

The Evaluation of Stereopsis and Its Correlation with Refractive Errors in Iranian 7-Year-Old Schoolchildren

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ABSTRACT

Background and Objective: This study investigates stereopsis and its correlation with refractive errors in Iranian 7-year-old schoolchildren.

Methods: This cross-sectional study included 3,675 first-grade primary school students in seven cities of Iran. The subjects were randomly selected and evaluated after obtaining an informed consent letter from their parents. There were two inclusion criteria: no systemic diseases and no medication use. Refractive errors were examined with an auto refractometer and stereopsis was measured using the TNO test. Data were analyzed by SPSS 21 and using independent t-test, ANOVA, and post hoc tests.

Results: The results of the present study showed that the rate of stereopsis in all students was 43.97 ± 11.75 arcsec and there was a significant difference between the mean of stereopsis in females (43.30 ± 10.62 arcsec) and males (44.59 ± 12.66 arcsec) ($P < 0.001$). There was also a significant difference between different types of refractive errors (myopia, ametropia, hyperopia) and stereopsis ($P = 0.001$).

Conclusion: According to the results of the present study, girls had a better stereopsis rate than the boys. Also, after correction of refractive errors, stereopsis was not the same value in different refractive states, which could be an indication of more attention to stereopsis testing as an indicator of binocular vision performance.

Keywords: Stereopsis, Refractive Errors, Iranian Children

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Introduction

Stereopsis is one of the most important features of binocular vision and is regarded as a barometer of binocularity (Momeni Moghaddam.H 2008). The minimum level of disparity that causes stereopsis is known as stereoacuity, which is in the range of 2-10

arcsec in the best laboratory conditions (Diamond GR 1993; GK, 1990). Stereopsis measurement is used to diagnose binocular anomalies (Momeni-Moghaddam H, 2012). A study conducted in Iran showed that in more than 40% of normal subjects, stereoacuity was 40 arcsec or less, and in people with binocular vision

disorders, this value was more than 40 arcsec (Lam SR, 1996). Refractive errors can reduce the stereopsis. So, stereopsis tests may be used for screening refractive errors in students (Farvardin .M 2004). As stereopsis is a binocular mechanism, any factor that disrupts binocular vision can also affect stereopsis. Binocular vision disorders can be prevented by early diagnosis and treatment, leading to optimal binocular vision and better stereopsis in students for daily activities and education. In Iran, students enter the first grade of primary school at the age of seven and their visual tasks such as reading, writing, and attending classes begin at this age as they enter social groups. So, this age is of particular importance in terms of eye health. Due to the lack of similar studies, especially on this age group in different regions of Iran, and considering that stereopsis test is the best way to diagnose binocular visual impairment, it seems necessary to evaluate stereopsis among these children. The main aim of this study was to investigate stereopsis in Iranian 7-year-old children in order to make better planning for their eye health.

Materials and Methods

The present research is a cross-sectional study. Sampling was conducted randomly in seven cities of Iran through considering their different geographical and economic distributions. The selected cities included: Sari, Birjand, Ardabil, Mashhad, Bandar Abbas, Dezful and Arak. First, a number of all-girls and all-boys elementary schools were randomly selected in each city, and all first-grade students in each school were selected. Then, an informed and written consent letter was obtained from the parents. Demographic data, history of ophthalmologic examinations, and history of systemic diseases and medications were recorded in a separate researcher-made survey. Finally, the students entered the examination phase if they met the study criteria.

First, non-cycloplegic refraction was performed on the students with TOPCON RM8800 (Topcon Corporation, Tokyo, Japan) and the results were recorded. Then, if necessary, the results of auto-refractometer were checked using HEINE BETA 200 retinoscope (HEINE Optotechnik, Germany) and MSD lenses

(Meniscus Trial Case, Italy). Based on the subjective refraction tests, the visual acuity of children less than 20.25 was considered as the best optical correction. Then, stereopsis was measured by the designated correction procedure.

Stereopsis examinations were assessed using TNO Random Dot Stereogram booklet, so that the student had the best optical correction on his/her eyes, then wore the RED-GREEN glasses and looked at the picture of a butterfly and a geometric shape in the booklet at a distance of 40 cm. Each of the pages contained a circle from which a 60-degree segment was separated and the student had to identify the separated segment. Then, the level of detected disparity was recorded as arcsec using the test manual.

After measuring stereopsis for examination of cycloplegic refraction, the necessary steps were taken. The criterion for refractive error in cyclorefraction was considered as spherical equivalent (SE), which is the sum of sphere amount and negative half cylinder. For cyclorefraction, cyclopentolate 1% eye drop was used three times with 0, 5, and 10 min intervals. In addition, 35 min after administering the last eye drop, cyclo-autorefractometry, and if necessary, cyclo-retinoscopy were used. Also, to measure refractive error acuity, 0.5 and 3 diopters were considered as low hyperopia and myopia, 3 and 6 diopters as medium, and values greater than 6 diopters were considered as high refractive errors. Meanwhile, cyclo-refraction results between -0.5 and +0.5 were considered as ametropia.

