

**COMPARATIVE STUDY OF CONTRAST SENSITIVITY AND VISUAL ACUITY
WITH SPECTACLES LENSES AND SOFT CONTACT LENSES**

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UNIVERSITY OF BENIN

April, 2024.

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**A THESIS SUBMITTED TO THE DEPARTMENT OF OPTOMETRY, FACULTY LIFE
SCIENCES, UNIVERSITY OF BENIN IN PARTIAL FULFILMENT OF THE
REQUIREMENT FOR THE AWARD OF DOCTOR OF OPTOMETRY (O.D) DEGREE**

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

BENIN CITY

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NIGERIA

APRIL, 2024

CERTIFICATION

This is to certify that this research project titled [**COMPARATIVE STUDY OF CONTRAST SENSITIVITY AND VISUAL ACUITY WITH SPECTACLES LENSES AND CONTACT LENSES**] was carried out by (**AKAM IFY CHRISTIAN**) in the Department of Optometry, Faculty of Life Sciences, University of Benin in partial fulfillment of the requirement for the Doctor of Optometry degree in the 2022/2023 academic session.

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DEDICATION

This work is dedicated to the Almighty God for his blessings in my life, his invaluable grace and provision throughout my stay in the university and for giving me the strength to complete this work. I also humbly dedicate this work to my parents Mr. and Mrs. Akam Chukwuma Queen, for their unrelenting support, advice and continual guidance throughout the course of study.

ACKNOWLEDGEMENT

My profound gratitude goes to my project supervisor Dr. (Mrs.) A.O Shuaibu for her meticulous assistance during the different stages of this research work. (God bless you, Ma).

Special recognition and appreciation goes to the Head of Department, Prof (Mrs) F.K. Idu.

I would love to appreciate the effort and diligence of my brilliant lecturers whose passion and willingness to impart knowledge have brought me thus far.

To the entire staffs of the department of Optometry and the clinical staffs of the Optometry Teaching clinic, University of Benin, I am extremely grateful for your contributions towards the success of this work.

To my parents, tears run down my cheeks when I remember all you did for me, you guys are the very best. Thank you for your continued efforts and contributions towards my education.

To my siblings, Uche, Chukwudi, George, Isioma and Blessing thank you for being so amazing big loves my dearies.

To my friends and course mate Nelson(mentor), Emma,Enuma,Rhema,Innocent, Bro.Ayomide, Godwin, Collins, Francis,Tosin and to mention but a few you guys are amazing, thank you all for continuous love and support.

To my amazing friend Vera and Dr. Imomo Newton, I love you guys so much and I'm so grateful for your contributions and support at different stages of this research work.

To my Pastors, Pastor Emmanuel Ejiofor, Pastor Ajayi Pius, Pastor Shalom, and Pastor Hadome, Pst Frank.

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ABSTRACT

The purpose of this study was to compare contrast sensitivity and visual acuity with contact lenses and spectacle lenses. This study involved a total of 30 participants, with a mean age of 22.10 ± 3.66 years. Participants comprised of males ($n = 13$) and females ($n = 17$), who are myopic and hyperopic. Visual acuity was measured using a Snellen's chart at a distance of 6 m, and contrast sensitivity was determined by Pelli Robson chart at a distance of 1 m, one hour adaptation was given for the contact lens. The powers of the spectacle lenses are equivalent to the powers of the contact lenses. The results of the contrast sensitivity score and visual acuity measurement was compared using the Wilcoxon signed-rank test for non-parametric data to determine whether or not there were statistically significant differences in VA and Contrast Sensitivity using spectacles and contact lenses. The finding of this study reveals that there was no significant difference in visual acuity using both spectacle lens and contact lens ($p > 0.05$, where $p > 0.05334$). However, the result of this analysis shows a significant difference in contrast sensitivity using contact lens and spectacle lens ($p < 0.05$, where $p < 0.00137$).

In conclusion, this study show that soft contact lenses enhances visual performance and vision quality with increase in contrast sensitivity better than spectacle lenses And that the choice of refractive correction has impact on visual performance for the majority of myopic and hyperopic patients.

Keywords: Contrast sensitivity, Visual acuity, Spectacle lens, Contact lens

CHAPTER ONE

1.0 INTRODUCTION

Vision is an important part of day-to-day life. With the technological advancement in the field of optometry in recent years, the purpose of treatment has expanded to beyond just preventing a reduction of vision, but also to obtain better quality of vision and have high visual performance. The increasing use of soft contact lenses and spectacle lenses for correction has created a new patient group whose visual quality is affected independently of visual acuity, it becomes relevant to assess the contrast sensitivity function before and after correction with contact lens or spectacle lens. Best corrected visual acuity with contact lens or spectacle lens may not stand as a complete tool to represent visual performance because contrast greatly varies in the real world. However, there may be a significant relationship between contrast sensitivity, visual acuity and the type of optical correction. Vision represents our main modality of perception and interaction with the surrounding environment. While visual acuity (VA) is often considered the gold standard for vision assessment, contrast sensitivity (CS), defined as the ability to detect or discriminate low contrast gratings, may provide a more informative index of functional vision in both clinical and healthy populations (Owsley, 2003; Ng, 2012). A person can read the smallest line on a visual acuity chart but still have reduced Contrast sensitivity. Contrast sensitivity is the ability to perceive sharp and clear outlines of very small objects. Contrast sensitivity helps detect objects without a clear outline and distinguish them from their background contrast (Kaur & Gunani 2022). This differs from visual acuity, which measures your vision's clarity at a distance. Contrast sensitivity and visual acuity both refer to how well a person sees details. However, contrast sensitivity measures two variables, size and contrast, while visual acuity measures only size. Research findings suggest that contrast sensitivity tests show a more accurate assessment of

the quality of vision than visual acuity tests (Shandiz *et al* 2011). The standard test for contrast sensitivity is the Pelli-Robson contrast sensitivity test.

Contact lens is a thin, curved lens placed on the film of tears that covers the surface of the eye (Cooper Vision 2023). Contact lenses are gaining increasing popularity nowadays. Approximately 125 million people use contact lenses worldwide. Alongside its cosmetic aspect, the most important indication for using a contact lens is to correct refractive errors.

Spectacles, also known as glasses or eyeglasses are vision eyewear with clear or tinted lenses mounted in a frame that holds them in front of a person's eyes, typically used for vision correction, safety purposes and sometimes for cosmetic purposes. Spectacle lenses placed in eyeglass frames held before the eyes are commonly used to correct refractive errors like myopia, hyperopia, astigmatism, and presbyopia (Wolffsohn *et al.*, 2019).

However, it is a matter of common observation that patients may complain of poor vision even after correction with VA of 6/6.

1.1 BACKGROUND INFORMATION

1.1.1 VISUAL ACUITY

Visual acuity is the spatial resolving capacity of the visual system (Bahrami & Oberwinkler, 2018). It measures ability to discriminate fine levels of detail, especially patterns with high spatial frequencies (Geng *et al.*, 2021). Standard measurements of visual acuity determine the smallest optotypes that can be recognized at a set testing distance under optimal lighting conditions (Faria *et al.*, 2017). Visual acuity depends on optical quality of the eye, neural processing of retinal images, and integrity of foveal photoreceptors (Ross *et al.*, 2019). Common causes of reduced visual acuity include refractive errors, media opacities, amblyopia, and retinal

pathology (Vaghefi & Vaghefi, 2022). Visual acuity is carried out using the Snellen chart, Tumbling E chart, Landolt C chart, LogMAR chart and Allen chart. The results of visual acuity are classically reported using 20/20ft or 6/6m for standard vision. The numerator describes the distance from the chart, typically 20ft or 6m. The denominator describes the distance that an individual with normal vision (20/20 vision) can read the same line on the chart (Harrison & David, 2023). Central visual acuity refers to the ability of the visual system to recognize fine differentiation in the environment as measured with printed or projected visual stimuli. The presence of excellent visual acuity (VA) tells the examiner that the ocular media are clear, the image is clearly focused on the retina, the afferent visual pathway is working, and the visual cortex has appropriately interpreted signals received (Levenson and Kozarsky, 1990).

Visual acuity is a measure of central (macular) vision, indicates how clearly the patient can see an object. Always test acuity carefully as loss of acuity is a grave sign. Record it accurately, especially in a patient with eye injury (Collier *et al*, 2000). Visual acuity may range from normal to no light perception (Sadun and Wang, 2011). In a global society built on the ability to see, vision plays a critical role in every aspect and stage of life. Vision is the most dominant of the five senses and plays an important role in every second of our lives. It is integral to interpersonal and social interactions in face-to-face communication where information is conveyed through non-verbal speech such as gestures and facial expressions. From the time of birth, vision is very important in the development of child. For infants, visually recognizing and responding to parents, family members, and caregivers facilitates cognitive and social development and the growth of motor skills, coordination and balance (WHO 2019).

Both contrast sensitivity and visual acuity provide meaningful yet distinct assessments of visual function important for everyday tasks. Poor contrast sensitivity in the presence of normal visual

acuity can significantly impact quality of life, so testing both metrics is relevant for understanding patient experiences.

1.1.2 CONTRAST SENSITIVITY

Contrast sensitivity refers to the ability to perceive differences in luminance between adjacent areas (Owsley, 2016). It measures the smallest detectable difference in light levels that allows a person to discriminate an object from its background (National Research Council, 2015). Contrast sensitivity function is the inverse of contrast threshold as a function of spatial frequency (Marín-Franch & Pieroni, 2021). It is crucial for tasks like driving at night, navigating stairs or uneven surfaces, reading text, discerning facial expressions, and moving safely through varied environments (Bailey & West, 2021). Reduced contrast sensitivity, even in the presence of normal visual acuity, significantly increases risk of mobility limitations and falls in the elderly (Elliott *et al.*, 2019). Environmental modifications, such as high contrast colors or strips on the first and last steps of staircases, contrasting colors on door frames and the use of contrast on electrical outlets, can all improve patient safety. Decreasing contrast sensitivity function is associated with ocular pathological conditions such as a cataract, age-related macular degeneration, diabetic retinopathy, glaucoma and optic nerve degenerations. Various charts have been designed for the measurement of the contrast sensitivity function, the two most common charts are the Mars contrast sensitivity chart and the Pelli-Robinson contrast sensitivity chart. Assessment of contrast sensitivity provides insight into visual functioning beyond typical visual acuity tests alone (Wiecek *et al.*, 2015). The lowest level of contrast that allows pattern detection is deemed the contrast threshold (National Academies of Sciences & Medicine, 2016).

1.1.2.1 PELLI-ROBSON CONTRAST SENSITIVITY TEST

The Pelli-Robson test measures contrast sensitivity using a single, large letter size (20/60 optotype), with contrast varying across groups of letters. Patients read the letters, starting with the highest contrast, and continue until they are unable to read 2 or 3 letters in a single group called a triplet. The patient's sensitivity is indicated by the faintest triplet for which 2 of the 3 letters are named correctly. The Pelli-Robson uses triplets of letters at each contrast, and these declines in 0.15 log unit steps. The log contrast sensitivity for this triplet is given by the number on the scoring sheet nearest to the triplet.

