• Investigation •

Uncorrected refractive errors are important causes of avoidable visual impairment in Hungary: re-evaluation of two existing national data sets

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Abstract

● **AIM:** To review existing data for the prevalence of corrected, uncorrected, and inadequately corrected refractive errors and spectacle wear in Hungary.

● **METHODS:** Data from two nationwide cross-sectional studies were analysed. The Rapid Assessment of Avoidable Blindness study collected population-based representative national data on the prevalence of visual impairment due to uncorrected refractive errors and spectacle coverage in 3523 people aged ≥50y (Group I). The Comprehensive Health Test Program of Hungary provided data on the use of spectacles in 80 290 people aged ≥18y (Group II).

● **RESULTS:** In Group I, almost half of the survey population showed refractive errors for distant vision, about 10% of which were uncorrected (3.2% of all male participants and 5.0% of females). The distance spectacle coverage was 90.7% (91.9% in males; 90.2% in females). The proportion of inadequate distance spectacles was found to be 33.1%. Uncorrected presbyopia was found in 15.7% of participants. In all age groups (Group II), 65.4% of females and 56.0% of males used distance spectacles, and approximately 28.9% of these spectacles were found to be inappropriate for dioptric power (with 0.5 dioptres or more). The prevalence of inaccurate distance spectacles was significantly higher in older age groups (71y and above) in both sexes.

● **CONCLUSION:** According to this population-based data, uncorrected refractive errors are not rare in Hungary. Despite recent national initiatives, further steps are required to reduce uncorrected refractive errors and associated negative effects on vision, such as avoidable visual impairment.

● **KEYWORDS:** refractive errors; uncorrected refractive errors; spectacle wear; inaccurate spectacles; visual impairment

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INTRODUCTION

Refractive errors impact a large proportion of the population. Myopia affects around 2.6 billion individuals worldwide, whereas presbyopia affects approximately 1.8 billion[1]. According to a comprehensive review and Meta-analysis, the estimated pool prevalence (95%CI) of myopia and hyperopia in adults by World Health Organization area Europe is 27.0% (22.4%–31.6%) and 23.1% (6.1%–40.2%), respectively[2].

Recently, a new emphasis has been given on uncorrected refractive errors by the World Health Organization, World Report on Vision[1-4]. Uncorrected refractive errors are the leading cause of avoidable vision impairment worldwide, especially moderate and mild visual impairment (EVI)[1-4]. In Europe, the contribution of uncorrected refractive errors to blindness among adults aged 50y and older was estimated to be between 12.4% and 13.1%, which is lower than the global

average of 20.3%, but did not change from 1990 to 2015[5]. Uncorrected refractive errors contributing to moderate or severe vision impairments in Europe was more frequent, 48%–49%, in 1990 and 2015, which is close to the global average[5]. Unfortunately, relatively little European population-based statistics on blindness and visual impairment are available, and even less on the effect of uncorrected refractive errors[5-7]. Our team performed a Rapid Assessment of Avoidable Blindness (RAAB) survey and published the general results[6]. Refractive errors were found to be the second leading cause of moderate visual impairment (MVI) and EVI in 23.9% and 40.7% of participants, respectively[6]. Altogether, 44.0% of people used distance spectacles (37.4% of males and 47.7% of females) and 84.3% had reading spectacles (80.8% of males and 86.3% of females)[6].

Hungary is a nation in Central and Eastern Europe with an upper-middle-income. In Hungary, almost every permanent resident has access to state health insurance. Certain generic medicinal supplies, however, are not fully covered by public health insurance. Access to spectacles is difficult for those with lower socioeconomic position in Hungary, for example, because it is not covered by the National Health Insurance Fund at any level.

In this paper, we present statistics on the spectacle-wearing population in Hungary, as well as the consequences of uncorrected and inaccurately corrected refractive errors in the country, based on the datasets of two independent and comprehensive national surveys. These two studies were not specifically designed for this purpose, but, considering the scarcity of data on uncorrected refractive errors in Europe, may still provide us an insight in the magnitude of this cause of visual impairment in Hungary.

SUBJECTS AND METHODS

Ethical Approval This study was reviewed by an independent Ethical Review Board and conformed to the principles and applicable guidelines for the protection of human subjects in biomedical research. The Regional and Institutional Committee of Science and Research Ethics of Semmelweis University granted ethical permission for this RAAB study (TUKEB 234/2014). Written informed consent was obtained from all participants.

