren. Consequently, many simple and affordable visual interventions—such as spectacle correction—were missed. The gap was most evident in communities where specialised eye care was either unavailable or poorly coordinated with hearing-care services (Adegbehingbe et al., 2005; Kwarteng et al., 2022; Osaiyuwu & Ebeigbe, 2010).

Among this population, contrast sensitivity warranted particular attention because its reduction hindered mobility, reading performance, and facial recognition even when high-contrast visual acuity remained normal. Prior investigations reported that auditory deprivation was sometimes associated with altered visual processing and measurable reductions in contrast sensitivity, suggesting that comprehensive visual assessments should extend beyond standard distance acuity testing (Finney & Dobkins, 2001; Khorrami-Nejad et al., 2018; Radhakrishnan et al., 2004).

Considering the vital role of vision in compensating for hearing loss and the evidence of a considerable yet partly treatable ocular burden, it became important to evaluate visual anomalies systematically among hearing-impaired individuals. The present study therefore investigated the prevalence and nature of visual anomalies among hearing-impaired individuals, with particular attention to refractive errors and contrast sensitivity abnormalities.

1.1 BACKGROUND INFORMATION

In Nigeria, sensory health has remained an under-recognized component of public health—particularly among individuals with special needs. Although hearing impairment is widely acknowledged for its effects on communication, education, and social participation, the accompanying visual challenges in this population have often been overlooked (Abah et al., 2011; Abikoye et al., 2020). Many hearing-impaired individuals depend almost entirely on visual cues to navigate the world—lip-reading, facial expressions, and sign language serve as their primary means of interaction. Consequently, even a mild disturbance in visual function can profoundly affect their ability to communicate, learn, and live independently (Finney & Dobkins, 2001; Khorrami-Nejad et al., 2018). Despite this heavy reliance on vision, systematic vision screening and specialized eye-care services are seldom prioritized in schools for the hearing impaired across Nigeria (Adegbehingbe et al., 2005; Osaiyuwu & Ebeigbe, 2010).

The coexistence of visual and auditory deficits—commonly described as *dual sensory impairment* (DSI)—creates a compounded disability that significantly limits educational achievement, social interaction, and independence (Gopinath et al., 2013; Swenor et al., 2013; Bright et al., 2023). Students living with DSI often experience greater challenges in mobility, orientation, and classroom participation compared to those with single sensory loss. This reality is particularly evident in learning environments where visual cues are indispensable for understanding instruction and engaging in academic activities.

Empirical evidence from Nigeria and other regions underscores the notable prevalence of visual anomalies among hearing-impaired populations. In Kaduna, Abah et al. (2011) observed that 20.9% of deaf students exhibited ophthalmologic abnormalities, with refractive error being the most common. Similarly, Ovenseri-Ogbomo and Omuemu (2010) found that

5.8% of hearing-impaired schoolchildren in Ghana presented with significant visual problems, mainly refractive errors and strabismus. In Lagos, Abikoye et al. (2020) reported a high prevalence of visual impairment among hearing-impaired students, with refractive error again emerging as the leading cause. Collectively, these findings reveal that a substantial proportion of individuals with hearing impairment contend with preventable or treatable visual challenges, which in turn aggravate their functional limitations and diminish overall quality of life.

Globally, research continues to emphasize the interdependence of vision and hearing in shaping quality of life. Chia et al. (2006) highlighted that these sensory impairments often coexist, jointly reducing independence, social engagement, and psychological well-being. Finney and Dobkins (2001) further demonstrated that deaf individuals may undergo adaptive changes in visual processing—such as heightened peripheral awareness and contrast sensitivity differences—reflecting neural plasticity in response to auditory deprivation. Yet, despite these adaptations, structural ocular anomalies like refractive errors, amblyopia, and strabismus remain frequent and can interfere with daily functioning. Notably, Khorrami-Nejad et al. (2018) reported that over half of deaf individuals exhibit contrast sensitivity abnormalities, which can compromise mobility, spatial orientation, and the interpretation of visual communication cues.

Biologically, the frequent coexistence of auditory and visual impairments is not coincidental. Both the eye and ear share embryological origins and interconnected neural pathways responsible for sensory integration (Delmaghani & El-Amraoui, 2022). Thus, disturbances during early development—such as congenital infections, genetic mutations, or exposure to ototoxic substances—can simultaneously affect both organs. Syndromic conditions like *Usher syndrome* exemplify this link, combining congenital hearing loss with progressive retinal degeneration (Pennings et al., 2004; Nikolopoulos et al., 2006). Even in non-syndromic cases, neuroplastic adaptation enables hearing-impaired individuals to rely more heavily on visual attention and peripheral perception (Chung & Legge, 2007). However, these neural compensations do not eliminate the risk of refractive or structural ocular anomalies, which remain relatively common within this group.

From a functional standpoint, vision serves as the primary gateway through which hearing-impaired individuals perceive and interpret their surroundings. It is vital for recognizing facial expressions, reading lips, and interpreting sign language—all essential for effective communication (Thibos et al., 2002; Radhakrishnan et al., 2004). Even slight refractive errors or reduced contrast sensitivity can disrupt these processes, leading to miscommunication, diminished academic participation, and social withdrawal (Hashemi et al., 2017; Fuller-Thomson et al., 2022). Left uncorrected, such anomalies can erode independence, limit engagement in daily activities, and ultimately degrade quality of life.

Unfortunately, routine vision assessment in schools for the hearing impaired remains limited in Nigeria. Correctable conditions such as hyperopia, astigmatism, binocular vision anomalies, and reduced contrast sensitivity often persist unnoticed. The reasons are multifactorial: inadequate access to optometric services, communication barriers between practitioners and students, and a general lack of awareness among educators (Khandekar et al., 2009; Abikoye et al., 2020). Moreover, public health programs tend to focus predominantly on hearing rehabilitation, with little integration of visual health into special-education frameworks (Moyegbone et al., 2020). When screenings do occur, they are often generic and not adapted to the needs of deaf learners—lacking interpreters or appropriate communication strategies—resulting in under-diagnosis and undertreatment (Ostadimoghaddam et al., 2015; Johnston et al., 2010).

Understanding the nature and prevalence of visual anomalies among hearing-impaired individuals is therefore crucial for shaping effective interventions and policy. Variables such as age and gender have also been identified as possible correlates of dual sensory impairment (Huang et al., 2024; Kuo et al., 2021). Generating reliable local data can inform targeted advocacy for integrating optometric care into special education programs and for equipping schools for the deaf with basic screening tools (Chioma et al., 2022; Pardhan et al., 2021). Such data-driven initiatives are essential for improving eye-care accessibility, guiding inclusive policy, and ultimately alleviating the burden of dual sensory impairment in Nigeria.

In light of these considerations, the present study focused on determining the prevalence and characteristics of visual anomalies among hearing-impaired individuals and examining their relationship with auditory impairment. By documenting the ocular health burden in this population, this research sought to increase awareness among educators, clinicians, and policymakers, advocating for the inclusion of routine eye examinations in the management of hearing-impaired individuals. Ultimately, such measures could improve functional outcomes, enhance educational experiences, and raise the overall quality of life for persons living with dual sensory impairment in Nigeria.

1.2 STATEMENT OF THE PROBLEM

Hearing impairment alone presents significant barriers to communication, learning, and social integration. For most individuals with hearing loss, vision becomes the principal medium for understanding and engaging with their environment. Any decline in visual function, therefore, exerts a magnified effect—compounding the difficulties already associated with auditory deprivation. Yet, despite its importance, visual health among hearing-impaired individuals remains largely neglected within clinical and public health frameworks in Nigeria.

Findings from previous studies indicate that individuals with hearing impairment are more susceptible to visual anomalies such as uncorrected refractive errors, strabismus, amblyopia, and reduced contrast sensitivity than the general population. However, in Nigeria, routine comprehensive eye examinations are rarely integrated into the care or educational programs for hearing-impaired individuals, especially within special schools. Many of these students have never undergone full optometric evaluation, and their ocular issues often remain undetected until they begin to interfere with academic performance or everyday functioning.

This gap is further compounded by several systemic barriers: a shortage of optometrists in special-education settings, low awareness among teachers and caregivers, communication difficulties during eye examinations, and limited access to affordable corrective options. Consequently, numerous preventable or treatable visual conditions persist untreated, undermining visual performance and overall quality of life.

Moreover, there is a notable scarcity of empirical data in Nigeria regarding the specific patterns and determinants of visual anomalies among hearing-impaired individuals, as well as the influence of demographic factors such as age and gender. This lack of data restricts the development of targeted screening programs, evidence-based interventions, and inclusive educational policies tailored to this population's unique needs.

Hence, there is an urgent need to evaluate the visual status of hearing-impaired individuals, determine the prevalence and types of visual anomalies they experience, and explore their relationship with auditory impairment. Addressing this gap will not only facilitate early detection and appropriate management but also contribute to improved functional and educational outcomes, ultimately enhancing the quality of life for individuals living with dual sensory impairment.

1.3 AIMS AND OBJECTIVES

1.3.1 AIM

The primary aim of this study is to investigate the relationship between visual anomalies and hearing Impairment

1.3.2 OBJECTIVES

1. To determine the nature and prevalence of visual anomalies among hearing-deficient individuals.
2. To determine contrast sensitivity abnormalities in hearing-impaired individuals.
3. To determine the relationship between gender and dual sensory impairment (visual and auditory).
4. To determine the relationship between age and dual sensory impairment (visual and auditory).
5. To classify the grades of visual impairment in hearing-impaired individuals.
6. To determine the relationship between visual and hearing Impairment

1.4 HYPOTHESES

Null Hypothesis (Ho_1): There is no significant relationship between hearing impairment and the nature or prevalence of visual impairment.

Null Hypothesis (Ho_2): There is no significant difference in contrast sensitivity between hearing-impaired individuals and those with normal hearing.

Null Hypothesis (Ho_3): There is no significant relationship between gender and dual sensory impairment (visual and auditory).

Null Hypothesis (Ho_4): There is no significant relationship between age and dual sensory impairment (visual and auditory).

Null Hypothesis (Ho_5): There is no significant difference in the classification of visual impairment among hearing-impaired individuals.

Null Hypothesis (Ho_6): There is no significant relationship between visual impairment and hearing Impairment.

1.5 RESEARCH QUESTIONS

1. What is the nature and prevalence of visual anomalies among hearing-impaired individuals?
2. What types of contrast sensitivity abnormalities are present among hearing-impaired individuals?
3. Is there a significant relationship between gender and the occurrence of dual sensory impairment?
4. Is there a significant relationship between age and the occurrence of dual sensory impairment?
5. What are the grades of visual impairment found among hearing-impaired individuals?
6. What is the relationship between visual impairment and hearing impairment among the study population?

1.6 SIGNIFICANCE OF THE STUDY

1. Contribution to Optometry and Eye Care: This study will provide data on the prevalence and nature of visual impairment among hearing-impaired individuals, guiding optometrists in developing targeted screening and management strategies.
2. Improvement of Screening Programs: The findings will emphasize the need for routine vision screening in schools for the deaf, ensuring early detection and timely intervention.
3. Policy Development: The study will support policy recommendations for integrating vision screening into the healthcare management of hearing-impaired individuals in Nigeria.
4. Enhancing Educational and Social Outcomes: Addressing uncorrected visual impairments will contribute to improved educational performance and social integration for hearing-impaired individuals.

5. Future Research: The study will serve as a foundation for further research on dual sensory impairment, including intervention strategies and assistive technologies.

1.7 DEFINITION OF TERMS

1. Visual Anomalies

Visual anomalies refer to deviations from normal visual function that reduce visual efficiency or comfort. In this study, visual anomalies included uncorrected or under-corrected refractive errors, amblyopia, binocular vision dysfunctions, reduced contrast sensitivity, and observable anterior or posterior segment abnormalities. These parameters were assessed to quantify the burden of visual disorders among hearing-impaired individuals (Benjamin, 2006; Bennett & Rabbetts, 2007; Salmon, 2024).).

2. Hearing Impairment

Hearing impairment was defined as a partial or complete reduction in the ability to perceive sound in one or both ears. Participants were classified as "hearing impaired" based on school health records or documented audiological assessments (World Health Organization, 2021).

3. Dual Sensory Impairment (DSI)

Dual sensory impairment denotes the simultaneous presence of both visual and hearing deficits in an individual. Operationally, it was defined as the coexistence of a documented hearing impairment with visual impairment classified according to WHO/ICD-11 visual acuity criteria (World Health Organization, 2019).

4. Visual Impairment

Visual impairment is a functional reduction in vision that cannot be fully corrected through optical, medical, or surgical means and interferes with daily activities. This study used the WHO/ICD-11 classification in the better eye:

Normal vision: ≥6/12

Mild visual impairment: <6/12 to 6/18

Moderate visual impairment: <6/18 to 6/60,

Severe visual impairment: <6/60 to 3/60

Blindness: <3/60

Both presenting and best-corrected visual acuities were measured to differentiate correctable from permanent impairment (World Health Organization, 2019).

5. Refractive Errors

Refractive errors are optical disorders in which parallel rays of light fail to focus on the retina when accommodation is relaxed. They were classified in this study based on the spherical equivalent:

Emmetropia: −0.50 D to +0.50 D

Myopia: ≤ −0.50 D

Hyperopia: ≥ +0.50 D

Astigmatism: Cylindrical power ≥ 0.75 D (Benjamin, 2006; Bennett & Rabbetts, 2007).

6. Myopia

Myopia is a condition where light focuses in front of the retina when the eye is unaccommodated, resulting in blurred distance vision. Operationally, it was defined as a spherical equivalent of −0.50 D or greater (Benjamin, 2006).

7. Hyperopia

Hyperopia occurs when parallel light rays focus behind the retina in the unaccommodated eye, causing blurred near or distance vision. It was defined as a spherical equivalent of +0.50 D or greater (Benjamin, 2006).

8. Astigmatism

Astigmatism arises from unequal refractive power in the principal meridians of the eye. Clinically significant astigmatism was taken as cylindrical power ≥0.75 D. Subtypes were classified as:

Simple Myopic Astigmatism (SMA): One meridian emmetropic, other myopic.

Simple Hyperopic Astigmatism (SHA): One meridian emmetropic, other hyperopic.

Compound Myopic Astigmatism (CMA): Both meridians myopic, unequal.

Compound Hyperopic Astigmatism (CHA): Both meridians hyperopic, unequal.

Mixed Astigmatism: One meridian myopic, other hyperopic (Bennett & Rabbetts, 2007).

9. Amblyopia

Amblyopia is a developmental reduction in best-corrected visual acuity not attributable to structural ocular defects. It results from abnormal visual experience during the critical period of visual development, commonly caused by anisometropia, strabismus, or visual deprivation (Salmon, 2024).

10. Contrast Sensitivity

Contrast sensitivity is the visual system's ability to discern differences in luminance between an object and its background. It provides complementary information to visual acuity, particularly under low-contrast conditions (Pelli, Robson & Wilkins, 1988).

11. Contrast Sensitivity Abnormality

This refers to a reduction in contrast sensitivity below the expected range for age and testing conditions. In this study, the Pelli-Robson chart thresholds were applied to categorize severity: normal, mild, moderate, or severe reduction (Elliott, 2014; Pelli, Robson & Wilkins, 1988).

12. Binocular Vision

Binocular vision describes the ability of both eyes to work together to create single, fused perception and depth appreciation (stereopsis). It was evaluated using cover/uncover tests, alternate cover test, and convergence assessment (Salmon, 2024).

13. Visual Acuity (VA)

Visual acuity quantifies the eye's ability to resolve detail. Distance VA was measured using the Tumbling E chart at six metres, recorded before and after correction, and categorized according to WHO/ICD standards (World Health Organization, 2019).

14. Visual Screening

Visual screening is a simplified evaluation to identify individuals requiring comprehensive eye examination. Procedures included distance and near VA, anterior segment inspection, and referral for full optometric assessment (Elliott, 2014).

15. Optometric Evaluation

A detailed assessment of the visual system including refraction (objective and subjective), binocular vision testing, contrast sensitivity evaluation, and ocular health examination using direct ophthalmoscopy (Benjamin, 2006).

16. Ocular Abnormality

Ocular abnormality encompasses structural or pathological changes in the eye, such as corneal opacities, cataracts, conjunctivitis, or retinal lesions, potentially requiring medical or surgical management (Salmon, 2024).

17. Prevalence

Prevalence is the proportion of individuals in a population with a specific condition at a particular point in time. In this study, it represented the percentage of participants with visual anomalies among the total examined.

18. Sample Population

The sample population consisted of cooperative hearing-impaired students from special schools in Benin City who met inclusion and exclusion criteria.

19. Gender

Gender refers to the biological categorization of participants as male or female, used to analyze differences in the occurrence of visual anomalies.

20. Age

Age refers to chronological age in completed years, grouped as 5–8, 9–12, 13–16, 17–20, 21–24, and 25–29 years, to examine age-related visual patterns.

21. Special School for the Hearing Impaired

These are educational institutions providing tailored instruction and communication for learners with hearing loss. Two schools served as sampling sites: Izevibigie School of the Hearing Impaired and Ihogbe College.

22. Tumbling E Visual Acuity Chart

A non-alphabetic chart with the letter "E" in four orientations, suitable for non-readers and hearing-impaired students. Responses are given by indicating the direction of the arms (All About Vision, 2023).

23. Near Vision Chart

Used to evaluate visual performance at reading distance, identifying accommodative or near-vision problems affecting learning (Elliott, 2014).

24. Trial Lens Set and Frame

Contains calibrated lenses and an adjustable frame for subjective refraction, enabling refinement of lens powers until optimal clarity is achieved (Benjamin, 2006).

25. Retinoscope (Objective Refraction)

A handheld instrument used to determine refractive status objectively by observing retinal reflex movement. Cycloplegic retinoscopy was applied where needed (Bennett & Rabbetts, 2007).

26. Pelli-Robson Contrast Sensitivity Chart

Measures contrast sensitivity using triplets of letters decreasing in contrast by 0.15 log units per triplet. Scores were classified as normal (≥1.65), mild (1.30–1.60), moderate (1.00–1.25), or severe (<1.00) reduction (Pelli, Robson & Wilkins, 1988; Elliott, 2014).

27. Pen Torch

A portable light source used to examine anterior segment structures and pupil reactions (Elliott, 2014).

28. Direct Ophthalmoscope

Used to inspect the fundus, including the optic disc, blood vessels, and macula, for early detection of posterior segment disorders (Salmon, 2024).

29. Occluder

A small paddle used to cover one eye during monocular VA testing or cover/uncover assessments to evaluate ocular alignment (Elliott, 2014).

30. Visual Acuity Assessment

Involves determining the smallest optotype correctly identified at a standard distance, conducted monocularly and binocularly using the Tumbling E chart, with presenting and best-corrected VA recorded (World Health Organization, 2019).

31. Objective and Subjective Refraction

Objective refraction estimates refractive error using a retinoscope, while subjective refraction refines correction based on participant response. Cycloplegic retinoscopy was applied when necessary (Benjamin, 2006; Bennett & Rabbetts, 2007).

CHAPTER TWO

LITERATURE REVIEW

This chapter explores the key ideas, theories, and studies that help to explain how visual anomalies relate to hearing impairment. It brings together findings from different researchers to build a clear understanding of what is already known and where gaps still exist. By comparing and connecting previous work, this review aims to provide a solid foundation for the present study and to shed more light on how dual sensory impairment affects people with hearing impairment.

Abah et al. (2011) conducted a sizeable, school-based ophthalmic survey of deaf students in Kaduna State — a study that remains one of the most directly relevant Nigerian prevalence investigations for the present work. Their sample and setting were unusually substantial for a special-education context in Nigeria, and they showed that a meaningful share of deaf learners carried treatable eye conditions. Refractive error was the single most frequent diagnosis; allergic conjunctivitis and corneal pathology also contributed noticeably to morbidity. Importantly, Abah et al. emphasised pragmatic, context-appropriate methods — non-letter optotypes for non-literate and sign-language-dominant participants, on-site basic clinical exams, close collaboration with school staff to ease communication, and concrete arrangements for spectacles or referral — so their work reads as much like a service-delivery model as an epidemiologic survey. Methodologically, its strengths are scale and feasibility: a purposive, school-based approach uncovers a high-yield caseload in low-resource settings, and modest on-site measures (simple refraction, topical management) convert detection into immediate benefit. Its limitations are also clear — limited exploration of contrast sensitivity and orthoptic detail, and little emphasis in the published record on cycloplegic refraction across the cohort, a technique that can materially alter hyperopia classification in younger children. For the Benin City project Abah et al. therefore functions in three concrete ways: it supplies a regional prevalence benchmark, justifies purposive sampling of special schools to maximise yield, and operationally validates field methods (Tumbling-E or other non-letter optotypes, sign-language-aware staff, recording of presenting and best-corrected VA, and planning for spectacles/referral).

Abikoye et al. (2020) report prevalence and causes of visual impairment among hearing-impaired students in Lagos, offering an urban Nigerian comparator that complements the northern and regional datasets. Their team combined objective refraction with reporting of both presenting and best-corrected acuities — a design choice that lets them quantify the reversible (correctable) fraction of visual loss, which is an essential public-health metric. Findings mirror patterns seen elsewhere: uncorrected refractive error and anterior-segment disease (for example, conjunctivitis) dominate, and a non-trivial proportion of students had previously unrecognised problems that responded to simple interventions. Notably, Abikoye et al. discuss barriers to spectacle uptake — cost, stigma, logistics — a practical point often omitted in prevalence reports. Methodologically, the Lagos study's use of objective measures and corrected outcomes is a strength because it moves beyond case finding to estimate potential impact; its weaknesses include sample-size limitations and scant contrast-sensitivity or orthoptic testing in the published account. For Benin City, Abikoye et al. supports three design choices: record both presenting and best-corrected acuities to document correctability, prioritise objective refraction (retinoscopy) for accurate refractive profiling, and plan pragmatic interventions/referral mechanisms that anticipate uptake barriers. The Lagos data also caution that urban location does not guarantee service access — reinforcing the policy argument for school-based screening even in metropolitan settings.

Adegbehingbe et al. (2005) examined ocular disorders among deaf children in South-West Nigeria and provides an early, regionally grounded perspective on treatable patterns — refractive error, allergic conjunctivitis, and occasional binocular vision anomalies. Of particular operational value were their observations on screening practicalities: examiner training, non-verbal or interpreter-assisted instructions, and the critical role of appropriate optotype selection to obtain valid acuity measures. Methodologically, the study shows how modest investments in training and communication accommodations improve case detection — well-trained examiners and sign-language–aware assistants reduce misclassification and increase cooperation during testing. Like several comparable reports, it lacked robust contrast-sensitivity measures and comprehensive cycloplegic refraction data (potentially underestimating latent hyperopia in younger children); nevertheless, its pragmatic focus makes it highly instructive for fieldwork planning. For Benin City, Adegbehingbe et al. reinforces the use of Tumbling-E for non-readers, recruitment of sign-language-competent staff, documentation of cooperation, and inclusion of objective refraction and simple orthoptic tests where feasible — decisions that protect measurement validity and ethical standards in special-education settings.

