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Farah Fareed Tarik
College of Health & Medical Techniques, Middle Technical University (MTU), Iraq

Corresponding Author:
Farah Fareed Tarik
College of Health & Medical Techniques, Middle Technical University (MTU), Iraq

Optical refractive errors and obesity

Farah Fareed Tarik

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Abstract
Refractive errors are among the most common visual impairments worldwide, impacting individuals of all ages. These include myopia, hyperopia, astigmatism, and presbyopia, each affecting how the eye focuses light on the retina, often leading to blurred vision. Simultaneously, obesity has emerged as a global epidemic associated with multiple health risks, including potential effects on ocular structure and function. This study aimed to assess the relationship between obesity and refractive errors. A cross-sectional study was conducted on 70 obese patients (ages 8-72) at Martyr Ghazi Al-Hariri Hospital in Baghdad. Data collected included BMI, demographic information, and ophthalmologic examinations using auto refractors, visual acuity tests, trial lenses, trial frames, retinoscopy, and pachymetry. The findings revealed variations in refractive error prevalence across obesity classes, with potential implications for eye health in obese populations. Understanding this relationship may help in the early detection and prevention of vision problems through lifestyle modifications and improved public health awareness.

Keywords: Optical Refractive errors, obesity, spherical equivalent SE, corneal central thickness CCT

Introduction
Imagine waking up and struggling to see the details around you, whether it's reading a book or recognizing faces across the room. For many people, this is the reality caused by refractive errors conditions that affect the eye‘s ability to focus light properly onto the retina, leading to blurry vision.
When parallel rays of light entering the non-accommodating eye do not focus on the retina, refractive error (ametropia) is present. A common optical aberration in which parallel light rays from a distant image are focused on a point anterior to the retina is myopia, also a common aberration and one in which distant light rays converge incompletely before striking the retina is hyperopia. When incident light rays do not converge at a single focal point, a stigmatism and other forms of optical aberrations occur [1]. The World Health Organization identifies obesity as the most prominent chronic health problem in adults, even worse than malnutrition [2]. Recent changes in socioeconomic conditions, lifestyle, food consumption, and increasing urbanization have led to an increase in obesity. Obesity is a gateway for various diseases and has become one of the leading causes of disability and death, affecting not only adults but also children and adolescents around the world. It is associated with increased mortality and risks of cardiovascular disease, stroke, type 2 diabetes, and cancer [3, 4]. Obesity could influence eye shape and structure, increasing the risk of refractive problems. For example, excess weight could alter the length of the eye or cause changes in the eye‘s corneal shape.
Furthermore, obesity-related inflammation could exacerbate or contribute to the developpment of However, the relationship is complex and influenced by genetic, environmental, and lifestyle factors. While some studies show a connection between obesity and conditions like myopia, it’s also possible that maintaining a healthy weight through diet and exercise could help reduce the risk of vision problems, including refractive errors. Understanding the potential links between obesity and refractive errors is essential for promoting better eye health.

Refractive errors
Refractive errors occur when the shape of the eye prevents light from focusing directly on the retina. The length of the eyeball (longer or shorter), changes in the shape of the cornea, or

aging of the lens can cause refractive errors. Refractive errors occur when the shape of the eye prevents light from focusing directly on the retina. The length of the eyeball (longer or shorter), changes in the shape of the cornea, or aging of the lens can cause refractive errors [5].

Myopia (near sightedness)

Myopia is the state of refraction in which parallel rays of light are brought to focus in front of the retina of a resting eye [6]. One of the most dominant illnesses of the eye is the myopia, it causes visual impairment in both children and adults that is typically correctable using optical supports such as spectacles and contact lenses, or through progressively popular surgical means. Higher myopia may result in comorbidities associated with meaningfully improved dangers of severe and irreversible loss of vision, such as retinal detachment, subretinal neovascularization, dense cataract as well as glaucoma [7-12].