The National Public Health and Medical Officer Service granted permission (operating licence number: ÁNTSZ 2380–5/2010) to the Comprehensive Health Test Program of Hungary from to 2010–2020. Data collection did not include any personal identification data, and the participants volunteered to participate in the screening examinations, which implied consent.

Data from two nationwide cross-sectional data collections were re-analysed. Both studies were conducted in accordance with the tenets of the Declaration of Helsinki.

Data Collection I (Group I) A population-based, nationwide RAAB study was performed in Hungary according to the standardised RAAB6 protocol in 2015. The study details, including sample size calculation, have been described in earlier publications[6,8]. Briefly, a total of 105 clusters of 35 persons were included, chosen using systematic sampling with a probability proportionate to size from a sample frame consisting of all census enumeration areas of the country. In total, 3675 eligible participants aged 50y or older were in the survey, of whom 3523 were examined (participation rate: 95.9%)[6,8]. Among the examined participants there were 2250 females (63.9%) and 1273 males (36.1%)[6,8]. The age distribution of the participants was similar to that of the Hungarian population in both sexes; however, the age group of 50-59y was somewhat underrepresented in the sample (by 8.7% in males and 5.9% in females), while the age group of 70-79y was overrepresented (by 7.3% for males and 4.9% for females)[6,8].

Definitions Used in the RAAB6 Protocol and in this Article Refractive error: Phakic eyes with visual acuity <6/12, improving with pinhole or optical correction to 6/12 or better. Uncorrected refractive errors: visual acuity with presenting correction less than 6/12 if it improves with pinholes. Presbyopia: Loss of accommodation of the lens due to aging resulting in refractive errors. The RAAB6 protocol assumes that everyone above the age of 50 has presbyopia (P). Corrected presbyopia (CP) is defined as every participant wearing reading spectacles or having multifocal-CP. The number of uncorrected presbyopes (UCP) is calculated by subtracting the number of people with corrected presbyopia from the total number of participants (UCP=P−CP).

EVI: Visual acuity between <6/12 and 6/18 in the better eye with presenting correction.

MVI: Visual acuity between <6/18 and 6/60 in the better eye with presenting correction.

Spectacle coverage: Number of people in the sample with distance spectacles and presenting with a visual acuity of 6/18 or better/number of people in the sample with distance spectacles and presenting visual acuity of 6/18 or better + number of people presenting visual acuity <6/18 and no distance spectacles.

The distance vision effective refractive error coverage (eREC) calculation was as follows: eREC=100×A/(A+B+C), where A=individuals who present with spectacles or contact lenses for distance (or have a history of refractive surgery) and whose presenting visual acuity (PVA) is ≥6/12 in the better eye (met need); B=individuals who present with spectacles or contact lenses for distance (or have a history of refractive surgery) and whose PVA was <6/12 in the better eye, but who improve to ≥6/12 on pinhole or refraction (undermet need);

Table 1 Number of people in the sample with refractive error, uncorrected refractive error and uncorrected presbyopia and their prevalence *n* (%)

Parameters	Males	Females	Total
Total refractive error	505 (39.7)	1148 (51.0)	1653 (46.9)
Uncorrected refractive error	41 (3.2)	113 (5.0)	154 (4.4)
Uncorrected presbyopia	245 (19.3)	309 (13.7)	554 (15.7)

and C=individuals with PVA<6/12 in the better eye who do not have correction and who improve to ≥6/12 on pinhole or refraction (unmet need). PVA=presenting visual acuity means if spectacles or contact lenses are worn to the assessment, and visual acuity is measured with the person wearing them[9].

Data Collection II (Group II) The nationwide Comprehensive Health Test Program of Hungary 2010–2020 included eye examinations and spectacle-wearing data of 80 290 people aged 18y and older who participated in the nationwide screening between 2014 and 2019[10]. Among the participants, there were 42 121 females (52.5 %) and 38 169 males (47.5%). Their age distribution was similar to the national demographic distributions, but the age group of 30–44y in both sexes was somewhat overrepresented in the sample (by about 8%), the age group of 60–74y was underrepresented (by about 10%)[11]. Participants enrolled voluntarily for this database, which may have impacted the outcomes. However, from an ophthalmic standpoint, the risk of sample bias should be minimal (please read the "Limitations" section below)[11]. In the survey, questions were asked about spectacle wear. Trained personnel performed autorefractometry and spectacle lens power measurements. The match or mismatch was recorded between the refraction of the eye and the dioptric power of the actual distance spectacles, which was measured using a calibrated PRK-6000 Auto Ref-Keratometer (Potec, Daejeon, Korea) without pupillary dilatation and PLM-6100PD Auto Lensmeter (Potec, Daejeon, Korea), respectively. The refractometer measured each eye three times automatically and derived the unweighted arithmetic means. A match was considered if the difference was less than 0.5 diopters on both sides, and a mismatch if it was greater than this on either side.

