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Prevalence of cataracts in Iran based on the Persian eye cohort study

Fateme Alipour[1], Parisa Abdi[1]✉, Hassan Asadigandomani[1], Mehran Rezakhani[2], Fatemeh Moosaie[3], Fateme Jafari[1], Mehdi Yaseri[4], Nazgol Motamed-Gorji[2], Fahimeh Khalili[5], Roya Tavakoli[6], Abolfazl Tahkor[7], Masoome Mohseni[8], Samira Salimpour[9], Seyed Mohammad Javad Mousavi Aref[10], Mohammad Mirzaei[11], Mohammadreza Soleimani[12], Kourosh Shahraki[13], Yousef Alizade[14], Mohammad Reza Shoja[15], Gholam Reza Khataminia[16], Mahmoud Jabbarvand Behrouz[1] & Hassan Hashemi[17]

The PERSIAN eye cohort study is a population-based study that evaluates the overall prevalence of cataracts and their subtypes (nuclear sclerosis, cortical, and PSC) in Iran. In this study, from January 2015 to September 2021, 16,016 participants over 35 years of age from four provinces who were selected by random cluster sampling were examined. Demographic information, education, socioeconomic status, and place of residence were collected through interviews. The cataract status of the study participants was examined by two experienced ophthalmologists using slit lamp photography. The average age of the study participants was 49.52 ± 9.31 and 8891 (55.5%) were female. The overall prevalence of each type of cataract, nuclear sclerosis, cortical, and PSC was 18.90%, 12.65%, 9.20%, and 3.08%, respectively. The results indicated that the prevalence of any type of cataract (adjusted OR = 0.85, 95% CI: 0.78–0.92, $p < 0.001$) and NS cataract (adjusted OR = 0.80, 95% CI: 0.73–0.88, $p < 0.001$) is lower in women. The risk of developing cataracts increased exponentially with aging. The prevalence of any type of cataract and cortical subtype was higher in rural than urban populations. Also, the risk of developing cataracts decreased with an increase in education level and socioeconomic status and some Iranian races such as Arabs, Azari, and Guilak were also at a higher risk of cataracts. The results of this study indicate the importance of a comprehensive regard of cataract as one of the causes of avoidable blindness in Iran due to its higher prevalence than the global average.

Keywords Cataract, Iran, Cohort, Prevalence, Persian eye cohort study

[1]Translational Ophthalmology Research Center, Department of Ophthalmology, Farabi Eye Hospital, School of Medicine, Tehran University of Medical Sciences, Tehran 1336616351, Iran. [2]Digestive Diseases Research Institute, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran. [3]International Surgical Research Association (ISRA), Universal Scientific Education and Research Network (USERN), Tehran, Iran. [4]Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran. [5]Liver and Gastrointestinal Diseases Research center, Tabriz University of Medical Sciences, Tabriz, Iran. [6]Non-Communicable Diseases Research Center, Rafsanjan University of Medical Sciences, Rafsanjan, Iran. [7]Zahedan University of Medical Science, Zahedan, Iran. [8]Gastrointestinal and Liver Diseases Research Center, Guilan University of Medical Sciences, Guilan, Iran. [9]Geriatric Ophthalmology Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. [10]Hoveyzeh Cohort Study Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. [11]Department of Ophthalmology, Tabriz University of Medical Sciences, Tabriz, Iran. [12]Department of Ophthalmology, Rafsanjan University of Medical Sciences, Rafsanjan, Iran. [13]Department of Ophthalmology, Zahedan University of Medical Sciences, Zahedan, Iran. [14]Department of Ophthalmology, Amiralmomenin Hospital, Gillan University of Medical Sciences, Rasht, Iran. [15]Department of Ophthalmology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. [16]Department of Ophthalmology, Jundishapur University of Medical Sciences, Ahvaz, Iran. [17]Noor Ophthalmology Research Center, Tehran, Iran. ✉email: paris.abdi@gmail.com

Visual impairment has affected at least 2.2 billion people, globally. Of these, at least 1 billion were preventable or not yet addressed[1]. It is noteworthy that the loss in productivity due to visual impairment has posed an annual cost of 411 billion US dollars, globally[2,3].

Cataract is the leading cause of avoidable distance vision impairments worldwide; accounting for 94 million of the 1 billion people with visual impairment or blindness. The causes of visual impairment, differ depending on the regional differences. For instance, cataracts account for a higher percentage of visual impairment in low- and middle-income compared to high-income countries[1–3]. Cataract affects an individual's life in many different aspects; being associated with a higher risk for dementia, falls, road traffic crashes, lower quality of life, and higher mortality[4]. There are several factors associated with the prevalence of cataract. Previous studies suggest that cataract is more prevalent among the female gender and its prevalence increases with age[5–8]. Low socioeconomic status[9], smoking[10,11], diabetes[12–14], and hypertension[15,16] are also considered risk factors for the development of cataract. Timely intervention for surgical treatment can save the system a lot of costs inflicted by visual impairment due to cataract, especially in low-income countries.

Cataract has three subtypes. Nuclear cataract is the most common type; followed by cortical and posterior subcapsular (PSC) cataracts. Several studies have addressed the association between these three types of cataracts and age and gender[4–6,17–19]. The Beaver Dam eye study has reported a cubic, quadratic, and linear correlation between age and cortical, nuclear, and PSC cataracts, respectively[6]. According to the Singapore Malay study, the 6-year incidence of cortical, nuclear, and PSC cataracts was significantly most prevalent among the 60-69-year-old, ≥ 70, and ≥ 70-year-old populations, respectively. The relative risk of age was highest for the incidence of nuclear cataract, followed by PSC and cortical cataract (RR = 3.59 vs. 2.10 vs. 1.44, respectively; $P < 0.001$)[17]. The LA Latino study has reported that nuclear cataract was more prevalent among females while there was no significant gender difference in terms of the other two types of cataracts. Age was significantly associated with all three types of cataracts[7].

Several large-scale cohorts are being conducted worldwide. They have mostly focused on the rate of cataract surgery rather than the prevalence of cataract[18,20–23]. This could be because most of these studies are conducted in developed countries where cataract will be screened and surgically managed before progression to higher grades. This is not necessarily true in the MENA region (Middle East and North Africa) including Iran. There are several possible explanations for this difference; including unequal accessibility to screening, inefficient selection of individuals for ophthalmologic examination in terms of cataract, inadequate public awareness of the importance of this matter, or limited financial resources to perform surgery[3,24].

The PERSIAN Eye COHORT Study (PECS) is a branch of the prospective study PERSIAN COHORT[25]. PECS was launched in 2015. Six centers of the PERSIAN Cohort study were selected based on two criteria: (1) centers with maximum geographical and ethical diversity and (2) centers with a supportive, well-organized ophthalmology center. The protocol of the study has been published elsewhere[25,26].