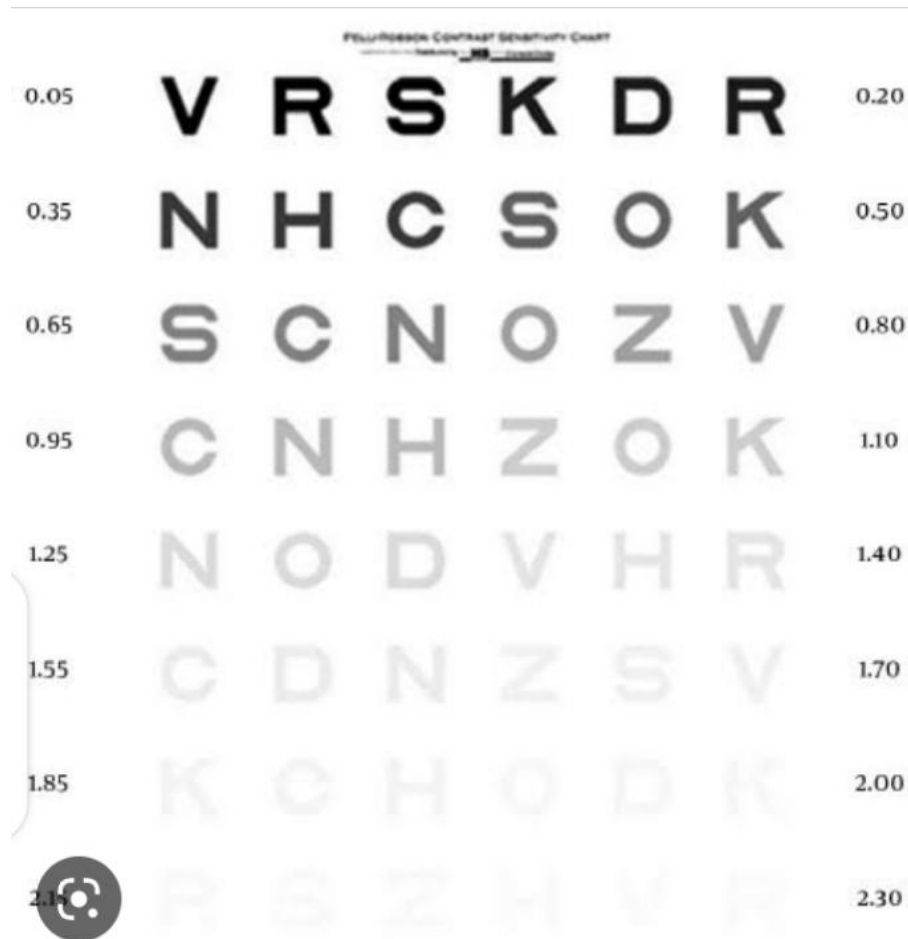


Fig. 1.1: Pelli Robson Contrast Sensitivity Chart

1.1.3 CONTACT LENSES

Contact lenses are thin, clear plastic disks you wear in your eye to improve your vision (Boyd, Mendoza 2023). Contacts float on the tear film that covers your cornea. Like eyeglasses, contact lenses correct vision problems caused by refractive errors (Boyd *et al.*, 2023). There are different types of contact lenses based on the materials they are made from, they include ;soft contact lenses, hard contact lenses and hybrid contact lenses.



Fig. 1.2: Soft Contact Lens

1.1.3.1 HARD CONTACT LENSES

The most common type of hard contact lens is a rigid gas-permeable (RGP) lens (Boyd & Mendoza 2023). These lenses are usually made from plastic combined with other materials. They hold their shape firmly, yet they let oxygen flow through the lens to your eye. Hard, or rigid gas

permeable (RGP), contact lenses are more durable than soft contact lenses and are resistant to buildup of eye-produced deposits on the lens surface. Hard contact lenses generally provide clearer, crisper vision. They also tend to be less expensive over the life of the lens since they last longer than soft contact lenses. Hard contact lenses are easier to handle and less likely to tear. However, they may take a longer period of time to adjust to as compared to soft contact lenses. They also require a more complex cleaning and disinfection process than soft contact lenses.

RGP lenses are especially helpful for people with astigmatism and a condition called keratoconus. This is because they provide sharper vision than soft lenses when the cornea is unevenly curved. People who have allergies or tend to get protein deposits on their contacts may also prefer RGP lenses. Some special contact lenses that are hard contact lenses include the following;

1.1.3.1.1 ORTHOKERATOLOGY (ORTHO-K)

Orthokeratology, or Ortho-K, uses specially designed hard contact lenses to change the shape of the cornea. This contact lens temporarily corrects vision and is mainly used in patients who are nearsighted (CDC 2022). Ortho-K lenses are most often prescribed to be worn while sleeping. They are usually removed in the morning and not worn during the day. Most people can go all day without their glasses or contact lenses. For others, vision correction will wear off later in the day. Ortho-K lenses must be worn every night—or on some other prescribed schedule—in order to maintain the treatment effect. Your eye care provider will determine the best maintenance schedule for you.

1.1.3.1.2 SCLERAL LENSES

A scleral lens is a larger type of hard, or rigid gas permeable (RGP), contact lens. Scleral lenses rest on the sclera—the white part of the eye—and not the cornea (CDC 2022). Fluid collects in the small amount of space between the lens and cornea. This fluid protects the cornea and can also help heal damaged corneas. Scleral lenses are often prescribed to patients with damaged corneas or patients with severe dry eye conditions. People who wear scleral lenses should carefully follow their eye care providers' instructions for proper wear and care.

1.1.3.2 SOFT CONTACT LENSES

Soft contact lenses are made of soft, flexible plastics that allow oxygen to pass through to the cornea. This lens material may be easier to adjust to and provide better initial comfort than hard, or rigid gas permeable, contact lenses (CDC 2022). Most people choose to wear soft contact lenses, this is because they tend to be more comfortable and there are many options. Soft contact lenses can further be divided based on their wear schedule.

1.1.3.3 DAILY WEAR CONTACT LENSES

You wear these when you are awake and remove them when you go to sleep (Boyd; Mendoza 2023). Many are disposable, meaning that you wear a new pair of contacts each day. Or you might choose contacts that last longer and only need to be replaced once a week, every two weeks or every month. Some ophthalmologists recommend disposable daily wear contacts if you use them just once in a while.

1.1.3.4 EXTENDED WEAR CONTACT LENSE

Extended wear contact lenses are available for overnight wear ranging from one to six nights or up to 30 days (CDC 2022). Extended wear contact lenses are usually made of soft plastics that

allow more oxygen to pass through to the cornea. There are also a few brands of hard contact lenses designed and approved for overnight wear. Length of continuous wear depends on the contact lens type and your eye care provider's evaluation of your tolerance for overnight wear. It's important for the eyes to have a rest without lenses for at least one night following each scheduled removal. Talk with your eye care provider before considering this option, as overnight contact lens wear has been linked to serious eye infections.

1.1.3.5 TORIC CONTACT LENSES

These can correct vision for people with astigmatism, though not as well as hard contact lenses. Toric lenses can be for daily or extended wear. But they often cost more than other types of soft contact lenses.

1.1.3.6 BANBAGE LENSES

These contacts do not have a prescription built into them. Instead, they cover the surface of your cornea for comfort after an injury or surgery.

1.1.3.7 HYBRID CONTACT LENSES

Hybrid contact lenses have a rigid gas-permeable center attached to an outer "skirt" made of soft contact lens material. The soft, outer part of the lens increases comfort and helps the lens to stay centered on the eye, while the rigid gas permeable center provides clear vision. This design is intended for people who have irregular corneas. Because this is a newer type of contact lens, there are fewer options available and fewer eye care providers who fit these contact lenses as compared to soft or hard contact lenses (CDC 2022).

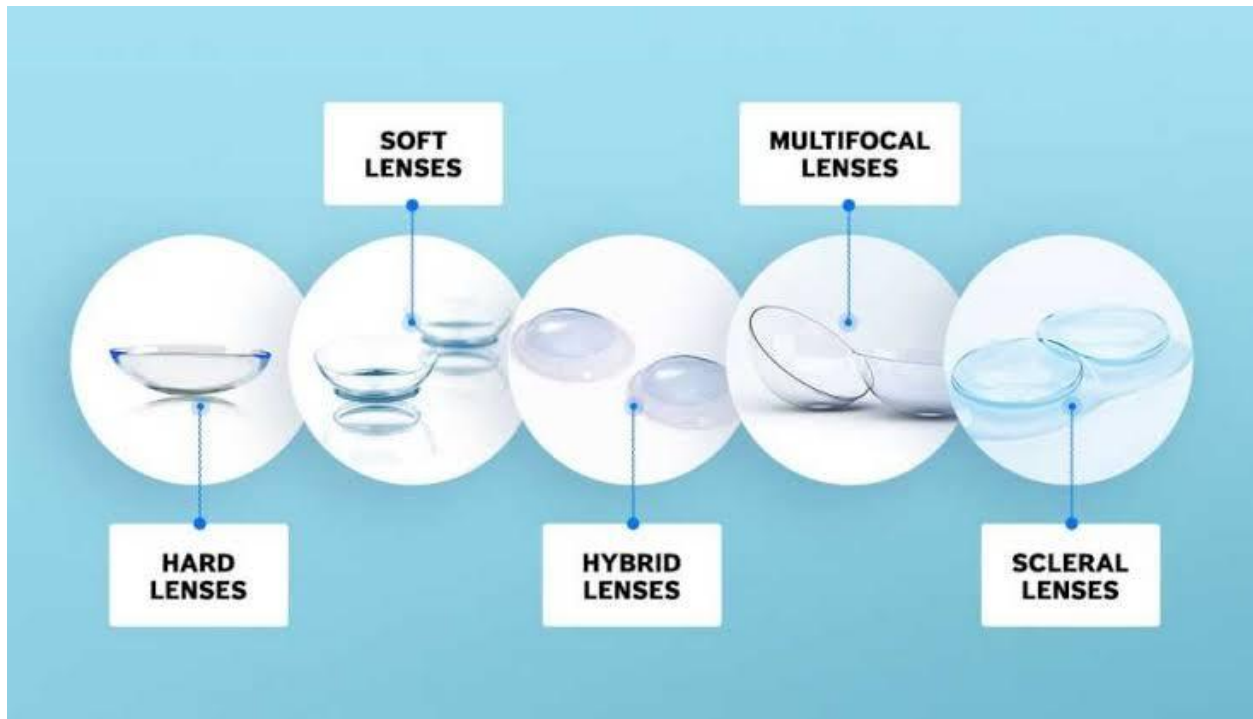


Fig 1.3 Types of contact lenses

1.1.4 SPECTACLE LENSES

Are vision eyewear with or tinted lenses mounted in a frame that holds them in front of a person's eyes, typically used for vision correction such as reading glasses, glasses used for nearsightedness, farsightedness and sometimes used for cosmetic purposes. Glasses can be marked or found by their primary function, but also appear in combinations such as prescription sunglasses or safety glasses with enhanced magnification. There are different types of spectacle lenses and they are as follows:



Fig 1.3: An object seen through a corrective spectacle lens, showing the effect of refraction

1.1.4.1 CORRECTIVE LENS

Are used to correct refractive errors by bending the lights entering the eye in order to alleviate the effects of conditions such as myopia (nearsightedness), hypermetropia(farsightedness), or astigmatism. The ability of one's eye to accommodate their focus to near and distant focus alters over time and when the eye loses this ability due to age and the crystalline lens losing its elasticity; it results to a condition known as presbyopia. Corrective lenses bring the image back into focus on the retina. Corrective lenses come in different forms such as single vision, bifocal, trifocal, progressive, reading and pinhole glasses.

1.1.4.2 SAFETY GLASSES

These are glasses worn to protect the eyes in various situations, made with break-proof plastic lenses to protect the eye from flying debris or other matter. Worn by construction workers, factory workers, lab technicians, welders.



Fig 4.5 safety glasses

1.1.4.3 SUNGLASSES

They provide more comfort and protection against bright light and often against ultraviolet (UV) light. To properly protect the eyes from the dangers of uv light, sunglasses should have UV-400 blocker to provide good coverage against the entire light spectrum that poses a



danger.

Fig 4.6 sunglasses

1.1.4.4 MIXED DOUBLE-FRAME (FLIP GLASSES)

The double frame uplifting glasses have one moving frame with one pair of lenses and the basic fixed frame with another pair of lenses, that are connected by four bar linkage. For example, the sunglasses could be easily lifted up and down while mixed with myopia lenses that always stay on, used by drivers when they pass through tunnels.



Fig 4.7 flip glasses

1.1.4.5 COMPUTER GLASSES

They are worn when working long hours on the computer, phones to reduce eyestrain from lack of blinking by filtering out high energy blue and ultraviolet light LCD screens and fluorescent lighting.

1.1.5 MYOPIA

Myopia is one of the most prevalent refractive errors. In myopia, the eye focuses images in front of the retina, so that distant objects are seen more clearly (Morgan *et al.*, 2012). Myopia often develops during childhood and tends to progress as the eye grows. Eyeglasses or contact lenses with concave lenses are commonly used to correct myopia by shifting the focal point to the retina.

According to Cheung *et al.* (1997), one of the most prevalent ophthalmological illnesses worldwide is myopia. In the last two decades, the prevalence has nearly doubled globally, and the age at initiation is lowering at a startling rate (Holden *et al.*, 2016). It is common knowledge that myopia progresses more quickly in younger patients. Some individuals may experience an unremitting progression that results in severe myopia and its unavoidable side effects, including

retinal detachment, macular haemorrhage and scarring, glaucoma, and myopic strabismus. Myopia may begin to develop slowly in both young and old eyes, but once it does, it advances further and more quickly in young eyes. The onset may be a two-stage process that starts with a long-term increase in vitreous body volume and evolves to a chronic accommodation increase under stimulus control. The ciliary muscle is blamed, and experiments showing improvement in myopia after prolonged pharmacological paralysis of this muscle are detailed. Myopia has also been reported arrested in some young children who wore positive corrective lenses while reading.