Statistical Analysis Statistical analysis was performed using Statistica 8.0 (StatSoft Inc., Tulsa, OK, USA). The Chi-square test was used for differences in the proportions of categorical variables. Statistical significance was set at 0.05.

RESULTS

The nationwide RAAB study (Group I) showed that almost half of the study population (46.9%) had refractive errors, and 9.3% of which were uncorrected (Table 1). The percentage of people with refractive errors and uncorrected refractive errors was 1.3–1.6 times higher among females than among males (odds ratio: 1.28 and 1.56; Chi-square P<0.001 and =0.012, respectively); however, UCP was less frequent in females (odds ratio: 0.71; Chi-square P<0.001).

The distance spectacle coverage was 90.7% (91.9% in males; 90.2% in females). Among people with visual impairments (MVI or EVI) due to refractive errors, 66.9% had no spectacles (people with no correction), but 33.1% wore their own spectacles during the screening (people with inaccurate correction). The calculated distance vision eREC was 88.9%. UCP was found in 15.7% of participants (Table 1). Overall, 9.2% of patients with MVI or EVI due to uncorrected refractive errors had undergone cataract surgery and had implanted intraocular lens.

In the total population examined in the nationwide RAAB study (Group I), spectacle wearing for both distance and reading was significantly more frequent in the age groups of 64–74y than in the younger (Chi-square, P<0.001) or older generations (Chi-square, P<0.001, normal distribution type, Figure 1). Between the younger (50–59y) and older (75y and older) age groups, there was a significant difference in wearing spectacles for distance (P<0.001); however, there was no such difference in reading spectacles (Chi-square, P=0.725).

Analysis of the data from the Comprehensive Health Test Program of Hungary 2010–2020 (Group II)[10], we found that more female participants (65.4%) wore distance spectacles than males (56.0%, Chi-square, P<0.001). Spectacle wearing increased by roughly 19% on average from the age group of 18–29y to the age group of 60–74y, then fell by around 5% until the age group of 75y and above (not symmetric bimodal distribution type, Figure 2). Young generations (18–40 years of age) wore distance spectacles less frequently than older generations (56y and above) in both sexes (Chi-square, P<0.001).

The percentage of inaccurate spectacles was 28.9%, similar in males (29.3%) and females (28.5%), and it was the lowest in the 46–55 years old group (Chi-square, P<0.001, bimodal distribution type, Figure 3). In the older age groups (71y and above), the prevalence of inaccurate spectacles was significantly higher than that in the youngest age groups (18–35y, Chi-square, P<0.001 for females and Chi-square, P=0.013 for males). Among those who had a driving licence, the frequency of potentially inaccurate spectacles was even higher, 40.6% (similar in males and females).

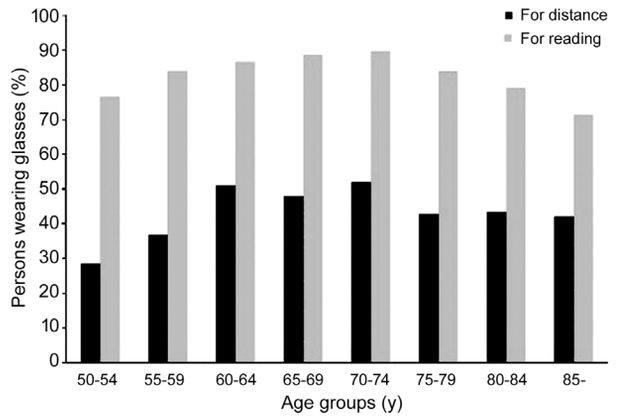

Figure 1 Percentages of people using spectacles for distant vision and for reading in the different age groups (Group I).