Osaiyuwu & Ebeigbe (2010) reported directly on visual disorders among deaf children in Benin City, making their study an immediate local comparator. They found a notable prevalence of uncorrected refractive error and anterior-segment disease within the same geographic context as the current project, and they documented systemic barriers to correction — limited local optical services and the cost of spectacles. Methodologically, their report emphasised adapted test selection, teacher engagement to facilitate communication, and clear referral pathways to convert identification into care. Its limitations echo the regional pattern: limited contrast-sensitivity and orthoptic detail, and restricted cycloplegia use across the cohort, so latent hyperopia and some binocular anomalies may be underrepresented. For the present Benin City project, Osaiyuwu & Ebeigbe serve three direct purposes: a local prevalence benchmark; operational lessons on test choice, examiner skills and spectacle provision logistics specific to Benin City; and reinforcement of purposive, school-based sampling because local data indicate special-education settings harbour a concentrated, remediable burden. Practically, their findings help the current study tailor referral pathways and anticipate barriers to spectacle uptake likely to be encountered locally.

Ostadimoghaddam et al. (2015) compared hearing-impaired children with age-matched hearing peers in Mashhad, Iran using rigorous refractive protocols including cycloplegic retinoscopy. Their principal finding — higher rates of hyperopia and astigmatism in the hearing-impaired cohort — is methodologically instructive: cycloplegic refraction in paediatric samples can unmask latent hyperopia that non-cycloplegic or subjective methods miss, and this influences prevalence estimates and amblyopia-risk classification. The comparative design clarifies whether refractive peculiarities are specific to hearing-impaired groups rather than reflecting population norms. Generalisability is tempered by cultural and population differences between Iran and Nigeria, yet the methodological lesson is clear: objective, cycloplegic refraction materially improves refractive profiling. For Benin City this implies practical steps — retinoscopy as the core objective technique; consideration of selective cycloplegic retinoscopy in younger children when ethically and logistically feasible; and systematic recording of presenting versus best-corrected acuities to quantify corrective benefit and amblyopia risk.

Pehere et al. (2019) describe a methodologically pragmatic, clinically focused school-screening programme in Guntur District, India, documenting refractive errors, amblyopia risk and ocular motility disorders among hearing-impaired children. Their battery was comprehensive yet feasible: Tumbling-E for non-readers, retinoscopy for objective refraction when cooperation was limited, and cover tests to detect strabismus. Crucially, they measured presenting and corrected outcomes and documented measurable functional improvement after spectacle provision — compelling evidence that linking screening to immediate service delivery yields tangible gains. Typical screening limits apply (short follow-up, limited cycloplegia across the cohort), but the programme's operational experience is invaluable: sign-language-aware staff, teacher liaison and on-site spectacle dispensing improved uptake. For Benin City, Pehere et al. offers a clear template — include orthoptic tests (cover/uncover), prioritise objective refraction, measure both presenting and best-corrected VA, and plan for spectacle provision or referral to ensure detection leads to intervention. Including amblyopia-risk assessment is justified: early detection supports rehabilitation and long-term visual potential.

Gogate et al. (2009) reported multiple screening initiatives in Indian schools for the deaf and consistently found that roughly one fifth to one quarter of pupils had previously undetected ocular problems — proportions that mirror many African and Asian surveys. Their contribution is strongly operational: programmes integrated screening with immediate services (spectacle dispensing, topical therapy), reinforced teacher engagement for follow-up, and produced measurable rises in spectacle uptake and corrected vision. Methodologically, Gogate et al. stressed adapted optotypes or picture charts for non-verbal children, recruitment of sign-language-familiar staff, and objective refraction for uncooperative pupils. Their success with same-day spectacle provision in low-resource contexts is particularly relevant for Benin City, offering a feasible model to reduce correction barriers and improve outcomes.

In short, the Gogate experience validates integrating detection with immediate or near-term intervention and underscores teacher involvement as central to sustained follow-up.

Khorrami-Nejad et al. (2018) investigated contrast sensitivity in deaf adolescents and young adults, demonstrating selective deficits — especially at higher spatial frequencies — even when high-contrast acuity was normal. Their psychophysical approach, using grating-based tests supplemented by clinical measures, highlights visual processing differences that standard Snellen-type or Tumbling-E tests do not capture. Methodologically, the study argues for including a validated contrast-sensitivity measure in screening batteries for hearing-impaired populations: functional complaints (difficulty reading fine sign-language details at distance or perceiving facial cues) can be explained by reduced contrast function despite normal high-contrast acuity. The authors discuss pragmatics too: grating tests are sensitive but less field-friendly, whereas Pelli-Robson charts measure mid-spatial frequency contrast, are portable and literacy-independent — making them more suitable for school screening. For Benin City, Khorrami-Nejad et al. justifies Pelli-Robson inclusion, specifies attention to illumination and viewing distance, and recommends separate analysis of "normal acuity + reduced contrast" subgroups because they have distinct functional implications and management needs (contrast enhancement strategies, low-vision support or specialist referral).

Pelli, Robson & Wilkins (1988) introduced and validated the Pelli-Robson contrast sensitivity chart — a portable clinical tool that quantifies contrast perception via grouped letters (or equivalent optotypes) with systematically decreasing contrast, producing a logCS score. Their protocols (controlled luminance, fixed viewing distance) and scoring conventions make Pelli-Robson suitable for epidemiological work. The chart's advantages for school screening are clear: portability, relative ease of administration, and adaptability for non-alphabetic populations. It assesses mid-spatial frequencies important for face recognition and sign-language handshape discrimination, and can help separate optical from neural causes of contrast loss when combined with refraction and ophthalmoscopy. For Benin City, adopting Pelli-Robson aligns with best practice: it permits classification of contrast sensitivity as normal, mild, moderate or severe, supports the study's objective to determine contrast abnormalities, and is operationally feasible when luminance and distance are standardised.

Kwarteng et al. (2022) produced a scoping review of prevalence and causes of visual impairment among hearing-impaired schoolchildren in sub-Saharan Africa. Their synthesis confirmed recurring regional patterns — refractive error and allergic conjunctivitis are common, largely treatable causes — while emphasising methodological heterogeneity among primary studies (varying test batteries, inconsistent impairment definitions, and differing use of objective refraction). The review also highlighted implementation barriers typical in the region: shortages of trained personnel, limited sign-language resources, and weak spectacle supply/follow-up systems. For Benin City, Kwarteng et al. performs two functions: it situates results within a regional epidemiologic framework, and it underscores the analytic necessity of standardised methods (objective refraction, WHO-aligned VA cutoffs, Pelli-Robson for contrast) to produce comparable data. Operationally, the review validates using a standardised, pragmatic battery and planning real-world referral and spectacle provision mechanisms to maximise impact.

Adetunji's (2013) MPH thesis on hearing and visual impairment among public primary pupils in Ibadan North LGA — although not limited to special schools — furnishes useful methodological and contextual lessons. The mixed-methods design (record review, clinical screening, teacher/caregiver questionnaires) demonstrates the value of combining objective impairment measures with functional reports (academic difficulty, attention). Adetunji highlights logistical realities frequently encountered in school surveys: securing consent, scheduling within school timetables, and ensuring communication aids for learners with sensory deficits. For Benin City, the thesis suggests that short, teacher-completed questionnaires yield contextual data that enrich clinical findings — for instance, correlating contrast deficits with classroom difficulties. Adetunji's pragmatic templates (consent logistics, school coordination) therefore help transform prevalence figures into actionable educational and public-health narratives; small additions such as a one- or two-item teacher-report form are low-cost ways to deepen interpretation.

Dandona & Dandona (2001) argued persuasively that uncorrected refractive error is a major, addressable cause of vision loss in low- and middle-income countries. Their global and regional analysis emphasises the large magnitude of the problem and that low-cost optical interventions (spectacles) can yield substantial population gains. Methodologically, they reinforce the need for population-based surveys and clear metrics (presenting vs best-corrected VA) to estimate the correctable burden. For Benin City, their messages are practical: measure presenting and best-corrected acuities to quantify preventable visual loss; link local rates of correctable impairment to global evidence to argue for resource allocation (spectacle programmes, school screening budgets); and consider cost-effectiveness when recommending interventions. Their caveats — accurate measurement in children and attention to demographic confounding — also inform Benin City's analytic decisions (age-stratified reporting and mitigation of cooperation/measurement bias).

Eksteen et al. (2022) examined combined hearing and vision loss in an underserved South African community using a mixed-methods approach: standardized clinical assessments plus household surveys and qualitative exploration of access barriers. They found substantial prevalence of dual sensory challenges linked with socioeconomic disadvantage and systemic barriers to integrated care (limited rehabilitation services, poor coordination between eye and ear services). Methodologically, Eksteen et al. demonstrate the value of situating clinical prevalence within health-system constraints; clinical data alone miss the access landscape that determines whether identified needs become treated needs. For Benin City, their work argues for adding concise health-system or access-focused items (where pupils currently receive eye care; obstacles to spectacle uptake) to complement prevalence statistics. The South African experience further supports integrated service pathways (school screening linked to ear/eye care) and collecting minimal socioeconomic context to interpret uptake and follow-up.

Herrero-Gracia et al. (2025) provide recent experimental data on age-related changes in contrast sensitivity under differing illumination conditions — a nuanced reminder that lighting interacts with measured contrast function. Although their cohort focused on general age effects rather than hearing-impaired pupils, the finding is highly relevant for school testing: contrast measures are sensitive to ambient luminance and suboptimal lighting can either over- or underestimate deficits. Methodologically, they quantify the interaction between age and illumination, showing that older adults show greater losses under reduced lighting while younger groups are less illumination-dependent though still affected. For Benin City this translates into a pragmatic requirement: standardise luminance when administering Pelli-Robson or, at minimum, document ambient lux and testing conditions; otherwise, age-related comparisons may be confounded. Even in a paediatric sample, adopting illumination controls improves validity and comparability.

Kangari et al. (2024) assessed refractive errors, amblyopia, strabismus and low vision among hearing-impaired students in Kermanshah, using a systematic screening with careful amblyopia-risk assessment and orthoptic evaluation. Their comprehensive battery — cycloplegic refraction when indicated, detailed cover testing, and low-vision categorisation — allowed robust classification of correctable refractive errors and less reversible conditions. For Benin City, Kangari et al. provides a contemporary comparator and supports adding selective orthoptic tests (cover/uncover, alternate cover, near point of convergence) and amblyopia-risk stratification. Their stratified reporting by severity (mild vs severe; reversible vs non-reversible) is a useful reporting strategy that enhances policy utility. Operationally, their work demonstrates the feasibility of combining objective refraction with orthoptic screening in school settings when resourced — a model Benin City could adopt selectively for pupils with suspected binocular dysfunction.

Leguire et al. (1992) remain one of the earlier systematic prospective investigations of ocular abnormalities in hearing-impaired students. Their prospective design and detailed clinical assessments characterised a broad spectrum of pathology — refractive errors, strabismus, posterior-segment anomalies — and importantly documented outcomes after intervention. Methodologically, prospective follow-up allowed evaluation of spectacle impact, an element often missing in cross-sectional surveys. For Benin City, Leguire et al. underscores the value of outcome-linked screening: recording improvement after correction (presenting vs best-corrected VA; short-term recheck after spectacle dispensing) provides stronger evidence of programmatic impact and aids advocacy. While resource constraints may limit full replication, the principle of outcome measurement is feasible and persuasive.

The WHO World Report on Vision (2019) supplies a programmatic and policy framework that strongly endorses integrated, people-centred eye care and highlights school-based screening as an efficient pediatric delivery model. WHO recommends targeting vulnerable groups — including children with disabilities — and stresses that screening must be linked to referral pathways and service availability to produce real gains. For Benin City, WHO's guidance legitimises the purposive school-based approach and provides authoritative rationale for integrating vision checks into special-education health services. Operational advice in the report — standardise procedures, link with referral services, and collect data to support health-system planning — aligns closely with the Benin City methods (Tumbling-E, Pelli-Robson, objective refraction, explicit referral mechanisms) and strengthens policy-oriented recommendations drawn from local findings.

Finally, Nikolopoulos et al. (2006) offer a foundational literature synthesis on ophthalmic disorders in deaf children. Their review aggregated prevalence studies worldwide and emphasised both the high prevalence of ocular problems in deaf cohorts and the methodological heterogeneity that complicates cross-study comparisons. Importantly, they recommended standardised approaches — objective refraction, orthoptic assessment, ophthalmoscopy, and repeated checks — and stressed examiner training in communication with deaf children. Methodologically, their critique of heterogeneity justifies Benin City's deliberate use of standard measures (Tumbling-E, retinoscopy, Pelli-Robson) and recording both presenting and best-corrected VA to produce comparable, high-quality data. They also insist on ophthalmoscopy to identify syndromic and posterior-segment disease (e.g., Usher syndrome) and on referral/follow-up arrangements. In short, Nikolopoulos et al. provides both epidemiologic justification and a methodological roadmap that reinforces the importance of rigor and standardisation so local results can be meaningfully compared and translated into policy and practice.

CHAPTER THREE

METHODOLOGY

3.1 STUDY DESIGN

This study was done using a cross-sectional design

3.2 STUDY AREA

This study was conducted at schools for the hearing impaired in Benin City, Edo State, Nigeria.

3.3 STUDY PERIOD

The study was conducted over a period of three months

3.4 SAMPLING TECHNIQUE

This study employed a purposive sampling technique to select participants.

3.5 STUDY POPULATION

The study population will consist of cooperative individuals with hearing impairment enrolled in special needs school in Benin City, Nigeria.

3.6 SAMPLE SIZE

Using Fisher's formula:

$$n = \frac{\{Z^2 \times P \times (1 - P)\}}{\{d^2\}}$$

Where;

N = minimum sample size

Z = Z statistic level of confidence of 95% (1.96)

P= Prevalence of visual impairment (5.8% or 0.058)(Ovenseri-Ogbomo et al. 2013)

D = confidence interval (±5%, d = 0.05)

$$n = \frac{\{(1.96)^2 \times 0.058 \times (1 - 0.058)\}}{\{(0.05)^2\}}$$

$$n = \frac{\{3.8416 \times 0.058 \times 0.942\}}{\{0.0025\}}$$

$$n = \frac{0.2098}{0.0025} = 83.9$$

Approximately 84

Adjusting for a 15% non-participation rate (attrition rate):

$$n_{final} = 84 + (0.1 \times 84) = 96.6$$

$$n_{final} \approx 100$$

Final Sample Size: 100 participants

Therefore 100 subject were used for this study

3.7 RESEARCH INSTRUMENTS AND MATERIALS

Instrument of Study: Direct ocular examination and review of existing records.

Study Materials:

1. Penlight
2. Occluder
3. Meter Rule
4. Trial Lens Box
5. Tumbling E Visual Acuity Chart
6. Pelli-Robson Contrast Sensitivity Chart
7. Retinoscope
8. Ophthalmoscope
9. Data Collection Sheet
10. Pen

3.8 INCLUSION CRITERIA

1. Children with Hearing Impairment

2. Age Range: 5–29 Years
3. No History of Systemic Diseases Affecting Vision
4. Ability to Cooperate with Testing Procedures
5. Parental/Guardian Consent

3.9 EXCLUSION CRITERIA

1. Children who do not meet the inclusion criteria
2. Children unwilling to participate or without parental/guardian consent

3.10 ETHICAL CONSIDERATIONS

1. Ethical approval to conduct this study was obtained from the Research and Ethics Committee of the Department of Optometry, University of Benin.
2. Consent was obtained from the parents or guardians of all participants before participation.
3. All participants were provided with comprehensive information regarding the study and informed of their right to withdraw at any time without consequences.
4. To maintain anonymity, personal identifying information such as names was not collected.
5. Data were used strictly for the purposes of this study.
6. The study will adhered to the tenets of the Helsinki Declaration and other relevant ethical guidelines.

3.11 PROCEDURE

1. Baseline Measurements

i. **Recruitment:** Participants who met the inclusion criteria were recruited from schools for the hearing-impaired. A list of eligible students was obtained from the school records. Additionally, teachers familiar with sign language were recruited to serve as interpreters, facilitating communication between the researchers and the hearing-impaired students during all stages of the study.

ii. **Informed Consent:** Permission was obtained from the school authorities and guardians where applicable. Participants were informed about the study objectives, procedures, potential risks, and confidentiality of their data.

iii. **Pre-Test Visual Acuity:** Distance visual acuity was measured using a Tumbling E Visual Acuity Chart at 6 meters. Near visual acuity was also measured where applicable. Testing was performed monocularly and binocularly with an occluder. Results were recorded and classified according to WHO standards.

iv. **Dark Room Setup:** A temporary dark room was created within the school premises to facilitate ocular examinations requiring controlled lighting conditions. This room was used for procedures such as ophthalmoscopy.

v. **Ophthalmoscopy:** Using a Direct Ophthalmoscope in the dark room, the internal ocular structures of each participant were examined. Any abnormalities were noted and recorded.

vi. **Retinoscopy:** Retinoscopy was carried out using a retinoscope and trial lens set to determine objective refractive errors.

vii. **Subjective refraction:** Refinement was performed based on retinoscopy findings to arrive at the best corrected visual acuity.

viii. **Contrast Sensitivity Test:** The Pelli-Robson Contrast Sensitivity Chart was used at a distance of 1 meter under standard illumination. Readings were recorded in log units.

ix. **Ocular Alignment Testing:** The Cover/Uncover Test and Alternate Cover Test were also performed to detect manifest and latent deviations.

2. Testing Procedures

i. Assessment of Visual Function

Visual Acuity Measurement: Each eye was tested independently and binocularly using a Tumbling E visual acuity chart.

Refraction: Both objective (retinoscopy) and subjective refraction were conducted as necessary.

Contrast Sensitivity: Measured monocularly using the Pelli-Robson chart at 1 meter under standard lighting.

i. **Assessment of Strabismus**

Cover Test:

The cover test was performed at both distance (6 meters) and near (33 cm) under normal room illumination to evaluate the presence and type of ocular misalignment. It consisted of two components: the cover-uncover test and the alternate cover test.

Cover-Uncover Test:

The patient was instructed to fixate on a stationary accommodative target. One eye was covered while the other was observed for any movement. This test was used to detect manifest deviations (tropias). A movement of the uncovered eye to take up fixation indicated the presence of a tropia. The test also helped determine whether the deviation was constant or intermittent, and whether it was unilateral or alternating.

Alternate Cover Test:

This test was used to detect latent deviations (phorias). The examiner alternately covered each eye in quick succession, without allowing time for binocular fusion. Refixation movements observed during this process indicated a phoria. The direction of eye movement was noted to classify the deviation as esophoria, exophoria, hyperphoria, or hypophoria**.**

3.12 DATA CLASSIFICATION

Participants' data were classified based on the following criteria:

1. Age Group Classification

5 – 8 years

9 – 12 years

13 – 16 years

17 – 20 years

21 – 24 years

25 – 29 years

2. Gender Classification

Male

Female

3. Visual Acuity Classification

Visual acuity was assessed using the Tumbling E chart and classified according to the ICD-11 standard before and after correction

Mild Visual Impairment (<6/12 to 6/18)

Moderate Visual Impairment (<6/18 to 6/60)

Severe Visual Impairment (<6/60 to 3/60)

Blindness (<3/60)

4. Hearing Impairment

Present

Absent

5. Refractive Error Classification (Based on Retinoscopy and Subjective Refraction)

Emmetropia

Myopia

Hyperopia

Simple Myopic Astigmatism

Simple Hyperopic Astigmatism

Compound Myopic Astigmatism

Compound Hyperopic Astigmatism

Mixed Astigmatism

6. Contrast Sensitivity Classification (Pelli-Robson Chart)

Normal Contrast Sensitivity: 1.65 – 2.00 logCS

Mild Reduction: 1.30 – 1.60 logCS

Moderate Reduction: 1.00 – 1.25 logCS

Severe Reduction: <1.00 logCS

7. Uncooperative Participants

Participants who could not reliably perform visual acuity or contrast sensitivity testing were classified as uncooperative. Their demographic data were recorded, but they were excluded from inferential statistical analysis.

8. Relationship Analysis (For Objective Correlation Studies)

Age vs. Dual Sensory Impairment: Comparison of the distribution of visual anomalies and hearing impairment across age groups.

Gender vs. Dual Sensory Impairment: Analysis of the prevalence of visual anomalies and hearing impairment among males and females.

Visual Impairment vs. Hearing Impairment: Determination of the association between the presence of visual anomalies and hearing impairment.

3.13 DATA ANALYSIS

1. Statistical analysis was performed using SPSS Version 25.0.
2. Descriptive statistics (mean, standard deviation, frequency, and percentages) were used to summarize data on visual acuity, contrast sensitivity, and types of visual anomalies.
3. Chi-Square tests were used to analyze relationships between gender, age, and dual sensory impairment.
4. Chi-Square tests were used to analyze the relationship between visual anomalies/impairments and hearing impairment.

Results were presented in tables and charts for clear interpretation.

CHAPTER FOUR

RESULTS AND DATA ANALYSIS

This study involved a total of 100 participants, with a mean age of 15.32 ± 5.19 years, comprising of male (n = 61) and female (n = 39) participants. The study was conducted to determine the relationship between visual and hearing-impairment in affected individuals.

Table 4.1: Gender Distribution of Participants

Gender	Frequency	**Percentage**
Male	61	61.0%
Female	39	39.0%
Total	**100**	**100.0%**

The study comprised 100 participants, of which 61 (61.0%) were male and 39 (39.0%) were female. This indicates that males constituted the majority of the study population.

Table 4.2: Age Characteristics of Participants

Age Range	Frequency	Percentage
5–8	12	12%
9–12	19	19.0%
13–16	25	25.0%
17–20	32	32.0%
21–24	7	7.0%
25–29	5	5.0%
Total	**100**	**100.0%**

- **Minimum age:** 5 years
- **Maximum age:** 29 years
- **Mean age:** 15.32 years
- **Standard deviation (SD):** ±5.19

The majority of participants were within the 17–20 age range (32.0%), followed by those in the 13–16 age range (25.0%) and the least 25-29 age range (5%). The mean age of participants was 15.32 years (SD = 5.19), with a minimum age of 5 years and a maximum of 29 years.

Table 4.3: Distribution of refractive anomalies by Gender Among Study Participants

Refractive Status	Male	Female	Total	Percentage
Emmetropia	5	3	8	8.0%
Myopia	5	6	11	11.0%
Hyperopia	24	10	34	34.0%
Simple Myopic Astigmatism (SMA)	10	1	11	11.0%
Simple Hyperopic Astigmatism (SHA)	2	6	8	8.0%
Compound Myopic Astigmatism (CMA)	5	2	7	7.0%
Compound Hyperopic Astigmatism (CHA)	8	7	15	15.0%
Mixed Astigmatism	2	2	4	4.0%
Uncooperative	0	2	2	2.0%
Total	**61**	**39**	**100**	**100.0%**

Among the 100 participants, **hyperopia (34%)** was the most common refractive anomaly, followed by **compound hyperopic astigmatism (15%)**, while the least was **mixed astigmatism (4%)**. Hyperopia was more frequent among **males (24)** than **females (10)**.