1.1.6 HYPEROPIA

Another typical refractive defect is hyperopia. When a person has hyperopia, the eye concentrates images behind the retina, blurring adjacent things. Eye strain can occur for those who have hyperopia, especially when reading or doing close-up work (Castagno *et al.*, 2014). By moving the focal point forward into the retina, convex lenses can be used to treat hyperopia in both spectacles and contact lenses.

Myopia and hypermetropia are both axial refraction defects, and the latter is most usually caused by a reduction in the anteroposterior diameter of the eye (Strang *et al.*, 1998). Hypermetropia is frequent in young children and often gets worse with age. Moderate hypermetropia is often well tolerated in young patients. If hypermetropia is severe or connected to functional impairments, prescription lenses should be used to address it.

1.1.7 HOW DOES THE EYE FOCUSES LIGHT AND ALLOWS US TO SEE CLEARLY?

The eye is an intricate organ adapted to focus images of the visual world onto the retina, where photosensitive cells then convert patterns of light into nerve signals that are transmitted to the brain (Troilo *et al.*, 2019). Light enters the eye through the cornea, the clear protective outer layer at the front of the eye which accounts for over 70% of the eye's total focusing power (Kading *et al.*, 2022). After passing through the cornea, light travels through the pupil (an opening in the colored iris controlled by muscles) then into the crystalline lens (Vaghefi & Vaghefi, 2017). The lens adjusts shape and focuses incoming rays of light onto the retina, located along the inner rear of the eye. Changes in lens curvature allow the eye to focus on objects at various distances in processes called accommodation and emmetropization (Iskander *et al.*, 2018). The retina contains roughly 120 million rod and cone photoreceptors that detect light and transmit signals via the optic nerve for higher cortical processing into visual images (Duncan *et al.*, 2016). The macula is a specialized central part of the retina, and its structural integrity is vital for detailed, high resolution vision (Uhlmann *et al.*, 2017). At the very center of the macula is the fovea, a 0.3 mm diameter pit containing only high acuity cones for color vision and sharpest eyesight (Hammer *et al.*, 2022). Normal visual functioning relies on proper transmission and refraction of light entering the eye to generate focused retinal images, intact retinal cells to transduce light signals, and higher cortical pathways to construct meaningful perceptions from neural signals. Disruptions anywhere along this process can degrade visual clarity.

Myopia (nearsightedness) and hyperopia (farsightedness) are among the most prevalent vision disorders globally (Flitcroft, 2019). An estimated 2.6 billion people worldwide have myopia, with nearly 1 billion cases considered high myopia (>6 diopters) associated with increased risk

of blindness from retinal damage or detachment (GBD 2019 Blindness Collaborators, 2021). Myopia develops when the eyeball is too long for the optical power of the cornea and lens, causing light from distant objects to focus in front of the retina rather than directly on its surface (Verkicharla *et al.*, 2015). Blurred distance vision is the hallmark symptom that necessitates optical correction through concave lenses to reshape incoming light rays appropriately (Wu *et al.*, 2018).

Hyperopia arises when the eyeball is too short in comparison to optical power, causing light from nearby objects to focus behind the retina rather than converging precisely on its surface (Sankaridurg & Holden, 2014). Close-up vision becomes difficult without optical intervention. Hyperopic refractive errors are estimated to impact over 1.4 billion individuals globally (Rudnicka *et al.*, 2016). Plus-powered convex lenses compensate by adding more convergent optical power to redirect light rays entering short hyperopic eyes (Walline, 2016). Severe cases with prolonged attempts to compensate can induce headaches, eyestrain, strabismus, amblyopia during childhood refractive development (Dwyer, 2022). Given the high prevalence of myopia and hyperopia worldwide, investigating correction techniques like spectacles and contact lenses to optimize visual performance remains tremendously important (Wolffsohn *et al.*, 2022). Additional concerns around myopic progression control highlight the value of research in this domain (Lingham *et al.*, 2020)

1.1.8 EXPLANATION OF CORRECTION METHODS: CONTACT LENSES AND SPECTACLE LENSES.

Spectacle lenses placed in eyeglass frames held before the eyes are commonly used to correct refractive errors like myopia, hyperopia, astigmatism, and presbyopia (Wolffsohn *et al.*, 2019). Made of optically transparent plastic or glass, spectacle lenses with concave or convex curvature

are designed based on prescription to redirect incoming light in myopic or hyperopic eyes to achieve best retinal focus (Chen *et al.*, 2017). Advantages include wide availability, lower cost than other interventions, no need for solutions or insertion/removal maintenance. However, spectacle lens limitations can arise from cosmetic aesthetics disapproval, distorted peripheral vision especially with high corrections, visual field obstruction from lens frames (especially bifocals) (Santana *et al.*, 2017). Lens smudges or scratches and frame shifts with head movements can also interfere with optimal eyesight correction.

Contact lenses represent an alternative corrective method involving directly placing optical devices onto the surface of the eyes (Sindt, 2020). Modern soft lenses made of plastics like silicone hydrogels allow oxygen permeability while correcting refractive errors via similar focusing principles as spectacles (Wolffsohn & Hunt, 2019). Contact lens benefits include improved peripheral vision, cosmetic acceptability, no interference during sports/exercise (Efron & Brennan, 2018). However, potential disadvantages include higher cost, insertion/removal needed, lens replacements every 1-2 years depending on material (Rampat *et al.*, 2015). Ocular discomfort issues like dryness, irritation, infections require management as well (Kang *et al.*, 2017).

Overall both spectacles and contact lenses effectively correct common vision disorders, with relative advantages and disadvantages that can guide decisions around recommending either modality for patients depending on factors like cost, convenience, comfort, treatment goals (Gomes *et al.*, 2017).

1.1.9 COMPARISONS OF BENEFITS AND LIMITATIONS OF BOTH CORRECTION METHODS.

Both spectacle lenses and contact lenses effectively correct common vision disorders, but relative advantages and disadvantages exist that inform decisions around recommending either modality (Wolffsohn & Hunt, 2019). Contact lenses provide better optics and improved peripheral vision since they move with eye movements. Soft lenses today have high oxygen permeability for corneal health too (Andrasko & Ryen, 2022). Contact lens use also avoids cosmetic and social acceptability issues associated with wearing spectacles. However, contact lens challenges include higher cost, insertion/removal maintenance, lens replacement schedules, infection risk, dry eye exacerbation requiring management (Kang *et al.*, 2018).

Spectacle lenses are widely accessible and affordable vision correction. Frame development has improved aesthetics and materials advancements reduce scratching, dust/smudges (Cui *et al.*, 2022). However, peripheral vision can be limited, especially with higher power corrections. Frame slippage, field obstruction, and image jump with head movements also decrease spectacle visual performance (Wu *et al.*, 2019). Fogging issues persist with changes in temperature/humidity as well. Bifocals and progressive addition lenses also require neuro-adaptation for dynamically switching focus (Castillo-Oyagüe *et al.*, 2022). Still, spectacles avoid direct ocular surface issues that prolong contact lens wear may induce.

Evidence suggests visual acuity is equivalent with properly fitted spectacles versus soft contact lenses, but contrast sensitivity differences are less comprehensively studied (Nazarali *et al.*, 2020). Some evidence finds toric and multifocal contact lenses may provide better contrast sensitivity than spectacle equivalents (Hua *et al.*, 2022). Patient-reported outcomes like comfort

favour contact lenses but require compliance with lens replacement and safe wear (Sindt *et al.*, 2021).

More comparative research between modalities is warranted to guide prescribing practices balancing vision optimization and ocular health. Assessing real-world functionality like contrast sensitivity and patient perspectives in tandem is essential too (Srinivasan *et al.*, 2021).

1.2 STATEMENT OF THE PROBLEM

While both spectacle lenses and soft contact lenses effectively correct common vision issues like myopia and hyperopia, there remains a lack of robust evidence directly comparing visual outcomes across these modalities (Wolffsohn *et al.*, 2019). Most studies demonstrate that properly prescribed spectacles and well-fitted soft contact lenses provide comparable visual acuity, which relates to spatial resolution capacity under high contrast conditions (Pérez-Prados *et al.*, 2017). However, fewer investigations have analyzed differences in contrast sensitivity—the ability to distinguish slight gradations in luminance across adjacent areas. This metric better predicts functional vision difficulties related to glare, night driving, mobility under variable illumination than standard acuity assessments alone (Owsley & McGwin, 2016). Recent systematic reviews of available comparative data for spectacles versus contact lenses note significant research gaps exist regarding impacts on contrast sensitivity across different correction modalities (Nazarali *et al.*, 2020; Kollbaum *et al.*, 2022). Bias from industry sponsorship also pervades many such studies. While some evidence suggests daily disposable and silicone hydrogel contact lenses may provide better contrast sensitivity, sample sizes remain small and lighting conditions variable between investigations (Hua *et al.*, 2022). There is a lack of real-world, randomized, double-blinded comparisons measuring both contrast sensitivity and visual acuity outcomes with spectacle lens versus contemporary soft lenses available (Lockey *et*

al., 2015). Most research also fails to assess patient-reported metrics like subjective comfort, quality of life, satisfaction in tandem with quantified visual performance.

1.3 AIM OF THE STUDY

The aim of this study is to compare contrast sensitivity and visual acuity performance in patients corrected with spectacle lenses and with soft contact lenses.

1.4 OBJECTIVES OF THE STUDY

1. To compare the contrast sensitivity scores between contact lenses and spectacle lenses.
2. To compare visual acuity between contact lenses and spectacle lenses.

1.5 RESEARCH HYPOTHESIS

H₀₁ : There is no significant difference between contrast sensitivity scores measured using spectacle lenses and contact lenses.

H₀₂ : There is no significant difference between visual acuity values measured using spectacle lenses and contact lenses.

1.6 SIGNIFICANCE OF THE STUDY

This study offers significant value by addressing major gaps in understanding visual outcomes with two leading but under-compared methods of managing common refractive errors. Quantitatively assessing and comparing both contrast sensitivity and visual acuity performance between properly fitted soft contact lenses and optimally prescribed spectacle lenses will provide meaningful evidence regarding the relative real-world vision and functionality provided by both modalities.

In addition to empirically demonstrating advantages and disadvantages of contact lenses versus spectacles for corrected vision, results will offer eye care providers valuable guidance regarding prescribing practices.

CHAPTER TWO

2.0 LITERATURE REVIEW

For the purpose of this study selected literatures on contrast sensitivity and visual acuity with contact lens and spectacle lens will be reviewed.

2.1 CONTRAST SENSITIVITY

The ability to distinguish contrast plays an important role in patients' everyday vision. Contrast sensitivity testing can identify many ocular diseases. Research findings suggest that contrast sensitivity (CS) tests show a more accurate assessment of quality of vision than visual acuity tests (Mahjoob 2019).

Currently, with the high need to constantly perform tasks that require continuous observation of objects with varying degrees of contrast, and not only objects easily visible with high contrast, it becomes relevant to assess the CSF. As the CSF is positively correlated with vision-related quality of life, it is important to learn whether current CL affect contrast sensitivity (Ugurlu 2017). While visual acuity (VA) is often considered the gold standard for vision assessment, contrast sensitivity (CS), defined as the ability to detect or discriminate low contrast gratings, may provide a more informative index of functional vision in both clinical and healthy populations (Owsley 2003)

Sapkota K *et al.*, (2020) conducted a study to compare contrast sensitivity function (CSF) with contact lenses and spectacles wear. Forty-seven myopic subjects with no history of contact lens wear were included in this longitudinal prospective study. CSF was measured with spectacles using the CSV-1000 (VectorVision, Greenville). And subsequently, subjects were fitted a daily disposable lens. Differences in CSF with spectacles and CLs on baseline and changes to CSF

after three months of contact lens wear were assessed. The effect of lens materials and wearing modality on CSF change was also investigated. CSF was higher with CLs in comparison to the values with spectacles for spatial frequencies of 3, 6, 12 cycles per degree (cpd) ($p < 0.05$) while there was no difference for spatial frequency of 18 cpd ($p = 0.114$). No significant differences were found in the CSF with CLs between baseline and after three months of lens wear ($p > 0.05$). CSF is better with CLs than with spectacles.

Hong *et al.*, (2010) demonstrated that the optical performance for the spectacle and SCL correction tends to be quite similar, while RGPCLs showed superior visual performance. They explained their results by the fact that SCL conforms to the anterior surface of the cornea, while RGPCL correction reduces odd-symmetric aberrations, decreases spherical aberration, and significantly reduces wave front variance, resulting in improved optical performance.

