Original Article

Refractive Errors, Corneal Power, and Far and Near Visual Acuity in Cancer Patients

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Abstract

Purpose: To determine visual acuity, central and peripheral corneal power, and the prevalence of refractive errors in cancer patients from Imam Hossein Medical Center, Tehran, Iran.
Patients and Methods: In this cross-sectional, population-based study, cancer patients were examined for far and near visual acuity (VA), refractive errors, central and peripheral corneal power, and near addition. Data analysis was performed using SPSS version 22 software.
Results: Data were collected from 330 eyes of 165 patients. The mean age was 54.26 ± 13.39 years (range: 18-86 years). The prevalence of hyperopia, myopia, and astigmatism was 30.3 % (95 % confidence interval [CI]: 25.5-35.5 %), 27 % (95 % CI: 22.1-31.8 %), and 80.3 % (95 % CI: 76.1-84.5 %), respectively. The mean uncorrected and corrected distance visual acuity (VA) was 0.29 ± 0.36 logMAR (95 % CI: 0.25-0.33) and 0.07 ± 0.21 logMAR (95 % CI: 0.05-0.09), respectively. The mean uncorrected and corrected near VA was 0.51 ± 0.32 logMAR (95 % CI: 0.47-0.54) and 0.04 ± 0.19 logMAR (95 % CI: 0.017-0.06), respectively. The mean near addition was 1.73 ± 0.93 D (95 % CI: 1.63-1.84). The mean central and peripheral keratometry values were 44.20 ± 1.54 D (95 % CI: 44.03-44.37) and 44.17 ± 1.50 D (95 % CI: 44.00–44.34).
Conclusion: The prevalence of refractive errors in this study was higher than in most previous reports and increased significantly with age. Based on our results astigmatism was the most common refractive error in cancer patients, followed by hyperopia and myopia.

Keywords: Refractive Error; Visual Acuity; Cancer; Keratometry.

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Introduction

Cancer refers to a large group of diseases characterized by the uncontrolled proliferation of abnormal cells that can spread to various organs in almost any part of the body [1]. Due to multiple factors, the prevalence and incidence of cancer, along with related mortality rates, are rapidly increasing worldwide [2-6]. The most common types of cancer are lung, prostate, and stomach cancers in men and breast, lung, and cervical cancers in women [5,7]. Given the high prevalence of cancer risk factors in Iran, the incidence of cancer in the country is expected to rise in the near future [8].

A significant portion of human perception of the surrounding world is obtained through the visual system [9]. Uncorrected refractive errors are among the leading causes of visual impairment and blindness. Although these errors are easily corrected, they remain a serious issue in many countries, affecting approximately 50 % of both children and adults [10-12]. These errors impact patients' quality of life from functional, psychosomatic, and aesthetic perspectives, in addition to imposing financial burdens [13]. Refractive errors are among the top four non-fatal causes (out of 20) of disability-adjusted life years (DALYs) [14], contributing to the loss of 44.8 years of healthy life per 100,000 people worldwide, with an increasing trend [15-17].

Near vision impairment is generally observed in individuals aged 50 years or older or in those who have undergone cataract surgery. This condition diminishes a person's ability to perform tasks such as reading and can result from refractive errors, aging, diseases, or medications [18].

The aim of this study was to determine the prevalence of visual impairment and refractive errors including myopia, hyperopia, astigmatism, and presbyopia among Iranian cancer patients.

Patients and Methods

This cross-sectional study was conducted in 2019 on 330 eyes of 165 cancer patients whose diagnoses were confirmed by a radio-oncologist. These patients were referred to the chemotherapy department of Imam Hossein (AS) Hospital in Tehran, Iran for the first time. The ethics committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran, approved the study protocol (ethics code: IR.SBMU.RETECH.REC.1397.1006). Informed consent was obtained from all participants, and the study adhered to the ethical guidelines outlined in the Declaration of Helsinki.

