Original Article
http://fdj.iums.ac.ir
Function & Disability Journal

Func Disabil J. 2019 (Nov 18);2:20. https://doi.org/10.34171/fdj.2.20.

Evaluation of visual skills in primary school children with poor performance in reading and writing

Razieh Ahangarani[1], Ebrahim Jafarzadehpur*[2], Ali Mirzajani[3], Alireza Mohamadi[4]

Received: Jun 10, 2019 Published: Nov 18, 2019

Abstract

Background: To determine visual skills in primary school children with poor performance in reading and writing.

Methods: This cross-sectional study was conducted on 28 poor-performances in reading and writing students from 600 schoolchildren, based on their teacher's score and 14 control children in second to sixth grade in one of the primary schools of Tehran. Visual acuity, refractive error, distance and near horizontal heterophoria, amplitude and facility of accommodation, amplitude and facility of vergence were measured in all subjects of both groups.

Results: Statistical comparison showed a higher hyperopia ($p<0.001$) and astigmatism ($p<0.05$) in the study group. Facility of accommodation and vergence showed lower values in the study ($p<0.001$). The near exophoria was significantly greater in the study group ($p<0.001$).

Conclusion: This study indicates that children with poor performance in reading and writing had difficulty in visual skills. Management of visual problems in children with poor reading and writing performance should be considered.

Keywords: Refractive errors, Binocular vision, Reading disability, Dyslexia

Conflicts of Interest: *The authors have no conflict of interest in this study.*
Funding: *This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.*

Cite this article as: Ahangarani R, Jafarzadehpur E, Mirzajani A, Mohamadi A. Evaluation of visual skills in primary school children with poor performance in reading and writing. *Func Disabil J. 2019* (Nov 18);2.20. https://doi.org/10.34171/fdj.2.20.

Introduction

Various questions are discussed in the process of reading because this process requires the integration of both visual and audio information (phonemics). Normal reading requires a disease-free retina and optic nerve and coordination of a number of visual functions including refraction, accommodation, convergence, saccade, and fusion to send coordinated information for processing to the visual cortex. Furthermore, the process of reading is learned through repetition, language, and integration .This process involves linguistic processing of words, vision, and motor control of the eye aimed to provide the desired reading function [1]. Previous findings indicated that the results of visual tests in some children with reading difficulties differ from the normal values [2]. Likewise, poor reading and writing performances in school-age children cause poor academic performance. Considering the importance of visual function in reading ability, evaluation of visual anomalies in school-age children is of particular importance [3].

Reading and writing abilities are critical for an individual to success in school, occupation, and other aspects of life. Thus early diagnosis of problems in such abilities is necessary to prevent academic failure of children in the future

Corresponding author: *Dr. Ebrahim Jafarzadehpur, jafarzadehpour.e@iums.ac.ir*

[1] Department of Optometry, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran

↑***What is "already known" in this topic:*** *Sensory – motor evaluation is very critical in primary school. However, different screening protocols are conducted in primary schools.*

→***What this article adds:*** *Detailed and precise binocular and visual skills performances must be scheduled in poor writing and reading students.*

[4]. Reading and writing disorders in children are seen in two forms, specific and non-specific. For the specific type, which is the most common type of dyslexia, reduced learning ability will be considered [5]. However, in the non-specific type (normal learning ability and intelligence); there are problems with reading and writing. Approximately 5% of normal school students have poor reading and writing skills, which is more common in boys [6].

Many studies indicated that little amounts of refractive errors, accommodative problems, and non-compensatory heterophoria are often not detected and children with poor reading and writing performance mistakenly identified as dyslexic patients [7]. Although there are controversies about the influence of visual skills on reading and writing performance, according to the American Ophthalmology Academy, 39% of children with reading difficulties have vision problems in long-term reading [8].

Visual screening tests are done at the time of admission to the school, but a significant number of children with visual deficits are not recognized. In other words, screening tests performed by health workers at the time of entering school are not sufficiently valid. A recent study in Iran showed that more than 60% of first graders who have visual acuity equal to or worse than 20/25 is not identified through the screening program. This is while their parents will not seek vision testing because they are assured that their children have already been examined at school [9]. Many of these children with binocular vision problems may enter the school while these problems cause poor performance in reading and writing. Although some of these children demonstrate normal visual acuity, there are reports of poor reading and writing by their parents or teachers [10].