Data were analyzed by SPSS 21 (SPSS Inc., Chicago, Illinois, USA) using independent t-test, ANOVA, and post hoc tests. Significance level was considered as 0.05.

Results

Out of 4,157 students, 3,675 met the inclusion criteria and entered the study. Also, 482 subjects were excluded due to not meeting the inclusion criteria or non-willingness to get involved in later stages. In this study, 77% of the total population (2,845 subjects) had stereopsis of 40 arcsec and 23% (830 subjects) had stereopsis of 50-200 arcsec. The sample under study included 1,914 (52.08%) males and 1,751

29. Stereopsis and Its Correlation with Refractive Errors

(47.64%) females. The stereopsis rate in all students was 43.30 ± 11.75 arcsec. This mean in male students was 44.59 ± 12.66 arcsec and in female students was 43.30 ± 10.62 arcsec. Independent t-test results showed a statistically significant difference between the mean of stereopsis in male and female students ($P < 0.001$).

The results of stereopsis were evaluated in different types of refractive errors including ametropia, hyperopia, and myopia. According to this evaluation, there was a statistically significant difference in the mean stereopsis indices between the three groups of ametropia, myopia, and myopia (after designating the best optical correction) ($P = 0.001$), so that ametropia with stereopsis of 44 ± 12 arcsec, hyperopia with stereopsis of 46 ± 11 arcsec, and myopia with stereopsis of 48 ± 17 arcsec showed the best, average, and worst levels, respectively.

Moreover, the comparison of refraction at different acuities revealed that in the selected population, none of the students had high myopia and only 4 subjects

had myopia between 3 and 6 diopters. Comparison of the hyperopia in the three groups (low, medium, high) with the low myopia and ametropic groups showed that the ametropia and the low hypermetropia groups had the best stereopsis; in addition, the low myopia group had the worst stereopsis (Table 1). No comparison was made in the medium myopia group due to very low number of subjects, and also in the high myopia group due to the lack of subjects.

The mean of stereopsis in different groups of low myopia, ametropia, low hyperopia, medium hyperopia, and high hyperopia were compared by post hoc least significant difference (LSD) test. The results are shown in Table 2 with P-value at significance level of 0.05.

Discussion

The present study is the first comprehensive population-based report on the stereopsis and its relation to refractive errors in first-grade primary school children in Iran. Compared to previous studies in Iran,

Table 1: Comparison of the correlation between refractive state at different acuities and stereoacuity index

Refraction	(Binocular stereopsis Mean \pm SD (arcsec)
Low Myopia	48 \pm 17
Ametropia	44 \pm 13
Low Hyperopia	44 \pm 12
Medium Hyperopia	45 \pm 10
High Hyperopia	47 \pm 5

Table 2. Comparison of the lateral view at different refraction intensities with P-values

Refraction	High Hyperopia	Medium Hyperopia	Low Hyperopia	Ametropia	Low Myopia
Low Myopia	0.371	0.023	0.001	0.002	-
Ametropia	0.433	0.259	0.468	-	0.002
Low Hyperopia	0.358	0.113	-	0.468	0.001
Medium Hyperopia	0.673	-	0.113	0.295	0.023
High Hyperopia	-	0.673	0.358	0.433	0.371

this study is more general in terms of sampling and selecting cities from different geographical areas. Therefore, the results of the present study can be regarded as an estimate of the status of stereopsis and its relation to refractive errors in this age group in Iran. Since 98% of 7-year-old children in Iran are in first-grade primary schools, it was assumed that this population could well represent the population of all 7-year-olds in Iran.

In this study, the stereopsis rate of students was 43.97 ± 11.75 arcsec, which is consistent with the study by Wajuihian (43.95 ± 25.23 arcsec); but was worse than the study by Lam et al. (40 arcsec) (Wajuihian, 2018; Lam SR, 1996). It should also be noted that Lam et al. used the Titmus test (a local test), but we used the TNO stereopsis test (a global test).

Furthermore, our results indicated that 23% of 7-year-old children had stereopsis worse than 40 arcsec (50- 200 arcsec). Considering the results of current study and some previous studies conducted in Iran and other countries, it can be concluded that refractive errors are the main cause of decrease in stereopsis rate (Da-dong Guo, 2016; Heravian J, 2010).

