

# The prevalence of refractive errors among Saudi adults in Riyadh, Saudi Arabia

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## Abstract:

**PURPOSE:** To determine the prevalence of refractive errors among Saudi adults in Riyadh, Saudi Arabia.

**METHODS:** A cross-sectional study was conducted targeting healthy Saudi adults (20–40 years old) at two major gatherings in Riyadh, Saudi Arabia from December 2018 to January 2019. Refractive errors were measured, and data pertaining to age, sex, region of origin, and spectacle use was collected. Clinically significant myopia was defined as SE  $\geq$  -0.50 D, hyperopia as SE  $\geq$  0.50D, and astigmatism as cylindrical error  $\geq$  0.50D. Refractive error measurements were assessed using Topcon's Auto-Kerato-Refractometer, KR-800.

**RESULTS:** A total of 660 adult individuals (1,319 eyes) were included in this study, of which 321 participants (48.7%) were found to be myopes, 167 subjects (25.2%) were hyperopes, and 438 individuals (66.3%) had astigmatism. With regards to correlations, myopia was highly correlated with being male ( $P$ -value = 0.036), belonging to age group 20–25 years ( $P$ -value = 0.033), originating from the northern regions of Saudi Arabia ( $P$ -value < 0.001). Similarly, hyperopia was significantly correlated with being male ( $P$ -value = 0.048), age groups 20–25 years ( $P$ -value = 0.04), and 31–35 years ( $P$ -value = 0.011) and was higher in people from northern region ( $P$ -value = 0.011). In contrast, astigmatism was only found to be correlated with age group 36–40 years ( $P$ -value = 0.002). Additionally, 71.7% of myopic participants and 76.1% of astigmatic individuals opted not to wear spectacles ( $P$ -value < 0.001).

**CONCLUSION:** In this study, the refractive error with the highest prevalence among Saudis was astigmatism, followed by myopia and hyperopia. Gender, region of origin, and spectacle wear were all observed to be highly correlated with higher rates of refractive error.

## Keywords:

Astigmatism, auto-kerato-refractometer, hyperopia, myopia, refractive errors

## INTRODUCTION

Globally, uncorrected refractive errors (such as myopia, hyperopia, presbyopia, and astigmatism) is thought to be the second most leading cause of blindness<sup>[1]</sup>. It is estimated that over 108 million individuals worldwide are affected by uncorrected refractive errors<sup>[2]</sup>.

Many studies have estimated and documented the prevalence of refractive errors across different settings, regions, and healthcare systems. For instance, studies have demonstrated that the prevalence of myopia among adults to be 14.9% in Taiwan, 41.8% in Japan, 33.1% in the United

States, 30% in Canada, 48.1% in Indonesia, 22.9% in China, 34.6% in India, 36.5% in Pakistan, and 28.6% in Singapore<sup>[3-7]</sup>.

However, with regards to Saudi Arabia, very few studies have been conducted that accurately estimate the prevalence of refractive errors. Moreover, most of these studies were hospital-based and focused on children and adolescents as their target population. For instance, a study by Dr. Rowaily demonstrated that in preschool children attending King Abdul-Aziz medical city, 2.5% of children had myopia, 2.5% had astigmatism, and 2.1% had hyperopia<sup>[8]</sup>. Similarly, another study found that 4.5% of primary school Saudi children experienced myopia, 1.5% had hyperopia, and 6.5% had astigmatism<sup>[9]</sup>. However, data is minimal with

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regards to studies pertaining to the prevalence of refractive errors among adults in Saudi Arabia. Therefore, realizing the paucity of data on adults, in this study we aimed to assess the prevalence of refractive errors in adults in Riyadh.

## METHODS

### Design and setting

This was a descriptive, cross-sectional study aimed to estimate the prevalence of refractive errors amongst adults in Riyadh, Saudi Arabia. Currently, Riyadh serves as the capital city of Saudi Arabia, and is also the largest city in the country with a population of approximately seven million.