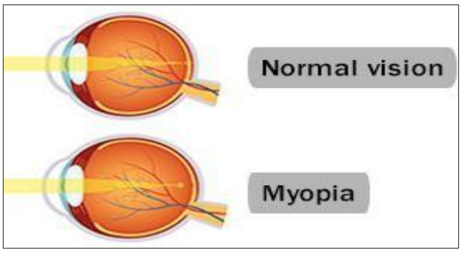

Fig 1: Myopic eye [13].

Hyperopia (far sightedness)

In farsightedness, or hyperopia, vision is often better at a distance than up close (although it may be blurry both at a distance and up close) [13]. A common type of refractive error where distant objects may be seen more clearly than objects that are near is known a farsightedness [14].

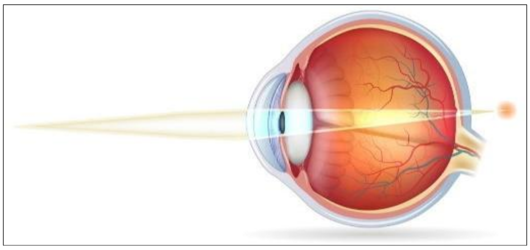

Fig 2: Hyperopic eye [14].

Causes of Hyperopia

Eyeball size and optical power vary among individuals, just like height and weight. Hyperopia (short for hypermetropia) results when the eyeball is too small. There is less optical power present than the eye needs for bringing light rays into clear focus on the retina. Fortunately, the normal focusing mechanism (accommodation) can usually supply the additional optical power needed. At birth, nearly everyone is somewhat farsighted, but the amount lessens as the eye cultivates. Once you have reached adulthood, any hyperopia quiet present will tend to remain. It is not affected by diet, vitamins, or eye exercises [14].

Astigmatism

A conjoint type of refractive errors that evolves of your eye (either the cornea or lens) is more curved than it should be is astigmatism. This altered eye shape makes your vision blurry. Most cases of astigmatism can be treated with corrective lenses like eye glasses or contact lenses [15].

Presbyopia

A global problem affecting over a billion people worldwide is a presbyopia. The prevalence of unmanaged presbyopia is as high as 50% of those above Presbyopia 50 years of age in evolving world populations, due to a lack of awareness and accessibility to affordable treatment and is even as high as 34% in developed countries [42].

Effects of refractive errors on quality of life

Uncorrected refractive errors impair the quality of life of millions of people of Different ages, genders, and ethnicities and they impose heavy burdens on the families of the affected individuals as well as the society as a result of loss of manpower [43]. Refractive errors can lead to problems in a person's quality of life- related to vision and make it difficult for them to do tasks pertinent to it [44].

Obesity

A chronic complex disease defined by excessive fat deposits that can impair health is called an obesity. Obesity can lead to amplified risk of type 2 diabetes and heart diseases, it can distress bone health in addition reproduction, it upsurges the risk of assured cancers. Obesity effects the quality of living, such as sleeping or moving. The diagnosis of overweight and obesity is ended by measuring people's weight and height and by calculating the body mass index (BMI): weight (kg)/height² (m²). The body mass index is a surrogate marker of fatness and additional depths, such as circumference, can help the diagnosis of obesity. The BMI categories for essential obesity vary by age and gender in infants, children and adolescents [16].

The overweight rate of African children under 5 years old has increased by 24% since 2000. As of 2019, almost half of the Asian children under 5 years old were obese or overweight [17-26]. WHO datasets from sub-Sarahan Africa reveal that the prevalence of overweight and obese in adults and stunting, underweight, and wasting in children are inversely associated [27].