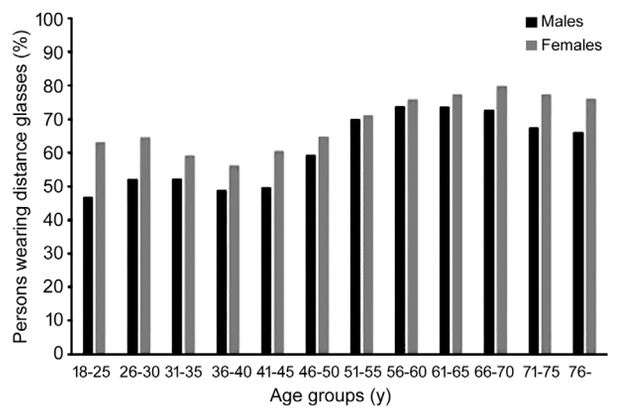

Figure 2 Percentages of people using spectacles for distant vision in different age groups in both sexes (Group II).

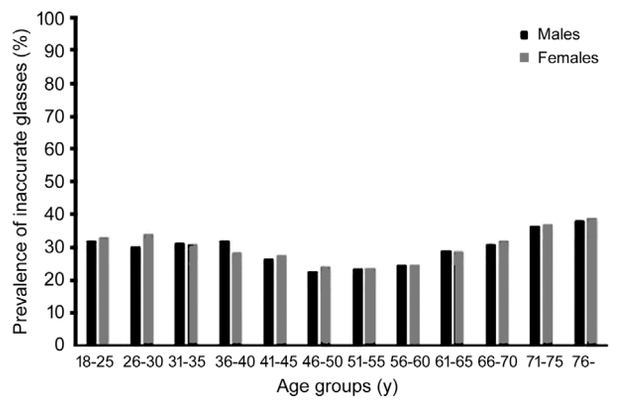

Figure 3 Percentage of inaccurate spectacles among the presenting spectacles in different age groups and sexes (Group II).

DISCUSSION

The main results of our two surveys show in agreement that a considerable proportion (44.0%–61.1%) of people have spectacles for correcting their refractive errors in Hungary. Despite the relatively high economic state of the country, a large proportion of the population (between 29% and 33%) suffers from incorrect correction or no correction of their refractive errors.

Both of the two groups analysed here showed that more than half of the participants (61.1%) had spectacles or wear spectacles (44.0%) for far distance[6]. These ratios were somewhat higher among females than males (by 9.4% and 9.7%, respectively). Similar results were found in a German survey of people aged 20–69y, where 54.1% of the participants were habitual spectacle wearers[12], although other German data showed even higher use of visual aids: 64.8% in people aged 35–74y[13], and 68.7% in subjects over the age of 16y (63.4% had spectacles, 5.3% wore contact lenses)[14].

In both of our two groups, we found that the proportion of inaccurate distance spectacles might be as high as 29%–33%. This means that both the missing correction and the inaccurate correction of refractive errors contributed significantly to the emergence of uncorrected refractive errors (by approximately 70% and 30%, respectively).

The World Health Organization has advocated that eREC serve as ideal indicator for tracking progress in the uptake and quality of eye care services, as well as overall progress toward universal health coverage[15]. At the 74th World Health Assembly in May 2021, WHO Member States endorsed global objectives for 2030 for this indicator. As a basis of our RAAB survey data, we computed that distance eREC was quite high (88.9%) in Hungary, even slightly higher than in high-income nations (79.1%) and considerably higher than the average value in Central Europe, Eastern Europe, and Central Asia (49.5%)[9].

The percentage of people wearing reading spectacles in both sexes reached above 80% in those aged 50y and older in Hungary[6]. Thus, the UCP was found to be low in our country, and among them, there may be a large proportion of people with myopia (prevalence is 18%–37% in the older generations) [11] who need no correction for reading. Based on this, it is likely that those in need are provided reading spectacles in Hungary.

In Hungary, we found that uncorrected refractive errors were responsible for a high proportion of visual impairments (MVI: 23.9% and EVI: 40.7%), and was the second most common cause of MVI and EVI[6]. This is in accordance with the high prevalence of refractive errors and high percentages of no or inaccurate correction in Hungary. Even after cataract surgery, 9.2% of patients had MVI or EVI due to uncorrected refractive errors. Our results show that despite the relatively high economic state of the country, a high percentage of the population (around 1.2%–2.8%) suffers from visual impairments due to inaccurate or lack of correction. The EPIC-Norfolk Eye Study revealed a comparable rate of uncorrected refractive error in elderly British people (1.9%)[16], whereas the Gutenberg Health Study observed in Germany 3.5% of persons aged 35–74y had uncorrected refractive error[13]. Vision impairing refractive error prevalence (age-sex adjusted) was found similar also in Kyrgyzstan (Northeast: 4.5% and Southwest: 5.8%)[17-18].