Participation in the study was voluntary, and patients were invited to join if they were willing to participate and were diagnosed with cancer. Regardless of the type of cancer, eligible volunteers were evaluated before starting systemic chemotherapy for distance and near visual acuity, refractive errors, central and peripheral corneal power, axis of astigmatism, and near addition. Eligibility criteria included having a diagnosis of cancer other than eye cancer, being in good general health (Eastern Cooperative Oncology Group Performance Status [ECOG PS]: 0-1), and being at least 18 years old.

Testing Protocols

Refractive errors and central and peripheral keratometry were measured using an auto kerato-refractometer (CHAROPS, CRK-9000), and refractive errors were confirmed through manual retinoscopy (Heine, Beta200). The best correction was determined based on both objective and subjective refraction. Refraction was assessed using a non-cycloplegic method, with three measurements taken for each eye.

The spherical equivalent was calculated as sphere power plus half of the cylinder power and was used to classify refractive errors. Myopia was defined as ≤ - 0.5 D, hyperopia as ≥ + 0.5 D, and emmetropia as between - 0.5 D and + 0.5 D. Astigmatism was considered present if the cylindrical power exceeded -0.25 D.

Astigmatism orientation was classified as against-the-rule (ATR) if it fell between 60 and 120 degrees (90 ± 30), with-the-rule (WTR) if it ranged from 150 to 30 degrees (180 ± 30), and oblique for all other orientations.

For visual acuity assessment, both corrected and uncorrected visual acuities were measured monocularly and subjectively under normal room lighting. Distance visual acuity was assessed using a Snellen chart designed for a four-meter distance and recorded in logMAR format. The final visual acuity was determined by the smallest line the patient could read. Near vision was tested at a distance of 40 cm using a Snellen near chart, with and without plus lenses, and the results were recorded in logMAR. The minimum spherical plus lens required correcting and complete near vision was recorded as near addition.

We used an auto kerato-refractometer to measure the corneal curvature radius and power in the central 3 mm of the cornea. It provided automatic keratometry readings by emitting light toward the cornea and analyzing the reflected images. The measured distance was then converted into the steepest and flattest meridians using convergence functions, with results recorded in diopters and millimeters.

To prevent potential drug interactions and adhere to ethical principles, no pharmaceutical interventions, such as cycloplegics or mydriatics, were used. All assessments were conducted while the patient was in a seated position.

Statistical Analysis

Data analysis was performed using SPSS version 22.0 (IBM Inc., Chicago, Illinois, USA). The distribution of data was assessed using the Kolmogorov-Smirnov test, which indicated that some variables did not follow a normal distribution. For inferential analysis, one-way analysis of variance (ANOVA) and Pearson correlation were used for normally distributed data, while their non-parametric equivalents, including the Kruskal-Wallis H test, Chi-square test, and correlation coefficients, were applied to non-normally distributed data. A P-value of less than 0.05 was considered statistically significant.

Results

Data were collected from 330 eyes of 165 cancer patients, of whom 55.2 % (n = 91) were female and 44.8 % (n = 74) were male. The mean age of the participants was 54.26 ± 13.39 years (range: 18–86 years). The majority of participants (25.5 %) were in the 50 to 60-year age group, while the lowest frequency was observed in the 80 to 90-year age group (1.2 %). Overall, 86.1 % (n = 142) of the patients were aged over 40 years.

Gastrointestinal cancer was the most common type, accounting for 36.4 % of cases, followed by breast cancer (15.2 %). Among women, breast cancer was the most prevalent (27.47 %), whereas colon cancer was the most frequent diagnosis among men (18.92 %). In patients under 40 years old, breast cancer was the most common type (20.83 %), while colon cancer was the most frequent diagnosis in patients over 40 years old (22.97 %).

Regarding comorbidities, 58.2 % of the patients (n = 192) had no underlying diseases other than cancer. Diabetes, hypertension, and hyperlipidemia were present in 15 %, 16.8 %, and 15.7 % of the patients, respectively.