Body mass index (BMI)

BMI is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2). For example, an adult who weighs 70kg and whose height is 1.75m will have a BMI of 22.9: BMI = 70(kg)/1.752 (m^2) = 22.9 The classification of overweight and obesity, allowing to BMI, Obesity is classified as a BMI 2:30.0. approves with that recommended by WHO, but embraces an additional subdivision at BMI 35.0-39.9 in recognition of the fact that management options for dealing with obesity vary overhead a BMI of 35. The WHO classification is founded principally on the association between BMI and mortality…. is a person's weight in kilograms (or pounds) divided by the square of height in meters (or feet) [28-31]. Obesity is defined as the buildup of excess fat in the body to the extent that it may harm health, according to WHO [32]. In regular practice, doctors use BMI > 30 to define obesity. Studies have revealed that over time, the improvement of obesity is mainly the result of overfeeding rather than a defect in basic energy expenditure [33].

Spherical equivalent (SE)

In optics, incident rays are moreover refracted or reflected off a surface at an angle constant to the degree of refractivity or reflectivity of the specified medium. The eye is principally an optical concentrating structure for the refraction of light stimuli onto a complex system of neurons and particular photoreceptors. This complex system delivers sensory information to the visual cortex for interpretation. These neural impulses are translated from the retina via cone photoreceptors populating the fovea centralis, which depolarize upon exposure to photopic stimuli. The cones also account for central 10° of peak visual field sensitivity and color sensitivity. The optical function of the eye is directly proportional to its gross focusing power [39]. It is a crucial concept in optometry and ophthalmology that simplifies the representation of a refractive error by combining the spherical and cylindrical components of a prescription into a single value. The SE calculation is derived from the formula SE = Sphere Power + (Cylinder Power / 2). This calculation condenses the complex prescription into a more manageable and interpretable value, aiding in the prescription of corrective lenses and assessment of visual acuity. Understanding SE is essential in clinical practice as it facilitates communication among eye care professionals and simplifies comparison of refractive errors across different individual [40].

Examples: - If an individual s eye prescription is -2.00 -1.50 x 90, the SE calculation would be:

SE = -2.00 + (-1.50 / 2) = -2.00 - 0.75 = -2.75 D

Thus, the spherical equivalent for this prescription is -2.75 diopters. - For another prescription of +3.50 -0.75 x 180, the SE would be:

SE = +3.50 + (-0.75 / 2) = +3.50 - 0.375 = +3.125 D

In this case, the spherical equivalent for the prescription is +3.125 diopters. A study using a slightly stricter definition for anisometropia (spherical equivalent) [40].

Aim of study: To assess the refractive errors and obesity.

Patients and Methods

The total number of patients in this study was 70 patients, all of whom were obese. The ages of the patients ranged from 8 to 72 years, of all genders, and all of them were from Martyr Ghazi Al-Hariri Hospital in Iraq / Baghdad.

Selection Criteria

Any patient who came to the hospital and had an obesity and was accepted to fill out the questionnaires and undergo the examination was included in the study.

Data Collection

With questionnaire, demographic data, including age, gender were collected from each patient. Patients were also asked about smoking, Height, weight and ocular examination information.

Data Analysis

Data were analyzed using SPSs statistical to determine the frequency and relationship between variables.

Measurements and instruments

- Auto refractors
- Visual acutiy
- Trial Lenses (Trial Case)
- Trial Frame
- Retinoscopy
- Pachymetry central cornea thickness (CCT)

Auto refractors

An auto refractor or automated refractor is a computer-controlled machine used during an eye examination to provide an objective measurement of a person's refractive error and prescription for glasses or contact lenses. This is achieved by measuring how light is changed as it enters a person's eye [34].

Fig 3: Auto refractive

Visual acutiy

Invented in 1862 by a Dutch was taken by Snellen chart, so the visual acuity the Snellen chart remains the most ophthalmologist named Herman Snellen, The acuity. Widespread technique in clinical practice for measuring visual Snellen chart serves as a portable tool to quickly assess monocular and binocular visual acuity. Throughout history, there have been several charts utilized by eye care professionals. The most common in clinical practice is the:

Snellen chart, The Snellen Chart uses a geometric scale to measure visual acuity, with normal vision at a distance being set at 20/20.