In this nationwide study, we aimed to assess the prevalence of cortical, nuclear, and PSC cataracts based on age, gender, ethnicity, province, and climate. Results from this study could help highlight the importance of early detection and prompt treatment of cataracts among the specific high-risk groups, for the health policymakers of a Middle Eastern population.

Method

Study population

PERSIAN Eye COHORT Study (PECS) is a branch of the larger prospective study PERSIAN Cohort, launched in 2015. The PERSIAN Eye COHORT Study (PECS) is a subset of the larger prospective study known as the PERSIAN Cohort, which was initiated in 2015. A total of 65,580 individuals met the criteria for participation in the study, drawn from six centers (Some'e Sara, Khameneh, Zahedan, Yazd, Rafsanjan, and Hoveizeh) affiliated with the main PERSIAN COHORT. The participants were categorized into four age groups: 35–44, 45–54, 55–64, and over 65 years old. The Iranian participants in this study represent a diverse array of ethnicities, including Fars, Turk (Azari), Kurd, Lur, Balouch, and Arab, among others, dispersed geographically throughout Iran. Moreover, Iran encompasses various climate zones, such as hot and cold deserts, semi-arid steppes, hot Mediterranean, and hot summer continental climates; all of these climate zones were represented among our participants. The population was evenly distributed across three socioeconomic statuses (low, average, and high) and segmented into four educational levels (illiterate, low, diploma, and higher education).

Ophthalmologic examination

An ophthalmologist conducted ophthalmic examinations at each center. Using a Photo slit lamp, slit lamp and anterior segment photography were carried out. Initially, a diffused photo was captured focusing on the eyelids, cornea, iris, and lens. The pupils were dilated by instilling two drops of topical tropicamide 1% in both eyes with 5-minute intervals in between each drop. If participants had a history of glaucoma or ocular pain accompanied by evening headaches, an ophthalmologist's permission for instillation was sought. After 20 min from the second installation, two slit photos were captured from each eye with a focus on the nucleus, from 45-degree angles. Afterward, two retro-illumination photos were taken from 30-degree angles (right and left direction) from each eye. In our study, some participants refused dilated photography because they were not satisfied with pupil dilation so were excluded from the study.

Following the optometry step, the optometrist reviewed the examination results with the participant. If the participant met any of the specified criteria, they were directed to proceed to the next stage, which involves scheduling an appointment with an ophthalmologist:[1] Positive diabetes history[2], Positive family history of glaucoma[3], IOP > 20 mmHg[4], Positive RAPD[5], BCVA < 8/10[6], Documented/suspicious strabismus[7], Suspicious keratoconus, based on positive scissor motion sign[8], Present eyelid abnormalities[9], Moderate to severe dry eye symptoms[10], Poor red reflex, and[11] Any other suspicious findings. The secretary staff at the cohort fields scheduled

appointments for all participants who needed an ocular examination. They organized the appointments based on the ophthalmologists' availability, ensuring that no more than 30 patients were seen in a single day.

Central reading center

In 2020, the PECS reading center team was established, comprising two panels dedicated to fundus photography and slit-lamp photography. These panels were overseen by board-certified subspecialists in cornea and retina, who served as human reference standards, along with professional assessors who underwent extensive training and certification in identifying abnormalities. Every image was reviewed by a minimum of two assessors. In cases where the primary readers did not reach a consensus, the reference standard ophthalmologists intervened as tiebreakers. World Health Organization (WHO) grading system was used for grading nuclear, cortical, and posterior subcapsular cataracts[27].

Data monitoring

Like the main PERSIAN Cohort, in the Eye sub-cohort, a smart data server was utilized to reduce common errors when entering data. Additionally, this system eliminated the entry of quantitative variables with out-of-range values. Each center had its focal point team, which acted as liaison with the central team in supervising the whole process and addressing issues that arose. In addition, every center was equipped with a quality assurance (QA)/quality control (QC) team that had the task of daily monitoring the data and sending weekly reports to the central team. The central team had the ability to assess the quality of the online data submitted by each center using the online data server.

Before commencing their tasks, the operators were informed that their voice and desktop performance would be recorded intermittently without their awareness, which would be then appraised by the central team. The recordings were captured using the FastSone Image Viewer software. Furthermore, the PECS central team members conducted routine unannounced inspections at each center to verify compliance with protocols, efficient workflow, and proper equipment maintenance.

Repeated measurement

The PECS's repeated measurement (RM) phase was intended to commence simultaneously with the main cohort, about 5 years after enrollment. However, the launch of this phase is currently postponed due to the impact of the COVID-19 pandemic. Nevertheless, the RM phase of the PECS will encompass repeating all the baseline steps, including eye questionnaire, optometry, ophthalmologic examinations, and ocular imaging. A subset of 30% of the whole participants of the baseline will be recruited, as well as those with referral indications.

Ethical approval

The proposal for the PERSIAN Eye Cohort Study received approval from the ethics committee at Tehran University of Medical Sciences (IR.TUMS.DDRI.REC.1396.1) and the six participating universities of medical sciences (Hoveizeh: IR.AJUMS.REC.1396.149, Yazd: IR.SSU.REC.1397.135, Some'e Sara: IR.GUMS.REC.1394.226, Khameneh: tbzmed.rec.1393.205, Zahedan: IR.ZAUMS.REC.1393.96451, Rafsanjan: IRUMS.REC.1394.254). This prospective study adhered to the tenets of the Declaration of Helsinki. In addition to providing informed consent during the enrollment stage of the main cohort, all participants were required to provide informed consent before entering the Eye sub-cohort study. It was explained to each individual that participating in any part of the eye sub-cohort is not obligatory and they could leave the study at any time.

Statistical analysis

Mean, standard deviation (SD), median, range, frequency, and percentage were used to present data. Their related 95% confidence interval (CI) was used to present the estimations. In the multilevel analysis, we used simple and multivariable logistic regressions to assess the impact of sociodemographic variables on cataracts taking into account cluster sampling and probable design effects. Odds ratios (ORs) with their 95% CIs were reported. All statistical analyses were performed by SPSS software (IBM Corp. Released in 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). A P-value less than 0.05 was considered statistically significant.

Results

Demographic characteristics

From the study population of the Persian Cohort (65580), 48,618 individuals above 35 years old were enrolled in the PECS (74.13%) until September 2021. Slit lamp photography was conducted for 28,702 individuals (59.03%), while fundus photography was performed for 27,437 individuals (56.43%). The number of participants who were referred for ophthalmology visits was 12,884, of whom, 6885 completed the ophthalmology visit. Most of the population fell in the 35–44 age category (35.5%) and mostly (39.35%) with low education (<7 years). Cataract status information is available for 16,016 (24.4%) participants out of a total of 65,580 people. The mean age of all the participants in the study is 49.52 ± 9.31 SD. Out of 16,016 participants, 7125 (44.5%) were male and 8891 (55.5%) were female, which does not differ significantly from the gender distribution of PERSIAN Cohort data (44.6% male and 55.4% female). Demographic information including gender, age, educational status, place of residence (urban or rural), wealth score index (WSI), and ethnic and racial status of the study participants are summarized in Table 1.