In the present study, we examined students who had poor performance in reading and writing, with a detailed examination in binocular vision at the optometry clinic of the school of rehabilitation, Iran University of Medical Sciences.

Methods

Forty two students from a boys' elementary school in Tehran including 28 students with reading and writing disorder aged 8-12 years old as study group and 14 normal students in the same age as control group were enrolled in the study.

In the curriculum of elementary schools in Iran, the score for any lesson qualitatively categorized in four levels, 1: very good, 2: good, 3: well-accepted, and 4: need to try . According to the teachers and the parent's opinion, students who were at the level 4 (need to try) and 1 (very good) was selected as the study and control groups respectively.

The examinations included the measurements of uncorrected and corrected distance visual acuity, refractive error, magnitude of heterophoria, amplitude and facility of accommodation, amplitude and facility of vergence [7] were conducted during October 2018 to February 2019 at the optometry clinic of the school of rehabilitation, Iran University of Medical Sciences in Tehran.

For both controls and study subjects, First uncorrected and best corrected visual acuity (UCVA, BCVA*)* was recorded using auto chart projector (HCP-7000; Huvitz, Gyeonggi-do, Korea) at a distance of 6 meters, based on the Log MAR.

All students underwent non-cycloplegic refraction with the HRK-7000 Auto refractometer (Huvitz, Gyeonggi-do, Korea) and the Heine Beta-200 retinoscope (HEINE Optotechnic, Hersching, Germany).

Amplitude of accommodation was determined binocularly using the push-up technique, so that the subject was instructed to fixate and focus on the smallest line of near chart, with change of fixation to smaller letters if they became resolvable as target distance was slowly decreased. The point of the first slight, sustained blur was recorded. The test repeated 3 times, and the mean value determined. Facility of accommodation was recorded as cycles per minute using flipper lenses ±2 diopters (Bernell, USA) at near to determine how many times the subject could clear the 20/20 line of near chart at 40 cm [11, 12]. Binocular measurements were done .

Distance and near heterophoria were measured using cover test and prism bar (Horizontal and Vertical Prism Bar Set, Luneau, France).

The prism bar was used to measure distance and near horizontal fusional vergence ranges. The prisms values are gradually added before one eye until the subject first reported blur (Blur) and then reported horizontal diplopia (Break). Then amount of prism was decreased until the subject could re-fuse diplopic images (Recovery) [13, 14]. Measurement of fusional vergence ranges was started with base in ranges, and then continued with base out [15].

Facility of vergence (cycles per minute) was measured using 12Δ base out / 3Δ base in flipper. Subjects were asked to fuse a 20/30 optotype while the optometrist shifted the flipper alternately from 12Δ base out to 3Δ base in. The number of cycles per minute was recorded [16].

Data were analyzed by SPSS software for Windows, version 22. The independent t-test was used to compare data between the study and control groups. P-value less than 0.05 were considered significant.

Results

28 students with reading and writing problems were 9.89±1.45 (Mean ±Standard Deviation (SD)) years of old (from 8 to 12 years old) and 14 control groups were 9.93±1.59 (Mean ±SD) years old with the same age range.

The mean ± SD of uncorrected visual acuity in the study group was 0.036±0.084 (Log MAR) and in the control group was 0.016±0.040 (Log MAR). Independent t-test showed no significant difference between the two groups (p=0.144). The mean Log MAR values of best corrected visual acuity were 0.005 ± 0.028 for study group and 0.00±0.001 for control group which were not statistically different (P=0.159).

Table 1 provides a summary of the mean refractive errors in two groups. The mean spherical refractive errors in the study group was significantly more hyperopic than the control group (P<0.001) and the mean cylindrical refractive error was significantly higher in poor readers than controls (P<0.05).

The Mean±SD binocular amplitude of accommodation was 11.117±1.516 diopters in the study group and

Table 1. Means and standard deviations of refractive errors (diopters)

Group	Mean		Standard deviation		p	
	Sphere	Cylinder	Sphere	Cylinder	Sphere	Cylinder
Study group (n=28)	0.303	-0.049	0.565	0.372	<0.001	0.001
Control group (n=14)	-0.035	-0.196	0.212	0.307		

11.873±1.173 diopters in the control group. Statistical analysis revealed no significant difference between the two groups (P=0.111).

Statistical analysis demonstrated a significant difference between the two groups on the binocular facility of accommodation test (p<0.001). The Mean±SD for this parameter in the study group was 6.678±1.336 cycles per minute (cpm) and in the control group was 8.738±1.326 cpm.