The numerator represents the distance that the patient is standing from the chart (in feet), while the denominator represents the distance from which a person with perfect eyesight is still able to read the smallest line that the patient can clearly visualize. For example, a patient standing 20 feet away from the chart visual who can clearly read until the line of font that a person with normal acuity can read from 40 feet away would be measured as 20/40 vision. A for testing near vision can be done using a pocket card similar assessment nine letters on about 14 inches from the patient's eyes. There are only held the chart, known as optotypes: C, D, E, F, L, O, P, T, and Z. Finally, the sizing of letters is geometrically consistent, meaning that optotypes representing 20/40 are twice the size of those representing 20/20 [35].

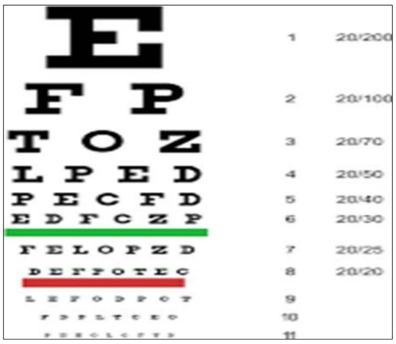

Fig 4: Snelln chart

Trial Lenses (Trial Case)

Trial lenses are used together with trial frames to determine the patient's refractive error. The set includes: lenses (spherical, cylindrical, prisms), as well as color filters and diaphragm [36].

Fig 5: Trial case

Trial Frame: A device designed for holding trial lenses before patients‘eyes; also, it enables the measurement of interpupillary distance (IPD) (Brown et al., 2019).

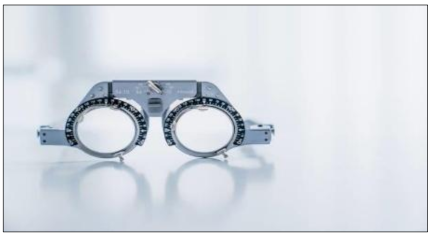

Fig 6: Trial Frame

Retinoscopy

Retinoscopy is an objective method of refraction in which the patient does not need to tell the practitioner how they see. If instead they ask the patient questions about how she/he sees, that is called subjective refraction. Retinoscopy is the use of a retinoscopy to measure a patient's refractive error [37].

patient questions about how she/he sees, that is called subjective refraction. Retinoscopy is the use of a retinoscopy to measure a patient's refractive errors [37].

Fig 7: Retinoscopy

Pachymetry central cornea thickness (CCT)

Measurement of central corneal thickness (CCT) is highly useful for both diagnostic and therapeutic assessment purposes. Accurate measurement of corneal thickness is of paramount importance for preoperative assessment and planning of all kerato refractive surgical procedure [38].

Fig 8: Pachymetry centreal corneal thickness

influenced by genetic, environmental, and lifestyle factors. While some studies show a connection between obesity and conditions like myopia, it’s also possible that maintaining a healthy weight through diet and exercise could help reduce the risk of vision problems, including refractive errors. Understanding the potential links between obesity and refractive errors is essential for promoting better eye health.

Results and Discussion

The data have been analyzed and organized statistically according to the aim of the current study (Refractive errors and obesity).

Table 1: Classification of body mass index (BMI) (Kg\m2) for study sample.

BMI(Kg\m^2)	Frequency	Percent
Obese class I (30 to 34.9)	23	32.9
Obese class II (35 to 39.9)	32	45.7
Obese class III (40 or more)	15	21.4
Total	70	100.0

The results represented in (Number and percentage %) the classifications of body mass index (BMI)(Kg\m^2) into the class I, II and III; (30 - 34.9), (35 - 39.9) and (40 or more) respectively by this shown in the table (1) and figure (9).

Table 2: Distribution the patients (n=70) according to age range (years) with body mass index BMI (Kg\m^2).