Distribution and prevalence of different types of cataracts

Table 2 indicates the overall prevalence of cataracts according to different subgroups and different types of cataracts (NS, PSC, Cortical). It also indicates the prevalence of unilateral or bilateral as well as the involved side.

Parameter	Subgroups	Number in cohort	Cataract available data		Available %
			n	%	
Gender	*M*	29,249	7125	44.5	24.4
	F	36,331	8891	55.5	24.5
Age	*< 44*	23,980	5215	32.6	21.7
	45–54	21,415	5777	36.1	27.0
	55–64	15,904	4113	25.7	25.9
	65+	4280	911	5.7	21.3
Education	*Illiterate*	12,527	2626	16.4	21.0
	Low	20,467	5253	32.8	25.7
	Diploma	25,400	6576	41.1	25.9
	Higher Education	7166	1561	9.7	21.8
Residence type	*Urban*	49,176	11,337	70.8	23.1
	Rural	16,404	4679	29.2	28.5
WSI_ categories	*Low*	23,683	5991	37.4	25.3
	Moderate	20,109	4887	30.5	24.3
	High	21,708	5138	32.1	23.7
Center ID	*10*	9991	2983	18.6	29.9
	11	10,009	2170	13.5	21.7
	3	10,520	6313	39.4	60.0
	5	15,006	4550	28.4	30.3
Ethnicity main categories	*Fars*	21,425	2991	18.7	14.0
	Azari	15,221	4734	29.6	31.1
	Arab	10,049	2183	13.6	21.7
	Guilak	9358	5614	35.1	60.0
	Others	1541	494	3.1	32.1

Table 1. Demographic characteristics of the population.

The most common form of cataract was NS (12.6%), followed by cortical cataract (9.2%). PSC cataract with a prevalence of 3.1% had the lowest prevalence rate among different types. Bilateral NS cataracts were observed in 6.6% (95% CI: 6.2–7%) of participants, while this rate was 3.9% (95% CI: 3.5–4.2%) and 0.8% (95% CI: 0.6–1%) in cortical and PSC, respectively (Table 2).

To determine the associative factors of various types of cataracts, univariate and multivariable logistic regression with different parameters was used. Tables 3 and 4 show the prevalence rates, P values as well as odds ratios (Tables 3 and 4). The results indicated that in both univariate and multivariate models, the prevalence of any types of cataract (unadjusted OR = 0.88, adjusted OR = 0.85, 95% CI: 0.78–0.92, $p < 0.001$) and NS cataract (unadjusted OR = 0.85, adjusted OR = 0.80, 95% CI: 0.73–0.88, $p < 0.001$) was lower in women, while the prevalence of cortical (unadjusted OR = 1.03, adjusted OR = 0.99, 95% CI: 0.87–1.11, $p = 0.87$) and PSC (unadjusted OR = 0.97, adjusted OR = 1.01, 95% CI: 0.82–1.24, $p = 0.12$) did not differ significantly between the two gender groups.

The results revealed a significant increase in the prevalence of all cataract types with advancing age, a trend consistent across both genders (Tables 3 and 4; Figs. 1, 2 and 3). This upward trajectory in cataract prevalence with age followed an exponential pattern. For example, the prevalence of any type of cataract among individuals aged over 65 was 58.7% (95%CI: 55.5–61.9%), compared to 4.9% (95%CI: 4.3–5.5%) among those under 44 years. Similar trends were observed in each type of cataract (the analyses were performed considering the age group under 44 years as the reference group). A notable correlation was observed between lower levels of education and higher probability of cataracts (Figs. 3 and 4). Prevalence rates of any type of cataract in participants with illiterate, low, diploma, and higher education levels are 33.2%, 18.0%, 12.8%, and 14.7%, respectively ($p < 0.001$). By considering the low WSI group as the reference group, the risk of developing NS cataract decreased as the WSI level rose. The unadjusted odds ratio in the Moderate and High WSI groups was 0.93 (adjusted OR = 0.75, 95% CI: 0.67–0.84, $p < 0.001$) and 0.84 (adjusted OR = 0.57, 95% CI: 0.51–0.65, $p < 0.001$), respectively. This trend was also present in PSC cataract (unadjusted OR = 1.11, adjusted OR = 0.91, 95% CI: 0.71–1.15, $p = 0.44$ in moderate and unadjusted OR = 0.84, adjusted OR = 0.55, 95% CI: 0.42–0.72, $p < 0.001$) (Figs. 3 and 5). The prevalence of any type of cataract and cortical subtype was higher in rural than urban populations (Figs. 3 and 6). The results of cataract prevalence analysis according to different ethnicity categories showed that the prevalence rate of NS cataracts was highest in Arabs (16.2%, 95% CI: 14.7–17.8%) followed by Azeri (15.6%, 95% CI: 14.6–16.7%), Guilak (10.3%, 95% CI: 9.5–11.1%), and lowest in Fars (6.6%, 95% CI: 5.8–7.6%) ethnic (Fig. 3).

Parameter	Grade	Number	Percentage	95% CI	
				Lower	Upper
NS cataract	*0*	14,362	87.3%	86.8%	87.9%
	1	1060	6.4%	6.1%	6.8%
	2	581	3.5%	3.3%	3.8%
	3	439	2.7%	2.4%	2.9%
PSC cataract	*0*	12,916	96.9%	96.6%	97.2%
	1	203	1.5%	1.3%	1.7%
	2	107	0.8%	0.7%	1.0%
	3	101	0.8%	0.6%	0.9%
Cortical cataract	*0*	11,861	90.8%	90.3%	91.3%
	1	720	5.5%	5.1%	5.9%
	2	340	2.6%	2.3%	2.9%
	3	143	1.1%	0.9%	1.3%
Status cataract	*None*	10,836	80.7%	80.0%	81.4%
	NS	1214	9.0%	8.6%	9.5%
	PSC	158	1.2%	1.0%	1.4%
	NS + PSC	75	0.6%	0.4%	0.7%
	CC	733	5.5%	5.1%	5.9%
	NS + CC	257	1.9%	1.7%	2.2%
	PSC + CC	80	0.6%	0.5%	0.7%
	NS + PSC + CC	76	0.6%	0.4%	0.7%
NS status (Uni/bilateral)	*None*	13,985	88.1%	87.6%	88.6%
	OD	405	2.6%	2.3%	2.8%
	OS	431	2.7%	2.5%	3.0%
	Bilateral	1046	6.6%	6.2%	7.0%
PSC status (Uni/bilateral)	*None*	12,650	97.2%	96.9%	97.4%
	OD	140	1.1%	0.9%	1.3%
	OS	128	1.0%	0.8%	1.2%
	Bilateral	103	0.8%	0.6%	1.0%
Cortical status (Uni/bilateral)	*None*	11,441	91.1%	90.6%	91.6%
	OD	292	2.3%	2.1%	2.6%
	OS	335	2.7%	2.4%	3.0%
	Bilateral	485	3.9%	3.5%	4.2%

Table 2. The overall prevalence of different types of cataracts.