Statistical analysis revealed a significant difference between the two groups on facility of vergence (P<0.001). Facility of vergence measurements was lower in the study group than in the control group (Table 2).

Mean distance and near, base-in and base-out values were not significantly different in the two groups (P>0.05). Only the result of blur base-out at distance showed significant difference between the two groups (P=0.001) (Table 2).

The Mean±SD near horizontal heterophoria values were 4.607±1.499 prism diopters (exophoria) in the study group and 2.571±1.157 prism diopters (exophoria) in the control group. Statistical analysis demonstrated a significant difference between these two groups (P<0.001). However, Mean±SD distance horizontal heterophoria values were 1.535±1.170 prism diopters (exophoria) in the study group and 0.857±1.027 prism diopters (exophoria) in the control group. Independent t-test showed no significant difference between the two groups (P>0.05).

Discussion

The results of the present study indicated that some of the visual functions in the study group are worse than that in the control group.

There was no significant difference in the mean corrected and uncorrected visual acuity between the two groups. The possible reason for this issue can be that visual acuity is a perceptual occurrence and may not be related to reading and writing. Likewise, a good visual acuity is a precondition for entering the school for students. Many studies about this topic are consistent with the findings of the present study [17, 18]. A study found that poor readers had lower far visual acuity than normal subjects [19]. The possible reason for this difference can be attributed to different measurement method in the present study (auto chart projector at 6 meters) and that study (Zeiss Polatest at a distance of 5 meters).

As shown in Table 1, we found a significantly higher amount of hyperopia and astigmatism in the study group. Since the measurement of refractive error was not in cycloplegic condition, the measures of hyperopia may be underestimated [20]. These findings indicate that poor readers are at more risk of refractive anomalies than normal readers. Therefore, these children should be regularly evaluated for refractive error in screening programs. Some previous studies reported similar findings to our results [21-23]. Small degrees of hyperopia or astigmatism may not cause blurred vision. However, since too much accommodative effort may be involved, it could cause symptoms such as asthenopia, headache, and inattention in some children [24].

As indicated in previous studies, hyperopia can be considered as a negative factor for reading and may impact on students' performance in academic education [25].

Our results also indicated that amplitude of accommodation was lower in the study group than in the control group, but it was not statistically significant. Although this finding is consistent with the results of some studies [26-28], some other studies reported contradictory findings [19, 29]. Measurements of the amplitude of accommodation in these studies were performed monocular, whereas in the present study, measurements were performed binocular, which can be a reason for this difference.

Several studies reported that children with reading difficulties have worse facility of accommodation than normal

Table 2. Means and standard deviations of facility of vergence (cycles per minute) near and distance horizontal fusional vergence ranges (prism diopters)

Parameters	Study group	Standard deviation	Control group	Standard deviation	p
Facility of vergence	6.928	1.274	8.714	0.726	<0.001
B.I*, F* break**	7.142	1.483	7.142	1.292	0.422
B.I, F recovery	4.714	1.242	4.875	1.027	0.827
B.O, F blur**	10.357	0.951	11.714	2.198	0.001
B.O, F break	15.642	2.556	14.857	2.567	0.823
B.O, F recovery	11.678	2.389	12.000	2.075	0.533
B.I, N** blur**	11.714	1.760	11.714	1.728	0.676
B.I, N break	16.214	1.771	16.500	1.786	0.940
B.I, N recovery	11.642	1.704	11.428	1.827	0.685
B.O, N blur	15.964	1.688	16.500	1.698	0.414
B.O, N break	20.142	1.693	20.875	1.875	0.185
B.O, N recovery	15.964	2.755	17.142	3.009	0.341

* Base In, ** Base Out, *** Far, **** Near

subjects [18, 30-32]. We found that facility of accommodation was 2.06 cycles per minute lower in poor readers than that obtained from normal readers. One of the reasons that can effect on the facility of accommodation values is uncorrected refractive error. Although the difference of refractive error between the two groups was not large enough to affect visual acuity, it may induce a reduction in facility of accommodation. Hyperopic eyes require extra accommodation during reading at short distances. Inability of the eye muscles to cope with this stress results in impairment in reading [33].

According to the studies conducted to assess near work symptoms in poor readers, assessment of facility of accommodation is the most useful test for prediction of visual discomfort [18, 34]. Accommodation disorders can also cause problems in reading speed and fluency as children develop reading and writing skills [35]. The decrease in facility of accommodation leads to asthenopia in the near work [36]. Some studies have reported contradictory results with the present study. This may be related to the different type of measuring test used in these studies [37].