Study by Bailey *et al.*, (2015) compared high- and low-contrast VA in spectacle and CL wearers. RGPCL wearers had statistically worse habitual high-contrast VA compared with spectacle wearers, but no difference was present under best-corrected conditions. Authors hypothesized that RGPCL wearers were not fitted with their optimal correction habitually. Bailey found significantly poorer low contrast VA with soft conventional hydrogel CL wear compared to spectacle wear.

In contrast, Collins and Carney (2017) found a significant reduction in CS with spectacles compared to both RGPCLs and SCLs for high myopes, but no such effect was noted for low myopes.

Liou and Chio (2003) conducted research that low and moderate myopes showed no statistically significant difference with spectacle and contact lens correction ($p\text{value} < 0.05$) and contrast

sensitivity functions were also not reduced for both the groups. The patients were categorized into four myopic groups' i.e. low, medium, high and severe myopia. contrast sensitivity was measured for all the four groups. The contrast sensitivity was reduced for group 3 myopes corrected with spectacle lens. However, no significant discrepancy was found for the contrast sensitivity functions of the myopic group with contact lens correction. Contrast sensitivity was significantly reduced for group 4 myopes corrected with both the spectacle and contact lens correction.

B S Wachler *et al.* (1999) compare the visual performance of soft contact lenses and spectacles on Twenty eyes of ten patients. Each patient was fit with Acuvue, Cibasoft, and Biomedics contact lenses in random order. LogMar visual acuity and contrast sensitivity using the VectorVision CSV-1000 were measured. There was no significant difference in visual acuity between any contact lenses ($P=.15$). Contrast sensitivity at 12 cycles/degree was significantly lower for the Cibasoft lens compared to spectacles ($P=.04$). There was no significant difference between spectacles and contact lenses for remaining spatial frequencies ($P=.07-.35$).

Monireh Mahjoob *et al.* (2021) assessed the contrast sensitivity in clear and colored soft contact lenses under different lighting conditions. This study was performed on 34 medical students. Visual acuity was measured using a tumbling E chart at a distance of 6 m, and contrast sensitivity was determined by Pelli Robson chart at a distance of 1 m. These tests were repeated in mesopic (3 lux) and glare (2000 lux) conditions. Then, a clear contact lens was applied to one eye and a colored contact lens was applied to the other. After 2 hours, visual acuity and contrast sensitivity were measured for each individual. The results were compared with and without contact lenses under normal, mesopic, and glare conditions.

The mean refractive error was 0.44 ± 0.20 diopters. Repeated measures ANOVA showed a decline in contrast sensitivity with colored and clear contact lenses as compared to no-lens condition ($P < 0.001$). Additionally, lighting conditions had a significant impact on contrast sensitivity ($P < 0.001$); contrast sensitivity was lower in mesopic and glare conditions than under normal lighting condition. In addition to the drop in contrast sensitivity under unusual lighting conditions (e.g., glare and mesopic), wearing soft contact lenses can further reduce contrast sensitivity in different lighting conditions. Therefore, people who wear contact lenses should be aware of this reduction in visual performance in conditions like driving at night or in the fog.

Breno Barth *et al.* (2008) Evaluated the visual performance by high contrast visual acuity, contrast sensitivity and wavefront in myopic patients with or without astigmatism corrected with spectacles and with three different soft contact lenses [Acuvue 2 (Vistacon J&J Vision Care Inc., USA), Biomedics 55 (Ocular Science, USA), and Focus 1-2 week (Ciba Vision Corporation, USA)].

An interventional prospective clinical trial studied a sample of 40 myopic patients (-1.00 to -4.50 sph, with or without astigmatism up to -0.75 cyl). Each patient had one eye randomized to visual performance evaluation. The Zywave aberrometer detected a over refraction and significant difference between Acuvue 2 and Biomedics 55 regarding spheric refractive components and spheric equivalent. Both soft contact lenses showed hypercorrection as compared to Focus 1-2 week. Visual performance was not significantly different with spectacles and the three soft contact lenses in visual acuity and contrast sensitivity measurements. The wavefront analysis detected a significant difference in a third order aberration with and without soft contact lenses, with better visual performance with Acuvue 2 and Biomedics 55.

In visual performance evaluation with spectacles and soft contact lenses the wave front analysis was a more sensible measurement of visual function when compared to high contrast visual acuity and contrast sensitivity. The evaluation model of visual performance with wave front analysis developed in this investigation may be useful for further similar studies.

2.2 SPECTACLES

Holden *et al* (2016) The use of corrective lenses, often glasses, to enhance visual acuity and correct refractive defects including myopia (nearsightedness), hyperopia (farsightedness), and astigmatism is referred to as the usage of spectacles. Spectacles are a common and readily available method of vision correction that uses light-refracting lenses to correct each individual's eyes' unique refractive defect. Globally, the prevalence of myopia has been rising, which has substantial effects on public health and visual care services.

Yi Gao *et al*, (2021) Spectacle lenses containing multiple small peripheral elements have been developed for myopia control in children. It is important that their vision be quantized by (i) fixation through the peripheral portion, thereby using foveal vision and (ii) by fixation through the central portion and presentation of peripheral targets. The above approaches were used in several studies to evaluate two novel spectacle lens designs: spectacle lenses with Highly Aspherical Lenslets (HAL) and Slightly Aspherical Lenslets (SAL). A single vision lens served as a control. Visually normal adults participated in each study. The first two studies had subjects fixate through the periphery of the lenses. High and low (10%) contrast visual acuity was measured with the Freiburg Vision Test and reading speed for high and low contrast words measured with a sentence generator. The other three studies assessed peripheral vision while subjects fixated through the central portion of the lens. Peripheral contrast sensitivity was measured using two

cycles per degree drifting Gabor stimuli. Peripheral motion perception was further evaluated using random dot stimuli. Finally, attention was measured using an established test of useful field of view with three levels of complexity. The periphery of the HAL lens significantly reduced low contrast visual acuity, but not high contrast visual acuity, while the effect of the SAL lens was not significant for either. Neither test lens affected reading speed for high contrast words, but the HAL lens significantly affected performance for low contrast words. Neither test lens affected peripheral motion perception or useful field of view.

Selva *et al*, (2023) Carried out a prospective cross sectional study with spectacle lenses, assessing three key factors: contrast sensitivity (using pelli-robson chart), color vision and visual reaction time on 100 participants, aged 18-30 years with normal vision. Contrast sensitivity values were consistent at 2.00 logMAR, indicating good contrast sensitivity, irrespective of the presence of tinted lenses, importantly the use of yellow tint appears to enhance rapid reactions and contrast perception.

Gwiazda *et al*, (2003) Myopia is a condition characterized by difficulty seeing distant objects clearly, and it can progress over time. Spectacles with appropriate lens prescriptions can help correct myopia and improve visual acuity for individuals with this condition. The use of spectacles is supported by scientific research and clinical trials. For example, a randomized clinical trial conducted by comparing the use of progressive addition lenses (PALs) with single vision lenses in children with myopia. The study found that PALs were effective in slowing the progression of myopia in children, highlighting the importance of appropriate lens selection and fitting for optimal vision correction. Spectacle use offers several benefits beyond vision correction. It can enhance visual comfort, improve safety, and support overall quality of life by enabling individuals to perform daily activities with greater ease and clarity.

2.3 CONTACT LENSES

Much effort has been invested into trying to understand how the various physical aspects of a lens (Jones *et al* 2013) or how the ocular surface characteristics of a patient (Craig *et al* 2013) can affect ocular surface comfort but relatively little work has been carried out to try to understand the contribution of factors such as vision. Poor vision is known to cause discontinuation as demonstrated by Young *et al*.

Marcelo *et al* (2008), Evaluated the optical performance of 40 myopic patients with two different soft contact lenses: Acuvue 2 and world vision soft contact lenses. High contrast visual acuity was significantly higher for world vision soft contact lenses. Low contrast visual acuity was similar for both soft contact lenses. Contrast sensitivity improved significantly for both soft contact lenses.

Eric *et al* (2007) Evaluated the visual performance of thirty-five professional football players, ranging in age from 18-32 years with clear and sport tinted contact lenses. Contrast sensitivity was measured monocularly on a sine –wave grating 4 spatial frequencies, each with decreasing contrast. Comparison was made to determine if statistically or clinically significant data would support the claim of increased contrast enhancement for the athletes while wearing the sport tinted contact lenses. Sport tinted contact lenses appear to have a statistically significant effect on contrast sensitivity.

Stella *et al* (1998), The contrast sensitivity function (CSF) of soft contact lens wearers and CSF of those without corrective lenses were measured. Subjects without corrective lenses achieved higher contrast sensitivity (CS) scores than those wearing soft contact lenses, whether tinted or clear. Subjects wearing clear soft contact lenses had slightly higher CSF at most spatial

frequencies than did those wearing tinted soft contact lenses , but the difference was not significant.

In 2021, Codina *et al* concluded that symptoms of ocular discomfort may be more intense if there is also perceived visual compromise in daily disposable soft toric lenses. A study was carried out with thirty-eight habitual soft contact lens wearers who wore each of three daily disposable toric lenses for one week in a prospective, crossover, randomised, single-masked study. The following clinical measures were recorded at dispensing and follow-up visits: biomicroscopic scores, lens fitting (including rotation and rotational stability), high and low contrast visual acuity, subjective vision quality and subjective ocular surface comfort. Subjective scores were collected using 0–10 numerical grading scales. Comfort scores were analysed using a linear regression model with age, sex, visit, phase of crossover (‘phase’), lens type, lens rotation, lens rotational stability, visual acuity, cylinder power and subjective vision quality as factors of interest and then refined using backward stepwise regression. Thirty six participants (31.1 ± 13.5 years) completed the study. Comfort scores were found to be associated with subjective vision quality ($F = 127.0$; $p < 0.0001$), phase ($F = 7.2$; $p = 0.001$) and lens type ($F = 4.9$; $p = 0.009$). Greater comfort scores were observed with greater subjective vision quality scores. Visual acuity was not statistically significant in the model. There was a stronger positive correlation between comfort and subjective vision quality compared with comfort and measured visual acuity.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY DESIGN

This was a comparative cross-sectional study which was carried out on 30 subjects (myopic and hyperopic corrected to visual acuity of 6/6) with the Snellen visual acuity chart and Pelli-Robson Contrast Sensitivity Chart using their spectacle corrections and soft contact lenses.

3.2 STUDY POPULATION/LOCATION

Sample population of 30 subjects both male and female within 18-35 years participated and was conducted at the optometry Clinic, University of Benin, Ugbowo campus. The volunteers came from the campus with educational level ranging from secondary to tertiary education and workers.

3.3 SAMPLING TECHNIQUE

This study used a convenience sampling technique, so participants were selected based on their availability and willingness to participate.

3.4 SAMPLE SIZE

Using Fischer's formula

$$N = \frac{Z^2 P [1-P]}{d^2}$$

Where, n = sample size,

Z = statistical level of confidence of 95% (1.96),

P = Proportion of the population between 18 – 35years taken as 98%,

D = confidence interval/margin of error (5%, d = 0.05)

Therefore,

$$N = 1.962 \times 0.88 (1 - 0.98) / 0.052$$

$$N = 30 \quad n = 30$$

3.5 RESEARCH MATERIALS

They consist of the following:

- Snellen visual acuity chart.
- Slit lamp/penlight.
- Pelli-Robson contrast sensitivity chart.
- Soft contact lenses (Opticom soft contact lenses) (62% polymacon, 38% water, base curve 8.50mm, diameter 14mm).
- Opticom refresh multi-purpose contact lens solution.
- Spectacle lenses.
- Schirmer strips.
- illumination source.
- Keeler Ophthalmoscope.

3.6 DESCRIPTION OF PROCEDURE

This was done in three stages:

3.6.1 STAGE 1: SUBJECTS VISUAL SCREENING EXAMINATION.

3.6.1.1 CASE HISTORY:

A functional case history was carried out to find out the capability and functionality of the patient. The preliminary details such as age, sex, hobbies as well as occupation were also recorded.

3.6.1.2 VISUAL ACUITY MEASUREMENT:

After history taking, the next most important task was the assessment of visual acuity unaided and aided 6m. And this was to be sure that they have refractive error and the spectacle correction they are wearing is the appropriate one.