Discussion

The PERSIAN Eye Cohort Study (PECS) is a national epidemiological study consisting of several provinces. It provides the first comprehensive insight into the overall prevalence of any cataract and its sub-types based on age, gender, education level, place of residence, socioeconomic status, and race in the Iranian population. While previous studies in Iran have investigated the prevalence of cataract in specific populations and geographic regions[28–32], this nationwide cross-sectional survey has tried to include a substantial representation of Iranians with diverse gender and racial distributions. A meta-analysis conducted by Hashemi et al. showed that the global age-standardized pooled prevalence estimate (ASPPE) of each type of cataract, cortical, nuclear sclerosis, and PSC was 17.20%, 8.05%, 8.22%, and 2.24%, respectively[33]. The results of our study indicate that the overall prevalence of cataracts and each of its subtypes in Iran is higher than the global average. Previous studies have shown that the Southeast Asia (SEARO) and Western Pacific Regions (WPRO) have the highest prevalence of cataracts and their subtypes, while the Pan American regions (AMRO) exhibit the lowest prevalence of cataracts. In other words, moving from the west of the world to the east, the prevalence of cataracts increases[33]. The results of our study showed that Iran has a higher prevalence than AMRO and lower than SEARO and WPRO.

Despite Iran's location within the MENA region (where the prevalence of diabetes and hypertension is among the highest globally, reaching 12.2% and 49.7% respectively[34,35]) the prevalence of cataracts in Iran, while higher than in the AMRO, remains lower than that observed in SEARO and WPRO. This discrepancy may be attributed to various environmental and socio-economic factors. For instance, SEARO countries experience elevated ultraviolet (UV) radiation exposure, high rates of outdoor activity, and have limited access to cataract surgery services, contributing to their elevated cataract prevalence[36–39]. In contrast, while the MENA region, including Iran, faces significant healthcare challenges due to economic disparities and high rates of chronic diseases, these factors may interact differently with cataract risk[35,40]. The impact of UV exposure, genetic factors, and other environmental risks (smoking rates and socioeconomic conditions) likely play a distinct role in SEARO's higher

Parameter		NS			PSC			Cortical			Any		
		%	95% CI		%	95% CI		%	95% CI		%	95% CI	
			Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Gender	*M*	13.2	12.4	14.0	2.9	2.5	3.4	8.7	8.0	9.4	19.5	18.5	20.4
	F	11.0	10.4	11.7	2.9	2.5	3.3	8.4	7.8	9.1	16.9	16.2	17.7
P		**< 0.001**			0.90			0.87			**< 0.001**		
Age	*< 44*	2.9	2.5	3.4	1.1	0.8	1.5	1.7	1.4	2.2	4.9	4.3	5.5
	45–54	7.8	7.1	8.5	2.3	1.9	2.8	5.1	4.5	5.8	12.6	11.8	13.5
	55–64	22.5	21.2	23.8	4.7	4.0	5.4	17.1	15.9	18.4	33.4	32.0	34.8
	65 +	44.4	41.2	47.7	8.5	6.6	10.6	29.8	26.7	33.2	58.7	55.5	61.9
P-value		**< 0.001**			**< 0.001**			**< 0.001**			**< 0.001**		
Residency state	*Urban*	12.0	11.4	12.6	3.1	2.8	3.5	8.8	8.3	9.4	18.1	17.4	18.8
	Rural	12.1	11.2	13.1	2.4	2.0	2.9	7.9	7.2	8.8	18.1	17.0	19.2
P-value		0.30			0.17			**0.001**			0.07		
Education	*Illiterate*	23.9	22.3	25.6	5.6	4.6	6.7	17.9	16.2	19.7	33.2	31.4	35.0
	Low	11.2	10.4	12.1	3.2	2.7	3.8	9.2	8.4	10.1	18.0	17.0	19.1
	Diploma	8.4	7.8	9.1	2.0	1.7	2.4	5.7	5.1	6.3	12.8	12.0	13.7
	Higher Education	9.6	8.2	11.2	2.0	1.3	2.9	6.3	5.1	7.7	14.7	13.0	16.6
P-value		**< 0.001**			**< 0.001**			**< 0.001**			**< 0.001**		
WSI categories	*Low*	14.7	13.8	15.6	3.1	2.7	3.7	10.0	9.2	10.9	21.1	20.0	22.1
	Moderate	11.6	10.7	12.5	3.3	2.7	3.8	8.3	7.5	9.2	17.9	16.8	19.0
	High	9.3	8.5	10.1	2.3	1.9	2.8	7.1	6.3	7.9	14.7	13.8	15.7
P-value		**< 0.001**			**< 0.001**			**< 0.001**			**< 0.001**		
Ethnicity categories	*Fars*	6.6	5.8	7.6	1.3	1.0	1.8	4.6	3.9	5.4	11.5	10.4	12.7
	Azari	15.6	14.6	16.7	5.9	5.3	6.7	15.0	13.9	16.1	25.4	24.2	26.6
	Arab	16.2	14.7	17.8	2.3	2.1	2.5	0.9	0.3	2.4	16.4	14.8	17.9
	Guilak	10.3	9.5	11.1	1.7	1.4	2.1	6.5	5.9	7.2	16.0	15.1	17.0
	Others	11.2	8.6	14.2	2.5	1.4	4.2	6.9	4.9	9.5	18.2	15.0	21.8
P-value		**< 0.001**			**< 0.001**			0.92			0.14		
Center	*10*	6.6	5.8	7.6	1.4	1.0	1.8	4.6	3.9	5.4	11.6	10.5	12.8
	11	16.3	14.8	17.9	1.7	1.1	2.0	3.4	3.5	3.6	16.3	14.8	17.9
	3	10.3	9.6	11.1	1.8	1.5	2.1	6.5	5.9	7.1	16.0	15.2	17.0
	5	15.9	14.8	17.0	6.1	5.4	6.9	15.6	14.4	16.7	26.0	24.7	27.3
P-value		**0.02**			**0.025**			**0.03**			**0.01**		

Table 3. Prevalence rates of different types of cataracts by gender, age, residency state, education, WSI, ethnicity, and centers.

prevalence rates, which could partly explain why Iran's prevalence does not reach SEARO and WPRO levels despite the high burden of diabetes and hypertension in MENA[36–39].