Table 4.4: Distribution of refractive anomalies by Age Range

Refractive Error	5–8	9–12	13–16	17–20	21–24	25–29	Total
Emmetropia	1	1	3	2	1	0	8
Myopia	0	2	1	5	2	1	11
Hyperopia	6	5	7	10	3	3	34
Simple Myopic Astigmatism	2	2	5	2	0	0	11
Simple Hyperopic Astigmatism	2	0	3	3	0	0	8
Compound Myopic Astigmatism	0	2	1	4	0	0	7
Compound Hyperopic Astigmatism	1	4	2	6	1	1	15
Mixed Astigmatism	0	2	2	0	0	0	4
Uncooperative	0	1	1	0	0	0	2
Grand Total	12	19	25	32	7	5	100

Among the 100 participants, the **17–20 years** age group had the highest occurrence of refractive anomalies, accounting for **32%** of the subjects, followed by the **13–16 years** group with **25%**, while the least was observed in the **25–29 years** group, representing **5%** of the participants.

Table 4.5: Distribution of Contrast Sensitivity by Age Range (Pelli-Robson Classification)

Contrast Sensitivity	5–8 yrs	9–12 yrs	13–16 yrs	17–20 yrs	21–24 yrs	25–29 yrs	Total (n=100)	Percentage
Normal (1.65–2.00)	11	18	24	32	7	4	96	96.0%
Mild Reduction (1.30–1.60)	1	0	0	0	0	1	2	2.0%
Moderate Reduction (1.00–1.25)	0	0	0	0	0	0	0	0.0%
Severe Reduction (<1.00)	0	0	0	0	0	0	0	0.0%
Uncooperative	0	1	1	0	0	0	2	2.0%
Total	12	19	25	32	7	5	**100**	**100.0%**

Out of 100 participants, 96% had normal contrast sensitivity, while 2% showed a mild reduction and 2% were uncooperative. The **17–20 years (32%)** age group had the highest occurrence of contrast sensitivity normal responses, followed by the **13–16 years (25%)**, while the least was observed in the **25–29 years (5%)** age group. Mild reduction in contrast sensitivity was noted in the **5–8 years (1%)** and **25–29 (1%) years** groups.

Table 4.6: Distribution of Contrast Sensitivity by Gender (Pelli-Robson Classification)

Contrast Sensitivity	Male (n=61)	Female (n=39)	Total (n=100)	Percentage
Normal (1.65–2.00)	59	37	96	96.0%
Mild Reduction (1.30–1.60)	2	0	2	2.0%
Moderate Reduction (1.00–1.25)	0	0	0	0.0%
Severe Reduction (<1.00)	0	0	0	0.0%
Uncooperative	0	2	2	2.0%
Total	**61**	**39**	**100**	**100.0%**

Out of 100 participants, 96% had normal contrast sensitivity, while 2% showed a mild reduction and 2% were uncooperative. Among males, 59 (96.7%) demonstrated normal contrast sensitivity, compared to 37 (94.9%) females. Mild reduction was observed only among males, whereas uncooperativeness occurred exclusively among females. Overall, contrast sensitivity remained largely normal across both genders, with no cases of moderate or severe reduction recorded

Table 4.7: Visual Impairment Classification of Study Participants by gender

Category	Normal (>6/12)	Mild (<6/12 to 6/18)	Moderate (<6/18 to 6/60)	Severe (<6/60 to 3/60)	Blindness (<3/60)	Uncooperative
Before						
Male	57	2	2	0	0	0
Female	35	2	0	0	0	2
Total	92	4	2	0	0	2
After						
Male	59	2	0	0	0	0
Female	37	0	0	0	0	2
Total	96	2	0	0	0	2

Among the 100 participants, Before refraction, **normal vision (>6/12)** was most common among participants, with **males (57)** and **females (35)** showing normal visual status. This was followed by **mild visual impairment (<6/12 to 6/18)**, observed in **males (2)** and **females (2)**, while **moderate impairment (<6/18 to 6/60)** was the least, found only among **males (2)**.
After refraction, **normal vision (>6/12)** increased to **males (59)** and **females (37)**, while **mild visual impairment (<6/12 to 6/18)** persisted only among **males (2)**. No cases of **moderate, severe, or blindness** were recorded after refraction.

Table 4.8: Visual impairment classification of study participants by age range before correction

Age Range (years)	Normal	Mild	Moderate	Severe	Blindness	Uncooperative	Total
5–8	10	1	1	0	0	0	12
9–12	17	1	0	0	0	1	19
13–16	24	0	0	0	0	1	25
17–20	30	2	0	0	0	0	32
21–24	7	0	0	0	0	0	7
25–29	4	0	1	0	0	0	5
Total	**92**	**4**	**2**	**0**	**0**	**2**	**100**

Before correction, **92%** of participants had normal vision, **4%** had mild visual impairment, **2%** had moderate impairment, and **2%** were uncooperative. No cases of severe visual impairment or blindness were recorded. The **17–20 years (30 individuals)** age group had the highest number of participants with normal vision, followed by the **13–16 years (24 individuals)** group, while the least was observed in the **25–29 years (4 individuals)** group.

Table 4.9: Visual impairment classification of study participants by age range after correction

Age Range (years)	Normal	Mild	Moderate	Severe	Blindness	Uncooperative	Total
5–8	11	1	0	0	0	0	12
9–12	18	0	0	0	0	1	19
13–16	24	0	0	0	0	1	25
17–20	31	1	0	0	0	0	32
21–24	7	0	0	0	0	0	7
25–29	5	0	0	0	0	0	5
Total	**96**	**2**	0	**0**	**0**	**2**	**100**

After refractive correction, 96% of participants achieved normal vision, while only 2% had mild visual impairment and another 2% were uncooperative. No cases of moderate, severe, or blindness were observed post-correction. The 17–20 years age group had the highest number of participants with normal vision (31 individuals), followed by the 13–16 years group (24 individuals).

Table 4.10: Hearing Impairment Status of Participants by Gender

Gender	**Hearing Impaired**	**%**	**Not Hearing Impaired**	**%**	**Total**
Male (n=61)	61	100.0%	0	0.0%	61
Female (n=39)	39	100.0%	0	0.0%	39
Total (n=100)	**100**	**100.0%**	**0**	**0.0%**	**100**

All participants in the study (100%) had hearing impairment, comprising 61 males (61%) and 39 females (39%). There were no participants without hearing impairment (0%) in either gender group.

Table 4.11: Hearing Impairment Status of Participants by Age Range

Age Range (years)	Hearing Impaired	%	Not Hearing Impaired	%	Total
5–8	12	100.0%	0	0.0%	12
9–12	19	100.0%	0	0.0%	19
13–16	25	100.0%	0	0.0%	25
17–20	32	100.0%	0	0.0%	32
21–24	7	100.0%	0	0.0%	7
25–29	5	100.0%	0	0.0%	5
Total (n=100)	**100**	**100.0%**	**0**	**0.0%**	**100**

All participants across all age ranges (5–29 years) had hearing impairment (100%), with no individuals (0%) identified as not hearing impaired. The 17–20 years (32%) age group had the highest representation, followed by the 13–16 years (25%), while the least was observed in the 25–29 years (5%) age group.

Table 4.12: Distribution of Visual and Hearing Impairment by Gender (Before Correction)

		Visual impairment						
Gender	**Hearing Impairment (n, %)**	**Normal**	**Mild**	**Moderate**	**Severe**	**Blindness**	**Uncooperative**	**Total**
Male (n=61)	61 (100%)	57(93%)	2(3%)	2(3%)	0 (0%)	0 (0%)	0 (0%)	61
Female (n=39)	39 (100%)	35(90%)	2(5%)	0 (0%)	0 (0%)	0 (0%)	2(5%)	39
Total (n=100)	**100 (100%)**	**92(92%)**	**4(4%)**	**2(2%)**	0 (0%)	0 (0%)	**2(2%)**	**100**

All participants (**100%**) had hearing impairment. Before correction, **92%** had normal vision, **4%** had mild visual impairment, **2%** had moderate impairment, and **2%** were uncooperative. Visual impairment was slightly more common among **males (6%)**, while **uncooperativeness** occurred only among **females (5%)**.

Table 4.13: Distribution of Visual and Hearing Impairment by Gender (After Correction)

		Visual impairment						
Gender	**Hearing Impairment (n, %)**	**Normal**	**Mild**	**Moderate**	**Severe**	**Blindness**	**Uncooperative**	**Total**
Male (n=61)	61 (100%)	59(96%)	2(3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	61
Female (n=39)	39 (100%)	37 (95%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2(5%)	39
Total (n=100)	**100 (100%)**	**96 (96%)**	**2(2%)**	0 (0%)	0 (0%)	0 (0%)	**2(2%)**	**100**

All participants (100%) had hearing impairment. After correction, 96% had normal vision, 2% had mild impairment, and 2% were uncooperative. Mild visual impairment was observed only among males (3%), while uncooperativeness occurred only among females (5%). No cases of moderate, severe, or blindness were recorded.

Table 4.14: Distribution of Visual and Hearing Impairment by Age Range (Before Correction)

		Visual impairment						
Age Range (years)	**Hearing Impairment (n, %)**	**Normal (n, %)**	**Mild (n, %)**	**Moderate (n, %)**	**Severe (n, %)**	**Blindness (n, %)**	**Uncooperative (n, %)**	**Total (n, %)**
5–8	12 (100%)	10 (83.3%)	1 (8.3%)	1 (8.3%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
9–12	19 (100%)	17 (89.5%)	1 (5.3%)	0 (0%)	0 (0%)	0 (0%)	1 (5.3%)	19 (100%)
13–16	25 (100%)	24 (96.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (4.0%)	25 (100%)
17–20	32 (100%)	30 (93.8%)	2 (6.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	32 (100%)
21–24	7 (100%)	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (100%)

25–29	5 (100%)	4 (80.0%)	0 (0%)	1 (20.0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)
Total	100 (100%)	92 (92.0%)	4 (4.0%)	2 (2.0%)	0 (0%)	0 (0%)	2 (2.0%)	100 (100%)

All participants (**100%**) had hearing impairment. Before correction, **92%** had normal vision, **4%** had mild visual impairment, **2%** had moderate impairment, and **2%** were uncooperative. The **17–20 years (32%)** age group had the highest number of participants with normal vision, followed by the **13–16 years (25%)**, while the least was observed in the **25–29 years (5%)** group. Mild impairment occurred in the **5–8 years (8.3%)**, **9–12 years (5.3%)**, and **17–20 years (6.3%)** groups, while moderate impairment was seen in the **5–8 years (8.3%)** and **25–29 years (20%)** groups.

Table 4.15: Distribution of Visual and Hearing Impairment by Age Range (After Correction)

		Visual impairment						
Age Range (years)	**Hearing Impairment (n, %)**	**Normal (n, %)**	**Mild (n, %)**	**Moderate (n, %)**	**Severe (n, %)**	**Blindness (n, %)**	**Uncooperative (n, %)**	**Total (n, %)**
5–8	12 (100%)	11 (91.7%)	1 (8.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (100%)
9–12	19 (100%)	18 (94.7%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (5.3%)	19 (100%)
13–16	25 (100%)	24 (96.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (4.0%)	25 (100%)
17–20	32 (100%)	31 (96.9%)	1 (3.1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	32 (100%)
21–24	7 (100%)	7 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (100%)
25–29	5 (100%)	5 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)
Total	100 (100%)	96 (96.0%)	2 (2.0%)	0 (0%)	0 (0%)	0 (0%)	2 (2.0%)	100 (100%)

All participants (**100%**) had hearing impairment. After correction, **96%** had normal vision, **2%** had mild visual impairment, and **2%** were uncooperative. The **17–20 years (32%)** age group had the highest number of participants with normal vision, followed by the **13–16 years (25%)**, while the least was observed in the **25–29 years (5%)** group. Mild visual impairment was recorded in the **5–8 years (8.3%)** and **17–20 years (3.1%)** groups only. No cases of moderate, severe, or blindness were recorded.

Table 4.16: Hearing Impairment and Contrast Sensitivity by Gender (Pelli-Robson Classification)

Contrast Sensitivity	Male (n=61)	Female (n=39)	Total (n=100)	Percentage (%)
Normal (1.65–2.00)	59 (96.7%)	37 (94.9%)	96	96.0%
Mild Reduction (1.30–1.60)	2 (3.3%)	0 (0.0%)	2	2.0%
Moderate Reduction (1.00–1.25)	0 (0.0%)	0 (0.0%)	0	0.0%
Severe Reduction (<1.00)	0 (0.0%)	0 (0.0%)	0	0.0%
Uncooperative	0 (0.0%)	2 (5.1%)	2	2.0%
Total	**61 (100%)**	**39 (100%)**	**100**	**100.0%**

Among the 100 hearing-impaired participants, **normal contrast sensitivity (96%)** was most common, followed by **mild reduction (2%)**, while **2%** were uncooperative. Normal contrast sensitivity was higher among **males (96.7%)** than **females (94.9%)**. Mild reduction occurred only among **males (2%)**, whereas **uncooperativeness** was observed only among **females (2%)**.

Table 4.17: Distribution of Participants with Both Visual and Contrast Sensitivity Impairment by Gender

Gender	Both Visual & Contrast Sensitivity Impairment	%	None	%	Total
Male (n=61)	0	0.0%	61	100.0%	61
Female (n=39)	0	0.0%	39	100.0%	39
Total (n=100)	**0**	**0.0%**	**100**	**100.0%**	**100**

None of the participants exhibited both visual and contrast sensitivity impairment. All (100%) had either normal vision or normal contrast sensitivity across both genders.

Table 4.18: Distribution of Participants with Both Visual and Contrast Sensitivity Impairment by Age Range

Age Range (years)	Both Visual & Contrast Sensitivity Impairment	%	None	%	Total
5–8	0	0.0%	12	100.0%	12
9–12	0	0.0%	19	100.0%	19
13–16	0	0.0%	25	100.0%	25
17–20	0	0.0%	32	100.0%	32
21–24	0	0.0%	7	100.0%	7
25–29	0	0.0%	5	100.0%	5
Total (n=100)	**0**	**0.0%**	**100**	**100.0%**	**100**

None of the participants across all age ranges (5–29 years) showed both visual and contrast sensitivity impairment. All (100%) had either normal vision or normal contrast sensitivity.

INFERENTIAL STATISTICS

Table 4.19: Chi-square result of Visual anomalies vs Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided) = p
Pearson Chi-Square	14.955	8	0.060
Likelihood Ratio	16.464	8	0.036
N of Valid Cases	100		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .78.

The chi-square test showed a Pearson Chi-Square value of 14.955 with 8 degrees of freedom and a p-value of 0.060. This indicates that the association between visual anomalies and gender was not statistically significant at the 0.05 level. However, the Likelihood Ratio (16.464, p = 0.036) suggests a borderline significant association. A total of 100 valid cases were analyzed, though 12 cells (66.7%) had expected counts less than 5, with a minimum expected count of 0.78, which may slightly limit the reliability of the test.

Table 4.20: Chi-square result for Visual & Hearing impairment by gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided) = p	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.053	1	.818	1.000	.592	
Continuity Correction[b]	.000	1	1.000			
Likelihood Ratio	.054	1	.816	1.000	.592	
Fisher's Exact Test				1.000	.592	
Linear-by-Linear Association	.053[c]	1	.819	1.000	.592	.330
N of Valid Cases	98					

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.27.

b. Computed only for a 2x2 table

c. The standardized statistic is -.229.

Note: Fisher p = 1.000, no association between gender and visual impairment. Chi-square (p) > 0.05, hence no association.

The chi-square analysis revealed a Pearson Chi-Square value of 0.053 with 1 degree of freedom and a p-value of 0.818, indicating no significant association between visual and hearing impairment and gender. The Likelihood Ratio (0.054, $p = 0.816$) and Fisher's Exact Test ($p = 1.000$) further confirm this finding. Out of 98 valid cases, 2 cells (50%) had expected counts less than 5, with a minimum expected count of 2.27, suggesting limited variability across gender groups. Overall, the results show that gender did not significantly influence the occurrence of dual sensory impairment.

Table 4.21: Chi-square result for Visual & Hearing impairment by age-group

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.029[a]	5	0.303	0.261		
Likelihood Ratio	6.639	5	0.249	0.318		
Fisher-Freeman-Halton Exact Test	5.860			0.206		
Linear-by-Linear Association	0.139[b]	1	0.709	0.752	.418	.118
N of Valid Cases	98					

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .31.

b. The standardized statistic is -.373.

Note: There was no statistically significant association between age group and visual impairment before correction (Fisher's Exact test, p = 0.200). Although the proportion of impaired cases was higher in age group 17 – 20, compared to others, this difference was not statistically significant.

CHAPTER FIVE

DISCUSSION

This chapter interprets the principal findings of the study, aligns them with the stated objectives, and situates them within the extant literature. One hundred hearing-impaired students (61% male, 39% female; age range 5–29 years; mean 15.32 ± 5.19 years) were examined. Refractive anomalies constituted the predominant ocular diagnosis, with hyperopia and hyperopia-related astigmatism most frequently observed. Broad mid-spatial-frequency contrast sensitivity, as assessed with the Pelli–Robson chart, was preserved in the large majority of participants. After refractive correction there was no statistically significant association between WHO-defined visual impairment and either gender or age. The subsequent discussion is organized by study objective: each subsection summarises the principal results, offers plausible explanations, and compares the findings with relevant studies from the selected reference set.

5.1 Nature and prevalence of visual anomalies among hearing-deficient individuals

Tables 4.3 and 4.4 and Figure 8 document that refractive error dominated the ocular diagnoses in this cohort. Hyperopia represented the single largest diagnostic category (34%), followed by compound hyperopic astigmatism (15%). Myopia and myopic-astigmatic forms were less frequent (myopia 11%; simple myopic astigmatism 11%; compound myopic astigmatism 7%), and emmetropia was infrequent (8%). The visual distribution by age illustrates a concentration of hyperopic findings across adolescent bands.

Several methodological and biological factors plausibly account for this distribution. First, purposive, school-based sampling of specialised institutions tends to concentrate individuals with congenital, developmental, or syndromic conditions, thereby producing refractive profiles that differ from general population samples. Second, the use of objective refraction (retinoscopy) and selective cycloplegia increases the detection of latent hyperopia that subjective refraction may under-detect; this effect is most pronounced in younger pupils who may accommodate during testing unless cycloplegia is applied. Third, incomplete emmetropisation during childhood and adolescence can result in persistent hyperopic refractive states within the sampled age range.

These findings are consistent with prior reports. Nigerian deaf-school surveys by Abah et al. (2011) and Abikoye et al. (2020) identified refractive error as the principal ocular abnormality; Ostadimoghaddam et al. (2015) reported increased rates of hyperopia and astigmatism in hearing-impaired children when objective cycloplegic refraction was used. Nikolopoulos et al. (2006) synthesised global studies demonstrating elevated refractive anomalies among deaf cohorts, and Kwarteng et al. (2022) noted that refractive and anterior-segment conditions are common and largely treatable in sub-Saharan school surveys. Bist et al. (2011) reported comparable ocular morbidity levels in a different school-based sample. The present hyperopia-dominant pattern therefore aligns with regional and international evidence and is plausibly attributable to sampling frame and objective refraction methodology. Dandona & Dandona (2001) further emphasise the public-health importance of uncorrected refractive error in low- and middle-income settings, reinforcing the practical relevance of these results. Population-based estimates (e.g., Williams et al., 2015) show geographic and age-related variation in refractive profiles, indicating that school-based samples should be interpreted as service-specific cohorts rather than as proxies for community prevalence.

5.2 Contrast sensitivity abnormalities in hearing-impaired individuals

Tables 4.5 and 4.6 show that 96% of participants recorded normal Pelli–Robson contrast sensitivity (≥1.65 logCS); 2% exhibited mild reductions and 2% were classified as uncooperative.

The near-normal Pelli–Robson results can be explained by test characteristics and cohort composition. The Pelli–Robson chart measures broad mid-spatial-frequency contrast sensitivity; it is portable and literacy-independent, making it suitable for field screening, but it does not evaluate narrow spatial bands, very high spatial frequencies, or temporal/motion channels. If posterior-segment pathology was uncommon and refractive errors were effectively neutralised at the time of testing, broad contrast function would be expected to remain within normal limits. High participant cooperation and appropriate test conditions would also favour normal scores. Conversely, selective deficits confined to specific spatial or temporal channels would not be detected by the Pelli–Robson chart and therefore would not be reflected in these results.

The present findings accord with pragmatic screening studies while remaining reconcilable with laboratory psychophysics. Khorrami-Nejad et al. (2018) and Finney & Dobkins (2001) documented selective contrast or motion-processing differences in some deaf populations using grating-based measures that probe specific channels; such selective deficits may escape detection by Pelli–Robson. Field surveys employing Pelli–Robson typically report a lower prevalence of clinically meaningful contrast loss (Pelli, Robson & Wilkins, 1988), and Pehere et al. (2019) similarly observed that broad contrast decline is not a universal finding in school-based programmes. Thus, preserved Pelli–Robson performance in this cohort is consistent with the screening literature and does not preclude the existence of more selective deficits detectable by alternative paradigms.

5.3 Relationship between gender and dual sensory impairment (visual and auditory)

Tables 4.1, 4.10, 4.12 and 4.13 indicate that males comprised 61% of the sample and females 39%. Inferential testing for detailed anomaly categories produced Pearson $\chi^2 = 14.955$ (df = 8, p = 0.060), which is not significant at $\alpha = 0.05$, while the likelihood-ratio test yielded a borderline p = 0.036. Binary testing of visual impairment (normal versus impaired) returned Pearson $\chi^2 = 0.053$ (p = 0.818) and Fisher's exact p = 1.000.

Interpretation should be cautious. Although males exhibited marginally higher absolute counts for certain refractive subtypes (for example, hyperopia), statistical tests did not provide robust evidence that gender predicts WHO-defined visual impairment in this purposive sample. The borderline likelihood-ratio result suggests heterogeneity in specific subtype frequencies; however, several contingency-table cells had low expected counts, reducing test power and increasing the risk of Type II error.

Previous school-based surveys report mixed gender effects. Abah et al. (2011) and Abikoye et al. (2020) recorded some gender differences in particular conditions but did not demonstrate consistent, strong gender associations across outcomes. Population-level analyses (e.g., Caban et al., 2005) show variable gender relationships with dual sensory loss, and recent work suggests that gender interactions may be age-dependent (Liu et al., 2025). The present equivocal findings therefore reflect a broader literature in which gender effects, when present, appear context- and age-dependent.

5.4 Relationship between age and dual sensory impairment (visual and auditory)

Tables 4.2, 4.11 and 4.14–4.15 show that the largest subgroup belonged to the 17–20 year band. Tests for association between age group and visual impairment yielded Pearson χ^2 = 6.029 (df = 5, p = 0.303) and Fisher-Freeman-Halton exact p ≈ 0.206, indicating no statistically significant age-related association.

This null finding may be accounted for by sample characteristics and statistical power considerations. Although the modal age group contributed the greatest absolute counts of refractive anomalies, the hyperopia/astigmatism pattern was distributed across age strata rather than concentrated in a narrow band. Purposive sampling of special schools may select for developmental or congenital conditions present across a wide age range. In addition, limited numbers in several age strata (expected counts <5 in some cells) diminish the ability to detect modest associations. While age-related refractive changes (for example, incomplete emmetropisation in younger children and refractive shifts during adolescence) are biologically plausible, such trends are more readily demonstrated in larger, population-based samples (Ostadimoghaddam et al., 2015; Kangari et al., 2024). Accordingly, the absence of a significant age effect in the present sample is consistent with the study design and sample size.

