



Anisocoria and Pupil-Size Normative Data in Israeli Children

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Abstract

Purpose: The aim of this study is to present the normative data collected by Plusoptix S12 photoscreener, among children in Israeli kindergartens, in order to determine a good estimate of average pupil size and incidence of anisocoria among the pediatric population.

Methods: This is a retrospective study of 101,417 Israeli children between ages 4 - 5 years old, examined using the Plusoptix S12 photoscreener. The examinations were carried out at kindergartens in major cities in Israel. Data collected included age, sizes of both pupils and magnitude of anisocoria obtained between the years 2013 - 2018.

Results: The size of the pupil, in our study group, was measured separately for the right and left eyes. The calculated results were 5.83 mm ± 0.87, and 5.82 mm ± 0.88 respectively. 13.26% (13,448 children) were found with anisocoria ≥ 0.4mm; of these, 6.23% (6,314 subjects) had anisocoria of 0.5 - 0.9 mm, and 0.66% (669 subjects) had anisocoria of > 1.0 mm. There was no difference in pupil size between sexes, or between different cities.

Conclusion: The presented data, which is the largest study group to the best of our knowledge, gives an estimate of normative pupil size, and anisocoria prevalence. Further examinations in other geographic areas and in other age groups should be continued.

Keywords: Anisocoria; Pupil Size; Plusoptix S12 Photoscreener

Introduction

Anisocoria and pupil size have been a subject of interest in ophthalmology for decades. Measuring children's pupil size can be a difficult task due to limited cooperation and pupillary hippus causing inconsistent pupillary size. There are many measurements presented in the literature that have tried to estimate the average pupil size. Results differ from source to source and vary between ages. A notable anisocoria is defined as a pupil size difference of ≥ 0.4 mm in a low ambient illumination environment [1-3]. According to various studies, about 20% of healthy people meet this criterion [1-3].

Our study intended to determine an estimate of average pupil size and incidence of anisocoria in Israeli children, by collecting a large dataset of pupil size surveys using the Plusoptix S12 photoscreener.

Methods

Study design

A retrospective cross-sectional study was used to assess the population group. The original purpose of the examinations was to detect young children with amblyopia and amblyogenic risk factors. Examinations were approved by the Israeli Ministry of Health and took place at kindergartens between the years 2013 - 2018. The examination rooms were adjusted uniformly. The measurements were carried out by placing the child one meter away from the device, in a semi-darkened, minimally illuminated room. Both eyes, with undilated pupils, were measured simultaneously as the child fixated on a "smiling face". The measurements were taken by volunteers from Lions Clubs Israel.

The data was automatically stored in the device's memory, from which we extracted and processed the data needed for our study.

Children who wore glasses and children that did not have parental signed consent form were excluded.

Subjects

We studied 101,417 Israeli children residing in major Israeli cities, aged 4 - 5 years old, by the Plusoptix S12 device. 50.3% were females. The study population represented urban Israeli children.

Variables

Plusoptix S12 device provided measurement values of an undilated pupil size, full refraction recording (i.e. sphere, cylinder, and axis), vector gaze, and interpupillary distance [4]. The device is known to have sufficient sensitivity and specificity [5]. There is a strong correlation between the refractive results received by this device and retinoscopy, which is the gold standard [6].

Ethical issues

Examinations were approved by the Israeli Ministry of Health and the local ethical committees. Informed consent was obtained from all participants’ parents. All data collected is completely anonymous, with no source through which patients or their details can be traced.

Results

Mean pupil size was measured simultaneously for the right and left eyes. Calculated results were 5.83mm ± 0.87, and 5.82mm ± 0.88 respectively.

13.26% (13,448 children) were found with anisocoria ≥ 0.4mm, of these 6.23% (6,314 subjects) had anisocoria of 0.5 - 0.9 mm, and 0.66% (669 subjects) had anisocoria of > 1.0 mm.

We defined anisocoria as a negative or positive value based on which pupil was larger. A negative value refers to a wider left pupil,

and a positive value indicates a wider right pupil. In our study, anisocoria was normally and symmetrically distributed with no significant laterality (Figure 1). There was no difference in pupil size between sexes, or between different cities.