The rise in cataract prevalence with age is an undeniable fact supported by several studies[33,41–43]. Various studies have shown that the prevalence of cataracts in individuals under the age of 40 is less than 1%[42–44]. The highest reported rate in people over 60 years of age is 88.17% for any type of cataract in South Korea[41], 66.96% for nuclear sclerosis, and 61.75% for cortical among Chinese residents of Singapore[45], and 38.79% for PSC among the rural population of Indonesia[39]. While this rate in the Iranian population over 65 years old is 58.7%, 44.4%, 29.8%, and 8.5% for each type of cataract, nuclear sclerosis, cortical, and PSC, respectively. Hashemi et al.'s meta-analysis showed that the global prevalence of each type of cataract, nuclear sclerosis, cortical, and PSC in people over 60 years old is 54.38%, 31.19%, 24.78%, and 7.29%, respectively[33]. Compared to the global prevalence, the overall prevalence of cataracts and all subtypes in Iranian society is higher in people over 60 years of age.

So far, there is no final agreement about the gender difference in cataract prevalence in different studies. Most studies consider women to be at higher risk by justifying hormonal effects[39,46,47], while some studies, considering the role of UV, have shown men to be a more detrimental group[48,49]. According to the results of our study, which indicated that the overall prevalence of cataract and nuclear sclerosis subtype was significantly higher in men and that the prevalence of cortical type was higher without statistical significance, it seems that in Iranian society, the prevalence of cataracts is higher in men. The results of our study are different from the study of Shahdadi et al., which in a meta-analysis showed that the prevalence of cataract in Iranian women is higher than that of men (8.32% compared to 8.03%)[32]. The results of Nirmalan et al.'s study are different from our results, which found the prevalence of cataracts in South Indian society to be higher in women[46]. Also, this study showed that the prevalence of nuclear and cortical cataract is significantly higher in Indian women. However, Deepayan et al. reported a higher prevalence of cataracts in men in the central regions of India[48]. The heterogeneity of studies on the effect of gender on the prevalence of cataract can be attributed to methodological differences or selection

Parameters	Subgroups	NS					PSC					Cortical					Any				
		Un-adj	Adj				Un-adj	Adj				Un-adj	Adj				Un-adj	Adj			
		OR	OR	95% CI		P		OR	95% CI		P	OR	OR	95% CI		P	OR	OR	95% CI		P
				Lower	Upper				Lower	Upper				Lower	Upper				Lower	Upper	
Gender	*M (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	F	0.85	0.80	0.73	0.88	**< 0.001**	0.97	1.012	0.82	1.24	0.12	1.03	0.99	0.87	1.11	0.87	0.88	0.85	0.78	0.92	**< 0.001**
Age	*< 44 (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	45–54	2.76	2.80	2.32	3.39	**< 0.001**	1.92	2.01	1.43	2.83	**< 0.001**	2.81	2.93	2.25	3.82	**< 0.001**	2.66	2.75	2.37	3.19	**< 0.001**
	55–64	9.32	10.10	8.45	12.08	**< 0.001**	3.62	4.13	2.98	5.73	**< 0.001**	10.53	11.70	9.15	14.96	**< 0.001**	8.95	10.02	8.69	11.55	**< 0.001**
	65 +	23.76	27.39	22.18	33.84	**< 0.001**	5.87	7.23	4.91	10.65	**< 0.001**	23.28	19.78	14.73	26.56	**< 0.001**	23.32	28.11	23.37	33.81	**< 0.001**
Residence Type	*Urban (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	Rural	0.86	1.06	0.94	1.19	0.30	0.98	1.20	0.92	1.57	0.17	1.00	1.29	1.10	1.52	**0.001**	0.90	1.12	1.01	1.24	**0.028**
Education	*Illiterate (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	Low	0.76	0.39	0.34	0.44	**< 0.001**	0.73	0.47	0.36	0.62	**< 0.001**	0.78	0.39	0.33	0.46	**< 0.001**	0.73	0.37	0.33	0.41	**< 0.001**
	Diploma	0.76	0.30	0.26	0.34	**< 0.001**	0.64	0.35	0.26	0.46	**< 0.001**	0.67	0.26	0.22	0.31	**< 0.001**	0.64	0.26	0.23	0.29	**< 0.001**
	Higher Education	0.88	0.35	0.28	0.42	**< 0.001**	0.64	0.31	0.20	0.49	**< 0.001**	0.76	0.28	0.21	0.36	**< 0.001**	0.78	0.30	0.25	0.36	**< 0.001**
WSI categories	*Low (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	Moderate	0.93	0.75	0.67	0.84	**< 0.001**	1.11	0.91	0.71	1.15	0.44	0.95	0.73	0.63	0.84	**< 0.001**	1.00	0.77	0.70	0.86	**< 0.001**
	High	0.84	0.57	0.51	0.65	**< 0.001**	0.84	0.55	0.42	0.72	**< 0.001**	0.94	0.55	0.47	0.64	**< 0.001**	0.90	0.57	0.52	0.64	**< 0.001**
Ethnicity groups	*Fars (reference)*	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-	1	1	-	-	-
	Azari	2.91	2.61	2.21	3.07	**< 0.001**	4.44	4.64	3.31	6.51	**< 0.001**	1.35	1.15	0.41	3.27	0.78	3.00	1.75	0.98	3.11	0.057
	Arab	3.10	2.72	2.27	3.27	**< 0.001**	1	1	-	-	-	1.54	1.32	0.22	7.69	0.75	1.54	1.54	0.91	2.60	0.10
	Guilak	1.96	1.61	1.36	1.91	**< 0.001**	1.29	1.28	0.88	1.85	0.19	1.72	1.40	0.51	3.83	0.50	1.78	1.65	1.06	2.56	**0.02**
	Others	2.25	1.77	1.29	2.42	**< 0.001**	1.99	1.89	0.98	3.64	0.054	1.75	0.02	0.00	0.22	**0.001**	1.84	2.24	1.68	2.97	**< 0.001**

Table 4. Multiple logistic regression models of the risk factors associated with types of cataracts.