5.5 Classification of grades of visual impairment in hearing-impaired individuals

Tables 4.7–4.9 indicate that 92% of participants had normal vision before correction and 96% after refraction; mild visual impairment declined from 4% to 2% following correction. No cases of severe impairment or blindness were recorded after refractive correction; 2% of participants were uncooperative during testing.

These results indicate that the majority of visual deficits identified were refractive and correctable with appropriate optical correction. The measurable improvement in the proportion of participants with normal acuity after refraction demonstrates the immediate clinical impact of spectacles. The residual small proportion with mild impairment after correction may represent amblyopia, ocular pathology not amenable to refraction, incomplete correction, or short-term adaptation effects following spectacle dispensing. The small uncooperative fraction highlights testing limitations that may bias prevalence estimates.

Comparable outcome patterns have been reported in the literature. Abah et al. (2011), Gogate et al. (2009) and Pehere et al. (2019) found that substantial proportions of ocular morbidity in deaf school cohorts were reversible with spectacles or simple therapy. Leguire et al. (1992) emphasised the importance of measuring post-correction outcomes when evaluating screening programmes. Dandona & Dandona (2001) and the WHO World Report on Vision (2019) identify uncorrected refractive error as a major, addressable cause of vision loss globally; the present findings reinforce the role of school-based screening linked to spectacle services as an effective public-health strategy.

5.6 Relationship between visual and hearing impairment

All participants were hearing-impaired by design; therefore, within-study comparisons are restricted to intra-cohort analyses rather than direct comparisons with hearing-normal peers. Cross-tabulations (Tables 4.12–4.13) examined visual status within the hearing-impaired population.

Within this cohort, visual anomalies were predominantly refractive and treatable; the data do not support the proposition that visual impairment is an inevitable consequence of hearing loss. Syndromic associations that link congenital hearing loss with retinal or progressive visual disease (for example, Usher syndrome) remain clinically important but are relatively infrequent in school screening contexts. The observed pattern—frequent comorbid but largely correctable visual problems—suggests that hearing impairment and visual anomalies commonly coexist because of overlapping developmental, genetic, or service-access factors rather than because of a direct causal relationship in most individuals.

This interpretation is concordant with both school-based and population-level evidence. Pehere et al. (2019), Ostadimoghaddam et al. (2015) and Nikolopoulos et al. (2006) distinguish common, non-syndromic correctable ocular morbidity in deaf schoolchildren from rarer syndromic associations (Delmaghani & El-Amraoui, 2022; Pennings et al., 2004). Population studies report that concurrent vision and hearing impairment constitutes an important public-health burden (Caban et al., 2005), and recent global analyses project substantial and rising prevalence of dual sensory impairment (Yeo et al., 2025). Moreover, longitudinal and cross-sectional research links combined sensory deficits with adverse cognitive and mental-health outcomes (Hong et al., 2016; Meher & Gharge, 2022; Liu et al., 2025), further supporting the need for early detection and integrated service delivery. Policy documents and regional recommendations (Eksteen et al., 2022; WHO, 2019; WHO Regional Office for Europe, 2023) advocate people-centred ear-and-eye services that link screening, referral and rehabilitation; the present data endorse these policy directions.

CHAPTER SIX

CONCLUSION

6.1 Conclusions

This study examined the visual status of a school-based cohort of hearing-impaired individuals and addressed six specific objectives: the nature and prevalence of visual anomalies; contrast-sensitivity abnormalities; associations between gender and dual sensory impairment; associations between age and dual sensory impairment; classification of grades of visual impairment; and the relationship between visual and hearing impairment. The principal empirical conclusions are as follows.

First, correctable refractive error—predominantly hyperopia and hyperopia-related astigmatism—constituted the principal ocular finding in the sample. Hyperopia (34%) was the most common refractive anomaly, followed by compound hyperopic astigmatism (15%), whereas myopic categories were less frequent (myopia 11%, simple myopic astigmatism 11%, compound myopic astigmatism 7%) and emmetropia was uncommon (8%). Hyperopia was more frequent among males (24) than females (10), and the 17–20 years age group had the highest occurrence of refractive anomalies (32%).

Second, broad-band contrast sensitivity as measured by the Pelli–Robson chart was preserved for the large majority of participants; 96% had normal contrast sensitivity, while only a small minority (2%) demonstrated mild reduction and 2% were uncooperative, with no cases of moderate or severe reduction recorded. Normal responses were highest in the 17–20 years age group (32%), and mild reduction was noted only in the 5–8 years (1%) and 25–29 years (1%) groups. Among genders, normal contrast sensitivity was slightly higher in males (96.7%) than females (94.9%), with mild reduction observed only in males and uncooperativeness only in females.

Third, visual-impairment grading showed that most participants had normal acuity prior to correction, and that optical correction produced measurable and clinically meaningful improvement: before refraction, 92% had normal vision (>6/12), 4% had mild impairment (<6/12 to 6/18), 2% had moderate impairment (<6/18 to 6/60), and 2% were uncooperative, with no severe impairment or blindness; after refraction, this improved to 96% normal, 2% mild, and 2% uncooperative, with no moderate, severe, or blindness cases. Improvements were evident across genders and ages, with normal vision highest in the 17–20 years group both before (30 individuals) and after (31 individuals) correction.

Fourth, inferential analyses did not demonstrate robust associations between visual impairment and either gender or age within the constraints of the present sample; the chi-square test for visual anomalies versus gender yielded a p-value of 0.060 (not significant at 0.05), though with a borderline likelihood ratio (p=0.036); for visual and hearing impairment by gender, p=0.818 (no association); and by age group, Fisher's Exact test p=0.200 (no significant association), with borderline signals in some subgroup analyses rendered inconclusive by small cell counts and limited statistical power.

Finally, the pattern of co-occurrence observed in this study indicates that, while visual and hearing impairments coexist within the school population (all 100% had hearing impairment, with visual impairment rates low at 6% before and 2% after correction), the visual burden is largely attributable to treatable refractive error rather than irreversible ocular disease directly linked to auditory pathology; notably, none of the participants exhibited both visual and contrast sensitivity impairment.

Taken together, these findings establish that the predominant and addressable contributor to visual morbidity among hearing-impaired students in this cohort is uncorrected refractive error. The preservation of broad-band contrast sensitivity on clinical testing suggests that, for most participants, optical correction is likely to restore or substantially improve functional vision for daily tasks and learning-related activities. The absence of clear age or gender effects in this sample should be interpreted cautiously given the study's cross-sectional design and sample-size limitations.

6.2 RECOMMENDATIONS

To improve upon the current study:

1. Expand the sample size and include a control group of non-hearing-impaired individuals for comparative analysis to strengthen causal inferences regarding the relationship between visual anomalies and hearing impairment.
2. Incorporate advanced diagnostic tools, such as automated refractors or optical coherence tomography, to enhance the accuracy of visual assessments beyond basic retinoscopy and contrast sensitivity testing.
3. Extend the study to multiple locations beyond Benin City to improve generalizability and account for regional variations in environmental or genetic factors influencing dual sensory impairments.
4. Utilize longitudinal designs in future research to track changes in visual anomalies over time among hearing-impaired individuals, providing insights into progression and intervention efficacy.

To improve outcomes at all levels:

1. Government level: Federal and state governments should integrate mandatory vision screening programs into national health policies for special education institutions, allocating funds for free spectacle distribution and training optometrists in sign language to facilitate access for hearing-impaired populations.
2. Community level (including local and academic): Local communities and academic institutions, such as universities and schools for the hearing impaired, should

organize regular awareness campaigns and free eye clinics in partnership with optometry departments to promote early detection and reduce stigma around dual sensory impairments.

3. Family or individual modifications: Families should encourage routine eye check-ups for hearing-impaired members starting from early childhood, while individuals can adopt lifestyle adjustments like using visual aids (e.g., magnifiers or high-contrast environments) and participating in adaptive training programs to enhance daily independence and quality of life.

REFERENCES

Abah, Ernest R., Oladigbolu, Kabiru K., Samaila, Emmanuel, Merali, Hafsat, Ahmed, Abubakar O., & Abubakar, Tahir H. (2011). Ophthalmologic abnormalities among deaf students in Kaduna, Northern Nigeria. *Annals of African Medicine, 10*(1), 29–33.

Abikoye, Tolulope M., Aribaba, Oluwatoyin T., Musa, Kabir O., & Idowu, Olukayode O. (2020). Prevalence and causes of visual impairment among hearing-impaired students in Lagos, Nigeria. *International Journal of Pediatric Otorhinolaryngology, 139*, 110487. https://doi.org/10.1016/j.ijporl.2020.110487

Adegbehingbe, B. O., Majemgbasan, T. O., & Akinsola, F. B. (2005). Ocular disorders among deaf children in South-West Nigeria. *East African Medical Journal, 82*(10), 510–514. https://www.ajol.info/index.php/eamj/article/view/9344

Adetunji, Olufunmilayo O. (2013). Hearing and visual impairment among public primary school pupils in Ibadan North Local Government Area, Nigeria (Master of Public Health Thesis, University of Ibadan, Ibadan, Nigeria). University of Ibadan Library Repository. https://library.adhl.africa/handle/123456789/12009

All About Vision. (2023). Tumbling E eye chart. Retrieved from https://www.allaboutvision.com/visual-tests/tumbling-e.htm

Benjamin, W. J. (Ed.). (2006). Contrast sensitivity and glare testing. In Borish's clinical refraction (2nd ed., pp. 247–260). Elsevier/Butterworth-Heinemann.

Bennett, A. G., & Rabbetts, R. B. (2007). Visual acuity and contrast sensitivity. In Clinical visual optics (4th ed., pp. 85–102). Butterworth-Heinemann.

Bist, J., Adhikari, P., & Sharma, A. K. (2011). Ocular morbidity in hearing-impaired schoolchildren. *Child: Care, Health and Development, 37*(3), 394–397. https://pubmed.ncbi.nlm.nih.gov/20637016/

Bright, T., Ramke, J., Zhang, J. H., Kitema, G. F., Safi, S., Mdala, S., Yoshizaki, M., Brennan-Jones, C. G., Mactaggart, I., Gordon, I., Swenor, B. K., & Burton, M. J. (2023). Prevalence and impact of combined vision and hearing (dual sensory) impairment: A scoping review. *PLOS Glob Public Health, 3*(5), e0001905. https://doi.org/10.1371/journal.pgph.0001905

Caban AJ, Lee DJ, Gómez-Marín O, Lam BL, Zheng DD. Prevalence of concurrent hearing and visual impairment in US adults: The National Health Interview Survey, 1997-2002. Am J Public Health. 2005 Nov;95(11):1940-2. Doi: 10.2105/AJPH.2004.056671. Epub 2005 Sep 29. PMID: 16195516; PMCID: PMC1449463.

Chia, Emmett M., Mitchell, Paul, Rochtchina, Elena, Foran, Sandra, Golding, Michael, & Wang, Jie Jin. (2006). Association between vision and hearing impairments and their combined effects on quality of life. *Archives of Ophthalmology, 124*(10), 1465–1470.

Chioma Lilian Owunna, Chigozie John Ekenze, Ifeoma Kate Okorie, Augustine Ugochukwu Akujobi, Jacqueline E. Obioma-Elemba, Oyinyechi Lilian Umunnakwe, Mamzhi Seljul Crown Ramyil, & Timothy Olugbenga Ogundeko. (2022). Oculo-Visual Assessment of Children and Adolescents With Special Needs in Selected Schools Within IMO State, Nigeria. *Ophthalmology Research: An International Journal, 16*(3), 8–19. https://doi.org/10.9734/or/2022/v16i330235

Chung, Susana T., & Legge, Gordon E. (2007). Visual performance and reading speed under induced blur: effects of defocus on visual function. *Vision Research, 47*(1), 102–115. https://doi.org/10.1016/j.visres.2006.10.001

Dandona, Rakhi, & Dandona, Lalit. (2001). Refractive error blindness. *Bulletin of the World Health Organization, 79*(3), 237–243. https://www.ncbi.nlm.nih.gov/pmc/articlesPMC2566380/

Delmaghani, Safia, & El-Amraoui, Afifa. (2022). The genetic and phenotypic landscapes of Usher syndrome: from disease mechanisms to a new classification. *Human Genetics, 141*(3–4), 709–735. https://doi.org/10.1007/s00439-022-02448-7

Eksteen, Susan, Saloojee, Haroon, & Parbhoo, Ajesh. (2022). Prevalence and characteristics of hearing and vision loss in an underserved South African community. *BMC Pediatrics, 22*, 54. https://doi.org/10.1186/s12887-021-03095-z

Elliott, David B. (2014). Clinical Procedures in Primary Eye Care (3rd ed.). Elsevier.

Finney, Eva M., & Dobkins, Karen R. (2001). Visual contrast sensitivity in deaf versus hearing populations: exploring the perceptual consequences of auditory deprivation and experience with a visual language. *Cognitive Brain Research, 11*(1), 171–183.

Fuller-Thomson, Esme, Nowaczynski, Aaron, & MacNeil, Ainsley. (2022). The association between hearing impairment, vision impairment, dual sensory impairment, and serious cognitive impairment: Findings from a population-based study of 5.4 million older adults. *Journal of Alzheimer's Disease Reports, 6*(1), 211–222. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9198776/

Gogate, Parikshit, Rishikeshi, N., Mehata, R., Ranade, S., Kharat, J., & Deshpande, M. (2009). Visual impairment in hearing-impaired students. *Indian Journal of Ophthalmology, 57*(6), 451–453. https://doi.org/10.4103/0301-4738.57155

Gopinath, B., Schneider, J., McMahon, C. M., Burlutsky, G., Leeder, S. R., et al. (2013). Dual Sensory Impairment in Older Adults Increases the Risk of Mortality: A Population-Based Study. *PLOS ONE, 8*(3), e55054. https://doi.org/10.1371/journal.pone.0055054

Hashemi, H., Fotouhi, A., Yekta, A., Pakzad, R., Ostadimoghaddam, H., & Khabazkhoob, M. (2017). Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. *Journal of Current Ophthalmology, 30*(1), 3–22. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5859285/

Herrero-Gracia, A., Hernández-Andrés, R., Luque, M. J., & Díez-Ajenjo, M. A. (2025). Age-related changes in contrast sensitivity function under different illumination conditions. *Clinical and Experimental Optometry, 108*(7), 880–885. https://doi.org/10.1080/08164622.2025.2483265

Hong, Thelma, Mitchell, Paul, Burlutsky, George, Liew, Gerald, & Wang, Jie Jin. (2016). Visual impairment, hearing loss and cognitive function in an older population: longitudinal findings from the Blue Mountains Eye Study. *PLoS One, 11*(2), e0147646. https://doi.org/10.1371/journal.pone.0147646

Huang, Ashley R., Cudjoe, T. Kwaku M., Rebok, George W., Swenor, Bonnielin K., & Deal, Jennifer A. (2024). Hearing and vision impairment and social isolation over 8 years in community-dwelling older adults. *BMC Public Health, 24*, 779. https://doi.org/10.1186/s12889-024-17730-8

Johnston, David R., Singh, Sukhbinder, Karmody, Charles S., & Klein, Diane. (2010). Ophthalmologic disorders in children with syndromic and non-syndromic congenital sensorineural hearing loss. *JAMA Otolaryngology – Head & Neck Surgery, 136*(6), 597–603. https://doi.org/10.1001/archoto.2010.75

Kangari H, Majd AE, Broumand MG, Tabatabaee SM. Assessment of refractive errors, amblyopia, strabismus, and low vision among hearing-impaired and deaf students in Kermanshah. BMC Ophthalmol. 2024 Jun 12;24(1):250. Doi: 10.1186/s12886-024-03515-5. PMID: 38867144; PMCID: PMC11167778.

Khandekar, R., Al Fahdi, M., Al Jabri, B., Al Harby, S., & Abdulamgeed, T. (2009). Visual function and ocular status of children with hearing impairment in Oman: a case series.

Indian Journal of Ophthalmology, 57(3), 228–229. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2683434/

Khorrami-Nejad, Mohammad, Heravian, Javad, Askarizadeh, Fariba, & Sobhani-Rad, Davoud. (2018). Contrast sensitivity abnormalities in deaf individuals. *Journal of Ophthalmic and Vision Research, 13*(2), 153–157. https://doi.org/10.4103/jovr.jovr_218_16

Kuo, P., Huang, A. R., Ehrlich, J. R., et al. (2021). Prevalence of Concurrent Functional Vision and Hearing Impairment and Association With Dementia in Community-Dwelling Medicare Beneficiaries. *JAMA Network Open, 4*(3), e211558. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2777678

Kwarteng, Michael A., Mashige, K. P., Kyei, S., Quarcoo-Dogbe, D., & Govender-Poonsamy, P. (2022). Prevalence and causes of visual impairment amongst hearing-impaired school-going children in sub-Saharan Africa: a scoping review. *African Health Sciences, 22*(4), 199–204. https://doi.org/10.4314/ahs.v22i4.24

Leguire, L. E., Fillman, R. D., Fishman, D. R., Bremer, D. L., & Rogers, G. L. (1992). A prospective study of ocular abnormalities in hearing-impaired and deaf students. *Ear, Nose & Throat Journal, 71*(12), 643–646, 651. https://pubmed.ncbi.nlm.nih.gov/1483402/

Liu Q, Zhou Z, Wang J, Zhang J, Pang J, Ma L, Xu Y, Li P, Xie H. Gender differences in the relationship between hearing and visual impairments, dual sensory impairment, and depression in middle-aged and elderly populations. Sci Rep. 2025 Jun 3;15(1):19442. Doi: 10.1038/s41598-025-04424-3. PMID: 40461594; PMCID: PMC12134158

Nikolopoulos, Theodore P., Lioumi, Despoina, Stamataki, Sophia, O'Donoghue, Gerard M., Guest, Mary, & Hall, Anne-Marie. (2006). Evidence-based overview of ophthalmic disorders in deaf children: a literature update. *Otology & Neurotology, 27*(Suppl 1), S1–S24.

Meher T, Gharge S. Visual and hearing impairment and their association with depression among middle-aged and older individuals in India: Evidence from a cross-sectional study. Int J Geriatr Psychiatry. 2022 May;37(5). Doi: 10.1002/gps.5716. PMID: 35466468.

Moyegbone, John, Nwose, Ezekiel, Nwajei, Samuel, Odoko, Joseph, Agege, Emmanuel, & Igumbor, Eunice. (2020). Epidemiology of visual impairment: focus on Delta State, Nigeria. *International Journal of Community Medicine and Public Health, 7*, 4171. https://doi.org/10.18203/2394-6040.ijcmph20204392

Ostadimoghaddam, Hadi, Sehat, Mahsa, Lashkari, Afsaneh, Aghajani, Azam, Yekta, Abbas A., & Heravian, Javad. (2015). Eye problems in children with hearing impairment. *Journal of Current Ophthalmology, 27*(1), 1–5.

Osaiyuwu, A. B., & Ebeigbe, Jennifer. (2010). Prevalence of visual disorders in deaf children in Benin City. *Journal of the Nigerian Optometric Association, 15*. https://doi.org/10.4314/jnoa.v15i1.55600

Ovenseri-Ogbomo, Godwin B., & Omuemu, Vivian O. (2010). Prevalence of refractive error among school children in the Cape Coast Municipality, Ghana. *Clinical Optometry, 2*, 1–8. https://doi.org/10.2147/OPTO.S10583

Pardhan, Shahina, Smith, Lee, Bourne, Rupert, Davis, Adrian, Leveziel, Nicolas, Jacob, Louis, Koyanagi, Ai, & López-Sánchez, Guillermo F. (2021). Combined vision and hearing difficulties result in higher levels of depression and chronic anxiety: Data from a large sample of Spanish adults. *Frontiers in Psychology, 11*, 627980. https://doi.org/10.3389/fpsyg.2020.627980

Pennings, R. J. E., Te Brinke, H., Weston, M. D., Claassen, A., & Cremers, C. W. R. J. (2004). Usher syndrome type II: A review of clinical features and molecular genetics. *Clinical Otolaryngology and Allied Sciences, 29*(4), 294–302. https://doi.org/10.1111/j.1365-2273.2004.00833.x

Pelli, Denis G., Robson, John G., & Wilkins, Arnold J. (1988). The design of a new letter chart for measuring contrast sensitivity. *Clinical Vision Sciences, 2*(3), 187–199.

Pehere, N. K., Khanna, R. C., Marlapati, R., & Sannapaneni, K. (2019). Prevalence of ophthalmic disorders among hearing-impaired school children in Guntur district of Andhra Pradesh. *Indian Journal of Ophthalmology, 67*(4), 530–535. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6446638/

Radhakrishnan, Hema, Pardhan, Shahina, Calver, Richard I., & O'Leary, Daniel J. (2004). Contrast sensitivity and optical defocus: effects of positive and negative defocus on visual performance. *Vision Research, 44*(30), 321–328. https://doi.org/10.1016/j.visres.2004.03.007

Resnikoff, S., Pascolini, D., Mariotti, S. P., & Pokharel, G. P. (2008). Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bulletin of the World Health Organization, 86*(1), 63–70. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2647357/

Salmon, John F. (2024). Kanski's Clinical Ophthalmology: A Systematic Approach (10th ed.). Elsevier.

Sjöstrand, Jan, Laatikainen, Leila, Hirvelä, Hanna, Popovic, Zlatko, & Jonsson, Ragnar. (2011). The decline in visual acuity in elderly people with healthy eyes or eyes with early age-related maculopathy in two Scandinavian population samples. *Acta Ophthalmologica, 89*(2), 116–123. https://doi.org/10.1111/j.1755-3768.2009.01653.x

Swenor, B. K., Ramulu, P. Y., Willis, J. R., Friedman, D., & Lin, F. R. (2013). The prevalence of concurrent hearing and vision impairment in the United States. *JAMA Internal Medicine, 173*(4), 312–313. https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/1558453

Thibos, Larry N., Hong, Xin, Bradley, Arthur, & Cheng, Xinyu. (2002). Statistical variation of aberration structure and image quality in a normal population of healthy eyes. *Journal of the Optical Society of America A: Optics, Image Science, and Vision, 19*(12), 2329–2348. https://doi.org/10.1364/josaa.19.002329

Williams, K. M., Verhoeven, V. J. M., Cumberland, P., et al. (2015). Prevalence of refractive error in Europe: the European Eye Epidemiology (E3) Consortium. *European Journal of Epidemiology, 30*, 305–315. https://doi.org/10.1007/s10654-015-0010-0

World Health Organization. (2019). *World Report on Vision*. Geneva: World Health Organization.

World Health Organization. (2021). *World Report on Hearing*. Geneva: World Health Organization.

World Health Organization Regional Office for Europe. (2023). Integrating people-centred eye and ear care within health systems. Copenhagen: WHO Regional Office for Europe. https://www.who.int/europe/activities/integrating-people-centred-eye-and-ear-care-within-health-systems.