Discussion and Conclusion

Amblyopia is a major visual problem with an incidence of 3 - 5% [7,8], hence the importance of identifying amblyopia and amblyopia risk factors. Photoscreening is commonly used for screening amblyopia [9-14], with the Plusoptix device being one of the instruments suitable for this purpose [15,16]. Because the Plusoptix S12 uses infrared lighting, the pupil size remains unchanged throughout the measuring process, minimizing the effect of hippus. It is also able to measure both pupils simultaneously, making it an ideal instrument to assess pupil size and anisocoria. The examination is objective, simple to perform, and well tolerated by the tested children and their parents.

There have been only a few reports on normative data concerning pupil size, anisocoria and laterality in children. Utilizing an infrared pupillometer, Silbert and colleagues [17] published a series on 1,306 children < 17 years of age (average, 5.4 years). The authors found an average pupil size for 4 - 7 years of 5.92 mm. There was no significant difference in size of left and right pupils. 219 (16.77%) had anisocoria of 0.5 - 0.9 mm, 30 (2.3%) had anisocoria of > 1.0 mm. Boev and colleagues [18] published a series on 90 children < 18 years of age. The authors found average pupillary resting diameter in ambient lighting conditions to be 4.11 mm for 2 - 6 years.

Our study of 101,417 children shows that mean pupil size was 5.83 mm. 6.23% (6,314 subjects) had anisocoria of 0.5 - 0.9 mm, and 0.66% (669 subjects) had anisocoria of > 1.0 mm. Laterality was not statistically significant. In conclusion, the results obtained in our study, both pupil size and anisocoria prevalence, are similar to Silbert and colleagues [17], who also used the Plusoptix device for measurements. Boev and colleagues [18] made their measurements with a different pupillometer, the Neuroptic device, which can explain the difference between the results in our studies.

This study has several drawbacks. It is a retrospective study in nature, relevant to Israeli children, at kindergartens in main cities. Thus, the results might not reflect the general pediatric population. We do not have data regarding the medical status of the children, or medications they may have been taking, which might affect pupil sizes. Yet, it is the largest study group to our knowledge, so it can give a good estimate of pupil size, and anisocoria prevalence.

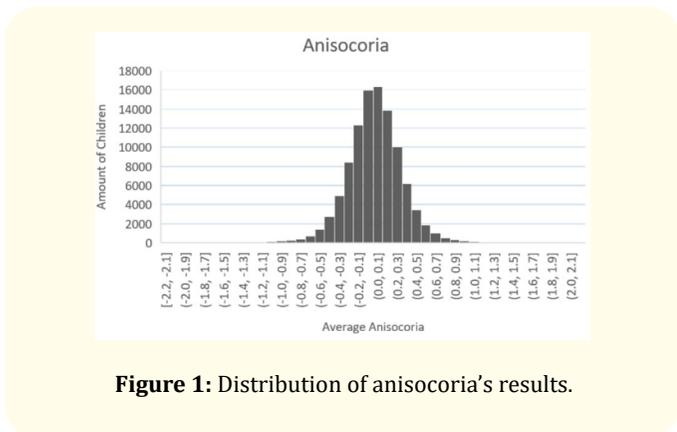


Figure 1: Distribution of anisocoria’s results.

In addition, our examinations focused on a specific age population, 4 - 5 years of age, so we could not check the dynamics of changes throughout the children's maturity. The lack of dark adaptation could represent another potential disadvantage of this study, although Cetinkaya and colleagues [19] reported that photoscreening does not necessarily require dark adaptation. In fact, they reported that after 10 minutes of dark adaptation the mean pupillary diameter decreased. In our study, photoscreening was performed in a semi-darkened uniformly screening room.

Although a pupil size varies under varying ambient lighting, Ettinger and colleagues [20] showed that a tenfold change in luminance caused no more than a 1 mm change in pupil size, implicating that such variability should not significantly affect this study.

More data from other geographic areas and among other age groups is indicated to further establish normative data, so the data could be used worldwide.

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