In order to accomplish our objectives, we sought to question Saudi adults during two gatherings that took place in Riyadh city from November 13<sup>th</sup>, 2018 - January 10<sup>th</sup>, 2019. The first data collection was done at Alhamra mall, whereas the second data collection was conducted at Aljenadriah festival, a 21-day festival that involves approximately 20,000 participants each day.

In this study, clinically significant myopia was defined as a spherical equivalent (SE) of  $\leq -0.50D$ , whereas hyperopia was defined as  $SE > 0.50D$  and astigmatism was defined as  $SE = 0.50D$ . Emmetropia was defined as  $SE < -0.5$  to  $< +0.50D$ .

### Participants

All Saudis between the ages of 20 to 40 years without any prior history of ocular diseases or procedures were eligible to be included in this study. Subjects from non-Saudi origins, keratoconus patients, patients with a history of any prior ocular intervention, or participants wearing contact lenses within the past two weeks of data collection, were examined but deemed ineligible for inclusion in this study. Assuming the population of Saudi adults between the ages of 20–40 in Riyadh are 1,656,711 according to the latest estimation by the general authority of statistics (2017) and with a confidence interval of 95% and a margin of error of 5% a minimum of 385 participants is needed.

Demographics data, such as age, gender, region, and history of ocular disease, among others, was obtained from the participants using paper collection sheets. All participants signed an ethical consent that was approved by the research ethics committee at King Abdullah International Medical Research Center (KAIMRC) in Riyadh. Trained physicians, residents, and medical students were involved with the data collection and sampling.

### Instrument

Refractive error, central corneal thickness measurement, spherical power, cylindrical power, astigmatism axis, and spherical equivalent were all measured by Topcan's Kerato-refractometer (KR-800).

### Statistical analysis

Baseline demographics were expressed as means with standard deviations (SD) or counts and percentages. Age of participants

was subcategorized into groups: 20–25, 26–30, 31–35 and 36–40 years. Variations were measured between different sexes, regions, and age groups. Finally, correlations were investigated between the baseline characteristics and myopia, hyperopia, and astigmatism individually. Statistical significance was set at 0.05 level, and all analyses were conducted using SAS 9.4 (SAS Institute Inc, Cary, NC). The study protocol was approved by the Research Ethics Board of the King Abdullah International Medical Research Center (KAIMRC).

## RESULTS

In total, there were 660 adults included in this study, predominantly comprising of males (54%). The mean age of the participants was 28 years old, with more than half of participants (56.1%) originally being from the central regions of Saudi Arabia. In total, 662 (50.2%) right eyes and 657 (49.8%) left eyes were examined. Of the 660 participants included in this study, 273 (20.7%) of participants wore spectacles regardless of their refractive error. Table 1 illustrates the baselines characteristics of the patients included in this study. An eye of one patient was excluded because the patient had keratoconus.

**Table 1: Demographics of Participants**

Variables	Description (n=1319)
Eye	
Right eye	662 (50.2)
Left eye	657 (49.8)
Sex	
Male	715 (54.2)
Female	604 (45.8)
Age	
Range	20-40
Mean±SD	28.2±5.8
Age	
20-25	503 (38.1)
26-30	357 (27.1)
31-35	269 (20.4)
36-40	190 (14.4)
Region	
Central	740 (56.1)
South	248 (18.8)
North	140 (10.6)
West	70 (5.3)
East	121 (9.2)
Glasses	
Yes	273 (20.7)
No	1046 (79.3)
Myopia	
Yes (=Prevalence)	642 (48.7)
No	677 (51.3)
Hyperopia	
Yes (=Prevalence)	333 (25.2)
No	986 (74.8)
Astigmatism	
Yes (=Prevalence)	875 (66.3)
No	444 (33.7)

n=numbers of eyes

With respect to refractive error, 321 (48.7%) individuals experienced myopia, while 167 (25.2%) participants had hyperopia, and 438 (66.3%) people had astigmatism. 185 (28.0%) individuals were found to be emmetropes.