Yeo BSY, Gao EY, Tan BKJ, Ong BDC, Cho RWY, Lim CY, Man REK, Fenwick EK, Gupta P, Chen CL, Chew STH, Teo NWY, Toh ST, Ng JH, Tan VYJ, Lamoureux EL. Dual sensory impairment: Global prevalence, future projections, and its association with cognitive decline. Alzheimers Dement. 2025 Feb;21(2):e14465. Doi: 10.1002/alz.14465. Epub 2025 Jan 30. PMID: 39887563; PMCID: PMC11851313

APPENDIX I

155

Faculty of Optometry,
University of Benin.
30th October, 2025.

The Chairperson
Research Ethics Committee (REC)
Faculty of Optometry,
University of Benin.

Through;
The Project Coordinator,
Faculty of Optometry,
University of Benin,
P.M.B 1154,
Ugbowo,
Benin City.

Dear Sir/Ma,

RE: APPLICATION FOR ETHICAL REVIEW AND CLEARANCE

I hereby apply for ethical clearance to conduct a research study titled:

"RELATIONSHIP BETWEEN VISUAL ANOMALIES AND HEARING IMPAIRMENT."

This study aims to investigate the relationship between visual anomalies and hearing Impairment.

Principal Investigator (PI):
Dr. Akpalaba R.U.E (Assoc. Professor)

Investigator:
Nwachukwu Samuel Afievahol
LSC2007126

I kindly request the Research Ethics Committee to provide the required application documents for completion and submission as part of the ethical review process.

Thank you for your consideration. I look forward to your favorable response.

Yours faithfully,

NWACHUKWU SAMUEL AFIEVAHOL
Investigator

DEPARTMENT OF OPTOMETRY
UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.
RESEARCH AND ETHICS COMMITTEE

Date: 31st October, 2025.

NWACHUKWU SAMUEL AFIEVAHOL,
Faculty of Optometry,
University of Benin, Benin City

Dear **NWACHUKWU SAMUEL AFIEVAHOL,**

I write to inform you that you have been granted full ethical approval for you to carry out research project **"RELATIONSHIP BETWEEN VISUAL ANOMALIES AND HEARING IMPAIRMENT".** The REC approval number is **EC/UBEN/LSC.OPT/25/155.** This is sequel to a successful ethical review of your submitted research protocols by the Research and Ethics Committee.

You are however expected to adhere strictly to internationally acceptable ethical standards relating to biomedical research involving humans and animals and at all times ensure that the rights, dignity and privileges of volunteering participants are upheld. Any amendments to this study protocol, unless urgently required to ensure the safety of participants, must be approved by REC prior to implementation.

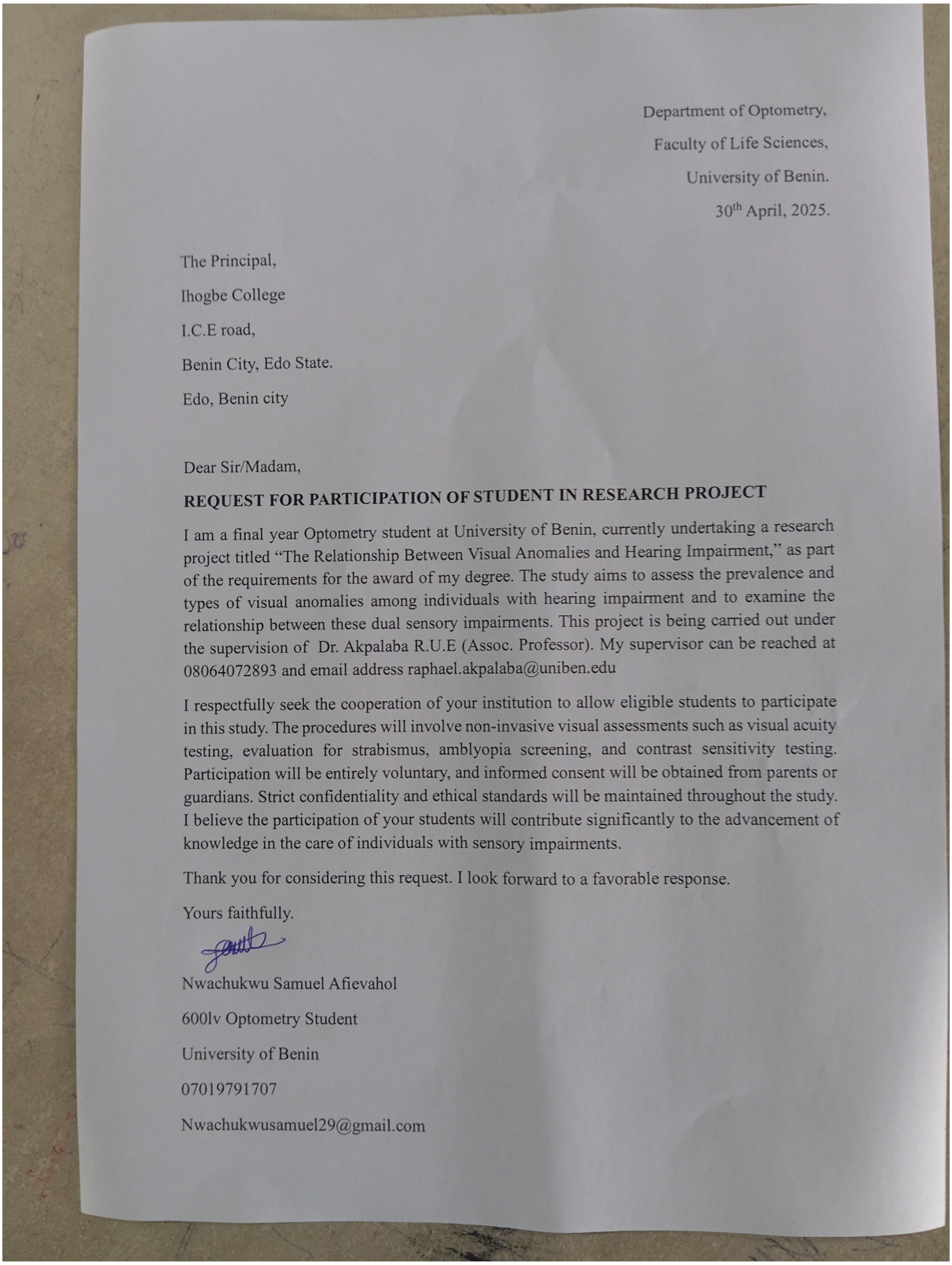
We would appreciate receiving copies of all publications and excerpts arising from this study for filling and possible interventions. Please quote the reference number in all correspondence to this committee.

Thank you.

Dr. (Mrs.) Juno O. Okukpon
Project Coordinator

For:
Chair, Research and Ethics Committee
Faculty Of Optometry,
University Of Benin.

FIGURE 2a: Letter to school



Department of Optometry,
Faculty of Life Sciences,
University of Benin.
30th April, 2025.

The Principal,
Ihogbe College
I.C.E road,
Benin City, Edo State.
Edo, Benin city

Dear Sir/Madam,

REQUEST FOR PARTICIPATION OF STUDENT IN RESEARCH PROJECT

I am a final year Optometry student at University of Benin, currently undertaking a research project titled "The Relationship Between Visual Anomalies and Hearing Impairment," as part of the requirements for the award of my degree. The study aims to assess the prevalence and types of visual anomalies among individuals with hearing impairment and to examine the relationship between these dual sensory impairments. This project is being carried out under the supervision of Dr. Akpalaba R.U.E (Assoc. Professor). My supervisor can be reached at 08064072893 and email address raphael.akpalaba@uniben.edu

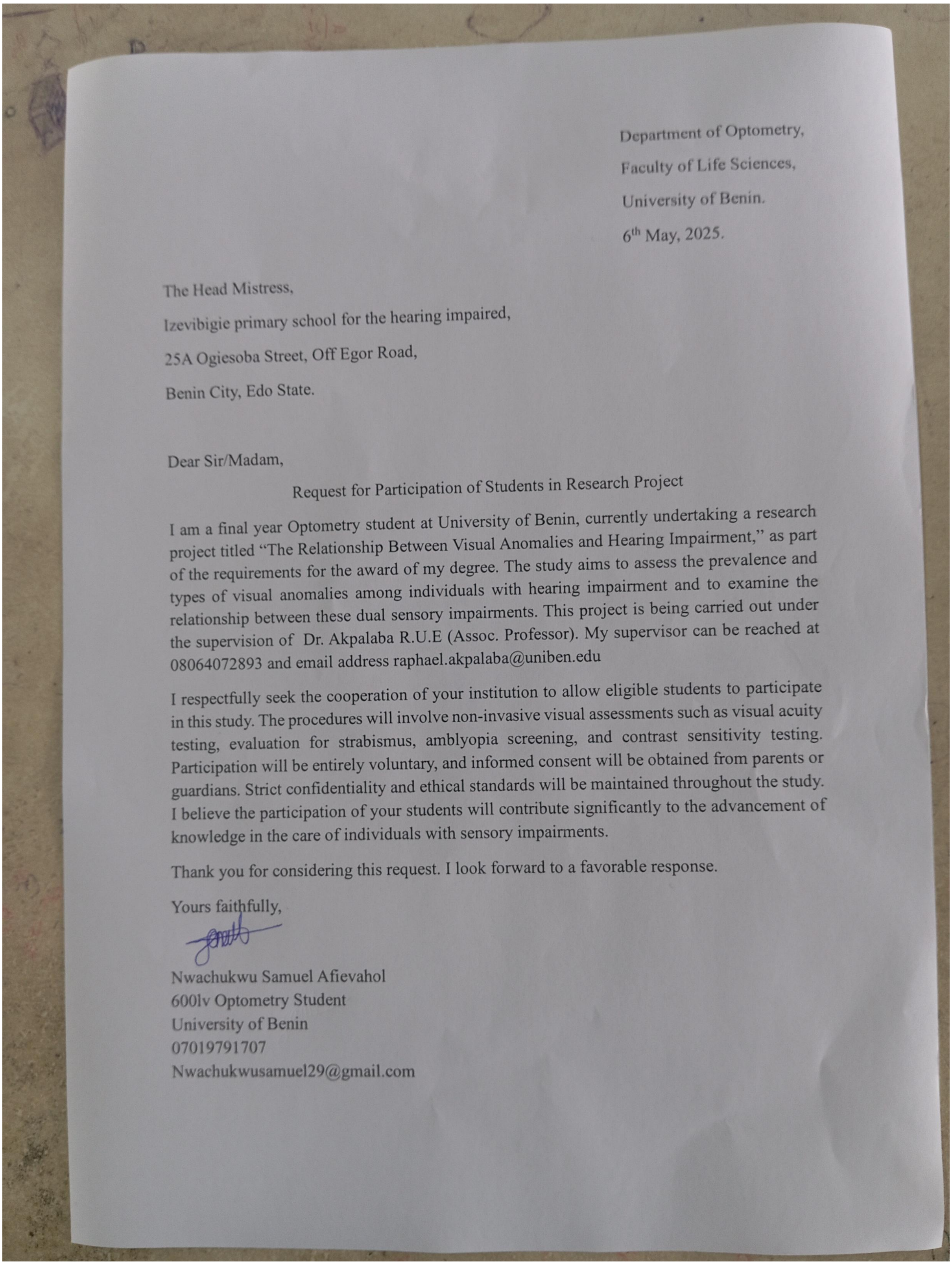
I respectfully seek the cooperation of your institution to allow eligible students to participate in this study. The procedures will involve non-invasive visual assessments such as visual acuity testing, evaluation for strabismus, amblyopia screening, and contrast sensitivity testing. Participation will be entirely voluntary, and informed consent will be obtained from parents or guardians. Strict confidentiality and ethical standards will be maintained throughout the study. I believe the participation of your students will contribute significantly to the advancement of knowledge in the care of individuals with sensory impairments.

Thank you for considering this request. I look forward to a favorable response.

Yours faithfully.

Nwachukwu Samuel Afievahol
600lv Optometry Student
University of Benin
07019791707
Nwachukwusamuel29@gmail.com

FIGURE 2b: Letter to school



Department of Optometry,

Faculty of Life Sciences,

University of Benin.

6th May, 2025.

The Head Mistress,

Izevibigie primary school for the hearing impaired,

25A Ogiesoba Street, Off Egor Road,

Benin City, Edo State.

Dear Sir/Madam,

Request for Participation of Students in Research Project

I am a final year Optometry student at University of Benin, currently undertaking a research project titled "The Relationship Between Visual Anomalies and Hearing Impairment," as part of the requirements for the award of my degree. The study aims to assess the prevalence and types of visual anomalies among individuals with hearing impairment and to examine the relationship between these dual sensory impairments. This project is being carried out under the supervision of Dr. Akpalaba R.U.E (Assoc. Professor). My supervisor can be reached at 08064072893 and email address raphael.akpalaba@uniben.edu

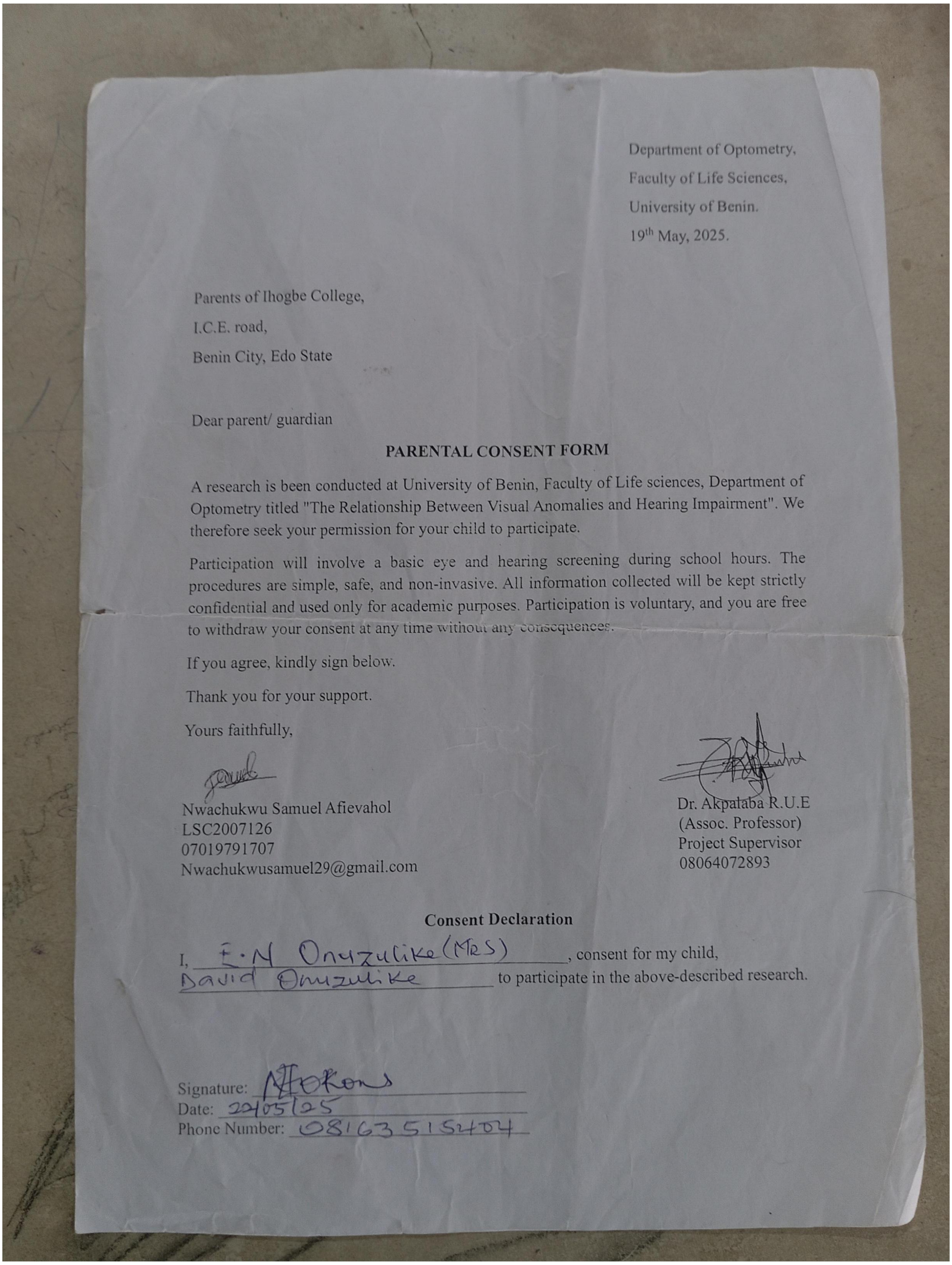
I respectfully seek the cooperation of your institution to allow eligible students to participate in this study. The procedures will involve non-invasive visual assessments such as visual acuity testing, evaluation for strabismus, amblyopia screening, and contrast sensitivity testing. Participation will be entirely voluntary, and informed consent will be obtained from parents or guardians. Strict confidentiality and ethical standards will be maintained throughout the study. I believe the participation of your students will contribute significantly to the advancement of knowledge in the care of individuals with sensory impairments.

Thank you for considering this request. I look forward to a favorable response.

Yours faithfully,

Nwachukwu Samuel Afievahol
600lv Optometry Student
University of Benin
07019791707
Nwachukwusamuel29@gmail.com

FIGURE 3a: consent letter from parents



Department of Optometry,
Faculty of Life Sciences,
University of Benin.
19th May, 2025.

Parents of Ihogbe College,
I.C.E. road,
Benin City, Edo State

Dear parent/ guardian

PARENTAL CONSENT FORM

A research is been conducted at University of Benin, Faculty of Life sciences, Department of Optometry titled "The Relationship Between Visual Anomalies and Hearing Impairment". We therefore seek your permission for your child to participate.

Participation will involve a basic eye and hearing screening during school hours. The procedures are simple, safe, and non-invasive. All information collected will be kept strictly confidential and used only for academic purposes. Participation is voluntary, and you are free to withdraw your consent at any time without any consequences.

If you agree, kindly sign below.

Thank you for your support.

Yours faithfully,

Nwachukwu Samuel Afievahol
LSC2007126
07019791707
Nwachukwusamuel29@gmail.com

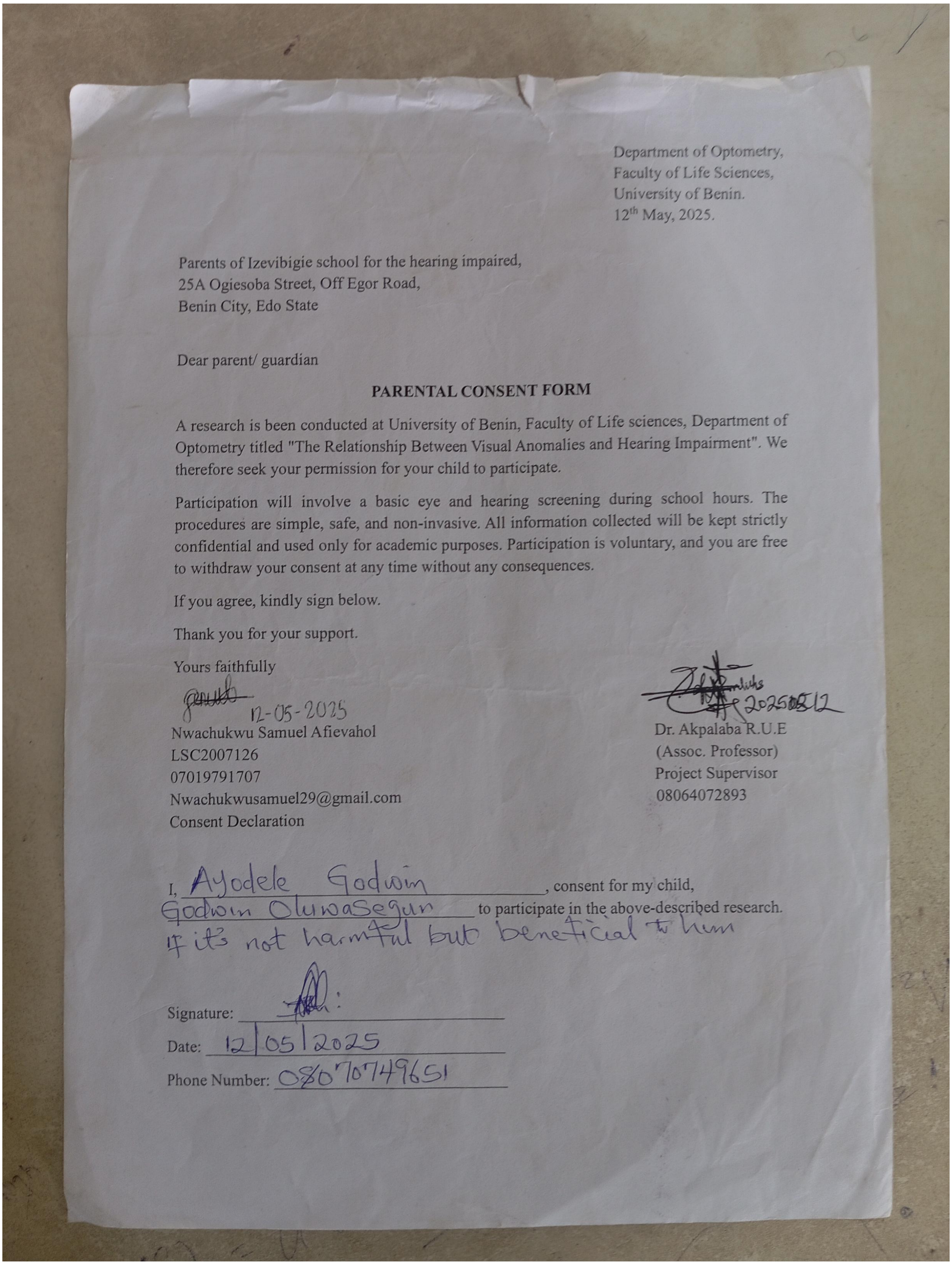
Dr. Akpalaba R.U.E
(Assoc. Professor)
Project Supervisor
08064072893

Consent Declaration

I, E.N Onyzulike (MrS), consent for my child, David Onuzulike to participate in the above-described research.

Signature: ______
Date: 22/05/25
Phone Number: 08163515404

FIGURE 3b: consent letter from parents



Department of Optometry,
Faculty of Life Sciences,
University of Benin.
12th May, 2025.

Parents of Izevibigie school for the hearing impaired,
25A Ogiesoba Street, Off Egor Road,
Benin City, Edo State

Dear parent/ guardian

PARENTAL CONSENT FORM

A research is been conducted at University of Benin, Faculty of Life sciences, Department of Optometry titled "The Relationship Between Visual Anomalies and Hearing Impairment". We therefore seek your permission for your child to participate.

Participation will involve a basic eye and hearing screening during school hours. The procedures are simple, safe, and non-invasive. All information collected will be kept strictly confidential and used only for academic purposes. Participation is voluntary, and you are free to withdraw your consent at any time without any consequences.

If you agree, kindly sign below.

Thank you for your support.