3.6.1.3 EXTERNAL EXAMINATION:

This was to examine the ocular adnexa for abnormalities with the use of penlight and slit lamp. Schirmer's and tear break-up time test was carried out for tear volume and tear stability. Any ocular diseases such as cornea ulcer, conjunctivitis were excluded from the test.

3.6.1.4 OPHTHALMOSCOPY: This was carried out to determine the of the ocular fundus.

3.6.2 STAGE 2: VISUAL ACUITY TEST (SNELLEN CHART) WITH CONTACT LENSES AND SPECTACLE LENSES.

3.6.2.1 PROCEDURE:

After the visual acuity has been taken with the patient's spectacle correction monocularly, binocularly and recorded 6m. Then the soft contact lens with equivalent power to the spectacle correction of the patient was cleaned with enzyme disinfecting solution and the lens was inserted in the eye. After confirmation of contact of contact lens fitting and free deposit on the lenses, an

hour was given for adaptation. Then visual acuity measurement was taken monocularly, binocularly and recorded 6m.

3.6.3 STAGES 3: PELLI-ROBSON CONTRAST SENSITIVITY TEST WITH SPECTACLE LENSES AND CONTACT LENSES.

3.6.3.1 PROCEDURES:

Contrast sensitivity (CS) was measured using the Pelli-Robson sensitivity chart in the following order:

- The chart was illuminated between 60 and 120cd/m², with adequate room lighting.
- The patient was seated comfortably (with their correct spectacle prescription on) 1m from the chart with the middle of the chart at eye level.
- The left eye was occluded.
- The patient was asked to read the lowest letter they can see and encourage to guess. Once they state that they cannot see any further, indicate where the next lower contrast triplet is on the chart and ask the patient to keep looking at this point for at least 20 seconds, generally if given sufficient time, at least one more triplet of the letters will be visible.
- When the patient reads the letter C as an O, the respond was taken as correct.
- For every letter read correctly, a score of 0.05 log contrast sensitivity was given to the patient. (the first triplet of letters should be ignored as it has a log contrast sensitivity value of 0.00).
- Measurement was repeated for the left eye and then binocularly.
- The contrast sensitivity was recorded in log units.

- Then the soft contact lens with equivalent power to the spectacle correction of the patient was cleaned with enzyme disinfecting solution and the lens was inserted in the eye. After confirmation of contact of contact lens fitting and free deposit on the lenses, an hour was given for adaptation. Then contrast sensitivity measurement was taken monocularly, binocularly and recorded.

3.7 INCLUSION CRITERIA:

Subjects were included in the study when:

- ❖ They are the ages of 18-30 years and are able to comply to the contact lens wearing procedure.
- ❖ Subjects with refractive errors (e.g. myopia and hyperopia) who are candidates for both contact lenses and spectacle lenses.
- ❖ Subjects with no previous history of eye disorder that might affect visual function, for example dry eye, corneal ulcer.
- ❖ No family history of glaucoma or diabetes.
- ❖ Subjects who do not any have any ocular disorder that will prevent them from wearing contact lenses safely.
- ❖ Patient with no astigmatism.

3.8 EXCLUSION CRITERIA:

- ❖ Subjects who are not between the ages of 18-30 years.
- ❖ Subjects who will not be able to comply with the contacts wearing procedures or have history of soft contact lens intolerance.

- ❖ Subjects with glaucoma, history of ocular surgery, ocular hypertension or any evidence of corneal pathology such as corneal ulcers, keratitis, dry eye or keratoconus.
- ❖ Subjects with corneal astigmatism.

3.9 PRECAUTION:

1. Great care was taken to ensure that the test is fully understood by the patient before it was carried out.
2. In order to avoid distractions and to ensure patient full concentration the test was isolated from all other activities going on in the clinic.
3. Great care was taken to ensure that all the procedures and measurements are done and taken in the right order.
4. Contact lenses were properly cleansed with suitable solution to remove deposits.

3.10 STATISTICAL METHODS AND DATA ANALYSIS

The values obtained from Pelli-Robson contrast sensitivity chart in logMAR and values obtained from the Snellen visual acuity chart in logMAR was arranged in spreadsheet for comparison of the differences. The data was analyzed using the Kolmogorov-smimov normality test to check for skewness, kurtosis and how deviated the values are from normal, that is whether it is parametric (normal distribution) or Non-parametric (not normal distribution. The Wilcoxon signed-rank test for non-parametric data was used to determine whether or not there were statistically significant differences in VA and Contrast Sensitivity using spectacles and contact lenses. The result of the analysis revealed a statistically significant difference in contrast sensitivity ($p < 0.05$), but no statistically significant difference between VA taken with spectacles and Contact Lenses ($p > 0.05$).

CHAPTER FOUR

4.0 RESULTS AND ANALYSIS

This study involved a total of 30 participants, with a mean age of 22.10 ± 3.66 years. Participants comprised of males ($n = 13$) and females ($n = 17$). The study was conducted to determine whether or not there is any significant difference in visual acuity and contrast sensitivity using spectacles and contact lenses. Participant's visual acuity and contrast sensitivity were determined with both spectacles and contact lenses.

The data collected was subject to analysis to test the predetermined hypothesis. The results of the analysis, which was conducted in line with the study's aim, objectives and hypothesis, will be presented in the subsequent sections of this chapter.

TABLE 4.1: Descriptive Statistics of Age

Age Range	Frequency (N =	Percentages (%)	Mean \pmSD
	30)		(22.10 \pm3.66)
18 – 22	19	63.4	20.0 \pm 3.45
23 – 26	7	23.3	24.5 \pm 2.24
27 – 30	3	10	28.5 \pm 2.24

Table 4.1 provides the descriptive statistics of age of the participants in the study. The mean age of the participants was calculated to be 22.10 \pm 3.66 years. The age range was 13 years (18 to 31).

FIGURE 4.1: Gender Distribution among Participants

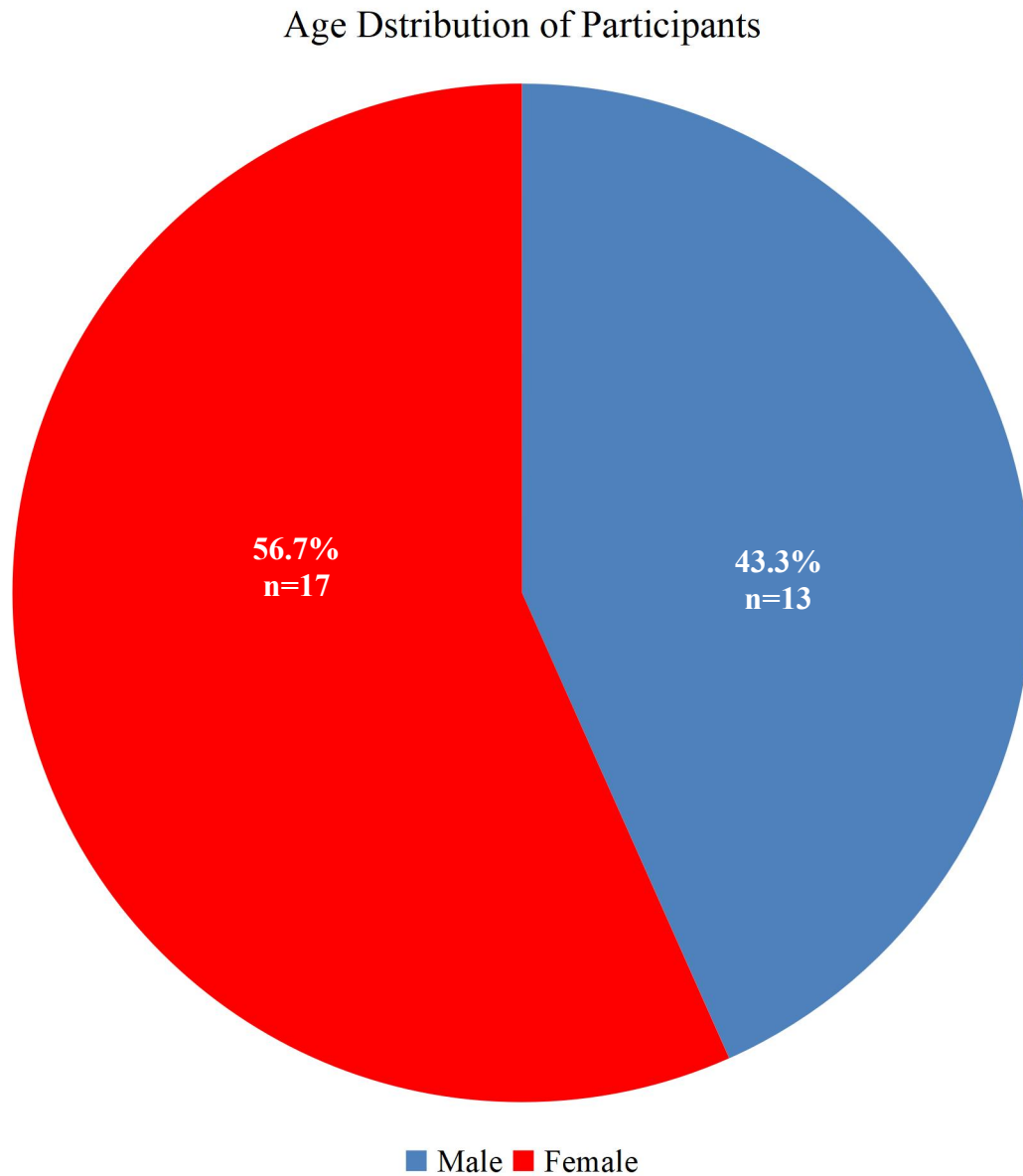


Figure 4.1 shows that a population of males (n = 13) and females (n = 17) were represented in the study.

TABLE 4.2: Visual Acuity with Spectacles

Variable	N	Mean ±SD
Visual Acuity with OD	30	-0.04 ±0.04
Visual Acuity with OS	30	-0.04 ±0.04
VA with both eyes (OU)	60	-0.055 ±0.0572

Table 4.2 presents the descriptive statistics of visual acuity both with each eye (n = 60) and both eyes (n = 30).

TABLE 4.3: Visual Acuity with Contact Lens

Variable	N	Mean \pmSD
Visual Acuity with OD	30	-0.031 \pm 0.041
Visual Acuity with OS	30	-0.031 \pm 0.041
VA with both eyes (OU)	60	-0.04 \pm 0.039

Table 4.3 shows the distribution of visual acuity with contact lenses.

TABLE 4.4: Descriptive Statistics of Contrast Sensitivity Values with Spectacles and Contact Lenses

Correction Modality	N	Mean \pmSD
Spectacles (OD)	30	1.090 \pm 0.049
Spectacles (OS)	30	1.076 \pm 0.045
Spectacles (OU)	60	2.17 \pm 0.094
Contact Lens (OD)	30	1.04 \pm 0.0042
Contact Lens (OS)	30	1.06 \pm 0.0090
Contact Lens (OU)	30	2.10 \pm 0.131

Table 4.4 shows the descriptive statistics of contrast sensitivity using contact lenses and spectacles.

TABLE 4.5: Normality Test Using the Kolmogorov-Smirnov Test

Correction Modality	Variable	N	K-S test Statistics	Skewness	Kurtosis	p value	Distribution
Spectacles	Visual Acuity (OU)	30	0.27067	-0.753		0.0197	Non-parametric
	Contrast Sensitivity (OU)	30	0.3392	-0.758	-0.321	0.00139	Non-parametric
Contact Lens	Visual Acuity (OU)	30	0.3413	0	-2.148	0.00127	Non-parametric
	Contrast Sensitivity (OU)	30	0.2119	-0.335	-0.831	0.11644	Parametric

The Kolmogorov-Smirnov normality test revealed that that all data followed a non-parametric distribution ($p < 0.05$), except contrast sensitivity determined using contact lens ($p > 0.05$).

TABLE 4.6: Wilcoxon Signed-Rank Test for Analysis of Differences between VA and Contrast Sensitivity.

Wilcoxon Signed-Rank Test Results				
Variables	Correction Modality	Mean ±SD	N (Sample size)	p-value
Visual Acuity	Spectacle lenses	-0.055±0.0572	30	0.05334
	Contact lens	-0.04 ±0.039	30	
Contrast Sensitivity	Spectacle lenses	2.17 ±0.094	30	0.00137
	Contact lenses	2.10 ±0.131	30	

The Wilcoxon signed-rank test for non-parametric data was used to determine whether or not there were statistically significant differences in VA and Contrast Sensitivity using spectacles and contact lenses. The result of the analysis revealed a statistically significant difference in contrast sensitivity ($p < 0.05$), but no statistically significant difference between VA taken with spectacles and Contact Lenses ($p > 0.05$).