The prevalence of hyperopia was 30.3 % (100 eyes) (95 % CI: 25.5-35.5 %), while myopia was present in 27 % (89 eyes) (95 % CI: 22.1-31.8 %). The mean values of central keratometry (Mean-K) and peripheral keratometry (Mean-k) were significantly higher in females ($P < 0.001$).

There was a significant relationship between age and sphere, spherical equivalent, distance visual acuity, near addition, and uncorrected near visual acuity (Table 1). Among the measured variables, the highest correlation coefficients with age were observed for near addition ($r = 0.888$, $P = 0.001$) and uncorrected near vision ($r = 0.615$, $P = 0.001$) (Table 1).

Among the participants, 27 % (89 eyes) had myopic eyes, 30.3 % (100 eyes) had hyperopic eyes, and 42.7 % (141 eyes) had emmetropic eyes. Among females, 31.32 % hypertropia and 27.47 % had myopia, while among males, 29.05 % had hyperopia and 26.35 % myopia.

The respective prevalence of myopic, hyperopic, and emmetropic eyes in patients over 40 years old was 24.3 % (69 eyes), 34.16 % (97 eyes), and 41.55 % (118 eyes), whereas in those younger than 40 years, the prevalence was 43.48 % (20 eyes), 6.52 % (3 eyes), and 50 % (23 eyes), respectively. The average astigmatic power was significantly higher in males than in females ($P = 0.026$). Regarding the mean spherical equivalent, myopia was observed across all age groups except in the 50 to 60-year age group.

Astigmatism above -0.25 D was found in 80.3 % (265 eyes) of participants, with 55.09 % (146 eyes) being female and 44.91 % (119 eyes) being male. Additionally, 19.7 % (65 eyes) of patients had astigmatism equal to or less than -0.25 D. Among those with astigmatism, 87.55 % (232 eyes) were over 40 years old. The prevalence of astigmatism was 71.74 % (33 eyes) in patients younger than 40 years and 81.69 % (232 eyes) in those older than 40 years. Astigmatism was observed in 76.04 % of participants without any underlying disease. Notably, all patients with concomitant diabetes had astigmatism, and 83.26 % of patients with comorbidities also had astigmatism.

Regarding the types of astigmatism, 36.4 % (120 eyes) of participants had with-the-rule (WTR) astigmatism (180 ± 30 degrees), 44.2 % (146 eyes) had against-the-rule (ATR) astigmatism (30 ± 90 degrees), and 19.4 % (64 eyes) had oblique astigmatism. Among participants younger than 40 years with astigmatism, 65.21 % (30 eyes) had WTR, 8.7 % (4 eyes) had ATR, and 26.09 % (12 eyes) had oblique astigmatism. In participants older than 40 years, these values were 31.69 % (90 eyes), 50 % (142 eyes), and 18.31 % (52 eyes), respectively (Figure 1).

Among females with astigmatism, 42.31 % had WTR, 39.56 % had ATR, and 18.13 % had oblique astigmatism, while among males, these values were 29.05 %, 50 %, and 20.95 %, respectively.

The relationship between the types of refractive errors and other variables was significant, except for keratometry (Table 2).

In individuals without comorbidities, the mean central keratometry was 44.09 ± 1.57 (181 eyes), while the mean peripheral keratometry was 44.07 ± 1.52 (177 eyes).

The correlation between age group and both near addition and uncorrected near vision was significant and positive (Table 3). The average keratometry reading in individuals over 40 years was slightly higher than in those under 40 years; however, this difference was not statistically significant (Table 3).

The correlation between central and peripheral keratometry and gender was significant (Table 4). The correlation between the average near addition, cylinder, and central and peripheral keratometry readings with gender was also significant (Table 4). Additionally, the correlation between mean keratometry values and gender was significant and inverse (Table 4).