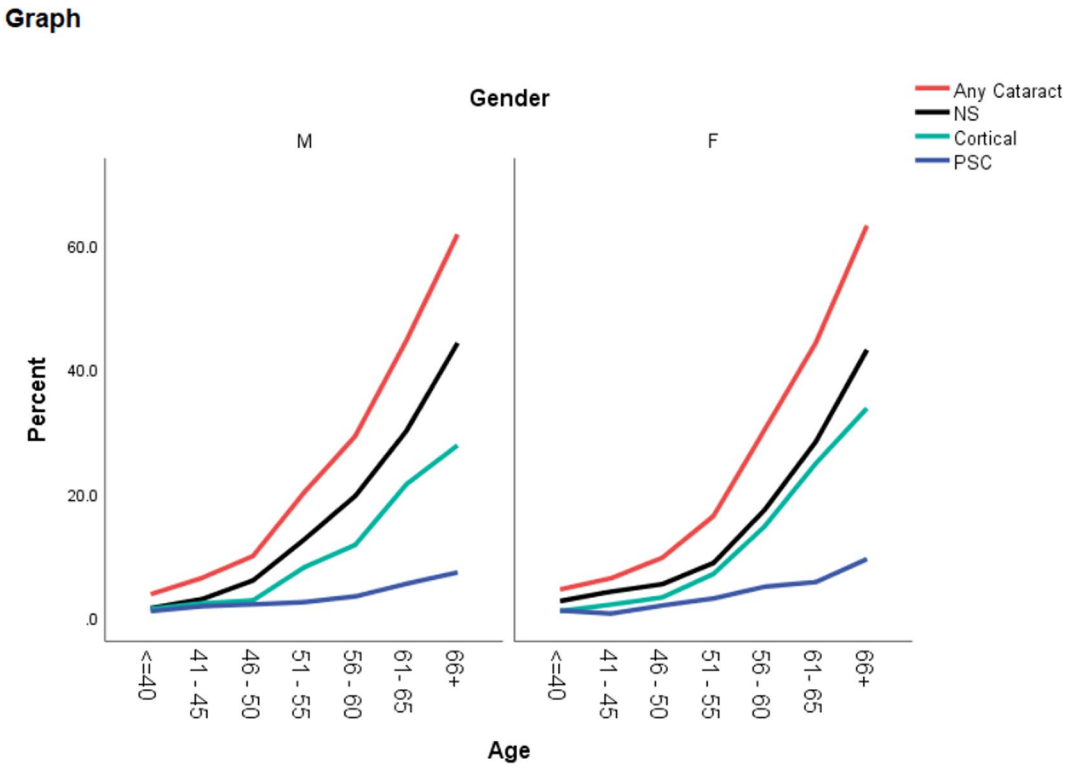

Fig. 1. Distribution of cataracts among different age groups between two genders.

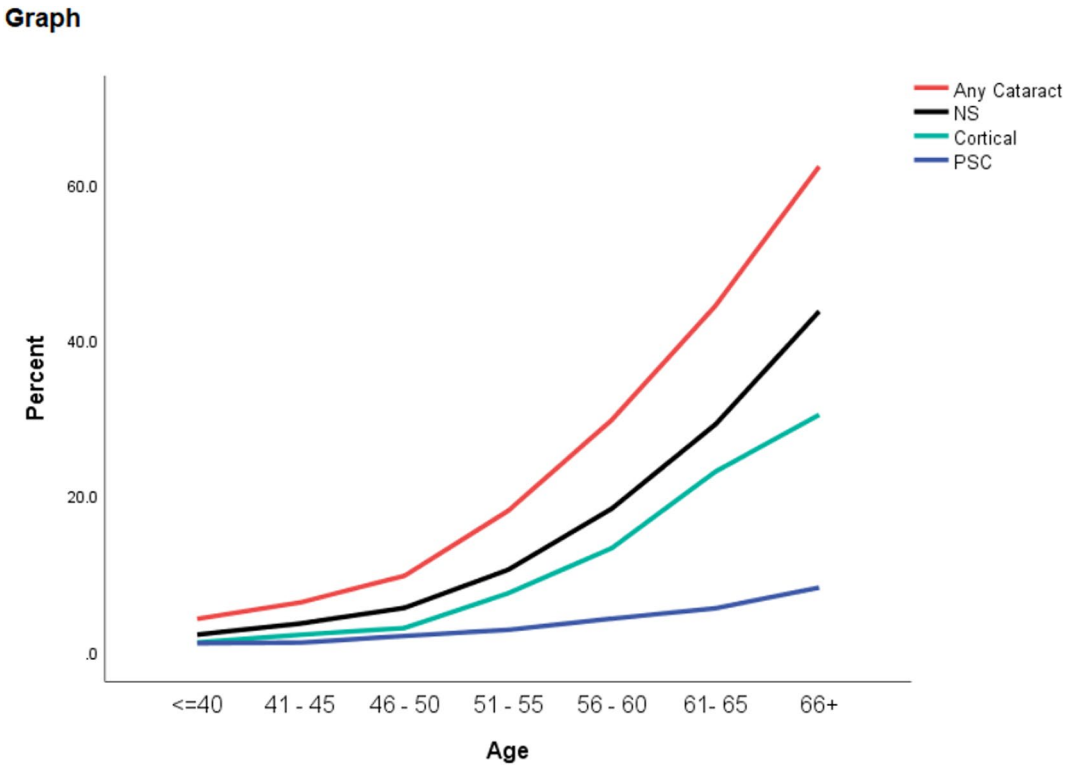

Fig. 2. Distribution of different cataracts across age groups.