Age range (years)	BMI (Kg\m^2)			Total	P - value
	(30 - 34.9)	(35 - 39.9)	>40		
(8-22)	4(5.7%)	1(1.4%)	0(0.0%)	5(7.1%)	*0.08 non-significant N.S
(23-37)	1(1.4%)	10(14.3%)	6(8.6%)	17(24.3%)	
(38-52)	5(7.1%)	9(12.9%)	5(7.1%)	19(27.1%)	
	11(15.7%)	10(14.3%)	3(4.3%)	24(34.3%)	
>67	2(2.9%)	2(2.9%)	1(1.4%)	5(7.1%)	
Total	23(32.9%)	32(45.7%)	15(21.4%)	70(100.0%)	

The results showed the relationship between the age groups (years) with the classification of BMI (I, II, III). A1 age group (8_22), the BMI were (4(5.74%), 1(1.4%), 0(0.0%)), at age group (23_37), the BMI were (1(1.4%), 10(14.36%), 6(8.6%)), at age group (38_52), the BMI were (5(7.1%), 9(12.9%), 19(27.1%)), at age group (53_67), the BMI were (11(15.7%), 10(14.3%), 3(4.3%)). As well as the find age group was > 67 had the values (2(2.9%), 2(2.9%), 1(1.4%)) for BMI classes (I, II, III) respectively, these results were insignificant statistically at *P*-value at (0.08).

Table 3: Distribution the patients (n=70) according to gender with body mass index BMI (Kg/m^2)

Gender	BMI (kg/m^2)			Total	*P*-value
	(30-34.9)	(35-39.9)	>40		
Male	13 (18.6%)	4 (5.7%)	4 (5.7%)	21 (30.0%)	*0.002
Female	10 (14.3%)	28 (40.0%)	11 (15.7%)	49 (70.0%)	
Total	23 (32.9%)	32 (45.7%)	15(21.4%)	70 (100.0%)	

*; Highly-significant

In table (3), the results revealed the relationship between the body mass index (BMI) (Kg\m^2) with gender (n=70): males (21) and females (49) according the BMI classes: class I, II and III (13(18.6%, 4(5.7%) and 4(5.7%)) for the males, and (10(14.3%), 28(40.0%) and II (15.7%) for females respectively. The relationship was highly significant at *p*- value at 0.002.

Table 4: The relationship between body mass index (Kg/m^2) with spherical equivalent right eye.

Spherical equivalent	BMI (Kg/m^2)			Total	*P*-value
	(30-34.9)	(35-39.9)	>40		
Emmetropia	11 (30.6%)	15 (41.7%)	10 (27.8%)	36 (100%)	*0.39 *N.S
Myopia	8 (34.8%)	10 (43.5%)	5 (21.7%)	23 (100%)	
Hyperopia	4 (36.4%)	7 (63.6%)	0 (0%)	11 (100%)	
Total	23 (32.9%)	32 (45.7%)	15 (21.4%)	70 (100%)	

***N. S: Non-Significant**

The finding showed in the table (4) the relationship between the body mass index classes (I, II, III) with spherical equivalent (SE) for right eye were Emmetropia (11(34.8%), 15(41.7%) and 10(27.8%)), myopia (8(35.8%), 10(43.5%) and 5(21.7%)), hyperopia (4(36.4%), 7(63.6%) and 0(0%) respectively. The result were insignificant statistically at *p*-value (0.39).

Table 5: The relationship between body mass index (Kg/m^2) with spherical equivalent (SE) left eye.

Spherical equivalent /D	BMI (Kg/m^2)			Total	*P*-value
	(30-34.9)	(35-39.9)	>40		
Emmetropia	11 (34.4%)	14 (43.8%)	7 (21.9%)	32 (100%)	*0.95 *N. S
Myopia	7 (28%)	12 (48%)	6 (24%)	25 (100%)	
Hyperopia	5 (38.5%)	6 (46.2%)	2 (15.4%)	13 (100%)	
Total	23 (32.9%)	32 (45.7%)	15 (21.4%)	70 (100%)	

***N.S:Non-Significant**

In the table (5), the findings showed for the left eyes the relationship between the body mass index (BMI) classes (I, II, III) with spherical equivalent were for Emmetropia (11(34.4%), 14(43.8%) and 7(21.9%) myopia (7(28%), 12(48%) and 6(35%)) hyperopia (6(38.5%), 6(46.2%)and 2(15.4%)) respectively. These findings were insignificant statistically at *p*-value (0.95).