As shown in Table 2, there is a significant difference in the mean of facility of vergence between the two groups. Seemingly, the mean of facility of vergence in other studies was significantly lower in poor readers too. [19, 29]. Due to the fact that reading speed is related to the facility of vergence, the decrease of facility of vergence could be a probable source of weakness in reading performance [22].

The mean distance base-out blur value in the study group was 1.157Δ lower than those obtained from the control group. The cause may be the absence of contributing factors in the distance, such as accommodative and proximal convergence. Palmo reported that mean distance base-in break and base-in recovery values were nearly 2Δ lower in poor readers than in normal readers [29]. Several studies reported decreased near base-out break [27, 31-36]. These differences are likely to be due to the fact that measuring of fusional vergence in poor cooperative children are not sufficiently stable and repeatable [20]. Appropriate amplitude of vergence provides the ability to maintain binocular vision [38]. Deficiency in vergence system can make the letters or symbols appear floating, moving and sometimes diplopia may be present [39].

Since near exophoria can cause symptoms such as asthenopia, the near exophoria in poor readers may be a cause of their reluctance to do close tasks such as reading and writing [40]. In binocular vision conditions should not neglect anomalies such as heterophoria, vergence and accommodation anomalies. If these problems are left to themselves, it can lead to difficulties reading and writing [41].

Conclusion

Although reading is a complex process and may be affected by many factors, it is recommended for poor reader children to have a complete visual assessment.

The present study demonstrated that students with poor performance in reading and writing may have problems in their refractive status, facility of accommodation, facility of vergence, fusional reserves, and binocular balance compared to normal readers. Thus, sensitive detection of these problems and appropriate treatment is crucial to future success of school age children.

Acknowledgement

This paper is part of a master's thesis. The authors received no funding for this research. Authors declared no conflict of interest.

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Thurston A, Thurston M. A literature review of refractive error and its Potential Effect on reading attainment in the early years of school. Optom Vis Perform. 2013 Jan; 1(1):25-31.
2. Christian LW, Nandakumar K, Hrynchak PK, Irving EL. Visual and binocular status in elementary school children with a reading problem. J Optom. 2018 Jul 1; 11(3):160-6.
3. Grosvenor T. Are visual anomalies related to reading ability? J Am Optom Assoc. 1977 Apr;48(4):510–7.
4. Horowitz-Kraus T, Schmitz R, Hutton JS, Schumacher J. How to create a successful reader? Milestones in reading development from birth to adolescence. Acta Paediatr. 2017 Apr; 106(4):534-44.
5. Simons HD. An analysis of the role of vision anomalies in reading interference. Optom Vis Sci. 1993 May; 70(5):369-73.
6. Lyon GR. Learning disabilities. Future Child. 1996 Apr 1:54-76.
7. Motsch S, Mühlendyck H. Differentiation between dyslexia and ocular causes of reading disorders. Der Ophthalmologe: Zeitschrift der Deutschen Ophthalmologischen Gesellschaft. 2001 Jul; 98(7):660-4.
8. Collins ME, Mudie LI, Inns AJ, Repka MX. Pediatric ophthalmology and childhood reading difficulties: Overview of reading development and assessments for the pediatric ophthalmologist. J Am Assoc Pediatr Ophthalmol Strabismus. 2017 Dec 1; 21(6):433-6.
9.Hashemi H, Yekta A, Jafarzadehpur E, Ostadimoghaddam H, Asharlous A, Nabovati P, et al. Sensitivity and Specificity of Preschool Vision Screening in Iran. Iran J Public Health. 2017 Feb; 46(2):207–15.
10. OstadiMoghaddam H, Fotouhi A, Hashemi H, Yekta A, Heravian J, Ghalandarabadi M, et al. Validity of vision screening tests by teachers among school children in Mashhad, Iran. Ophthal Epidemiol. 2012 Jun; 19(3):166–71.
11. Goss DA. Clinical accommodation testing. Curr Opin Ophthalmol. 1992;3(1):78–82.
12.Zellers JA, Alpert TL, Rouse MW. A review of the literature and a normative study of accommodative facility. J Am Optom Assoc. 1984;55(1):31–7.
13. Benjamin WJ. Borish's Clinical Refraction-E-Book. Elsevier Health Sciences; 2006 Jun 21.
14. Daum KM, Rutstein RP, Clore KA, Corliss DA. Evaluation of a new criterion of binocularity. Optom Vis Sci. 1989 Apr;66(4):218-28.
15. Rosenfield M, Ciuffreda K, Ong E, Super S. Vergence adaptation and the order of clinical vergence range testing. Optom Vis Sci. 1995;72:219–223
16. Gall R, Wick B, Bedell H: Vergence facility: establishing clinical utility. Optom Vis Sci. 1998;75:731-742.
17. Grisham JD, Simons HD. Refractive error and the reading process: a literature analysis. J Am Optom Assoc. 1986 Jan; 57(1):44–55.
18. Kiely PM, Crewther SG, Crewther DP. Is there an association between functional vision and learning to read? Clin Exp Optom. 2001;84(6):346–53.
19. DusekW, Pierscionek BK, McClelland JF. A survey of visual function in an Austrian population of school-age children with reading and writing difficulties. BMC Ophthalmol. 2010 May 25;10:16.
20. Wajuihian SO, Naidoo KS. A comparison of the visual status of dyslexic and non-dyslexic schoolchildren in Durban, South Africa. Afr Vis Eye Health. 2011 Dec 10;70(1):29-43.
21. Simons HD, Gassler PA. Vision anomalies and reading skill: a meta-analysis of the literature. Am J OptomPhysiol Opt. 1988 Nov;65(11):893–904.
22. Quaid P, Simpson T. Association between reading speed, cycloplegic refractive error, and oculomotor function in reading disabled children versus controls. Graefes Arch Clin Exp Ophthalmol Albrecht Von