Table 1: Patients' visual acuity, keratometric, and refractive characteristics

Variable	Mean ± SD	Range	95 % CI		Pearson Correlation with Age		* P value	
			Lower	Upper	r	P value	Age	Gender
SPH (D)	0.34 ± 1.64	-7.50 to +10.50	0.17	0.52	0.203	< 0.001	< 0.001	0.786
CYL (D)	-0.86 ± 0.66	-4.00 to 0.00	- 0.94	- 0.79	- 0.223	< 0.001	< 0.001	0.026
SE (D)	-0.09 ± 1.73	-8.13to +10.50	- 0.28	0.99	0.149	0.007	< 0.001	0.709
AXIS	79.66 ± 52.32	0 to 180	73.88	85.67	0.114	0.039	0.704	0.395
UDVA (logMAR)	0.29 ± 0.36	0.00 to 2.00	0.24	0.32	0.128	0.021	< 0.001	0.437
BCVA (logMAR)	0.07 ± 0.21	0.00 to 2.00	0.05	0.09	.244	< 0.001	< 0.001	0.802
UNVA (logMAR)	0.51 ± 0.32	0.00 to 2.00	0.47	0.54	.615	< 0.001	< 0.001	0.193
CNVA (logMAR)	0.04 ± 0.19	0.00 to 2.00	0.015	0.051	.112	.043	0.055	0.749
Add (D)	1.73 ± 0.93	0.00 to 3.25	1.64	1.84	0.888	< 0.001	< 0.001	0.013
CKRm (D)	44.20 ± 1.54	39.75 to 49.88	44.03	44.38	0.029	0.607	< 0.001	< 0.001
Kf (D)	43.73 ± 1.57	39.25 to 48.75	43.55	43.91	0.043	0.443	< 0.001	0.006
Ks (D)	44.68 ± 1.59	40.00 to 51.50	44.50	44.86	0.014	0.811	< 0.001	< 0.001
PKRm (D)	44.17 ± 1.50	39.75 to 47.75	43.99	44.34	0.062	0.278	< 0.001	< 0.001
PKf (D)	43.72 ± 1.54	39.50 to 47.50	43.53	43.88	0.096	0.092	< 0.001	0.008
PKs (D)	44.62 ± 1.53	40.00 to 48.00	44.44	44.78	0.024	0.672	< 0.001	< 0.001

D: diopter; SPH: sphere power (D); SE: spherical equivalent (D); SD: standard deviation; CYL: cylinder power (D); Add: addition power (D); UDVA: uncorrected distance visual acuity; BCVA: best-corrected visual acuity; UNVA: uncorrected near visual acuity; CNVA: corrected near visual acuity; $_{CKRm}$: central mean keratometry; $_{PKRm}$: peripheral K-Reading ; Kf: K-reading, flat meridian (D); Ks: K-reading, steep meridian; logMar: logarithm of the minimum angle of resolution. PKf: peripheral K-reading, flat meridian; PKs: K-reading, steep meridian.