We also assessed the correlation between each refractive error and the baseline characteristics. Myopia was found to be more prevalent among males when compared to females (51.2% vs. 48.8%.  $P$ -value = 0.03). Furthermore, 40% of the myopic participants were between 20–25 years ( $P$  = 0.03), and 14.5% of myopic patients were originally from the northern regions of Saudi Arabia ( $P$  < 0.001). Lastly, the data suggested that 71.7% of myopic participants opted not to wear spectacles for their myopia ( $P$  < 0.001) [refer to Table 2].

Similarly, several factors were found to be significantly associated with hyperopia. These included male sex ( $P$  = 0.048), being in the age groups of 20–25 years old ( $P$  = 0.04) and 31–35 years old ( $P$  = 0.01), as well as being from the northern region of Saudi Arabia ( $P$  = 0.01) [Table 2].

Lastly, astigmatism was associated with more older individuals (35 – 50 years old,  $P$  = 0.002). Furthermore, we found that 76.1% of astigmatic individuals opted not to wear spectacles for their astigmatism ( $P$  < 0.001) [Table 2].

## DISCUSSION

In this study, 660 participants were screened in order to determine the prevalence of refractive error among Saudi adults. We found that age, sex, and region of origin were factors that were found to be closely associated with refractive errors and that most participants did not wear spectacles to correct their refractive error.

Multiple studies have reported the prevalence of refractive errors within Saudi Arabia<sup>[8-13]</sup>. However, most of these studies had primary school children and adolescents as their population of interest<sup>[8,9,11]</sup>. With regards to refractive errors among Saudi adults, data is minimal and have methodological issues, such as small sample size. In this study, we were able to overcome this limitation by including 660 adults from various age groups and regions, ensuring the study was robustly powered.

## Myopia

The literature suggests that myopia is the most common type of refractive error worldwide<sup>[14]</sup>. In our study, we found that 48.7% of Saudi adults experience myopia. This contrasts with Western countries, who report a much lower prevalence of myopia. For instance, 19.4% of the population in Norway, 14.2% in Greece, 16.7% in France, 21.2% in Netherlands, 31.9% in Germany, and 21% in USA were found to be myopes. This difference could be attributed to disparities in clinical definitions for myopia. We defined clinically relevant myopia as <-0.50D, whereas authors from Western countries defined clinically relevant myopia to be <1.00 D<sup>[6,15]</sup>.

With that being said, our results were far more consistent with has been reported in Asian countries. For example, 41.8% of the Japanese population were found to be myopic, 48.1% in Indonesia, 41.8% in South Korea, 34.6% in India, 36.5% in Pakistan, and 53.7% in Jordan<sup>[15,16]</sup>.

Furthermore, we also found that myopia is more commonly related with being male. This is consistent with some of the scientific literature<sup>[17,18]</sup>. However, studies conducted by Ziaei *et al.* and Wong *et al.* demonstrate myopia to be more common among women<sup>[19,20]</sup>.