Graefes Arch Klin Exp Ophthalmol. 2013 Jan;251(1):169–87.
23. Collins ME, Mudie L, Slavin RE, Corcoran RP, Owoeye J, Chang D, et al. Prevalence of eye disease and reading difficulty in an inner city elementary school population—preliminary results of the Baltimore Reading and Eye Disease Study (BREDS). J Am Assoc Pediatr Ophthalmol Strabismus. 2016 Aug 1;4(20):e29-30.
24. Rosenbloom AA, Morgan MW, editors. Principles and practice of pediatric optometry. Lippincott Williams & Wilkins; 1990.
25. Rosner J. The relationship between moderate hyperopia and academic achievement: how much plus is enough? J Am Optom Assoc. 1997 Oct;68(10):648-50.
26. Goulandris N, McIntyre A, Snowling M, Bethel JM, Lee JP. A comparison of dyslexic and normal readers using orthoptic assessment procedures. Dyslexia. 1998 Mar;4(1):30-48.
27. Evans BJ, Drasdo N, Richards IL. Investigation of accommodative and binocular function in dyslexia. Ophthalmic and Physiological Optics. 1994 Jan;14(1):5-19.
28. Ygge J, Lennerstrand G, Rydberg A, Wijecoon S, Pettersson BM. Oculomotor functions in a Swedish population of dyslexic and normally reading children. Actaophthalmologica. 1993 Feb;71(1):10-21.
29. Palomo-Alvarez C, Puell MC. Binocular function in school children with reading difficulties. Graefes Arch Clin Exp Ophthalmol Albrecht Von Graefes Arch Klin Exp Ophthalmol. 2010 Jun;248(6):885–92.
30. Daum KM. Heterophoria and heterotopia. Clinical procedures in optometry. Philadelphia: JB Lippincott Company. 1991:72-90.
31. Eperjesi F. Optometric assessment and management in dyslexia. Optometry today. 2000; 15:20-5.
32. Palomo-Álvarez C, Puell MC. Accommodative function in school children with reading difficulties. Graefes Arch ClinExp Ophthalmol. 2008 May;246:1769–1774
33. Williams WR, Latif AH, Hannington L, Watkins DR. Hyperopia and educational attainment in a primary school cohort. Arch Dis Childhood. 2005 Feb 1;90(2):150-3.
34 Sterner B, Gellerstedt M, Sjostrom A. Accommodation and the relationship to subjective symptoms with near work for young school children. Ophthal Physiol Opt. 2006;26:148–155
35. Evans B. The role of the optometrist in dyslexia. Part. 2004;2:35-9.
36. Siderov J. Improving interactive facility with vision training. Clin Experim Optom. 1990 Jul;73(4):128-31.
37. Buzzelli AR. Stereopsis, accommodative and vergence facility: Do they relate to dyslexia?. Optom Vis Sci. 1991 Nov;68(11):842-6.
38. Bishop A. Binocular vision-Part 10: Convergence and convergent fusional reserves-Investigation and treatment. Optician Sutton. 1999:20-4.
39. Hoffman LG, Rouse M. Referral recommendations for binocular function and/or developmental perceptual deficiencies. J Am Optom Assoc. 1980 Feb;51(2):119-26.
40. Kommerell G, Gerling J, Ball M, de Paz H, Bach M. Heterophoria and fixation disparity: A review. Strabismus. 2000 Jan 1;8(2):127-34.
41. Conlon EG, Sanders MA, Wright CM. Relationships between global motion and global form processing, practice, cognitive and visual processing in adults with dyslexia or visual discomfort. Neuropsychological. 2009;47:907-15.