Based on these data, uncorrected refractive error is a major cause of national disability and reduces productivity and quality of life, despite the fact that the cure, prescription spectacles, is simple, effective, and inexpensive[19]. The planned correction campaign needs to concentrate on the older population as it has been widely shown that the risk of uncorrected refractive error is 1.8 times higher for each decade of life starting at 40 years of age[20]. In agreement with this, our results showed that the prevalence of inaccurate spectacles was more frequent in older people than in young people.

Uncorrected refractive errors are more frequent in women than in men in Hungary, as they are worldwide[21]. These results highlight the importance of developing a sex-sensitive health policy to address vision loss caused by uncorrected refractive errors[21].

As uncorrected refractive errors cause disability and economic loss at both the personal and national levels, it is important to reduce its burden worldwide and nationally. According to clinical experience and quantitative measures, refractive error has a significant impact on people's quality of life and affects people's psychosocial well-being[22-27]. Even under conservative assumptions, the estimated productivity loss associated with visual impairments from uncorrected refractive errors is substantially greater than the cost of correcting refractive errors[26]. To decrease visual impairments due to refractive errors, not only the recognition of the problem but also the development and implementation of new public health policy are important[28]. Special attention has to be directed to people of older age groups, female sex, and lower socioeconomic status which are associated with higher uncorrected refractive error burden[21,29]. Furthermore, a research found that schoolchildren in urban and suburban residential areas had a 2 to 3 times increased likelihood of developing uncorrected refractive error[30].

Our results showed that appropriate spectacle correction is an important issue even after cataract surgery with lens implantation. Our findings also proved that high percent (40.6%) of people with driving licence had inaccurate spectacles therefore a stricter check-up of spectacles of drivers would be necessary.

There is a need in Hungary to organise education campaigns for the public to increase their awareness of visual impairments and to allow them to recognise missing, inaccurate, or outdated spectacles. The next step would be to increase accessibility to eye examinations and prescription for appropriate correction. Although visual impairment due to uncorrected refractive errors can be easily corrected with spectacles, this problem remains unsolved. Therefore, more effort is needed in the future[31]. Furthermore, a new study suggests that those who wear spectacles on a daily basis may be less susceptible to COVID-19[32].

Our studies have several limitations. Our surveys did not collect data on contact lens wear or previous refractive surgery. Their participation rate in the samples is not known; however, it may be low as the proportion of contact lens wearers among those who need correction in Hungary is only around 2%–5% according to the general opinion of eye care specialists, and that of individuals after refractive surgery is even lower. The unregistered inclusion of contact lens wearers and people after refractive surgeries (in Group I, the RAAB survey) does not interfere with the results of uncorrected refractive errors because they are based on visual acuity with any type of actual correction.

The RAAB study provided population-based nationally representative data, but only for people aged 50y and older, as it concentrates on age groups where visual impairment is the highest. However, the distribution of refractive errors and uncorrected refractive errors is less age-dependent, and younger generations are particularly affected by myopia[11,33-34]. The other survey included a large number of cases and a wider age range (18–99y). However, participants were not statistically randomly selected, which may have biased the results[11]. However, we believe that the sampling risk of bias may be low because the results of the two data collections presented in this report evaluated overlapping topics, and the results and conclusions from the two studies were similar. Thus, based on this coincidence and agreement, the RAAB study validates the data of the other surveys, at least to some extent.

Another limitation of our data analysis was that we were unable to investigate the relationship between additional factors (other than sex) and uncorrected refractive errors since the databases did not include such sociodemographic and ophthalmologic variables. However, the literature indicates that some factors, such as living alone, being unable to come to the clinic for an eye exam, believing that the ophthalmologist consultation fee is too expensive, and believing that visual decline is normal with aging, are significantly associated with uncorrected refractive errors in older adults[35].

In conclusion, many people have refractive errors in Hungary, and many people wear spectacles both far and short distances; however, inaccurate spectacles are very frequent, even among drivers. Uncorrected or inaccurately corrected refractive errors cause a large number of visual impairments in Hungary, but almost all of them are avoidable. Educational campaigns may increase population awareness to achieve better correction coverage with accurate lenses in the future.

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