Yours faithfully

12-05-2025
Nwachukwu Samuel Afievahol
LSC2007126
07019791707
Nwachukwusamuel29@gmail.com

20250512
Dr. Akpalaba R.U.E
(Assoc. Professor)
Project Supervisor
08064072893

Consent Declaration

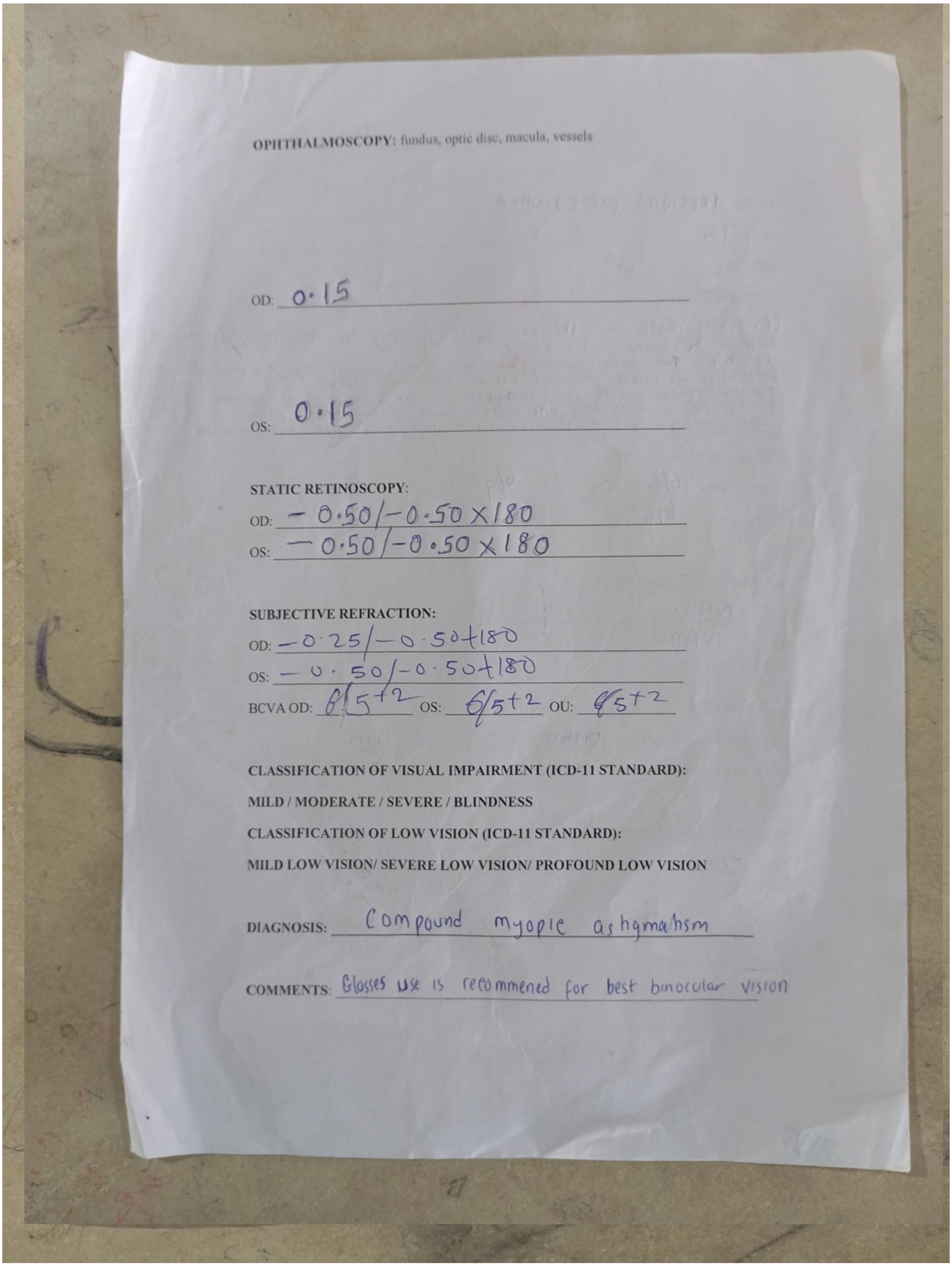
I, Ayodele Godwin, consent for my child, Godwin Oluwasegun to participate in the above-described research. If it's not harmful but beneficial to him

Signature: ______

Date: 12/05/2025

Phone Number: 08070749651

FIGURE 4: Basic Examination sheet



OPHTHALMOSCOPY: fundus, optic disc, macula, vessels

OD: 0·15

OS: 0·15

STATIC RETINOSCOPY:

OD: −0·50/−0·50×180

OS: −0·50/−0·50×180

SUBJECTIVE REFRACTION:

OD: −0·25/−0·50×180

OS: −0·50/−0·50×180

BCVA OD: 6/5+2 OS: 6/5+2 OU: 6/5+2

CLASSIFICATION OF VISUAL IMPAIRMENT (ICD-11 STANDARD):

MILD / MODERATE / SEVERE / BLINDNESS

CLASSIFICATION OF LOW VISION (ICD-11 STANDARD):

MILD LOW VISION/ SEVERE LOW VISION/ PROFOUND LOW VISION

DIAGNOSIS: Compound myopic astigmatism

COMMENTS: Glasses use is recommened for best binocular vision

FIGURE 6a: Field work

FIGURE 6b: Field work

Figure 5: Pie chart showing Distribution of Gender among Participants

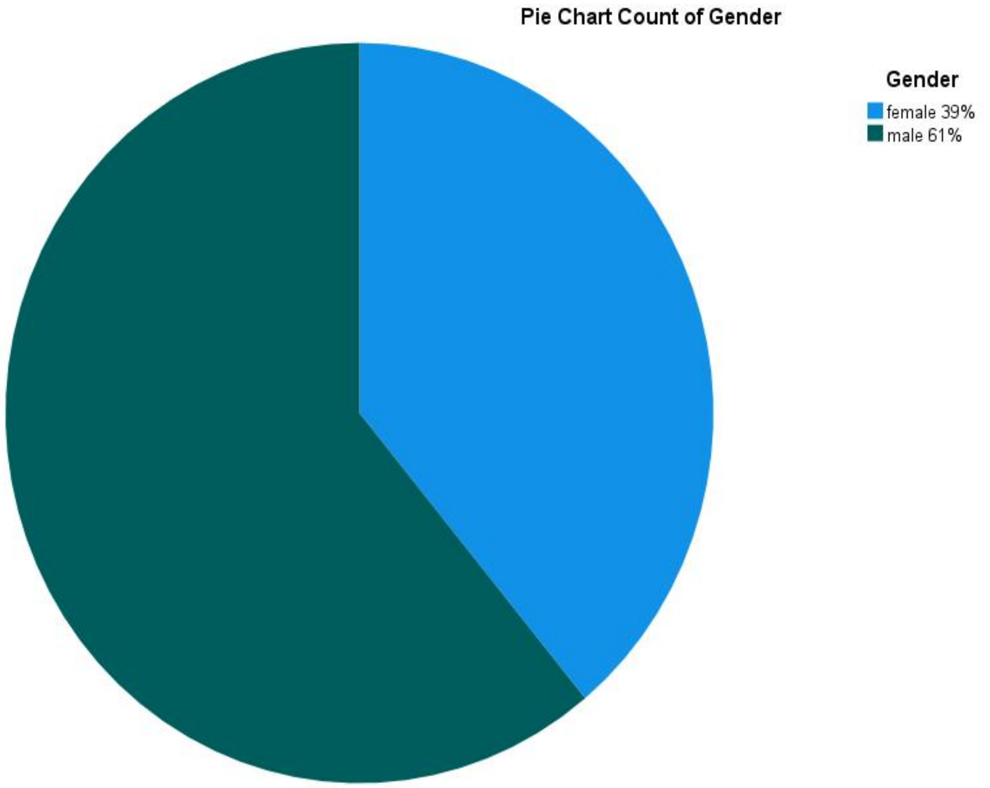


FIGURE 7: Bar chart showing Distribution of Age among Participants

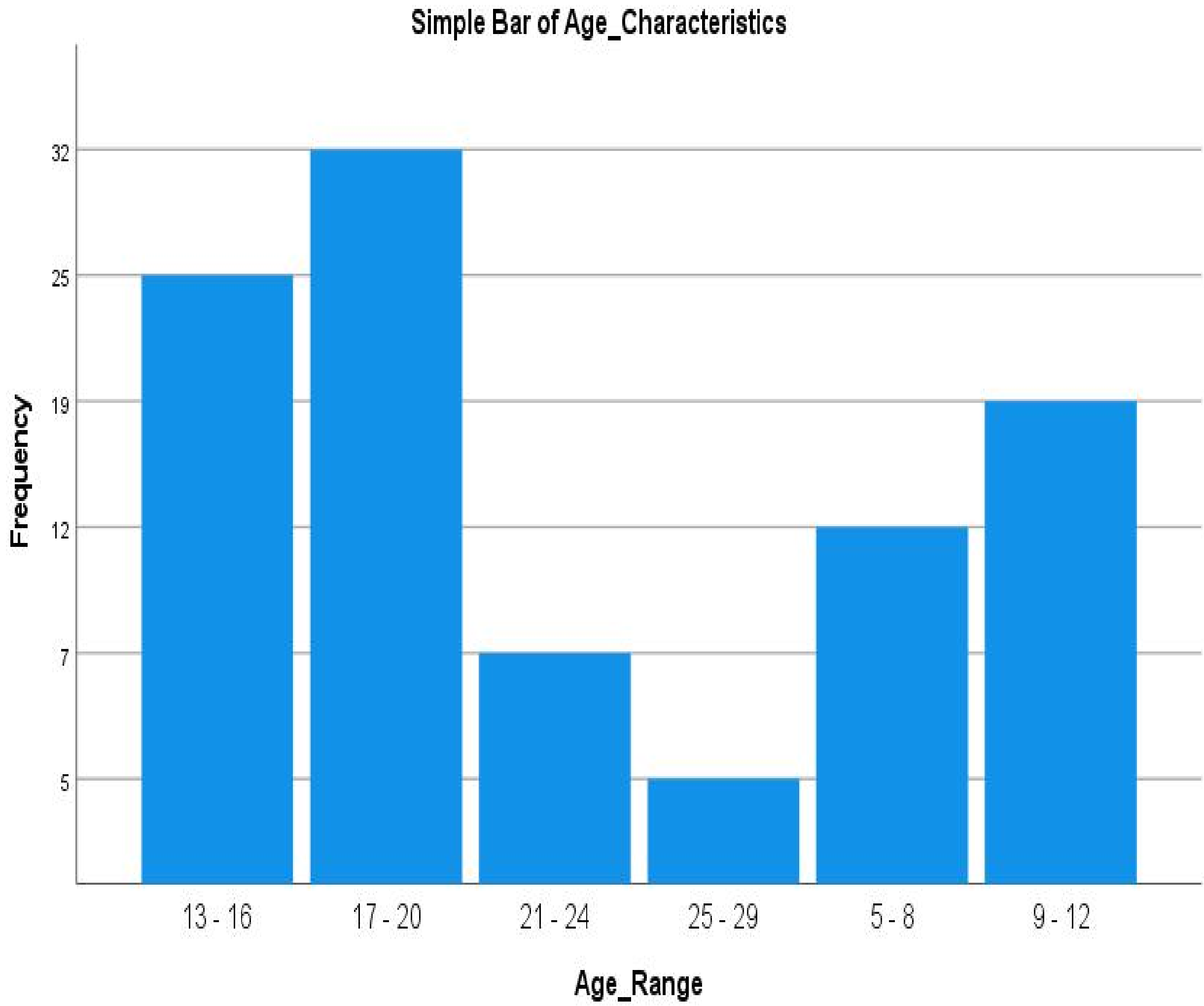
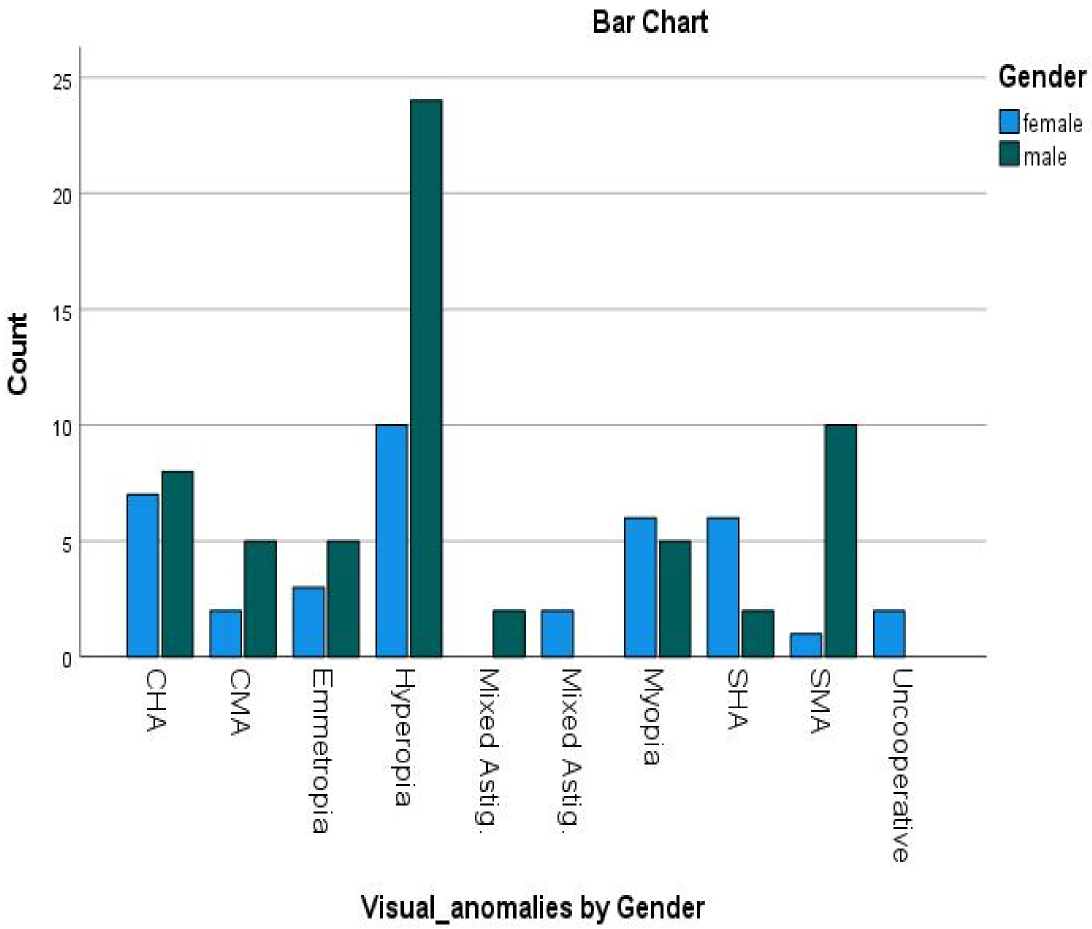
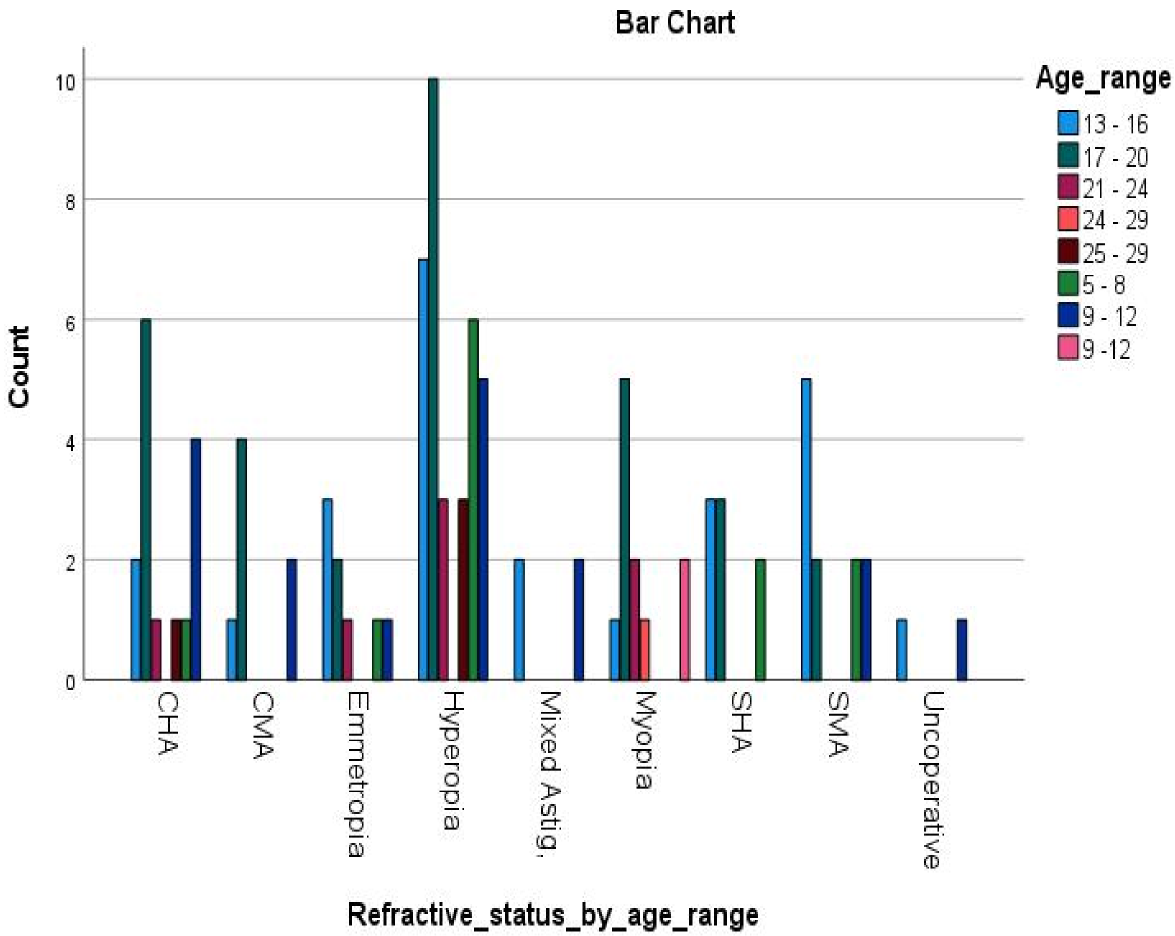


FIGURE 8: **Bar chart showing Distribution of refractive Anomalies and gender among Participants**



Key: CHA => Compound Hyperopic Astigmatism, SHA => Simple Hyperopic Astigmatism, CMA => Compound myopic Astigmatism, SMA => Simple myopic Astigmatism

FIGURE 9: Bar chart showing Distribution of Refractive Status and Age Range among Participants



Key: CHA => Compound Hyperopic Astigmatism, SHA => Simple Hyperopic Astigmatism, CMA => Compound myopic Astigmatism, SMA => Simple myopic Astigmatism.

FIGURE 10: **Bar chart showing Distribution of Contrast Sensitivity by Age Range among Participants**

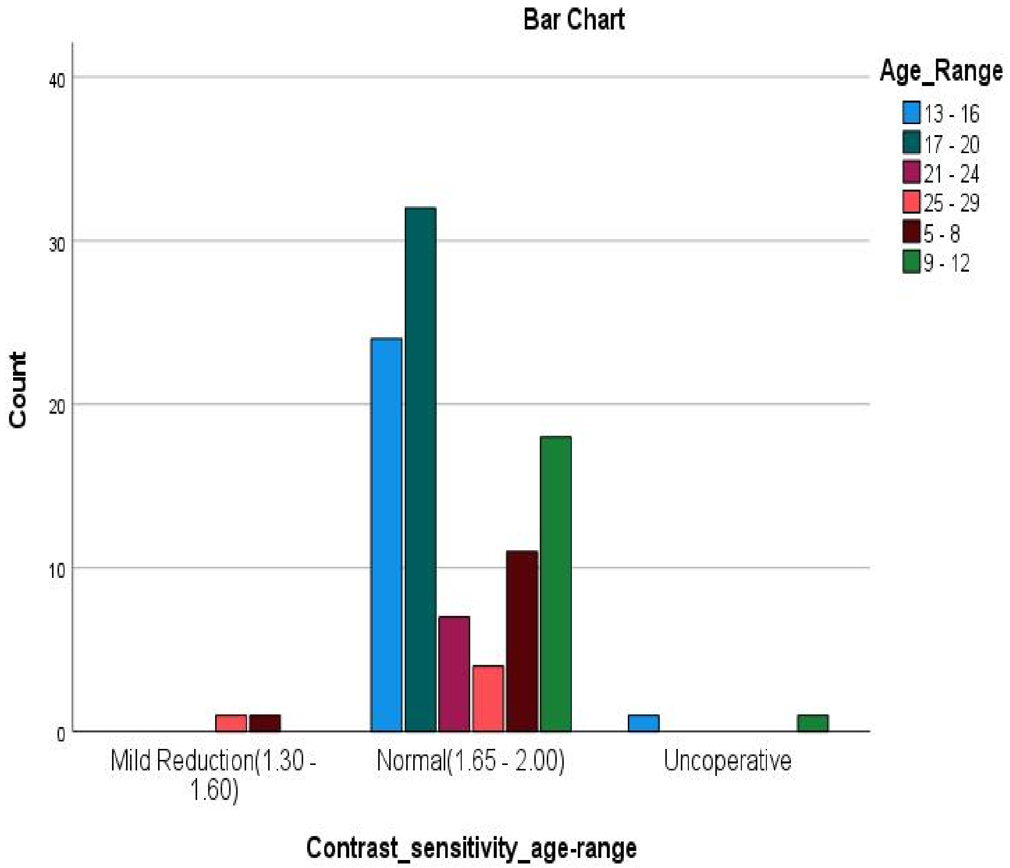


FIGURE 11: Bar chart showing Distribution of Contrast Sensitivity by Gender among Participants