Original Article
http://fdj.iums.ac.ir
Function & Disability Journal

Func Disabil J. 2019 (Nov 18);2:20. https://doi.org/10.34171/fdj.2.20.

بررسی مهارت‌های بینایی در کودکان مقطع دبستان با عملکرد ضعیف در خواندن و نوشتن

راضیه آهنگرانی[۱]، ابراهیم جعفرزاده پور*[۱]، علی میرزاجانی[۱]، علیرضا محمدی[۱]

۱. گروه اپتومتری، دانشکده علوم توانبخشی، دانشگاه علوم پزشکی ایران، تهران، ایران

چکیده

مقدمه: این مطالعه با هدف تعیین ارتباط مهارت‌های بینایی بر روی عملکرد خواندن و نوشتن انجام شده است.

روش‌ها: این مطالعه مقطعی بر روی ۲۸ کودک با عملکرد ضعیف در خواندن و نوشتن به عنوان گروه مطالعه و ۱۴ کودک بعنوان گروه کنترل در پایه دوم تا ششم در یکی از دبستان‌های منطقه ۴ تهران با جمعیت ۶۰۰ نفری با اندازه‌گیری حدت بینایی، بررسی میزان عیب انکساری، اندازه‌گیری هترو فوریای دور و نزدیک، اندازه‌گیری دامنه و سهولت تطابق و اندازه‌گیری دامنه و سهولت ورجنسی انجام شد.

یافته‌ها: مقایسه آماری، میانگین هایپروپی بیشتر ($p<۰/۰۰۱$) و آستیگماتیسم بالاتر ($p<۰/۰۵$) در گروه مطالعه نسبت به گروه کنترل را نشان داد. همچنین مقادیر سهولت تطابقی و سهولت ورجنسی در گروه مطالعه بطور معناداری ($p<۰/۰۰۱$) کمتر از گروه کنترل بود. میانگین هتروفوریای افقی نزدیک در گروه مطالعه اگزوفوریای بیشتری را نسبت به گروه کنترل نشان داد ($p<۰/۰۰۱$). میانگین دامنه ورجنس تاری Base Out دور در گروه مطالعه به طور معنی‌داری نسبت به گروه کنترل پایین‌تر بود ($p<۰/۰۵$).

نتیجه‌گیری: اگرچه خواندن یک فرایند پیچیده است و ممکن است تحت تاثیر فاکتورهای زیادی باشد، اما یک ارزیابی کامل بینایی به بچه‌هایی که در عملکرد خواندن ضعیف هستند توصیه می‌شود. این مطالعه نشان داد دانش آموزانی که در خواندن و نوشتن ضعیف بودند از لحاظ دید دوچشمی مشکلاتی در عیوب انکساری، سهولت تطابقی، سهولت تقاربی، ذخیره‌های فیوژنی و عملکرد دید دوچشمی در مقایسه با گروه مطالعه داشتند. بنابراین تشخیص این مشکلات و درمان مناسب آن در موفقیت آینده کودکان سن مدرسه بسیار مهم است.

کلیدواژه‌ها: عیوب انکساری، دید دوچشمی، ضعف خواندن و نوشتن، دیسلکسیا

Conflicts of Interest: *The authors have no conflict of interest in this study.*
Funding: *This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.*

Cite this article as: Ahangarani R, Jafarzadehpur E, Mirzajani A, Mohamadi A. Evaluation of visual skills in primary school children with poor performance in reading and writing. Func Disabil J. 2019 (Nov 18);2.20. https://doi.org/10.34171/fdj.2.20.