* Kruskal Wallis Test or ANOVA

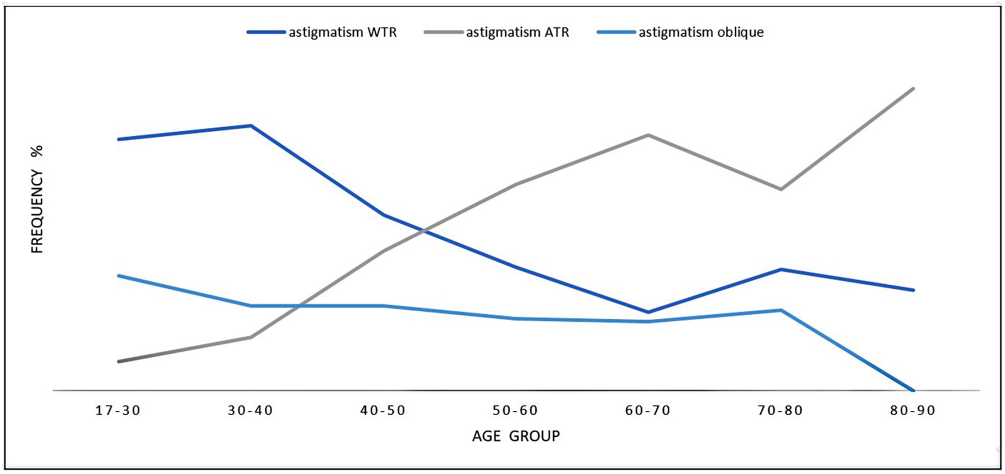

Figure 1: Frequency of different astigmatism orientations among patients by age group (ATR: against-the-rule, WTR: with-the-rule, O: oblique)

Table 2: Patients' visual acuity, keratometric and refractive characteristics according to refractive errors

Refractive Errors	Parameter										
	Measurment	SPH	CYL	SE	Add	CKR	PKR	UDVA	BCVA	UNVA	CNVA
Myopia	Mean ± SD	- 1.09 ± 1.64	- 1.35 ± 0.77	- 1.77 ± 1.66	1.59 ± 1.11	44.38 ± 1.46	44.39 ±1.52	0.53 ± 0.44	0.107 ± 0.29	0.47± 0.39	0.06 ± 0.25
	Range	-7.50 to + 0.75	- 4.00 to 0.00	-8.13 to - 0.50	0.00 to 3.25	40.38 to 47.13	40.50 to 47.13	0.00 to 2.00	0..00 to 2.00	0.00 to 2.00	0.00 to 2.00
	95 % CI	- 1.44 to 0.75	– 1.51 to – 1.19	2.11 to - 1.42	1.36 to 1.83	44.07 to 44.69	44.06 to 44.72	0.43 - 0.62	0.05-.17	0.38 to 0.55	0.01 to 0.11
Hyperopia	Mean ± SD	1.70 ± 1.64	-.64 ± 0.53	1.37 ± 1.67	2.07 ± 0.59	44.10 ± 1.45	44.14 ± 1.34	0.32 ± 0.32	0.09 ± 0.24	0.61 ± 0.26	0.05 ± 0.23
	Range	0.50 to + 10.50	- 2.25 to 0.00	0.50 to +10.50	0.00 to 3.25	40.88 to 49.38	40.88 to 46.63	0.00 to 1.60	0.00 to 1.33	0.00 to 1.60	0.00 to 1.33
	95 % CI	1.37 to 2.02	- 0.75 to - 0.54	1.04 - 1.71	1.95 to 2.19	43.81 to 44.39	43.86 to 4.41	0.25 to 0.38	0.044 to 0.14	0.56 to 0.67	0.01 – 0.10
Emmetropia	Mean ± SD	0.29 ± 0.33	-0.71 ± 0.51	- .07± .23	1.59 ± .95	44.16 ± 1.65	44.05 ± 1.58	0.11 ± 0.21	0.03 ± 0.11	0.46 ± 0.30	0.01 ± 0.07
	Range	-. 25 to + 1.50	- 3.25 to 0.00	- 0.38 to 0.38	0.00 to 3.00	39.75 to 49.88	39.75 to 47.75	0.00 to 1.60	0.00 to 1.03	0.00 to 1 .33	0.00 to 0.70
	95 % CI	0.23 to 0.34	- 0.80 to -0.63	- 0.11 to - 0.03	1.43 - 1.75	43.8 to 44.44	43.77- to 4.32	0.08 - 0.15	0.013 to 0.05	0.42 to 0.51	-0.002 to 0.02
*P value		< 0.001	< 0.001	< 0.001	0.003	0.476	0.394	< 0.001	< 0 .001	< 0.001	0.002