According to the results of the present study there was a statistically significant difference between the mean scores of stereopsis between male and female subjects, so that the stereopsis rate of female students was slightly better than males (but not clinically significant). Although the studies by Hofsetter and Mahjob et al. did not report a difference between the stereopsis of two genders (Hofstetter HW, 1976; Mahjoob M, 2011), our results may possibly account for the difference in visual system development between males and females, so that girls go through this evolution earlier than boys.

A study by Wajuhian in South Africa reported that there was a significant relationship between refractive errors and stereopsis and that ametropia had the best rate of stereopsis, which is consistent with the present study (Wajuihian, 2018).

A study by Mortazavi et al. indicated that refractive errors are a determining parameter in stereopsis analysis, which is consistent with the findings of present

study (Mortazavi SAA, 2005).

In addition, the results of this study showed that stereopsis is significantly reduced in children with refractive errors, which is in line with the studies conducted by Heravian et al. and Young et al. (Heravian J, 2010; Yang J, 2013).

Comparison of the three groups of low, medium, and high hyperopia with the low myopia and the ametropia groups showed that stereopsis rates are different from each other at different acuities; in addition, the ametropia and low hyperopia groups had the best stereopsis and low myopia had the worst rate of stereopsis. No comparative study of stereopsis between myopia and hyperopia at different acuities after optical correction was found to compare their results with the present study; but the superiority of stereopsis in corrected low and medium hyperopia compared to corrected myopia, along with the lack of difference between stereopsis rate of ametropia group and all the acuities of hyperopia (low, medium, high) need further investigation.

Conclusion

The present study showed that refractive errors were significantly correlated with stereopsis rate, so that after optical correction, myopia had the lowest stereopsis in comparison to low and medium hyperopia and ametropia. There was no difference between the stereopsis of low and medium myopia after optical correction with the stereopsis of ametropia. Also, the stereopsis of Iranian 7-year-old girls was slightly better than the boys of the same age. Therefore, given the fact that Iran is a country of different ethnicities and many studies have considered the influence of race and ethnicity on children's visual impairments, and since there is no study of the stereopsis and its association with refractive errors in 7-year-old Iranian children, the results of the present study suggest that more attention should be paid to stereopsis test as an indicator of binocular vision performance.

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بررسی دید بعد و ارتباط آن با عیوب انکساری در کودکان هفت ساله ایرانی

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اطلاعات مقاله	چکیده
تاریخ وصول: ۱۳۹۷/۰۵/۱۲	زمینه و هدف: بررسی دید بعد و ارتباط آن با عیوب انکساری در کودکان هفت ساله ایرانی
تاریخ پذیرش: ۱۳۹۷/۰۷/۰۱	روش کار: در این مطالعه مقطعی، ۳۶۷۵ نفر از دانش آموزان کلاس اول ابتدایی هفت شهر ایران، که دارای معیارهای ورود به مطالعه که شامل نداشتن بیماری های سیستمیک و عدم مصرف دارو بود، به صورت تصادفی انتخاب و با رضایت کتبی والدین مورد بررسی قرار گرفتند. معاینات شامل اندازه گیری عیوب انکساری با اتورفرکتومتر و دید بعد با تست TNO بود. پس از جمع آوری داده ها، اطلاعات توسط نرم افزار آماری SPSS و با استفاده از آزمون تی مستقل، آنوا و پست هاک تجزیه و تحلیل شد.
انتشار آنلاین: ۱۳۹۷/۰۷/۰۵	یافته ها: نتایج مطالعه حاضر نشان داد که میزان دید بعد در کل دانش آموزان شرکت کننده $۴۳/۱۱ \pm ۹۷/۷۵$ کمان ثانیه بود و تفاوت آماری معنا داری بین میانگین دید بعد دانش آموزان دختر ($۱۰/۶۲ \pm ۴۳/۳۰$ کمان ثانیه) و پسر ($۱۲/۶۶ \pm ۴۴/۵۹$ کمان ثانیه) وجود داشت ($P < ۰/۰۰۱$). همچنین بین گروه های مختلف حالت انکساری (نزدیک بینی، امروپی، دوربینی) و دید بعد اختلاف معنا داری وجود داشت ($P = ۰/۰۰۱$).
نویسنده مسئول: علی میرزاجانی گروه بینایی سنجی، دانشکده علوم توانبخشی، دانشگاه علوم پزشکی ایران، تهران، ایران	نتیجه گیری: مطابق با نتایج مطالعه حاضر، دید بعد دختران هفت ساله ایرانی از پسران هفت ساله ایرانی بهتر است. همچنین دید بعد پس از اصلاح عیوب انکساری، همچنان در حالات انکساری متفاوت مقادیر یکسانی را نشان نمیدهد که این یافته ها می تواند تأکیدی بر توجه بیشتر نسبت به تست دید بعد به عنوان شاخصی از عملکرد دید دو چشمی باشد.
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