Table 6: Relationship of visual acuity (V.A) class (Best correction) with body mass index (BMI)

VA-class-Left- with glasses	BMI (Kg/m^2)			Total	*P*-value
	(30-34.9)	(35-39.9)	>40		
I= 6/6, 6/9& 6/12	18 (30.0%)	28 (46.7%)	14 (23.3%)	60 (100.0%)	0.33*
II = 6/12, 6/24	4 (57.1%)	3 (42.9%)	0 (0.0%)	7 (100.0%)	*N.S
III =6/60 >and>6/6	1 (33.3%)	1 (33.3%)	1 (33.3%)	3 (100.0%)	
Total	23 (32.9%)	32 (45.7%)	15 (21.4%)	70 (100.0%)	
VA-class-Right-with glasses	(30-34.9)	(35-39.9)	>40	Total	0.18* *N.S
I = 6/6, 6/9& 6/12	21 (32.8%)	30 (46.9%)	13 (20.3%)	64 (100.0%)	
II = 6/12, 6/24	1 (33.3%)	2 (66.7%)	0 (0.0%)	3 (100.0%)	
III = 6/60 >and>6/6	1 (33.3%)	0(0.0%)	2 (66.7%)	3 (100.0%)	
Total	23 (32.9%)	32 (45.7%)	15 (21.4%)	70 (100.0%)	

***N.S:non-significant.**

Table (6) showed the relationship between the body mass index classes (I, II, III) with levels of visual acuity (V.A) for left and right eyes for patients wearing glasses, for left eyes for (V.A) class I were (18(30.0%), 28(46.7%)&14(23.3%)), for (V.A) class II were(4(57.1%), 3(42.9%) &0(0.0%)), for (V.A) class III were (1(33.3%), 1(33.3%), &1(33.3%)) respectively at *P*-value 0.33. statistically) as well as for the right eyes V.Aclass I were (21(32.8%), 30(46.9%) & 13(20.3%), V.A class II were (1(33.3%), 2(66.7%)& 0(0.0%), V.A class III were (1(33.3%), 0(0.0%) & 2(66.7%) at *P*-value0.18 (insignificant statistically).

Table 7: Relationship of visual acuity (V.A) class (No correction) with body mass index (BMI).

VA-class-Left- without glasses	BMI (Kg/m2)			Total	*P*-value
	(30-34.9)	(35-39.9)	>40		
I	11 (28.9%)	19 (50.0%)	8 (21.1%)	38 (100.0%)	*0.94 *N.S
II	10 (37.0%)	11 (40.7%)	6 (22.2%)	27(100.0%)	
III	2 (40.0%)	2(40.0%)	1 (20.0%)	5(100.0%)	
Total	23 (32.9%)	32 (45.7%)	15(21.4%)	70(100.0%)	
VA-class-Right- without glasses	(30-34.9)	(35-39.9)	>40	Total	*0.11 *N.S
I	13 (31.7%)	19 (46.3%)	9 (22.0%)	41 (100.0%)	
II	8 (36.4%)	12 (54.5%)	2 (9.1%)	22 (100.0%)	
III	2 (28.6%)	1 (14.3%)	4 (57.1%)	7 (100.0%)	
Total	23 (32.9%)	32 (45.7%)	15 (21.4%)	70 (100.0%)	

***N.S:non-significant**

In the table (7), the results showed the relationship between the body mass index (BMI) and visual acuity classes for right and left eyes without glasses. These results for the left eyes, the V.A class I were (11(28.9%), 19 (50.0%)& 8(21.1%)) the V.A class II were (10(37.0%), 11(40.4%) & 6(22.2%)) and the V.A class III were (2(40.0%), 2(40.0%)&1(20.0) respectively. these were insignificant at *p*-value (0.94) as well as for the right eyes the V. A class I were (13(31.7%), 19(46.3%) & 9(22%) c lass II were (8(36.4%), 12(54.5%)&2(9.1%) and class III were (2(28.6%), 1(14.3%), 4(57.1%) respectively. They were insignificant at *p*-value (0.11).