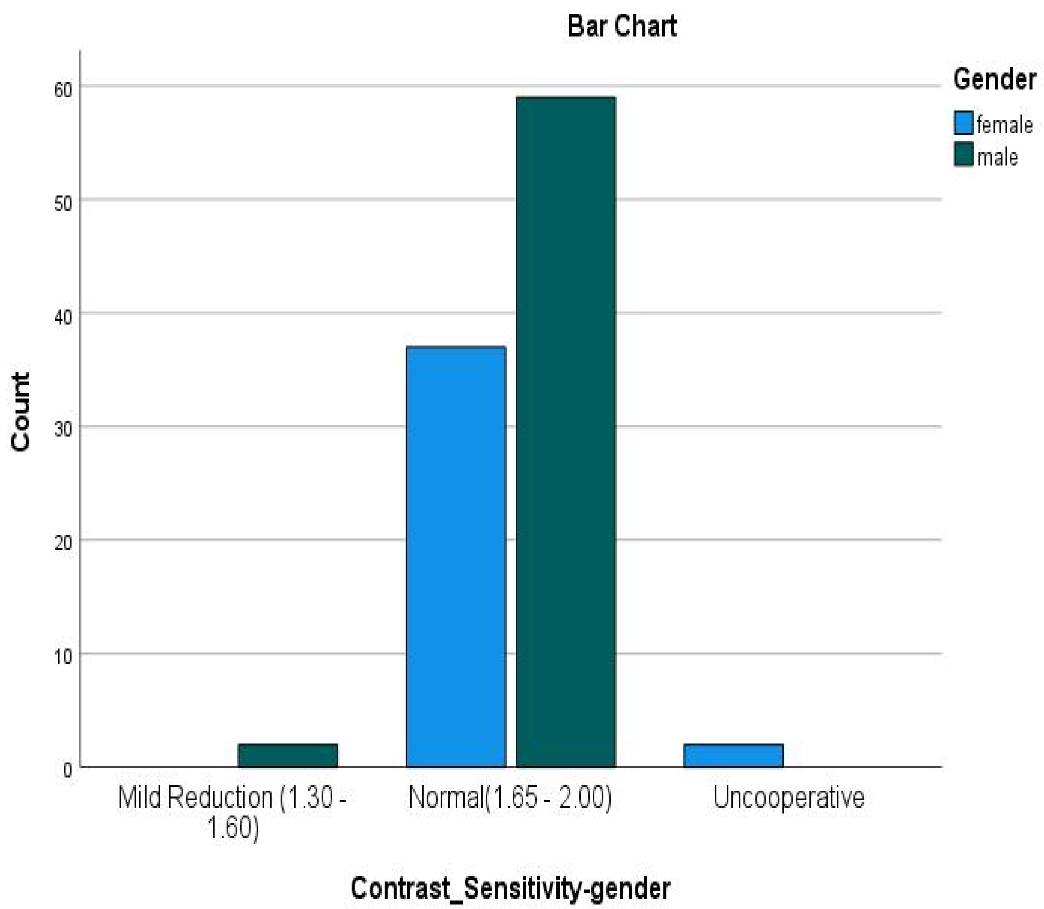


FIGURE 12: **Bar chart showing Distribution of Visual impairment and gender Category Before**

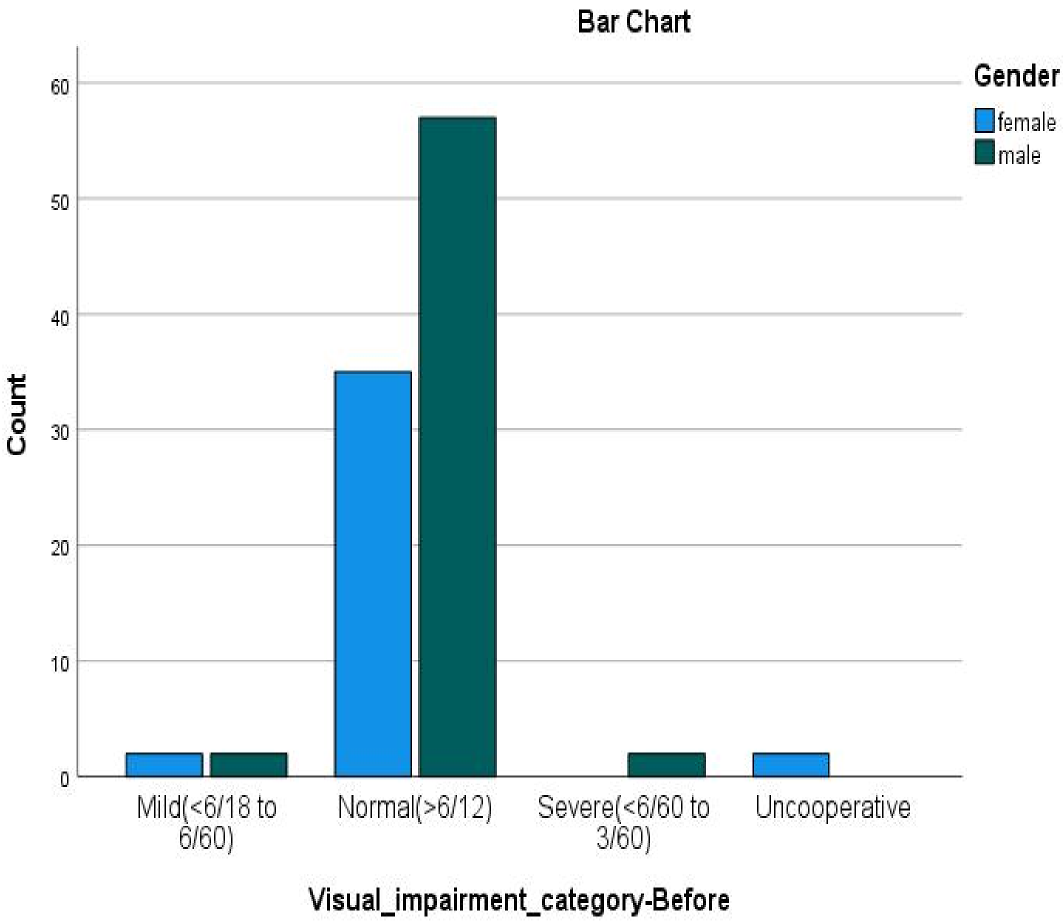


FIGURE 13: Bar chart showing Distribution of Visual Impairment and gender Category After

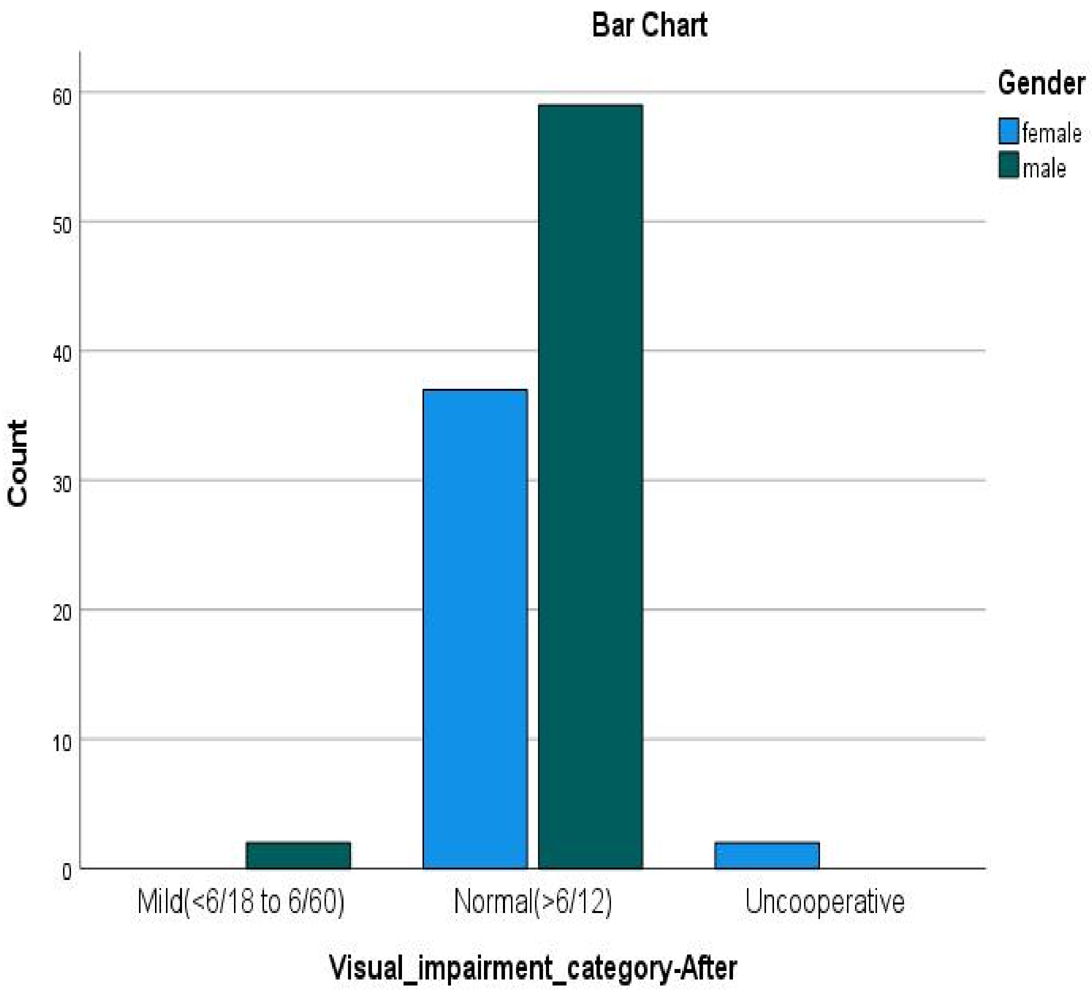


FIGURE 14: Bar chart showing Distribution of Visual Impairment and age range before Correction

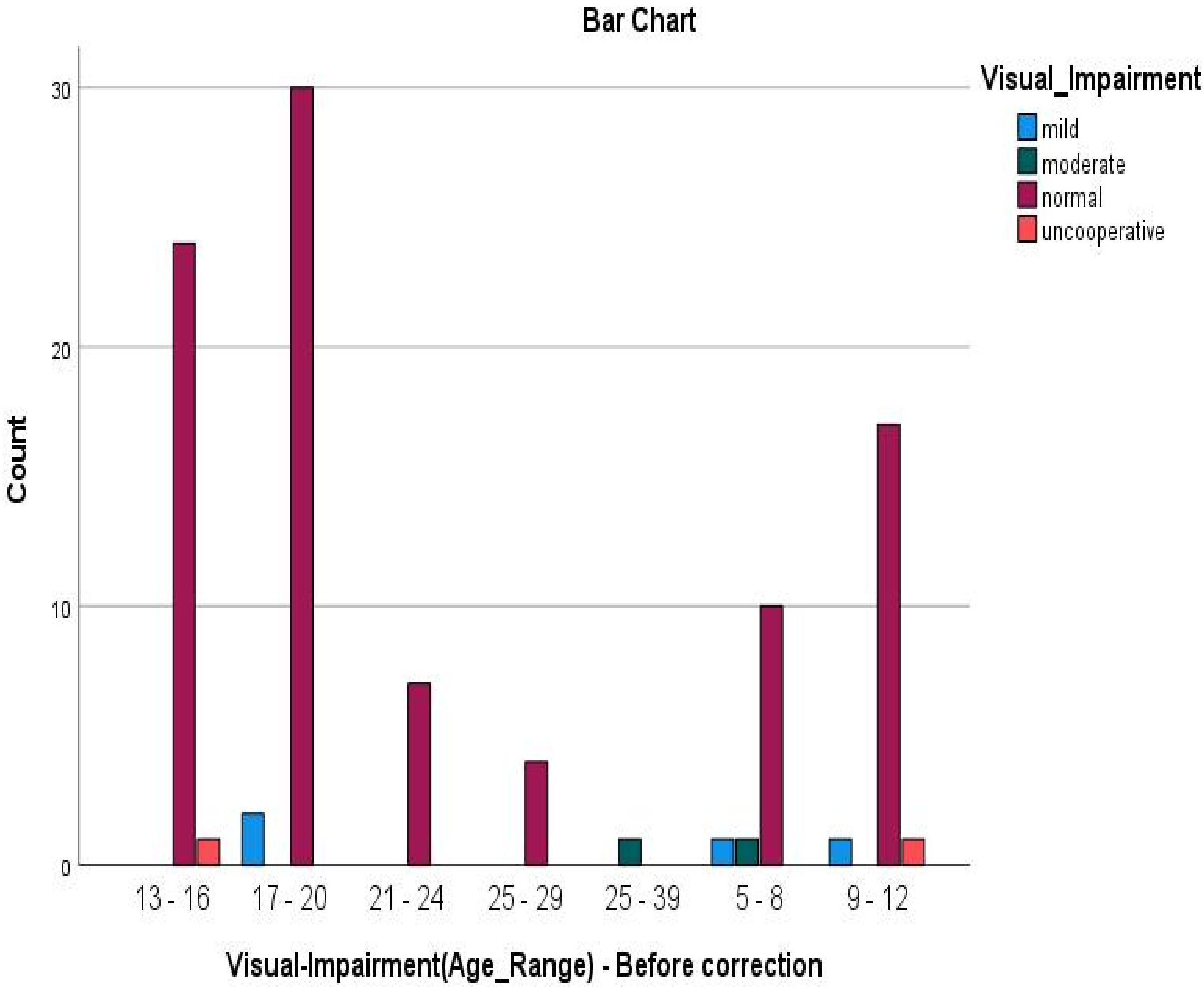


FIGURE 15: Bar chart showing Distribution of Visual Impairment and age range after Correction

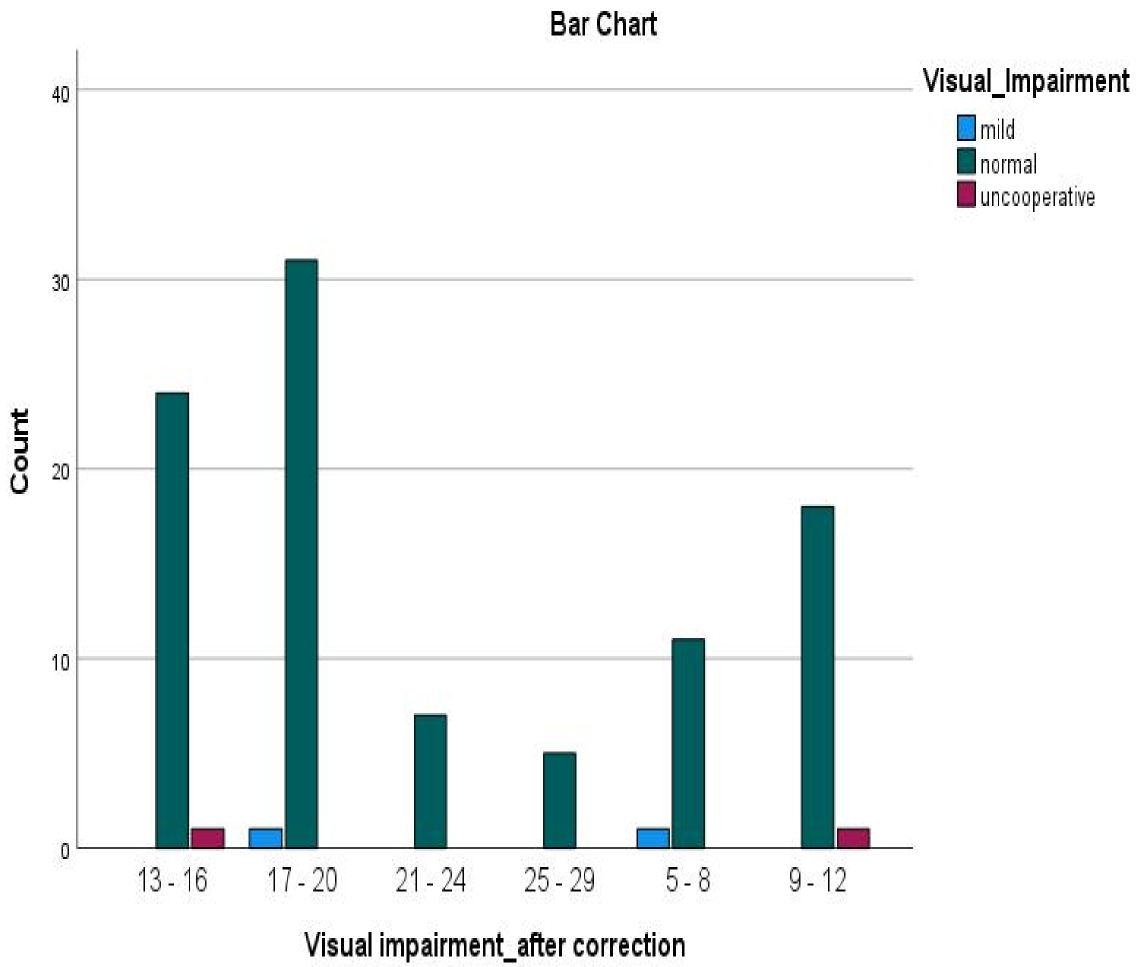


FIGURE 16: Pie Chart showing Distribution of Hearing Impairment by gender

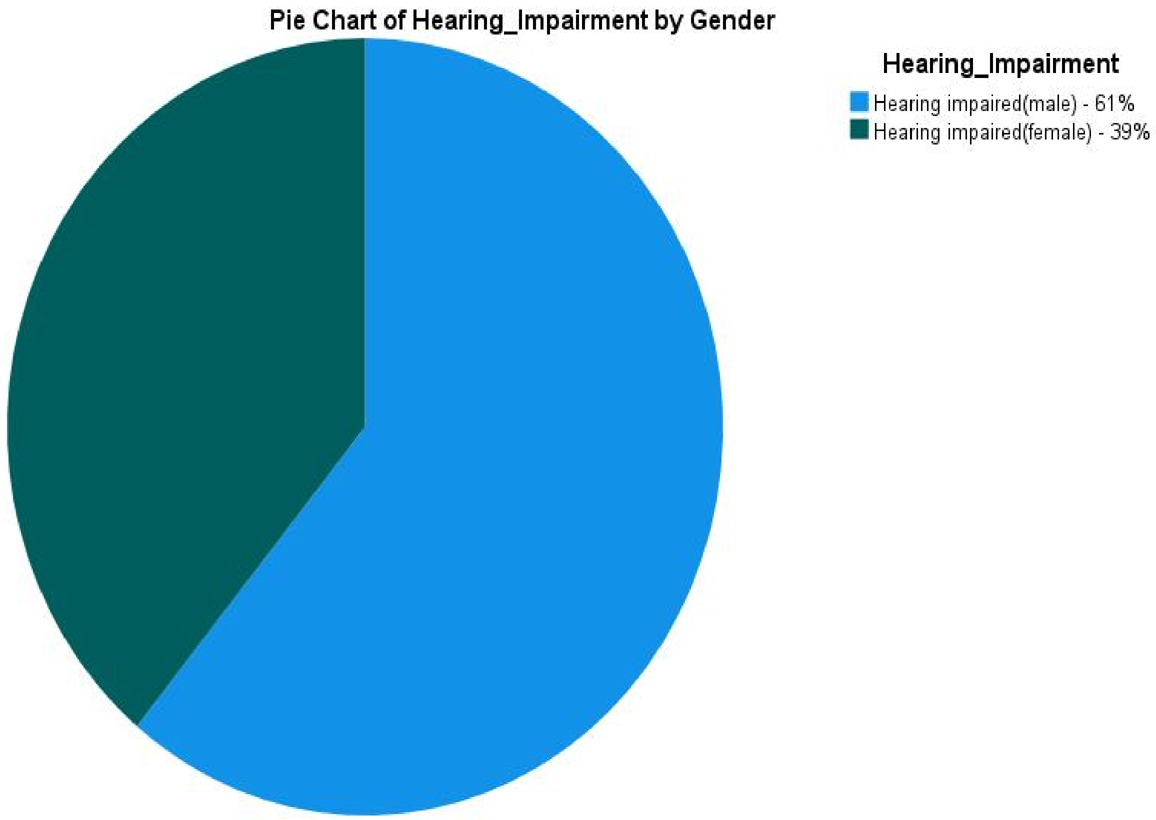


FIGURE 17: Bar chart showing Distribution of Hearing Impairment Status by Age Range (Before Correction)

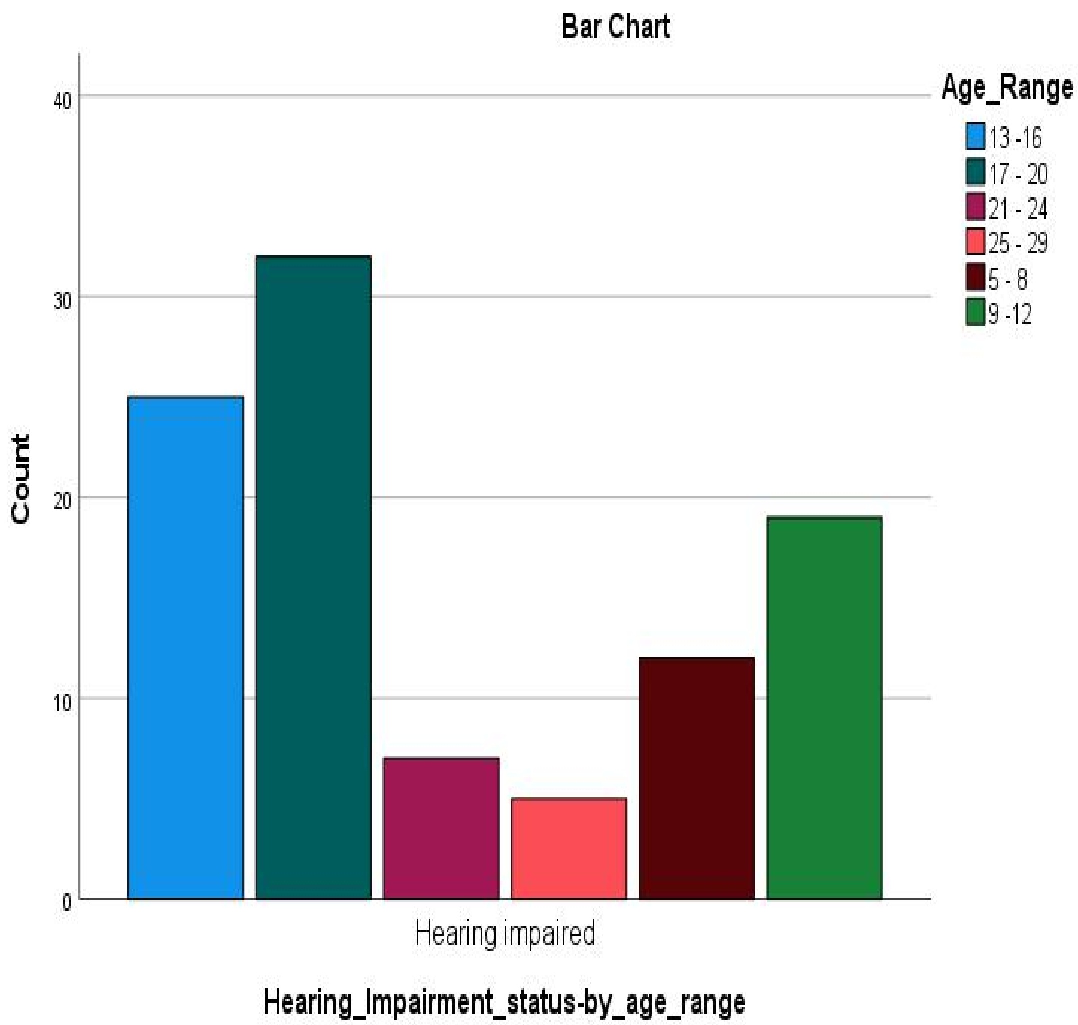


FIGURE 18: Bar chart showing Distribution of Visual and Hearing Impairment by Gender before Correction

