

## Prevalence of strabismus in different age groups in Macedonia

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Original article

Received: 22-Dec-2024

Revised: 26-Jan-2025

Accepted: 28-Jan-2025

Online first: 28-Jan-2025

### Abstract

**Aim:** To investigate the prevalence of strabismus by age groups in Caucasian Macedonian population.

**Methods:** A study population of 1900 patients (aged 0-86 years) from the capital city, Skopje, Macedonia, were analysed in a secondary health institution in the central urban area. Ophthalmological examination included: visual acuity, slit-lamp biomicroscopy, autorefractometry, and ocular motility examination.

**Results:** In our retrospective cohort (1900), 60 patients did have strabismus (3.2%). The highest prevalence of strabismus was in primary school children (10-14 years- 20.2 %; 0-4 years- 16.2 %; 15-19 years- 11.8% and 5-9 years- 8.6%). Our adult population showed results similar to Caucasian Danish population with prevalence of strabismus of 0.7% (age group 50-54 years) and 0.8 % (age group 55-59). The most frequently identified subtype was esotropia (73.3%), followed by exotropia (23.4%) and cyclovertical strabismus (3.3 %).

**Conclusion:** The overall prevalence of strabismus on Macedonian cohort was 3.2%. Our results on primary school children are much higher than other studies on Caucasian and Asian population, but similar to prevalence in the population in Saudi Arabia. The most prevalent type of strabismus was esotropia (73.3%). Regarding gender distribution, both esotropia and exotropia were more frequent in males.

**Keywords:** strabismus, prevalence, Caucasians, Macedonia, esotropia, exotropia

**Citation:** Ljubic, A., Neely, D., Todorovski, V. (2025). Prevalence of strabismus in different age groups in Macedonia. Journal of Health and Rehabilitation Sciences. Advance online publication.

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## 1. Introduction

Strabismus is a misalignment of the visual axes that commonly affects 2-3% of the population and can lead to loss of binocular vision. Males and females generally have the same prevalence of horizontal strabismus, including divergent strabismus (exotropia) (Laughton et al., 2023).

According to the American Association for Pediatric Ophthalmology and Strabismus, 4% of children in the United States suffer from strabismus (Fierson, 2018). The prevalence of strabismus in Saudi Arabia among children between 1 and 14 years of age was 11.8%. (Danish et al., 2015). Among the Saudi Arabian strabismic surgical population, the most prevalent type of strabismus was convergent strabismus (esotropia) at 69.3%, whereas exotropia accounts for 26.9% (Curtis et al., 2010). In a retrospective cohort study from the United States the prevalence of strabismus in 10 years, was 60.1% for esotropia and 32.7% for exotropia (Mohney, 2007). Strabismus impacts on vision-related quality of life (Hultman, 2019; Yoon, 2011), and had negative sensory and social effects, as amblyopia, impaired depth perception, reduced academic or work performance etc.

Early screening programs, diagnosis and appropriate treatment of strabismus should be medical goals while it will improve vision-related quality of life and will achieve better academic and work performance (Hashemi et al., 2019).

There is a need for more systemic screening programs, especially in developing countries such as Macedonia (Faghihi, 2012).

Risk factors that can lead to the development of strabismus includes family history, refractive error, prematurity, and poor vision for any reason (Cotter et al., 2011). In our retrospective cohort study on the Caucasian Macedonian population, we investigated the prevalence of strabismus by age groups and the subtype proportion of esotropia, exotropia, and cyclovertical strabismus.

## 2. Material and Methods

Our study population consisted of 1900 Caucasian Macedonian patients (aged 0-86 years) from the capital Skopje, Macedonia, who were analysed at a secondary health institution- the Department of Ophthalmology, Private Polyclinic Medika Plus, located in the central urban area of Skopje. Our retrospective study adhered to the tentents of The Declaration of Helsinki and the ethical standards of the procedures were approved by the institution where the study was performed (Medika Plus Polyclinic, Skopje, Macedonia).