CHAPTER FIVE

5.0 DISCUSSION

Visual acuity is the spatial resolving capacity of the visual system (Bahrami & Oberwinkler, 2018). It measures ability to discriminate fine levels of detail, especially patterns with high spatial frequencies (Geng *et al.*, 2021). Contrast sensitivity refers to the ability to perceive differences in luminance between adjacent areas (Owsley *et al.*, 2016). It measures the smallest detectable difference in light levels that allows a person to discriminate an object from its background (National Research Council, 2015). Spectacle lenses placed in eyeglass frames held before the eyes are commonly used to correct refractive errors like myopia, hyperopia, astigmatism, and presbyopia (Wolffsohn *et al.*, 2019). Contact lenses represent an alternative corrective method involving directly placing optical devices onto the surface of the eyes (Sindt *et al.*, 2020). Modern soft lenses made of plastics like silicone hydrogels allow oxygen permeability while correcting refractive errors via similar focusing principles as spectacles (Wolffsohn & Hunt, (2019)).

In this study, we compared contrast sensitivity and visual acuity with spectacle and contact lenses. This study investigate the possible relationship between visual acuity and contrast sensitivity using the two correction modalities was conducted among 30 participants with the mean age of 22.10 ± 3.66 (Table 4.1). The result of the social demographic characteristics of the participants showed that 13 (43.3%) of the participants were males, while 17 (56.7%) were females. A possible reason for this narrow gender gap is that, the increasing use of soft contact lenses and spectacle lenses for correction has created a new patient group whose visual quality is affected independently of visual acuity but also to obtain better quality of vision and have high visual performance. The result on the age distribution of the participants showed that 63.4% were within the age range of 18-22, 23.3% were within the age range of 23-26, 10% were within the

age range of 27-30, 3.3% were above 30 years. Before commencement, general ocular assessment was conducted such as external examination and ophthalmoscopy to rule out ocular pathologies that may affect our findings.

To determine the most appropriate test to statistically analyze the data, to check for statistical significance difference, normality test was conducted, the normality was carried out using the Kolmogorov-smimov normality test to check for skewness, kurtosis and how deviated the values are from normal, that is whether it is parametric (normal distribution) or Non-parametric (not normal distribution). The findings of the normality test showed that visual acuity and contrast sensitivity for spectacle lens as well as visual acuity for contact lens were Non-parametric; this means that the data were not normally distributed. However, contrast sensitivity for contact lens was found to follow a normal distribution.

Due to the fact that majority of the data followed a Non-parametric distribution, a non-parametric test was chosen for this study (Table 4.5).

So to statistically analyze the difference between visual acuity and contrast sensitivity using spectacle lens and contact lens, this study used the Wilcoxon signed-rank test. The test is well suited for this study for comparing two independent groups especially the dataset that follows the non-parametric trends (not normally distributed) (Table 4.6).

Table 4.2 and table 4.3 give a comprehensive overview of the visual acuity measurement with spectacles and contact lenses providing insights into the central tendency, mean and standard deviation, variability and distribution of the data for each eye and both eyes. Table 4.4 provides a detailed comparison of contrast sensitivity values obtained with spectacle and contact lenses. The

values for each modality help in understanding the central tendency, mean and standard deviation, variability and distribution of contrast sensitivity measurements, allowing for a comprehensive assessment of their effectiveness in vision correction.

The finding of this study reveals that there was no significant difference in visual acuity using both spectacle lens and contact lens ($p > 0.05334$) (Table 4.6). This is similar to the results gotten from a previous study done (Brennan et al. (2005), Rah & Jackson.(2009)) which showed no significant difference in visual acuity with spectacle lens and contact lens correction in both hyperopic and myopic. However, the result of this analysis shows a significant difference in contrast sensitivity using contact lens ($p < 0.00137$) (Table 4.6), this shows that we can reject hypothesis one but accept hypothesis two.

The findings of this study agree with previous studies done that reported an increase in visual performance with contact lens compared to spectacles. Some recent studies have shown that soft contact lenses enhances visual performance with increase in contrast sensitivity better than spectacle lenses ((Sapkota .K., 2020. Liou and Chio, 2003).And that the choice of refractive correction has impact on visual performance for the majority of myopic and hyperopic patients (Pirindhavellie 2003, L.H Tsai 2020).

Conversely, other studies show conflicting results as reported by Applegate and Massof indicate that comparing results of spectacle correction and contact lens correction indicates that contrast sensitivity was lower in subjects who wore soft contact lenses. Many subjects were left with residual astigmatism when corrected with contact lenses, which would have impaired their visual performance compared to spectacles. Increased spherical aberration induced by some contact lens designs at particular powers may have impaired vision with contact lenses, although others

claim the effect is negligible. In this study, optical problems were minimized by excluding myopes and hyperopes with astigmatism. (Asieh *et al*, 2011)

For studies employing the subjects' own contact lenses for comparison with spectacles, contact lens deposition may have been a factor since deposition is known to increase intraocular light scatter and hence reduce low contrast sensitivity. The majority of studies considering this subject were undertaken in the 1980's or before, when soft contact lenses were either spun cast or lathe cut, and suffered from poor homogeneity and surface quality. Lens materials also had lower oxygen transmissibility than modern lenses, giving rise to the potential for corneal edema and a subsequent reduction in contrast sensitivity. Lens designs, materials and manufacturing techniques have improved significantly over the last two decades and daily disposable soft contact lenses account for close to 60% of the UK contact lens market (ACLM report 2009), because of their convenience and the absence of deposit problems. For these reasons, a daily disposable lens made from conventional hydrogel material (Opticom soft contact lenses: 62% polymacon, 38% water, base curve 8.50mm, diameter 14mm) was selected for this study. The oxygen transmissibility of the lens chosen was adequate to prevent corneal hypoxia in an open eye, for the lens powers considered.

However, in spite of the fact that this study has added value to this topic, it is important that further studies that takes into account greater sample size and diverse population is conducted to further support this findings. Although this study only considered subjects with a relatively, narrow range of myopia and hyperopia.

Contact lenses especially for first time wearers may cause a bit of blurriness which usually quickly resolves, this blurriness is due to the effort of the eyes trying to adapt to the lenses (Rodriguez-Lopez 2020).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

In this study, there was a significant difference in contrast sensitivity scores with spectacle lens and contact lens. The results of this study support the theory that there is increase in visual performance and vision quality with soft contact lenses. The Contact lenses reduce optical defocus and enhance contrast sensitivity.

With modern soft lens materials worn as prescribed, eye care practitioners can be confident that they are not compromising the visual quality of their patients by fitting contact lenses rather than spectacles.

6.2 RECOMMENDATION

- Contact lens wearers, especially first timers should be enlightened on what to expect visually after the first fitting. Blurry vision and slight discomfort that reduces within the first few minutes are some of the expected complaints.
- More people need to learn or understand the impact of soft contact lenses on visual performance vision quality. Some visual problems can be solved just by changing the correction modality.
- Contrast sensitivity as a form of testing visual acuity should be embraced and used more often in eye clinics, hospitals and schools of optometry.

- More people should be encouraged to use contact lenses and any fears or misgivings they have concerning using contact lenses should be erased by better educating them on the benefits and simplicity of the use of contact lenses.
- When it comes to visual quality, it is also worth noting that some research suggests that the patient's age may impact visual adaptation, with younger age groups demonstrating greater adaptive abilities. Therefore, closer monitoring and/or reinforcement of visual performance may be needed in older age groups.

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APPENDIX

			SPECTACLE LENS							CONTACT LENS						
S/N	sex	age	VA			CS (logMAR)			VA			CS (logMAR)				
			power	RE	LE	BE	RE	LE	BE	power	RE	LE	BE	RE	LE	BE
1	m	30	-4.00	6/6	6/6	6/6	2.10	2.10	2.10	-4.00	6/6	6/6	6/6	2.25	2.25	2.25
2	f	25	-3.00	6/6	6/6	6/6	2.10	2.10	2.25	-3.00	6/6	6/6	6/6	2.25	2.25	2.25
3	f	22	+3.00	6/5	6/5	6/4	2.25	2.25	2.25	+3.00	6/5	6/5	6/5	2.25	2.25	2.25
4	m	28	-2.00	6/6	6/6	6/6	2.10	2.10	2.10	-2.00	6/6	6/6	6/6	2.10	2.10	2.25
5	m	19	+2.00	6/5	6/5	6/4	2.25	2.25	2.25	+2.00	6/5	6/5	6/5	2.25	2.25	2.25
6	m	31	-2.00	6/6	6/6	6/6	1.95	1.95	2.10	-2.00	6/6	6/6	6/6	2.10	2.25	2.25
7	m	24	-2.00	6/6	6/6	6/6	2.10	2.10	2.10	-2.00	6/6	6/6	6/6	2.10	2.25	2.25
8	m	18	-2.00	6/6	6/6	6/5	1.95	1.95	2.10	-2.00	6/6	6/6	6/6	2.10	1.95	2.25
9	f	20	+2.00	6/5	6/5	6/5	2.10	2.25	2.25	+2.00	6/6	6/6	6/5	2.25	2.25	2.25
10	m	21	+3.00	6/5	6/5	6/5	2.25	2.25	2.25	+3.00	6/5	6/5	6/5	2.25	2.25	2.25
11	m	26	-3.00	6/6	6/5	6/5	2.10	2.10	2.10	-3.00	6/5	6/5	6/5	2.55	2.10	2.25

12	f	17	-2.00	6/5	6/5	6/5	1.95	1.95	2.10	-2.00	6/5	6/6	6/5	2.10	1.95	2.25
								5								
13	f	23	-4.00	6/6	6/6	6/6	1.95	1.95	1.95	-4.00	6/6	6/6	6/6	2.10	1.95	2.25
14	f	22	-3.00	6/6	6/6	6/6	2.10	2.10	2.10	-3.00	6/6	6/6	6/6	2.25	2.25	2.25
								0								
15	m	19	+4.00	6/6	6/6	6/5	2.25	2.25	2.25	+4.00	6/5	6/6	6/5	2.25	2.25	2.25
			0					5								
16	f	18	-3.00	6/5	6/5	6/5	2.10	2.10	2.25	-3.00	6/5	6/6	6/5	2.10	2.25	2.25
								0								
17	f	20	-2.00	6/6	6/6	6/6	2.10	2.10	2.10	-2.00	6/6	6/6	6/6	2.10	2.10	2.25
								0								
18	m	27	-2.00	6/5	6/5	6/5	2.10	2.10	2.25	-2.00	6/5	6/6	6/5	2.10	2.25	2.25
								0								
19	f	19	+3.00	6/5	6/5	6/4	2.25	2.25	2.25	+3.00	6/5	6/5	6/5	2.25	2.25	2.25
			0					5								
20	f	19	-2.00	6/6	6/6	6/6	1.95	1.95	2.10	-2.00	6/6	6/6	6/6	2.25	2.25	2.25
								5								
21	f	21	-2.00	6/5	6/5	6/5	2.10	2.10	2.10	-2.00	6/5	6/5	6/5	2.25	2.25	2.25
								0								
22	f	17	+4.00	6/5	6/5	6/5	2.25	2.25	2.25	+4.00	6/5	6/5	6/5	2.25	2.25	2.25
			0					5								
23	f	22	-3.00	6/6	6/6	6/6	1.95	1.95	2.10	-3.00	6/6	6/6	6/6	2.10	2.10	2.25
								5								

24	f	24	-3.00	6/6	6/6	6/6	2.10	2.1 0	2.10	-3.00	6/6	6/6	6/6	2.25	2.25	2.25
25	m	21	-3.00	6/5	6/6	6/5	2.10	2.1 0	2.10	-3.00	6/6	6/6	6/6	2.25	2.25	2.25
26	f	21	-2.00	6/5	6/6	6/5	2.10	2.1 0	2.25	-2.00	6/5	6/5	6/5	2.25	2.25	2.25
27	f	18	-4.00	6/6	6/6	6/6	1.95	1.8 0	1.95	-4.00	6/6	6/6	6/6	1.95	1.95	2.10
28	f	20	-2.00	6/6	6/6	6/6	2.10	2.1 0	2.25	-2.00	6/6	6/6	6/6	2.25	2.25	2.25
29	m	23	-2.00	6/5	6/5	6/5	2.10	2.1 0	2.25	-2.00	6/5	6/6	6/5	2.10	2.25	2.25
30	m	26	+2.0 0	6/5	6/5	6/5	2.10	2.2 5	2.25	+2.00	6/5	6/5	6/5	2.25	2.25	2.25

TABLE 4.1: Descriptive Statistics of Age

Age Range	Frequency (N = 30)	Percentages (%)
18 – 22	19	63.4
23 – 26	7	23.3
27 – 30	3	10
>30	1	3.3
Mean (\pmSD)	22.10 \pm 3.66	
Variance	13.40	
Range	18 – 31 (13)	

Table 4.1 provides the descriptive statistics of age of the participants in the study. The mean age of the participants was calculated to be 22.10 ± 3.66 years. The age range was 13 years (18 to 31)

TABLE 4.2: Descriptive Statistics of Visual Acuity with Spectacles

Variable	N	Range	Minimum	Maximum	Mean	SD	Variance
Visual Acuity with Each Eye	60	0.08	-0.08	0.00	-0.04	0.04	0.002
VA with both eyes (OU)	30	.18	-.18	.00	-.0553	.05722	.003

Table 4.2 presents the descriptive statistics of visual acuity both with each eye (n = 60) and both eyes (n = 30).