SPH: Sphere power (D); SE: spherical equivalent (D); SD: standard deviation; CYL: cylinder power (D); Add: addition power (D); UDVA: uncorrected distance visual acuity; BCVA: best-corrected visual acuity; UNVA: uncorrected near visual acuity; CNVA: corrected near visual acuity; D = diopter; CKR: central mean keratometry; PKR: peripheral mean keratometry

* Kruskal Wallis Test or ANOVA

Table 3: Patients' Vision, keratometric and refractive characteristics by age groups

Age group (Years)	Measurement	Parameter									
		SPH (D)	CYL (D)	SE (D)	Add	UDVA	BCVA	UNVA	CNVA	CKR	PKR
< 40	Mean ± SD	- 0.86 ± 2.02	- 0.77 ± 0.71	- 1.24 ± 2.12	0.00 ± 0.00	0.31 ± 0.50	0.00 to 0.00	0.00 to 0.00	0.00 to 0.00	43.88 ± 1.52	43.80 ± 1.44
	Range	- 7.50 to 0.75	- 3.00 to 0.00	- 8.13 to 0.75	0.00 to 0.00	0.00 to 1.60	0.00 to 0.00	0.00 to 0.00	0.00 to 0.00	41.38 to 47.25	41.38 to 47.13
	95 % CI	- 1.4 6to -0.26	- 0.98 to -0.55	- 1.87 to -0.61	0.00 to 0.00	0.161 to 0.457	0.00 to 0.00	0.00 to 0.00	0.00 to 0.00	43.40 to 44.37	43.35 to 44.25
> 40	Mean ± SD	0.54 ± 1.49	- 0.88 ± 0.66	0.099 ± 1.59	2.02 ± 0.66	0.28 ± 0.33	0.08 ± 0.23	0.59 ± 0.26	.04±.202	44.25 ± 1.54	44.23 ± 1.50
	Range	- 4.25 to 10.50	- 4.00 to 0.00	-6.00 to 10.50	0.00 to 3.25	0.00 to 2.00	0.00 to 2.00	0.00 to 2.00	0.00 to 2.00	39.75 to 49.88	39.75 to 47.75
	95 % CI	0.37 to 0.71	- 0.96 to -0.80	-0.09 to 0.28	1.94 to 2.10	0.24 to 0.32	0.06 to 0.11	0.56 to 0.62	0.02 to 0.07	44.07 to 44.43	44.05 to 44.41
*P value		< 0.001	0.105	< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.018	0.159	0.052
Pearson	Correlation	0.295	- 0.059	0.268	0.755	- 0.026	0.133	0.643**	0.079	0.080	0.099
	P-value	< 0.001	0.288	< 0.001	< 0.001	0.642	0.016	0.000	0.151	0.159	0.084

D: diopter; SPH: sphere power (D); SE: spherical equivalent (D); SD: standard deviation; CYL: cylinder power (D); Add: addition power (D); UDVA: uncorrected distance visual acuity; BCVA: best corrected visual acuity; UNVA: uncorrected near visual acuity; CNVA: corrected near visual acuity; CKR: central mean keratometry; PKR: peripheral mean keratometry
* Kruskal Wallis Test or ANOVA

Table 4: Patients' visual acuity, keratometric and refractive characteristics by gender