Confidentiality of data was safeguarded in the National Health System by user and password entering. All subjects included in the study signed written consent. The study data was collected by the authors themselves (A. Lj.). All patients underwent ophthalmological examination over an 8-month period (from

October 1, 2014, to January 31, 2015, and December 1, 2023 to March 31, 2024). Patients were recruited from the general practitioners and pediatricians in Skopje, as routine preventive eye examinations were included. During this period all individuals with various types of strabismus were registered, including convergent strabismus (esotropia), divergent strabismus(exotropia) and cyclovertical strabismus. The prevalence of strabismus was defined as the proportion (%) of strabismus cases within cohort of the Macedonian population (1900 subjects).

The population cohort was divided into 18 distinct age subgroups (0-4 years; 5-9 years; 10-14 years; 15-19 years; 20-24 years; 25-29 years; 30-34 years; 35-39 years; 40-44 years; 45-49 years; 50-54 years; 55-59 years; 60-64 years; 65-69 years; 70-74 years; 75-79 years; 80-84 years; and >84 years).

Ophthalmological examinations of the patients included: visual acuity, examination of the anterior ocular segment, autorefractation, and ocular motility examination. Uncorrected visual acuity and best corrected visual acuity were measured by a logarithmic E chart (Geohide 955-95-43, Germany). An examination of the anterior segment of the eye was performed by slit-lamp biomicroscopy (Topcon slit lamp SL- 1E, Tokyo, Japan).

Autorefractation and curvature radius measurements were performed using photorefractation (Auto Ref-Keratometer PRK-5000, Potec, Daejeon, Korea). Alignment of the eyes was evaluated for distance fixation using Hirschberger's corneal reflex method, and cover test.

A cover test was also performed using an accommodative fixation target. Both distance and near ocular alignment were tested with optical correction, if prescribed. Deviation from the straight position was classified as esodeviation (esotropia), exodeviation (exotropia) or cyclovertical deviation.

## 3. Results

The number of subjects in the sample was 1900, and all patients were Caucasians, 53.5 % male and 46.5 % female.

According to age, the patients were divided into 18 groups (Table 1). Sixty (60) of them had strabismus, with an overall prevalence of 3.2% for the study population.

Demographic characteristics as well as the prevalence of strabismus in different age groups are presented in Table 1.

Strabismus was most prevalent in the 10-14 years age group (20.2%), followed by the age groups 0-4 years (16.2 %) and 15-19 years (11.8 %). The prevalence of different forms of strabismus (esotropia, exotropia, cyclovertical strabismus) by age group, are presented in Table 2. Esotropia was the most frequent form of strabismus in our study group (with 73.3 %), while exotropia was present in 23.4%, and cyclovertical strabismus in 3.3 %.

**Table 1:** Prevalence of strabismus in Caucasian Macedonian cohort

Age group, (years)	Patients (n)	Mean age, (years)	Gender male/female (%)	Strabismus patients, (n)	Prevalence Strabismus (%)
Whole sample	1900	44.5	53.5/46.5	60	3.2
0-4 y	37	2.5	45.9/54.1	6	16.2
5-9 y	58	7.1	43.1/56.9	5	8.6
10-14 y	84	11.8	52/48	17	20.2
15-19 y	143	17.5	59.4/40.6	17	11.8
20-24 y	93	21.3	52.7/47.3	3	3.2
25-29 y	102	27.1	58.8/41.2	2	1.9
30-34 y	100	32.1	69/31	5	5.0
35-39 y	96	37.2	66.7/33.3	1	1.0
40-44 y	155	43.1	60.6/39.4	1	0.6
45-49 y	146	47.2	57.2/42.8	0	0
50-54 y	145	53.4	62.8/37.2	1	0.7
55-59 y	133	56.9	42.9/57.1	1	0.8
60-64 y	138	62.3	49.3/50.7	0	0
65-69 y	142	67.0	51.4/48.6	0	0
70-74 y	130	72.3	38.5/61.5	0	0
75-79 y	126	75.9	49.2/50.8	0	0
80-84 y	47	81.4	46.8/53.2	1	2.1
<b>&gt;84 y</b>	<b>25</b>	<b>84.1</b>	<b>56/44</b>	<b>0</b>	<b>0</b>