TABLE 4.3: Descriptive Statistics of Visual Acuity with Contact Lens

Variable	N	Range	Minimum	Maximum	Mean	SEM	SD	Variance
Visual Acuity with Each Eye	60	0.08	-0.08	0.00	-0.031	0.005	.0407	0.002
VA with both eyes (OU)	30	0.08	-0.08	0.00	-0.04	-0.007	0.039	0.002

Table 4.3 shows the distribution of visual acuity with contact lenses.

TABLE 4.4: Descriptive Statistics of Contrast Sensitivity Values with Spectacles and Contact Lenses

Correction Modality	N	Range	Minimum	Maximum	Mean	SD	Variance
Spectacles	30	.30	1.95	2.25	2.17	0.094	0.009
Contact Lens	30	0.45	1.80	2.25	2.10	0.131	0.017

Table 4.4 shows the descriptive statistics of contrast sensitivity using contact lenses and spectacles.

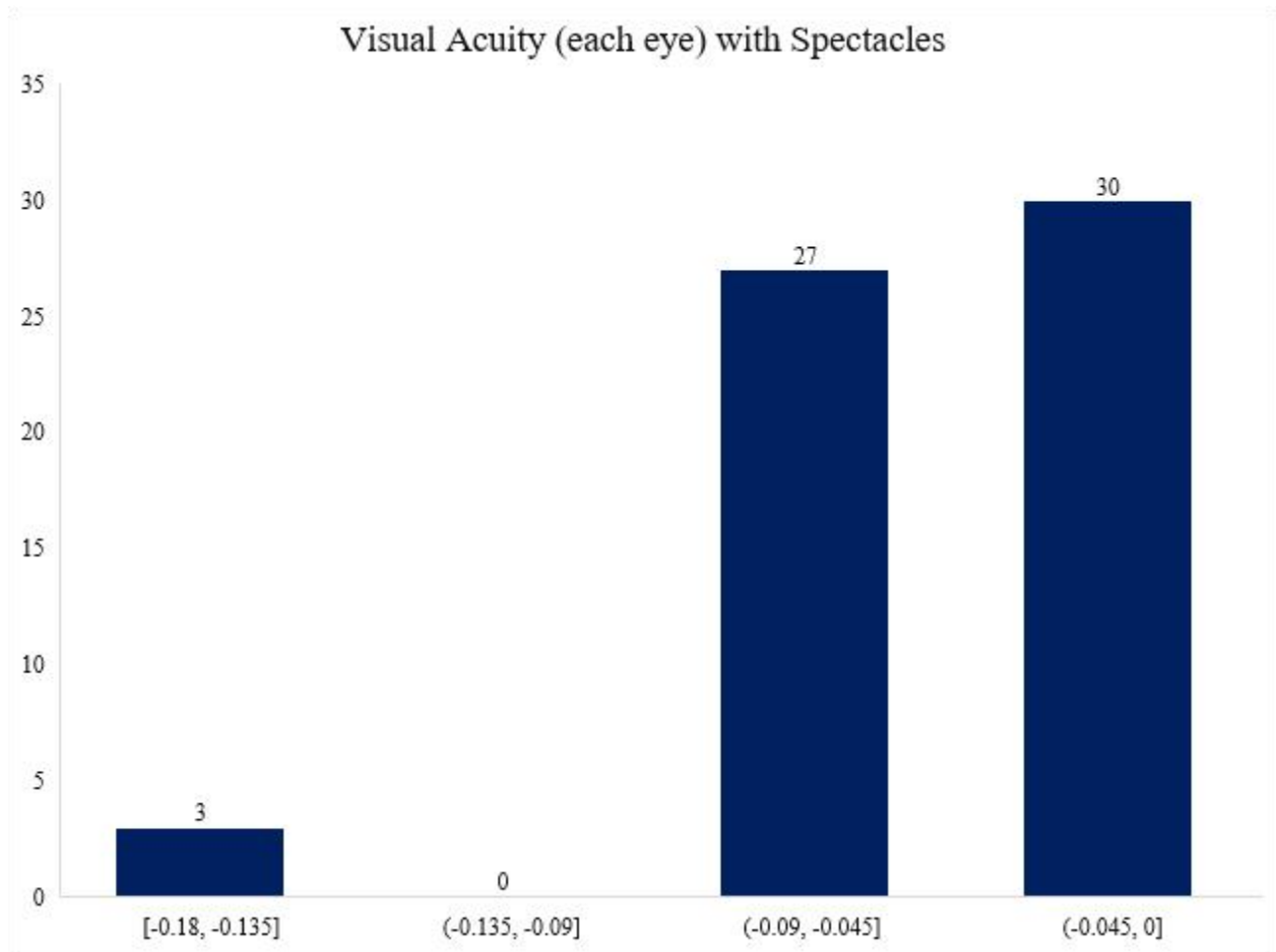


FIGURE 4.3 shows the distribution of logMAR visual acuity with each eye ($n = 60$) using spectacles.

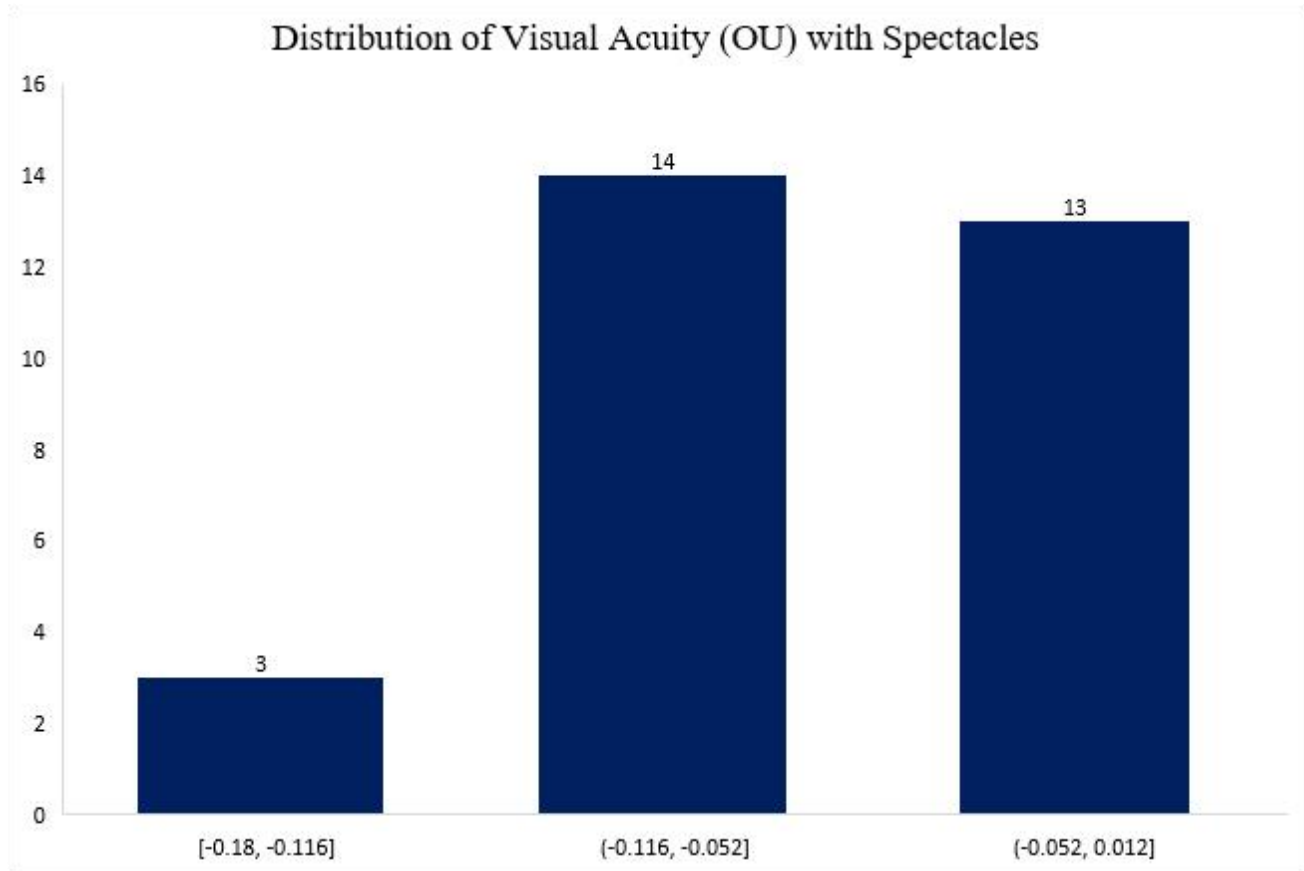


FIGURE 4.4 shows the distribution of logMAR visual acuity with both eyes ($n = 30$) using spectacles.

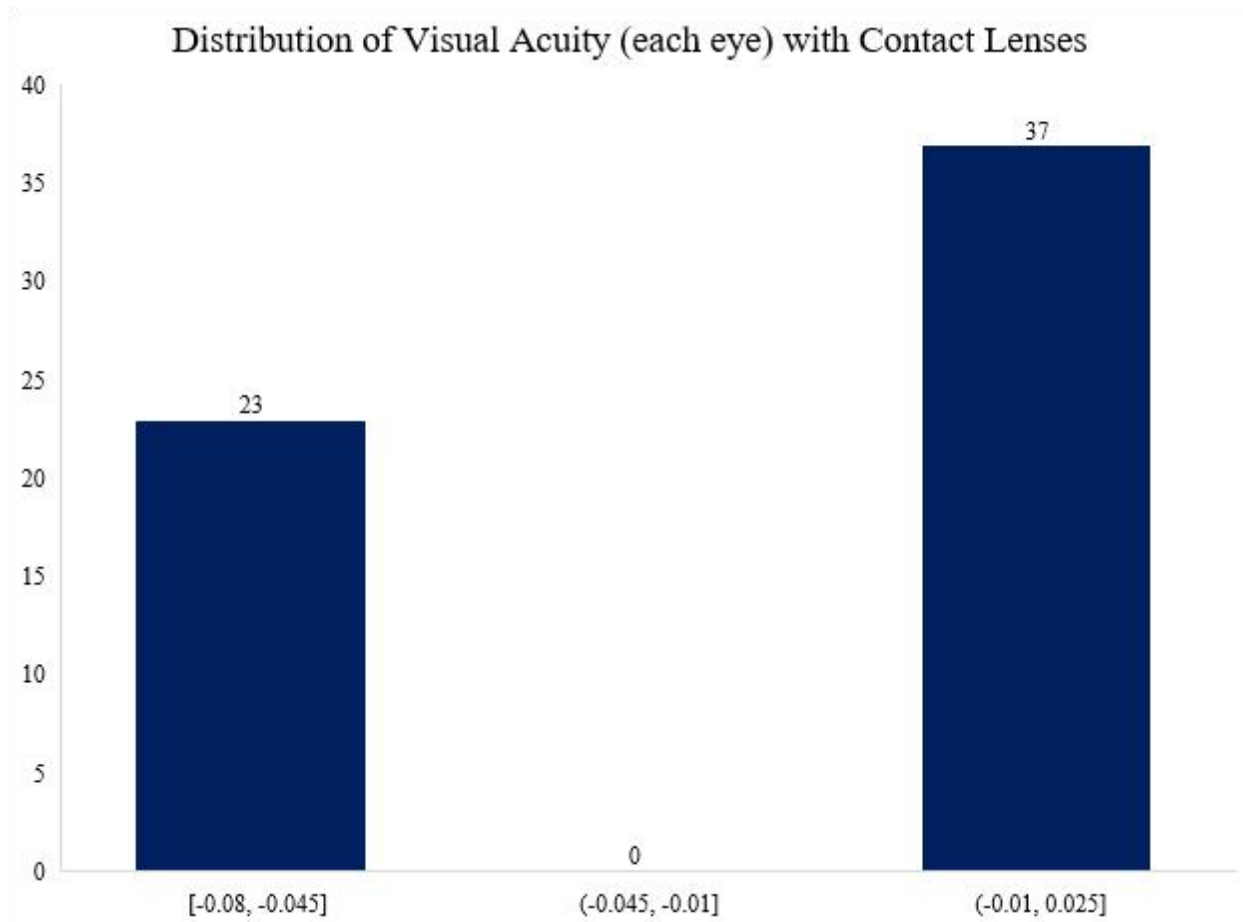


FIGURE 4.5 shows the distribution of logMAR visual acuity with each eye ($n = 60$) using contact lenses.