Gender	Measurement	Parameter									
		SPH	CYL	SE	Add	UNVA	CNVA	UDVA	BCVA	CKR	PKR
Female	Mean ± SD	0.41 ± 1.91	-0.79 ± 0.61	.01±1.99	1.64 ±.91	0.50 ± 0.33	0.04 ± 0.198	0.30 ± 0.38	0.08 ± 0.23	44.46 ± 1.61	44.42 ± 1.50
	Range	-7.50 to 10.50	-3.25 to 0.00	-8.13 to 10.50	0..00 to 3.25	0.00 to 1.60	0.00 to 1.33	0.00 to 1.80	0.00 to 1.60	40.38 to 49.88	40.50 to 47.75
	95 % CI	0.126 to 0.69	-0.88 to 0.70	-0.28 to .30	1.51 to 1.78	0.45 to 0.55	0.014 to 0.07	0.25 to 0.36	0.045 to 0.111	44.22 to 44.70	44.19 to 44.64
Male	Mean ± SD	0.27 ± 1.23	- 0.95 ± 0.72	-0.21 ± 1.35	1.84 ±.95	0.52 ± 0.30	0.03 ± 0.176	0.27 ± 0.342	0.06 ± 0.20	43.87 ± 1.38	43.85 ± 1.43
	Range	- 6.00 to 3.25	-4.00 to 0.00	- 6.25 to 2.13	0.00 to 3.25	0.00 to 2.00	0.00 to 2.00	0.00 to2.00	0.00 to2.00	39.75 to 46.88	39.75 to 47.13
	95 % CI	0.07 to 0.47	- 1.07 to -0.84	- 0.43 to 0.01	1.69 to 1.998	0.47 to 0.57	0.002 to 0.06	0.21to 0.32	0.03 to 0.09	43.64 to 44.10	43.61 to 44.09
p-value*		0.786	0.026	0.709	0.013	0.193	0.749	0.437	0.802	0.001	0.001
Pearson	Correlation	- 0.042	- 0.122	- 0.063	0.109	0.033	- 0.033	- 0.048	- 0.040	- 0.189	- 0.188
	P value	0.447	0.026	0.253	0.049	0.557	0.553	0.388	0.468	0.001	0.001

D: diopter; SPH: sphere power (D); SE: spherical equivalent (D); SD: standard deviation; CYL: cylinder power (D); Add: addition power (D); UDVA: uncorrected distance visual acuity; BCVA: best corrected visual acuity; UNVA: uncorrected near visual acuity; CNVA: corrected near visual acuity; CKR: Central Mean keratometry; PKR: Peripheral mean keratometry.
* Kruskal Wallis Test or ANOVA

Discussion

Based on the mean values of refractive errors, addition power, and visual acuity, the overall visual function among cancer patients was found to be acceptable, with no serious disability encountered. Far vision (both with and without correction) and corrected near vision were better in females, whereas near vision impairment was more common in males, who required a higher near addition power. Incomplete vision correction was mainly observed in patients over 40 years old, likely due to age-related structural changes in the eye.

The frequency of hyperopia was slightly higher than that of myopia, which could be attributed to the broad age range of the participants. Overall, refractive errors were more prevalent than emmetropia. Refractive errors are among the most common ocular conditions and can occur across all age groups. Studies have shown that they are the leading cause of vision problems, accounting for 43 % of vision disorders and the second leading cause of blindness worldwide [19-22]. In this study, no significant difference in the frequency of refractive errors was observed between males and females, though males were found to be more frequently emmetropic. Male patients tended to have a higher prevalence of myopia, while hyperopia was more common in females. Previous reports suggest that myopia is associated with factors such as genetics, male gender, higher education levels, prolonged near work, and environmental influences, whereas hyperopia is linked to aging, female gender, genetic predisposition, structural changes in the lens, and lower education levels [11]. The lower prevalence of myopia compared to hyperopia in this study may be related to the age distribution of the participants.

Overall, 27 % of eyes in this study were myopic, a rate comparable to global estimates. Among participants younger than 40 years, myopia was present in 43.5 %, which is higher than global reports [23, 24]. In 2010, approximately 28 % of the world's population was affected by myopia, a figure projected to rise to 34 % by 2020 and 50 % by 2050 [25]. Consistent with previous studies, the prevalence of myopia was higher in individuals under 40 years compared to those over 40. Myopia is the most common refractive error worldwide [23], and in this study, it was observed across all age groups except for the 50 to 60-year age group.