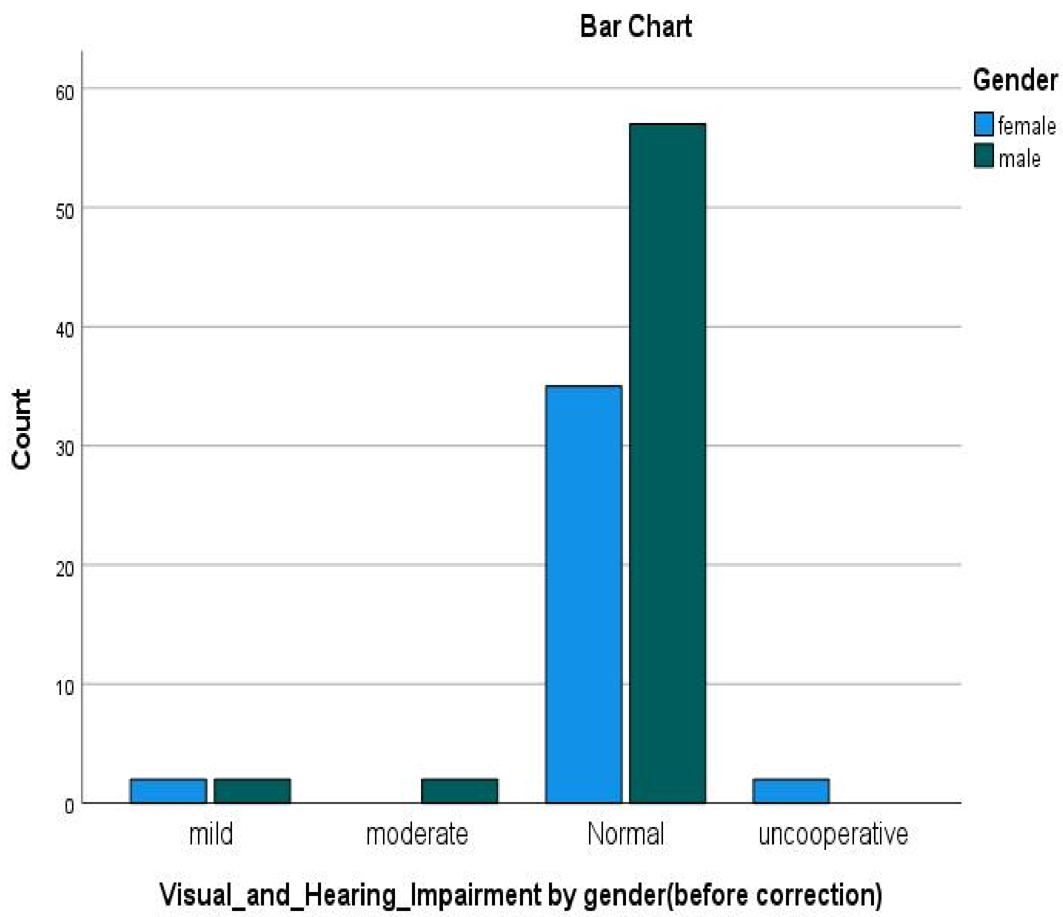


FIGURE 19: Bar chart showing Distribution of Visual and Hearing Impairment by Gender after Correction

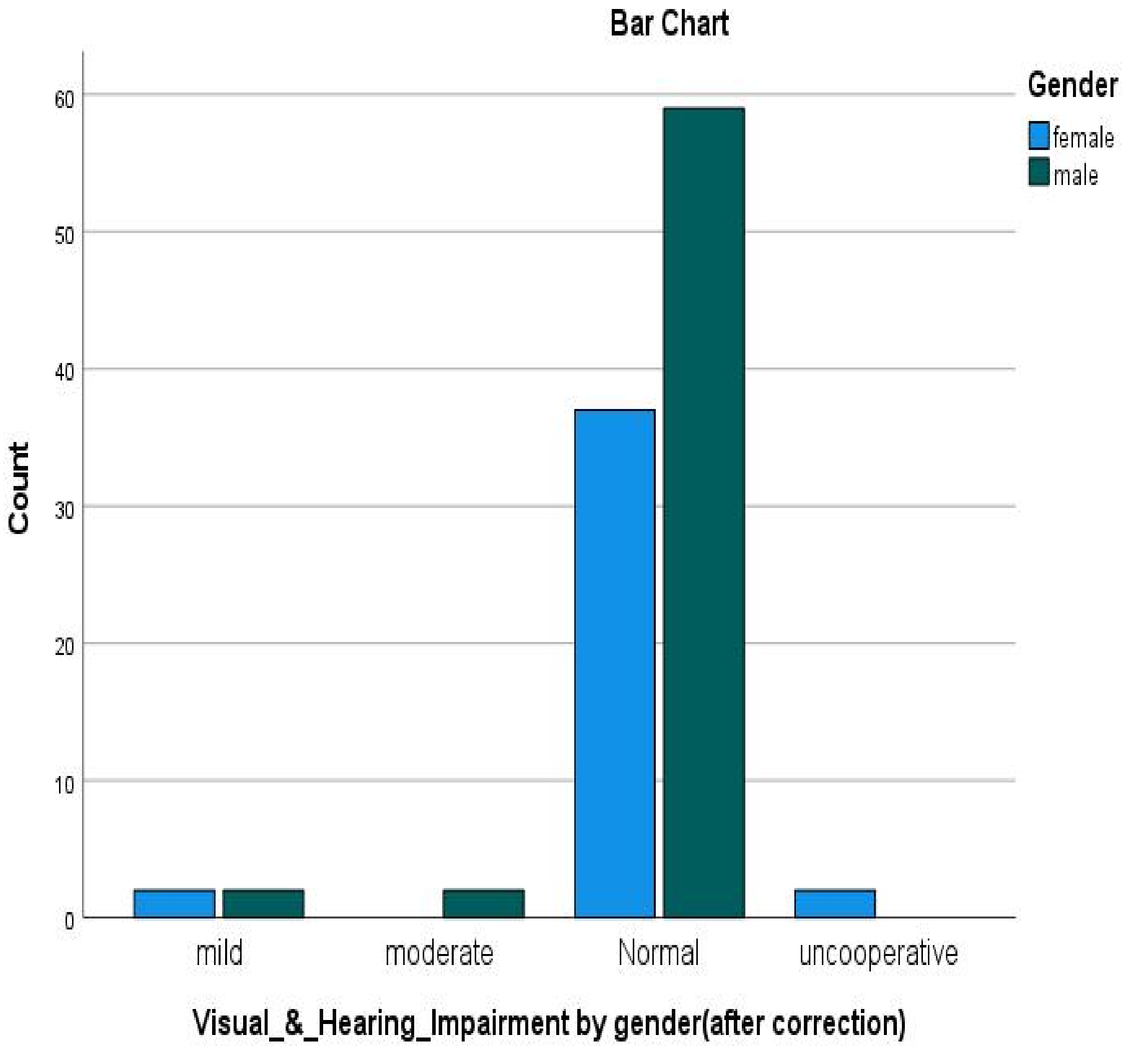


FIGURE 20: Bar chart showing Distribution of Visual and Hearing Impairment by Age Range before Correction

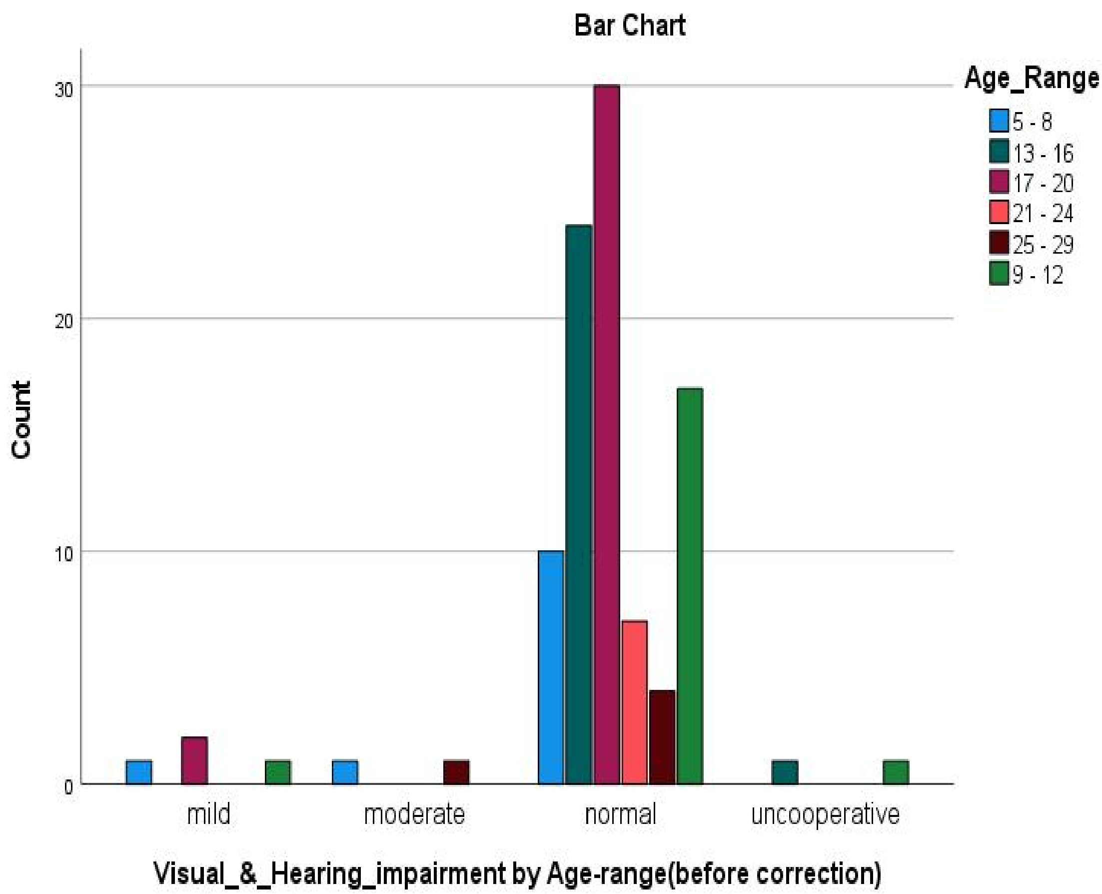


FIGURE 21: Bar chart showing Distribution of Visual and Hearing Impairment by Age Range After Correction

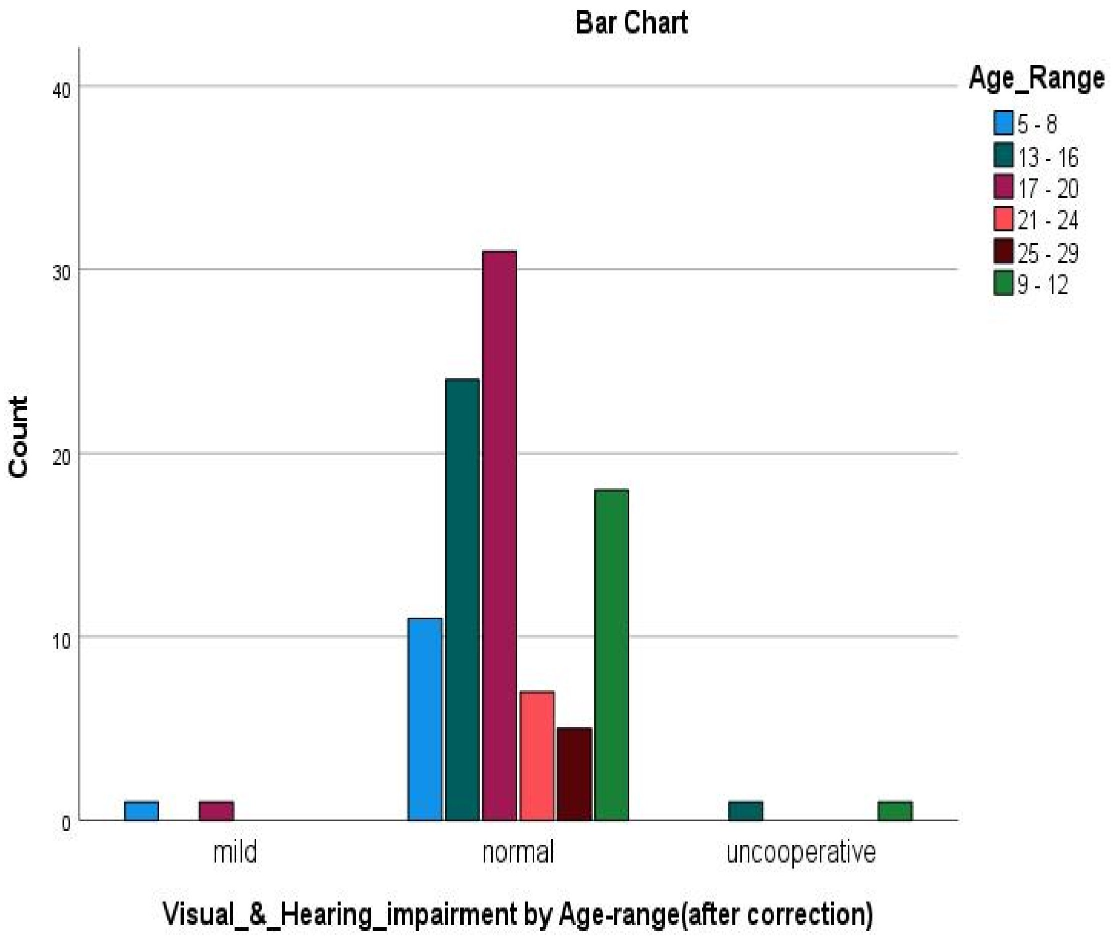


FIGURE 22: Distribution of Hearing Impairment and Contrast sensitivity by Gender

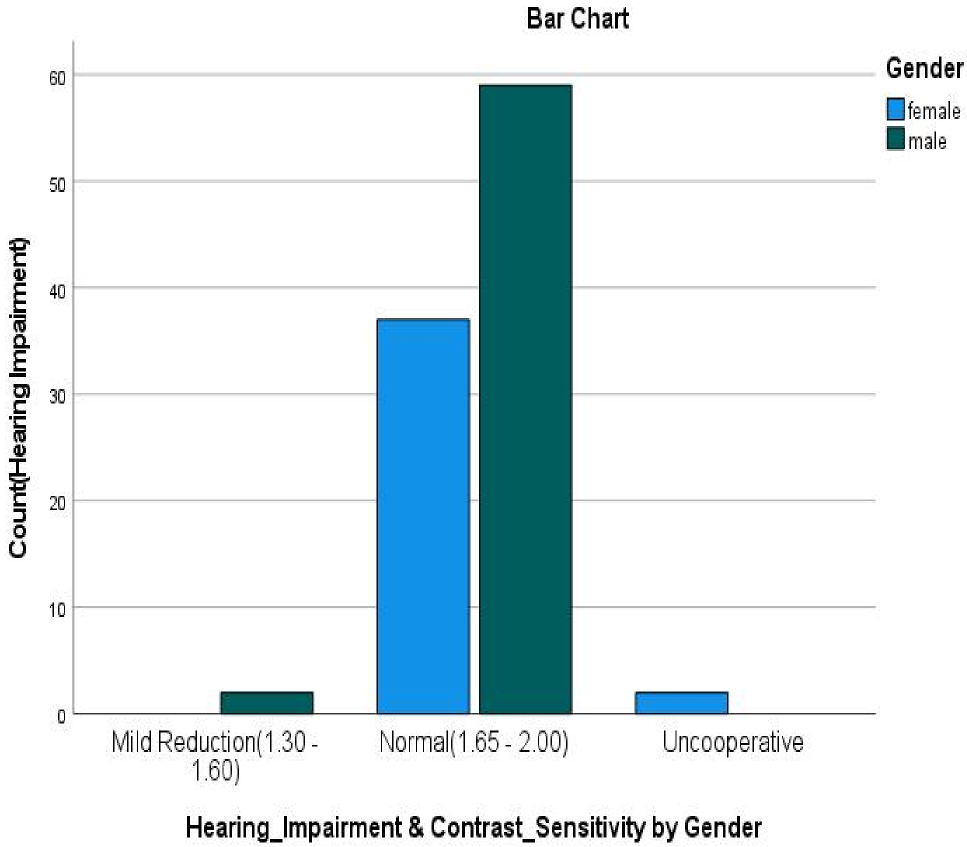
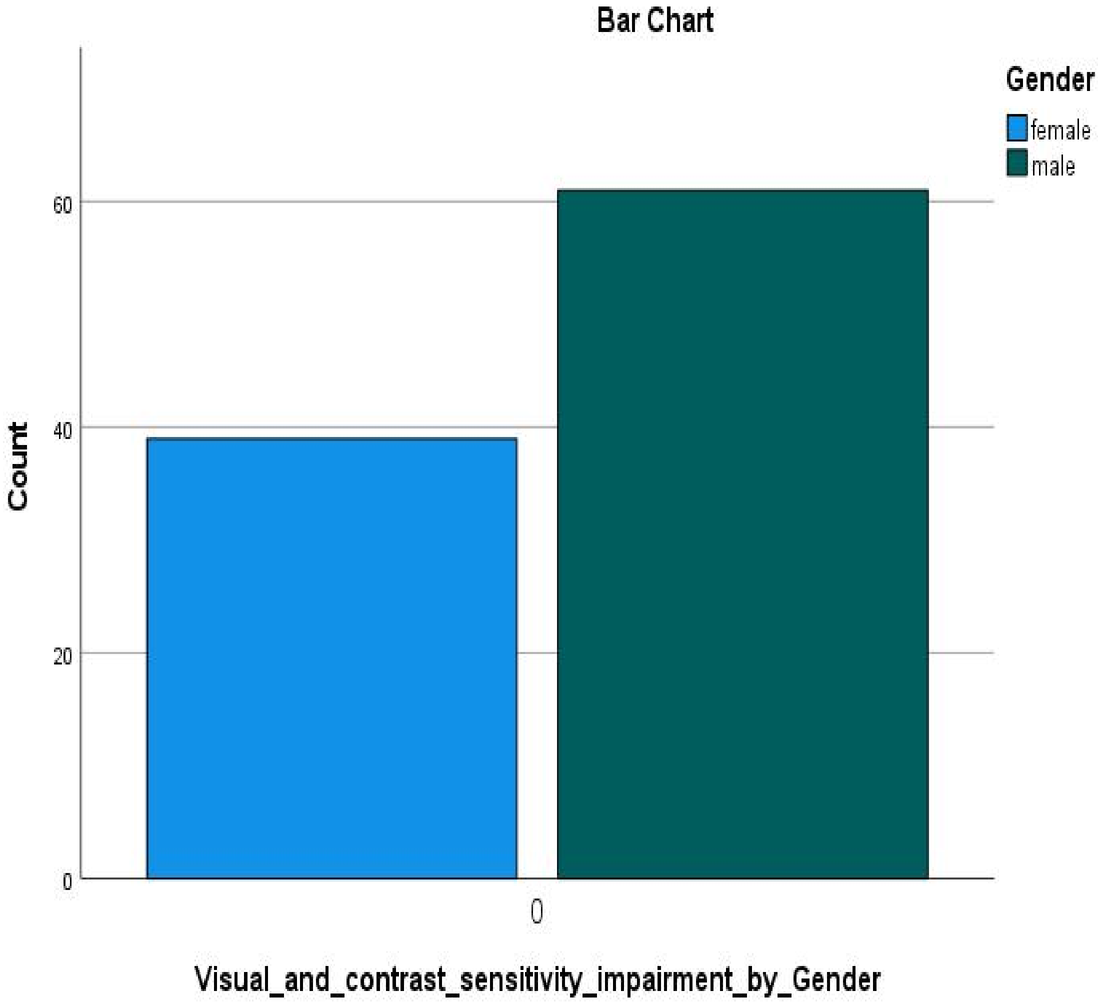
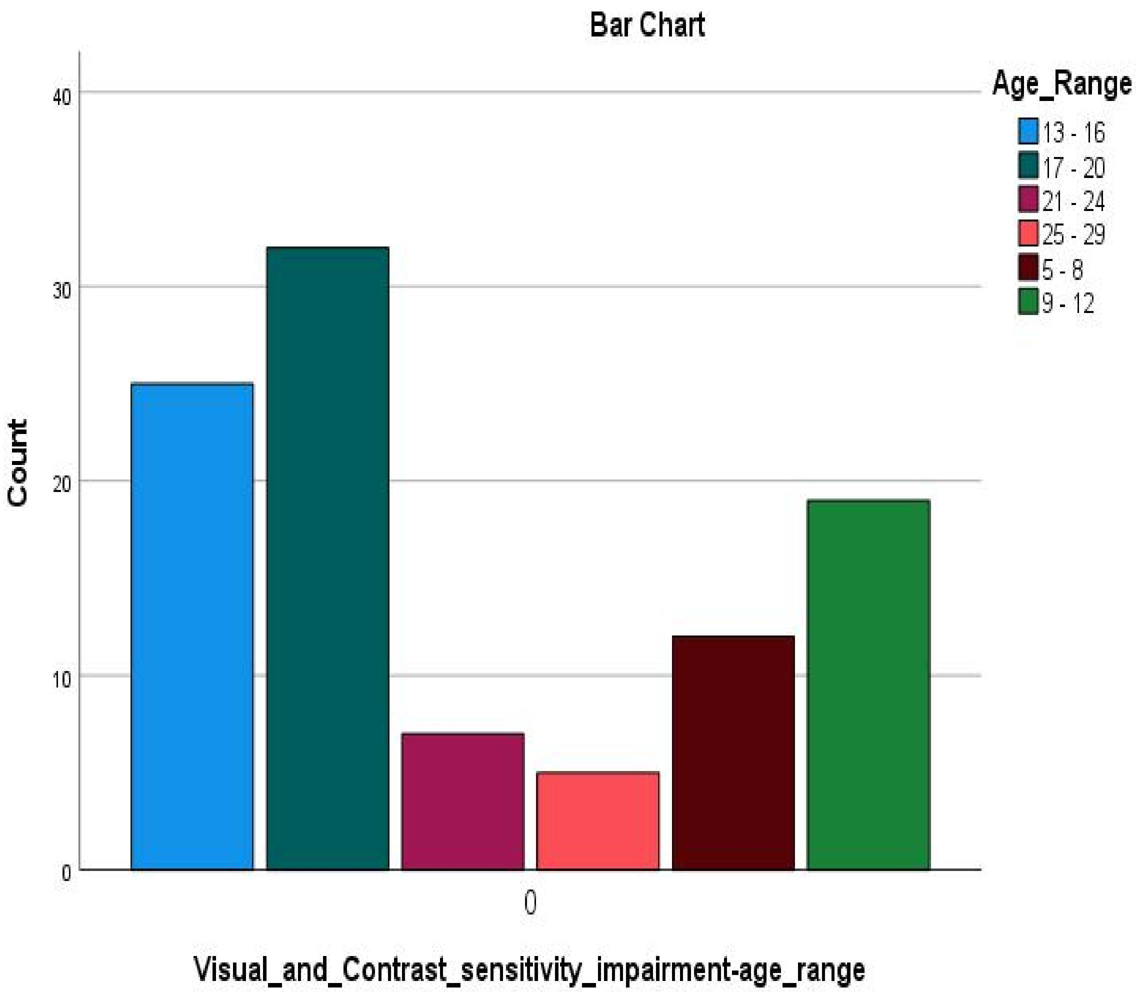


FIGURE 23: Distribution of Visual and Contrast Sensitivity Impairment by Gender



No Visual & contrast sensitivity impairment in relation to Gender

FIGURE 24: Distribution of Visual and Contrast Sensitivity Impairment by Age Range



No Visual & contrast sensitivity impairment in relation to age-range.