Table 8: Relationship between the body mass index (BMI) (kg/m2) and corneal central thickness (CCT/µm) for left and right eyes.

Corneal central thickness(CCT)		BMI / kg/m^2			*P*- value
		Class I	Class II	Class III	
Left eye	No.	23	32	15	*0.5 NS
	mean	518.17	513.12	491.20	
	Std. deviation	38.41	39.43	138.96	
Right eye	No.	23	32	15	*0.3 NS
	mean	513.04	519	531	
	Std. deviation	37.82	34.68	33.25	

***N.S: non-significant**

In the table (8), the results showed the relationship between the body mass index (BMI)with the cornel central thickness (CCT) levels that represented (no., mean & std. deviation) for CCT levels the right and left eyes. For the left eyes the CCT were for the BMI_class I were (23, 518.17±38) class II were (32, 513.12±39.34) class III were (15, 491.20±138.96), the results were insignificant statistically at *p*-value (0.5). as well as for right eyes; class I (23, 513.04±37.82) the CCT were class II (32, 519±34.68) class III (15, 531±33.25) *P*-value at (0.3) was insignificant statistically.

Discussion

This study aimed to explore the relationship between Body Mass Index (BMI) and several ophthalmic and demographic parameters in a sample of 70 patients. The distribution of patients across BMI categories (Class I, II, and III obesity) revealed that the majority fell within Class II obesity (45.7%), followed by Class I (32.9%) and Class III (21.4%). In table (2) Although age appeared to vary across BMI categories, the difference was not statistically significant (p=0.08). Most of the patients were within the 53-67 age group, indicating a tendency for higher BMI values among older adults. However, the lack of significance may suggest that age alone is not a strong determinant of BMI in this cohort. In table (3) A highly significant association was observed between sex and BMI (p=0.002). Females were more represented in the higher BMI classes, particularly in Class II and III. This aligns with existing literature that often reports higher obesity prevalence among females due to physiological, hormonal, and lifestyle factors.in table (4) and (5) The association between BMI and spherical equivalent (SE) in both right and left directions was statistically non-significant (p=0.39 and p=0.95, respectively). While emmetropia was most common in each BMI category, hyperopia was absent in Class III BMI in the right eye, and only slightly represented in the left. This may suggest minimal or no influence of BMI on refractive status. Table (6) and (8) visual acuity classifications (with and without correction) did not show significant associations with BMI across both eyes. The majority of patients, regardless of BMI, fell into Class I VA, indicating relatively preserved vision. However, patients with Class III obesity had a slightly higher presence in VA Class III, especially without correction, which may warrant further investigation.in table (8) Central Corneal Thickness (CCT) in both eyes showed no significant difference among BMI groups (p=0.5 for left eye, p=0.3 for right eye). Although mean CCT was lower in class III obesity for the left eye and higher in the right eye, the high standard deviation in this group weakens any possible conclusion. This variability might reflect individual differences unrelated to BMI.

Conclusion

In this research, we examined the effect of obesity on refractive errors.

Through our study of this research, we found that patients who were examined were obese, class (I)32.9%, Class (II), 45.7%, and Class III.

21.4% of women and men and class (II) is the highest percentage in our studies who have refractive errors, and we recommend that people in general and patients who have refractive errors and are especially obese by sticking to a healthy diet and sticking to a continuous examination Wearing eyeglasses.

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