**Table 2:** Distribution of different subtypes of strabismus in Caucasian Macedonian cohort (60)

Age group, (years)	Strabismus patients, (n)	Esotropia, n (%)	Exotropia, n (%)	Cyclovertical strabismus, n (%)
Whole sample	60	44(73.3)	14(23.4)	2(3.3%)
0-4 y	6	5	1	0
5-9 y	5	2	2	1
10-14 y	17	14	2	1
15-19 y	17	13	14	0
20-24 y	3	3	0	0
25-29 y	2	1	1	0
30-34 y	5	3	2	0
35-39 y	1	0	1	0
40-44 y	1	1	0	0
45-49 y	0	0	0	0
50-54 y	1	1	0	0
55-59 y	1	0	1	0
60-64 y	0	0	0	0
65-69 y	0	0	0	0
70-74 y	0	0	0	0
75-79 y	0	0	0	0
80-84 y	1	1	0	0
<b>&gt;84 y</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

In the strabismus group (n=60), 44 (73.3 %) had esotropia. Two of them (2/44) were surgical infantile esotropia (ETI), 24/44 had alternating esotropia, 15 /44 had monocular esotropia and 3/44 had microstrabismus. In the exotropia group (14/60, 23.4 %), 9/14 had intermittent exotropia and 5/14 had constant monocular exotropia (including 1 Exotropia operata). In the group of cyclovertical strabismus with hypertropia,

only 2/60 (3.3 %) were included and both patients had Paresis n. trochlearis (n. IV). Regarding gender distribution, in the Esotropia group (44), 29 patients were male and 15 female. In the exotropia group, 9 patients were male and 5 female. In the group of cyclovertical strabismus, 1 patient was male and 1 was female. In the sex distribution in the esotropia and exotropia group, male gender was dominant.

#### 4. Discussion

The prevalence of strabismus in our Caucasian Macedonian cohort of patients of all ages was 3.2%.

The overall prevalence of strabismus in Japanese nationwide cohort study was 2.2% and 1-year incidence of strabismus was 321 per 100.000 persons (Miyata et al., 2024).

The study showed that exotropia was the most frequent type of strabismus (with 67.3%), while esotropia was the second most frequent (with 23.9%) with an exotropia-to- esotropia ratio 2.8:1. Previous studies (Zhang et al., 2021; McKean-Cowdin et al., 2013; Chia et al., 2010; Matsuo & Matsuo, 2007; Yoon et al., 2011) have also demonstrated that exotropia was higher in the Asian population.

In Caucasian study populations, the frequency of esotropia was higher than that of exotropia (Fiess et al., 2020; Torp-Pedersen et al., 2017; Robaei et al., 2006). There are genetic differences in strabismus subtypes between races, and further studies on genetic and interracial differences in strabismic phenotypes are necessary (Miyata et al., 2024). The high prevalence of exotropia indicates a genetic difference in strabismus between Japanese and other ethnicities.

The largest Japanese population-based study (Miyata et al., 2024) showed a bimodal age distribution of prevalence of strabismus, with a high prevalence in school age (children 5-9 years-6.0%; 10-14years-7.6%; 15-19 years- 5.6%) and in older ages (75-79 years - 2.6%; 80-84 years - 2.7%; 85-89 years - 2.4). A Danish study on children, showed a cumulative incidence of strabismus of 2.56 % at 7 years (Torp-Pedersen et al., 2017). On the other side, study on the Danish adults showed that prevalence of strabismus was 1.1% (Hultman et al., 2019).

United States based- study found manifest strabismus in 3.3 % of Caucasian children and 2.1% of black rase children (Friedman et al., 2009). Another United States based-study on Asian and Non-Hispanic white preschool children showed strabismus prevalence of 3.55% (McKean-Cowdin et al., 2013).