**Table 2: The correlation between myopia, hyperopia, and astigmatism with demographics of participants**

Variables	Myopia n (%)		P	Hyperopia		P	Astigmatism		P
	Yes	No		Yes	No		Yes	No	
Sex									
Male	329 (51.2)	386 (57)	0.036*	196 (58.9)	519 (52.6)	0.048*	458 (52.3)	257 (57.9)	0.056*
Female	313 (48.8)	291 (43)		137 (41.1)	467 (47.4)		417 (47.7)	187 (42.1)	
Age									
Range	20-40	20-40		20 - 40	20-40		20 - 40	20-40	
Mean±SD	28.2±5.8	28.6±5.9	0.224#	29.1±5.9	28.2±5.9	0.011#	28.6±6	28±5.6	0.071#
Age									
20-25	257 (40)	246 (27.3)	0.033*	111 (33.3)	392 (39.7)	0.04*	328 (37.5)	175 (39.4)	0.319*
26-30	172 (26.8)	185 (27.3)	0.827*	86 (25.8)	271 (27.5)	0.556*	233 (26.6)	124 (27.9)	0.616*
31-35	126 (19.6)	143 (21.1)	0.500*	84 (25.2)	185 (18.8)	0.011*	169 (19.3)	100 (22.5)	0.172*
36-40	87 (13.6)	103 (15.2)	0.390*	52 (15.6)	138 (14)	0.467*	145 (16.6)	45 (10.1)	0.002*
Region									
Central	347 (54)	393 (58.1)	0.143*	187 (56.2)	553 (56.1)	0.982*	481 (55)	259 (58.3)	0.245*
South	116 (18.1)	132 (19.5)	0.507*	69 (20.7)	179 (18.2)	0.300*	162 (18.5)	86 (19.4)	0.707*
North	93 (14.5)	47 (6.9)	<0.001*	23 (6.9)	117 (11.9)	0.011*	95 (10.9)	45 (10.1)	0.687*
West	33 (5.1)	37 (5.5)	0.792*	16 (4.8)	54 (5.5)	0.636*	50 (5.7)	20 (4.5)	0.354*
East	53 (8.3)	68 (10)	0.261*	38 (11.4)	83 (8.4)	0.102*	87 (9.9)	34 (7.7)	0.174*
Glasses									
Yes	182 (28.3)	91 (13.4)	<0.001*	61 (18.3)	212 (21.5)	0.215*	209 (23.9)	64 (14.4)	<0.001*
No	460 (71.7)	586 (86.6)		272 (81.7)	774 (78.5)		666 (76.1)	380 (85.6)	

\*Chi square test, #t-test

Moreover, we also observed that myopia was more commonly seen among participants aged between 20–25 years. This is consistent with what AlRashidi *et al.* reported with regards to Saudi medical students<sup>[12]</sup>. However, a meta-analysis conducted by Pan *et al.* on age-specific myopic prevalence in Asians demonstrated a directly proportional relationship with age<sup>[21]</sup>.

### Hyperopia

In this study, we found that 25.7% of Saudi adults had some degree of hyperopia. This is significantly higher than what has been previously reported in other studies. For instance, Al-Rashidi *et al.* found that only 6.5% of Saudi medical students suffered from hyperopia<sup>[12]</sup>. This disparity in finding can be attributed to different definitions of hyperopia (>0.50 D in our study vs. >1.00 D in other studies).

In particular, our results suggest that Saudi adults from the region of Qassim have a higher prevalence of hyperopia when compared to other regions of the kingdom. This is consistent with the literature, as other studies have estimated a prevalence of 20.9%-35.9% for hyperopia among adults from the region of Qassim<sup>[11,12]</sup>.

### Astigmatism

Our data suggests that 66.3% of Saudis experience some degree of astigmatism. This is a much higher prevalence than most other countries worldwide. For instance, 32.4% of people in Bangladesh have astigmatism, 35.7% in South Africa, 32.3% in German, 36.8% in Jordan, 59.7% in Brazil, 4.4% in Rwanda, and 14.3% in Iran<sup>[15,18,22]</sup>.

### Corrective measures

Despite the high prevalence of refractive errors among Saudis, our data demonstrated 71.7% of myope's, 81.7% of hyperopes, and 76.1% of people who experienced astigmatism, opted not to wear spectacles to correct their refractive error.

There are several limitations to this study. First, our study was limited by context, as sampling was conducted at only two sites. However, these two sites were major attractions for locals and visitors from all over Saudi Arabia. Second, we did not adjust for any confounding factors, as no multivariate analyses was performed. Lastly, this study might not be geographically generalizable to other cities within Saudi Arabia.

### CONCLUSION

In conclusion, our study found that astigmatism (66.3%) was the most prevalent refractive error among Saudis, followed by myopia (48.7%) and then hyperopia (25.2%). In addition, refractive error was found to be correlated with age, as myopia was more prevalent in younger subjects whereas astigmatism was higher among older people. Lastly, all 3 refractive errors - myopia, hyperopia, and astigmatism - were found to be more prevalent among males than females, and more prevalent in the Northern regions of Saudi Arabia.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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