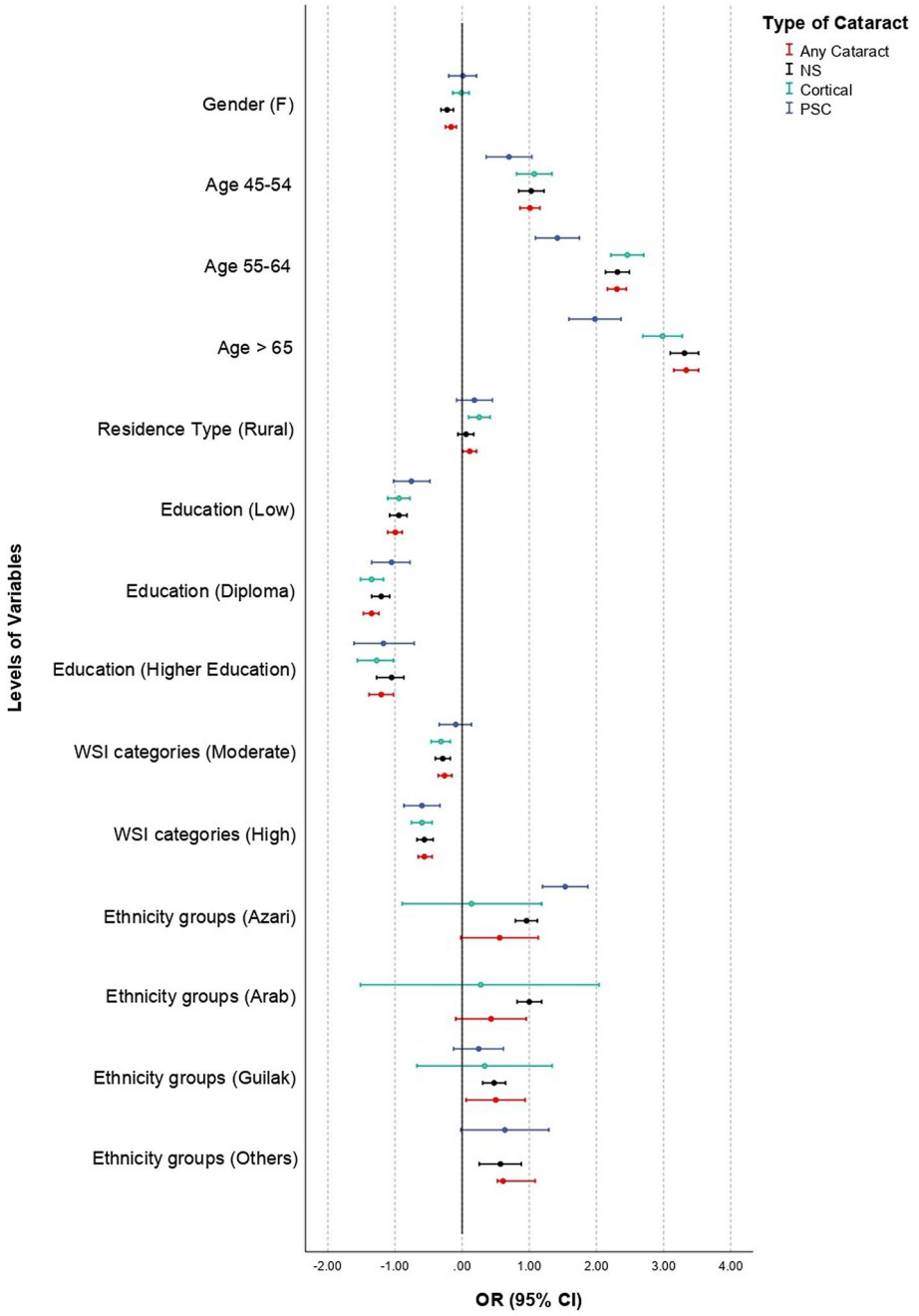

Fig. 3. Correlation between demographic and socioeconomic variables and the occurrence of specific cataract types.

bias, but cultural differences such as women's activities in outdoor environments and existing genetic differences can also be involved in justifying such differences.

Examining the difference in cataract prevalence in urban and rural communities shows different results. The results of adjusted multiple logistic regression analysis indicated that the prevalence of any type of cataract and cortical cataract was higher in the rural population than in the urban population. Singh et al. similarly, showed that the Indian rural group was at a higher risk of developing cataracts[50]. However, the results of the INDEYE study did not show a significant difference in the urban and rural groups[51].

Consistent with findings from other research, our study revealed that the prevalence of cataracts tends to rise with lower levels of education, socioeconomic status, and income[52,53]. In a study, DENG et al. pointed out the role of low socioeconomic status in increasing the prevalence of cataracts and considered the increase in UV exposure to be a determining factor in this process[54]. On the other hand, other studies also consider the decrease in income to be in line with the increase in the prevalence of cataracts, the main hypothesis being the decrease

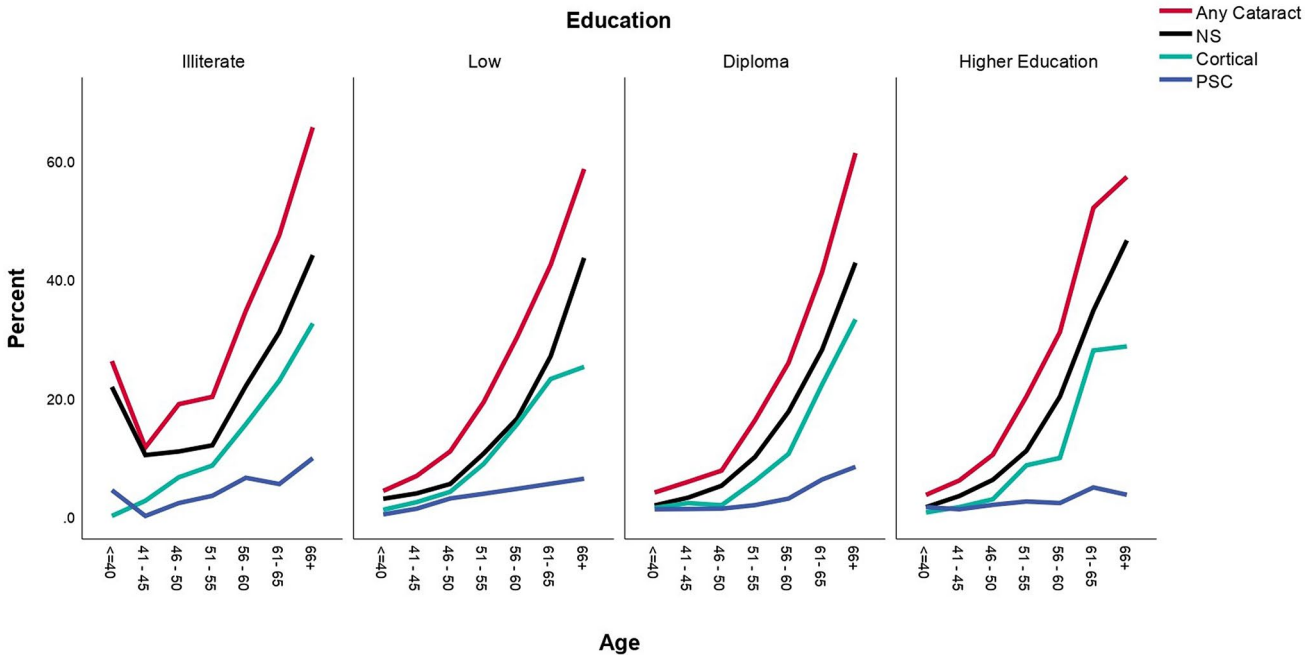

Fig. 4. Distribution of cataract types across different age groups, stratified by WSI categories.