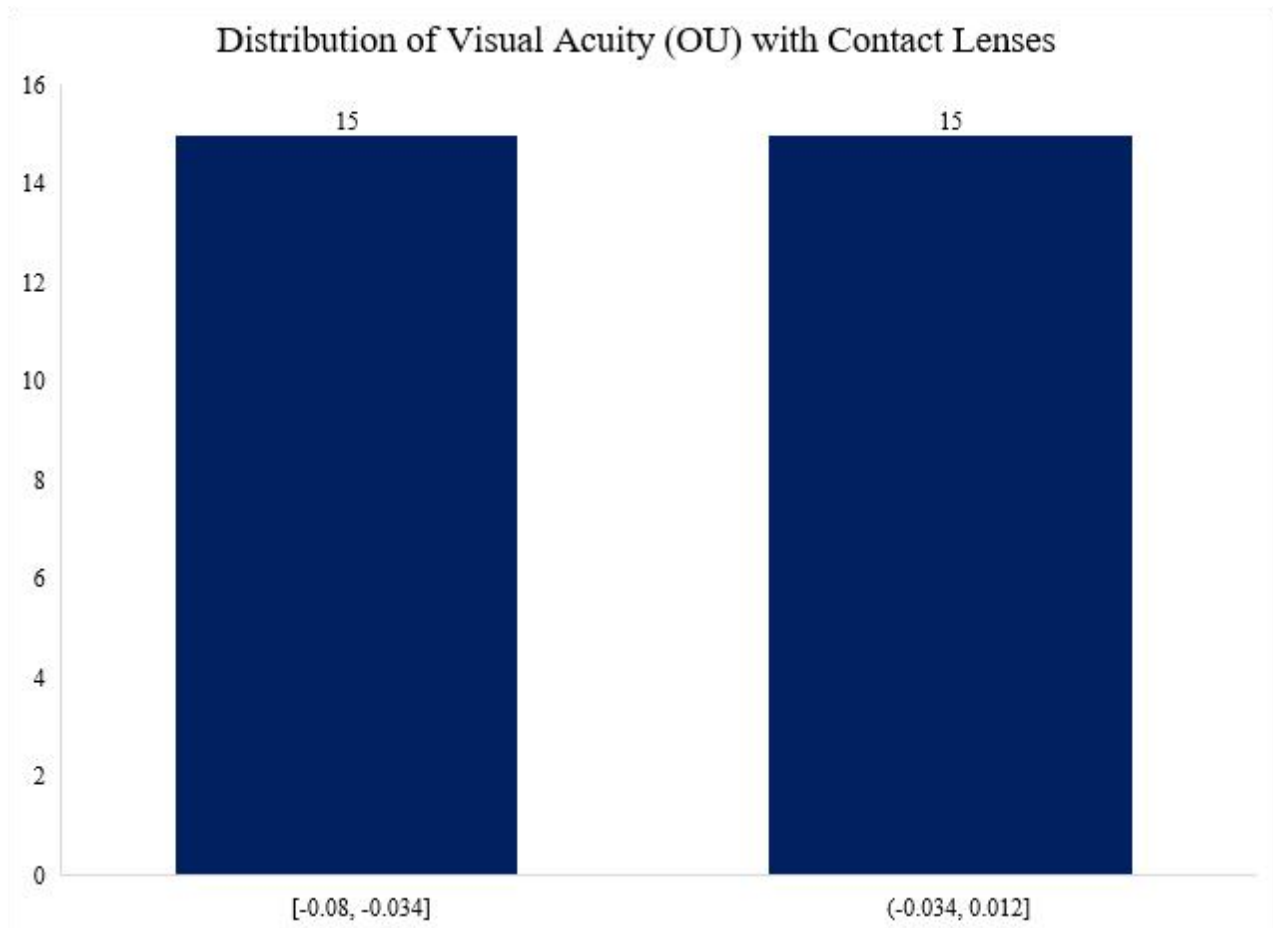


FIGURE 4.6 shows the distribution of logMAR visual acuity with both eyes ($n = 30$) using contact lenses.

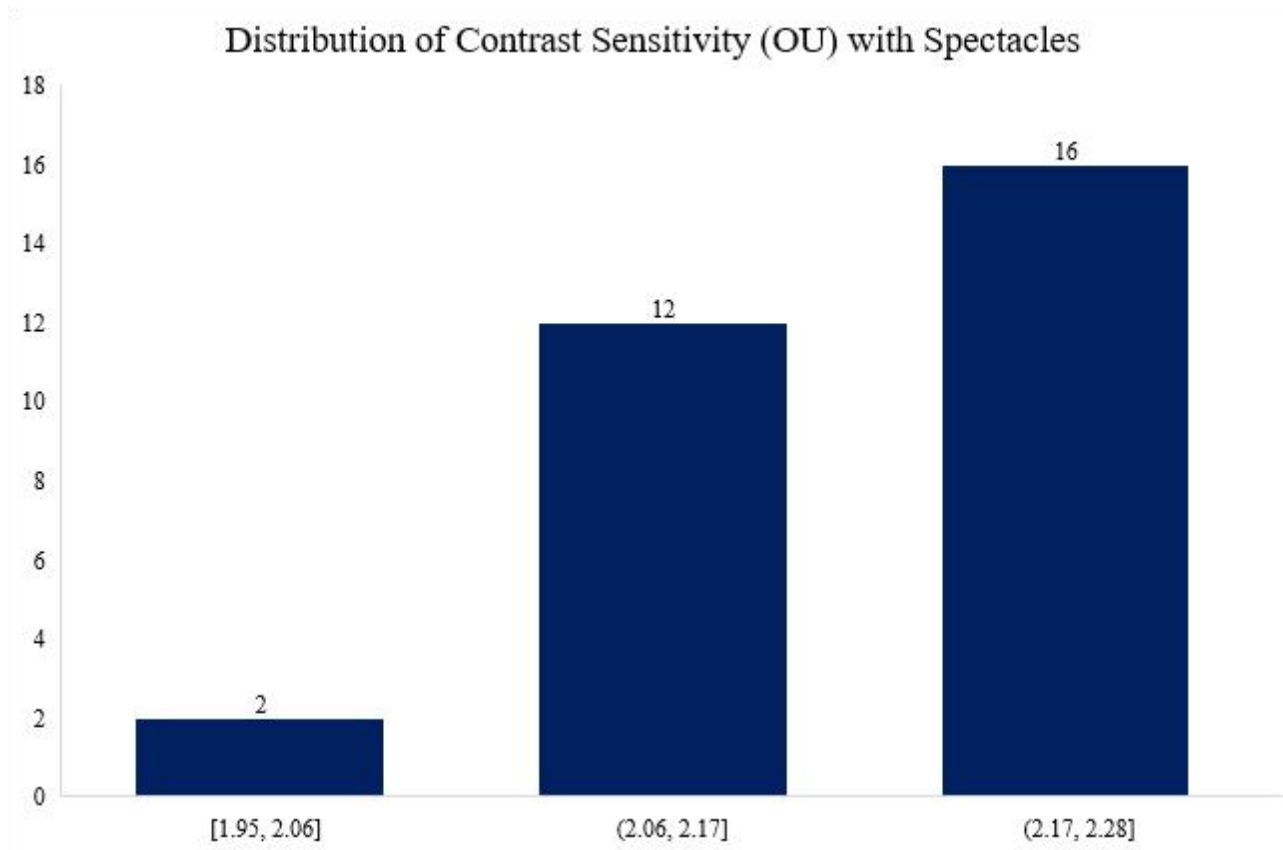


FIGURE 4.7 shows the distribution of logMAR contrast sensitivity using spectacles with both eyes (OU) (n = 30).

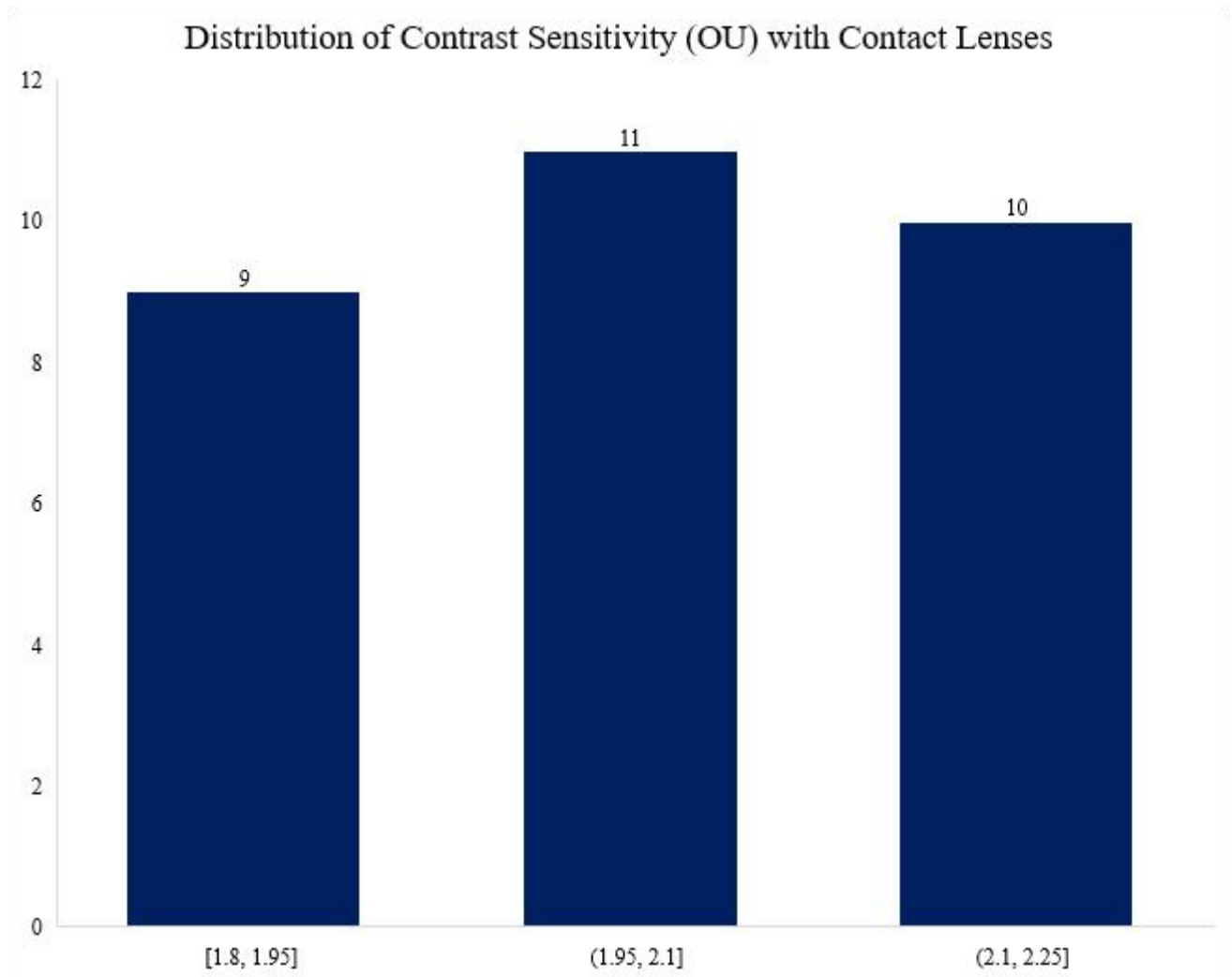


FIGURE 4.8 shows the distribution of logMAR contrast sensitivity with both eyes ($n = 60$), using contact lens.