The prevalence of strabismus among 328 primary school children in Saudi Arabia was 21 % (Alnuman et al., 2021). The prevalence of strabismus in studied children and adolescents in Hail city, Saudi Arabia was 17.1% (Alhazimi et al., 2019).

In our Macedonian Caucasian population, the highest prevalence of strabismus was in primary school children (10-14 years (20.2 %); 0-14 years (16.2 %); 15-19 years (11.8%) and 5-9 years (8.6%)). Our results are much higher than other studies on Caucasian and Asian populations, but similar to the prevalence of strabismus in the population in Saudi Arabia.

Our adult population showed similar results to the Caucasian Danish population with the prevalence of strabismus at 0.7% for (age 50-54 years) and 0.8 % (age 55-59). The Macedonian population of patients aged 80-84 years showed a higher prevalence of strabismus of 2.1 % similar to Asian population.

The most frequent subtype of strabismus in the Macedonian strabismic group (60) was esotropia (73.3%), followed by exotropia (23.4%) and less common cyclovertical strabismus (3.3%). Regarding gender distribution, both esotropia and exotropia were more frequent in males.

The prevalence of strabismus varies in different countries and WHO regions. The prevalence of strabismus is higher in western countries and Caucasians compared to Asian ethnicities such as Chinese and Indian people (Hashemi et al., 2019). One in every 50 people had strabismus, which severely affects their quality of life. Information about prevalence of strabismus can help health care planners design proper interventions and screening programs (Hashemi et al., 2019).

It is very important to diagnose and treat strabismus in early stages to achieve maximum best binocular vision (Garcia et al., 2004).

Alobaisi (2022) recommends health education through campaigns and school screening programs about strabismus and its effects at the community level to prevent strabismic amblyopia and its related psychological effects if left untreated.

Considering the medical, social, and psychological impacts of strabismus, there is significant need for relevant information to design plans for screening, early diagnosis, and timely intervention (Hashemi et al., 2019).

##### 4.1 Limitations of the study

This study suffered some limitations. First, the population sample of 1900 patients selected patients who were examined in a secondary health institution (Polyclinic), not in a hospital institution. The Polyclinic is located in a central urban area in the capital Skopje, and most of the examined patients have urban origin, so rural areas were not covered. Second, the distribution of the patients in different age groups was not equal, only 9.4% were children (age group 0-14 years) and most were adults (age group 44-54 years). The children's age groups were small compared to other age groups, and that can affect the prevalence of strabismus.

##### 4.2 Future directions

According to Vision 2020, many countries have different programs for early detection and treatment of some ocular disease, including strabismus (Yang, 1996). Relative to this ,although we expected a decrease in strabismus prevalence in the recent three decades, the results of meta-regression showed no change except for a borderline significant increase of the prevalence of exotropia (Hashemi H et al.,2019).It seems that efforts to control the disease are not yet at a scale to make a difference and there is a need for more systematic screening programs, especially in developing countries such as Macedonia (Faghihi, 2012). Further studies of strabismus prevalence in tertiary health institutions in Macedonia will be of great importance.

## 5. Conclusion

The overall prevalence of strabismus in the Macedonian Caucasian cohort was 3.2%. Our results on primary school children are much higher than in other studies on Caucasian and Asian populations, but similar to the prevalence of strabismus in the population in Saudi Arabia. Our adult population showed similar results to the Caucasian Danish population with the prevalence of strabismus of 0.7% and 0.8%. Only the population aged 80-84 years showed higher prevalence of strabismus (2.1%), similar to Asian population. The most prevalent type of strabismus was esotropia with 73.3%, while exotropia accounted for 23.4%. Regarding gender distribution, both esotropia and exotropia were more frequent in males.

To diagnose and treat strabismus in early stages is important to achieve maximum best binocular vision. Considering the medical, social, and psychological impacts of strabismus, there is need for public health and school screening programs in Macedonia.

## Conflicts of Interest

The authors have no conflicts of interest to declare.

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