Astigmatism is one of the most common refractive errors [26-28]. In this study, its prevalence was higher than that of other refractive errors and exceeded global estimates. Some studies have reported astigmatism rates as high as 75 % [26, 29]. A high proportion of participants had astigmatism, which was more common in individuals over 40 years of age and in men. Previous studies suggest that aging influences astigmatism patterns differently in men and women, likely due to a decline in sex hormone levels, which contributes to gender-related corneal structural changes with age [27, 30].

The prevalence of astigmatism varies by age and geographic region [26, 28, 31-33]. In this study, astigmatism was present in 76.04 % of participants without comorbidities, suggesting that systemic diseases may not play a substantial role in its development. However, all diabetic patients in this study had astigmatism. After hyperopia and myopia, astigmatism is the third most common refractive error in both children and adults [19].

In this study, ATR astigmatism was the most common type, although the prevalence of WTR astigmatism increased with age. The lowest prevalence was observed for oblique astigmatism, which aligns with its frequency in the general population. Previous reports

indicate that WTR astigmatism is the most common type, while oblique astigmatism is the least frequent [26, 30, 33, 34]. In this study, WTR astigmatism was more common in individuals under 40 years old, whereas ATR astigmatism was more prevalent in those over 40. Among patients younger than 40 years, ATR astigmatism had the lowest prevalence, whereas in those older than 40, oblique astigmatism was the least common. Notably, in individuals under 40, oblique astigmatism was more frequent than ATR astigmatism. The prevalence of WTR astigmatism typically decreases with age, while ATR astigmatism tends to increase [34, 35]. In the present study, WTR astigmatism was more common in women, whereas ATR astigmatism was more frequent in men, consistent with previous findings that older men are more likely to develop ATR astigmatism than women [27, 30].

As expected, near vision deteriorated in participants older than 40 years. The mean addition power in the 30 to 40-year age group was below 0.25 D, which was negligible. However, this value increased with age, with an additional 0.5 D required for every 10-year interval. Presbyopia and manifest hyperopia are the two primary causes of vision problems in older individuals [35, 36]. Presbyopia and latent hyperopia typically develop gradually, particularly around the age of 40 [35, 36]. In this study, the required near addition power was higher in male patients and in individuals with hyperopia. Overall, the near addition requirement was similar between emmetropic and myopic eyes.

Among the participants, gastrointestinal and breast tumors were the most common cancers. Breast cancer is the most prevalent malignancy worldwide and the leading cause of cancer-related deaths in women [36, 37]. Among our study participants, it was the second most common cancer overall but the most frequent among women and individuals under 40 years old. According to GLOBOCAN reports, breast cancer accounted for 11.7 % of all cancers in 2020, making it the most frequently diagnosed cancer globally [37, 38].

Central and peripheral keratometry values were slightly higher in myopic eyes compared to hyperopic and emmetropic eyes, consistent with previous studies. The values for central and peripheral keratometry were similar in emmetropic and hyperopic eyes, though peripheral keratometry was lower than central keratometry in emmetropic eyes. Overall, keratometric power in cancer patients was slightly higher than in the general population [38, 39]. The mean values of central and peripheral keratometry were higher in patients older than 40 years than in those under 40. Additionally, both central and peripheral keratometry values were higher in women than in men. Previous studies suggest that the cornea tends to be flatter in older men compared to older women, and corneal irregularity increases with age [27, 30]. Furthermore, females generally have steeper corneas than males [38, 39].

Some limitations of this study include the following: due to the age range (>17 years) and to avoid potential drug toxicity, non-cycloplegic refraction was chosen. Additionally, there was no available history of the patients' ocular condition before their cancer diagnosis. Moreover, many patients were unwilling to undergo an examination due to their overall health and psychological condition.

Conclusion

The prevalence of refractive errors in this study was higher than in most previous reports

and increased significantly with age. Based on our results astigmatism was the most common refractive error in cancer patients, followed by hyperopia and myopia. More comprehensive studies are needed to further investigate these findings.

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Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of the present manuscript.