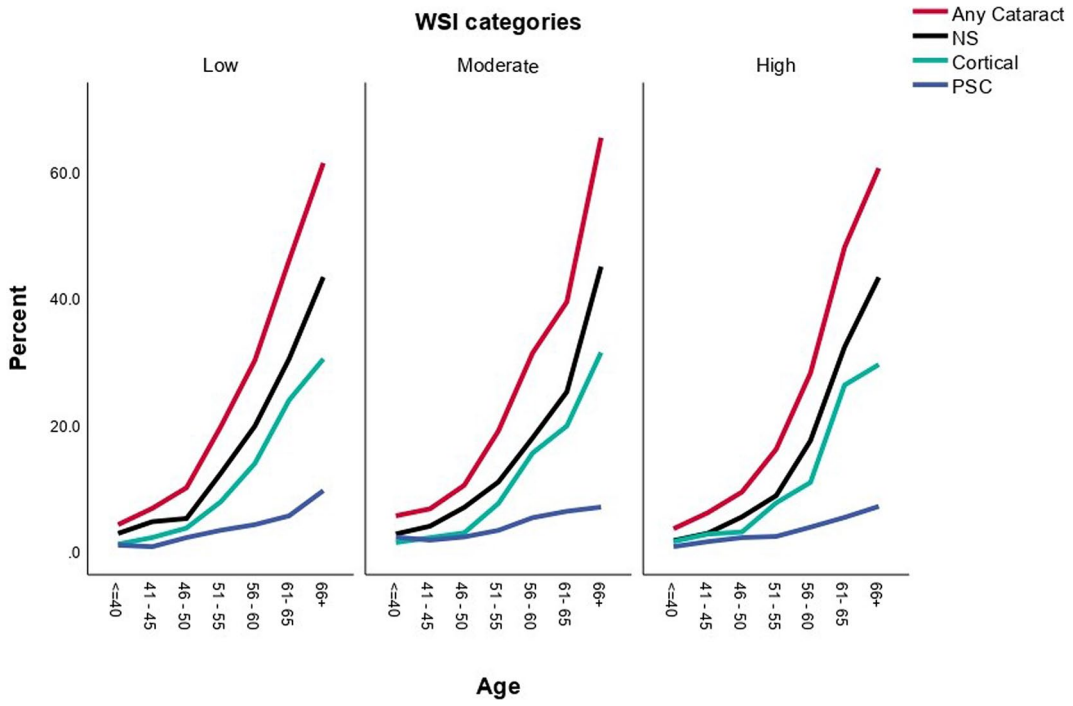

Fig. 5. Distribution of cataract types across age groups, categorized by education level.

in the intake of minerals and the poor nutritional status, as well as the harder occupational conditions of this group[55,56].

To the best of our knowledge, our study is the first that examines the effect of different races in the Iranian population on the prevalence of cataracts, and the results indicate that the prevalence of cataracts is higher in the Azari, Arab, and Guilak races, respectively compared to the dominant Farsi race. Different ethnicities and climates cause different cultural habits and lifestyles, which could result in various exposures among the people of Iran. This could be reflected in different patterns of systemic and ophthalmic diseases throughout Iran[19].

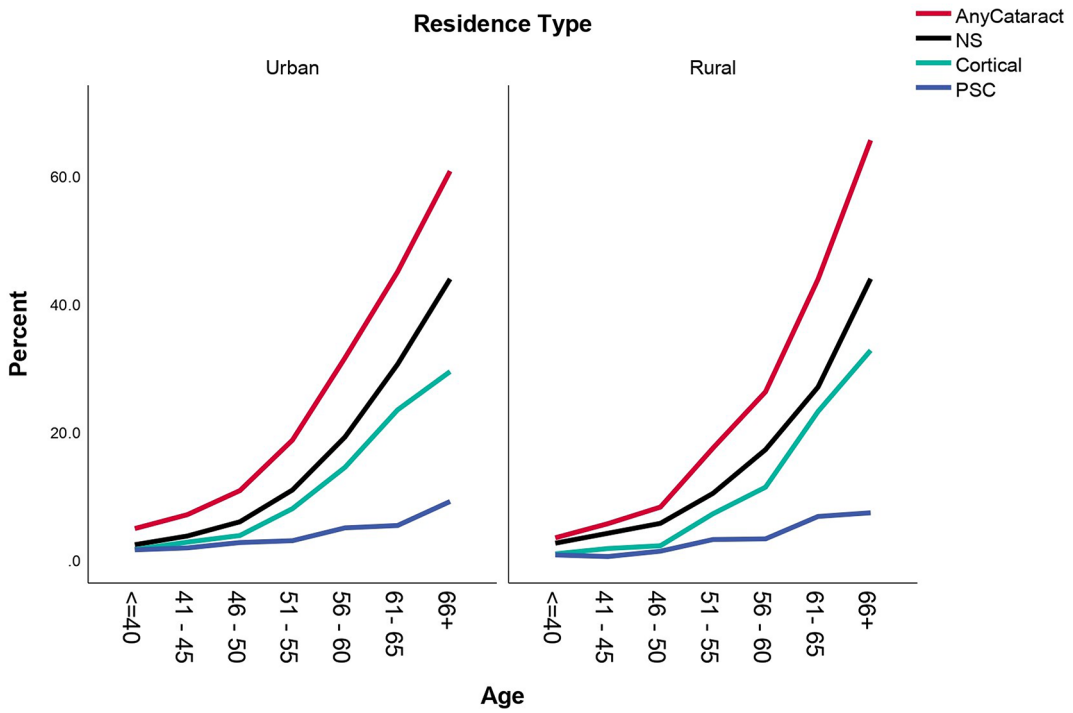

Fig. 6. Distribution of cataract types across age groups, compared between urban and rural residence types.

Initially, the PECS was intended to be a cohort study; however, in this study, the results of the initial phase have been presented exclusively in the context of a cross-sectional study. The development of the COVID-19 pandemic slowed down the progress of the second phase of this cohort project. Ideally, in the context of a comprehensive cohort study, we would have monitored progression over time. Further efforts should be made to continue the patient follow-up process to monitor the progress of cataracts and apply correct and timely treatment when it is appropriate. Other limitations of the study include the non-participation of some provincial centers (2 centers) in providing information related to the participants' cataracts, which led to not including all Iranian races (Balouch and Zaboli) in the final analysis. In addition, due to differences in sample size, examination methods, and definitions, it is difficult to compare different population-based studies. Additionally, our study did not include individuals below 35 years of age. As a result, data on younger age groups (e.g., 20–30 years) were not collected, limiting our ability to assess early-onset cataract prevalence.

Conclusion

In conclusion, our study concluded that the overall prevalence of cataracts and all its subtypes in Iran is higher than the average global prevalence. Nuclear sclerosis is the most common type of cataract in Iran. The prevalence of cataracts increases exponentially with increasing age, and men are at a higher risk than women. The prevalence of any type of cataract and cortical subtype is higher in rural than urban populations, and the risk of developing cataracts decreases with an increase in education level and socioeconomic status. Some Iranian races such as Arabs, Azari, and Guilak are also at a higher risk of cataract.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Author contributions

Fateme Alipour, Fateme Jafari, Parisa Abdi, and Mehran Rezakhani conducted the project. Hasan Asadigandomani and Fateme Moosayi wrote the manuscript, while all authors participated in data collection. Mehdi Yaseri analyzed the data.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Correspondence and requests for materials should be addressed to P.A.

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