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Refractive Errors and Binocular Anomalies in Primary Schools in Uyoun Aljawa: A Small Urban Town in Saudi Arabia

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Abstract

Aim: To assess the prevalence of uncorrected refractive error (RE) and binocular vision (BV) anomalies in school-aged children in Uyoun Aljawa, a small urban town in Saudi Arabia.

Methods: This was a cross-sectional study of 417 students (aged 6–13 years old) conducted in two primary schools in Uyoun Aljawa from November 2019 to January 2020. All students underwent comprehensive eye examination that include: distance visual acuity (VA), Non- cycloplegic refraction, ocular alignment assessment with the cover test; Near Point of Convergence (NPC) evaluation, Near stereo-acuity with Titmus-fly Stereotest, and finally, colour vision was screened with Ishihara plates.

Results: A total of 417 male schoolchildren (mean age ± SD: 9.2 ± 1.9) were included. In this study, 78 (18.4%) students had reduced vision (VA of ≤6/9) of which only 21 (27%) students had spectacles at the time of the study and 19.2% had uncorrected RE (VA of <6/18 and no corrections). Emmetropia was reported in 80.3% of children where hyperopia was the most common refractive error (8.9%) followed by myopia (7.7%), and simple astigmatism was reported only in 3.1%. Heterophoria was reported in 12.5% of the sample, 5.2% had convergence insufficiency, and 16.3% showed subnormal results in stereo-acuity and 11 cases had a colour vision deficiency.

Conclusion: The results of this study reveal a high prevalence of RE and other BVA among schoolchildren in Uyoun Aljawa. Vision Screening programs of children for RE and BVA should be conducted at the community level and integrated into school health programmes.

Keywords: binocular anomalies, primary schools, refractive errors, Saudi Arabia

1. Introduction

Refractive error (RE) and binocular vision anomalies (BVA) are major visual problems that affect a large proportion of school-aged children (W. Dusek, Pierscionek, & McClelland, 2010; Resnikoff, Pascolini, Mariotti, & Pokharel, 2008; Schneider, Leeder, Gopinath, Wang, & Mitchell, 2010). the World Health Organization (WHO) identified uncorrected RE as the leading cause of vision impairment globally (Resnikoff et al., 2008). RE and BVA are usually asymptomatic, and thus schoolchildren are at high risk, which consequently might impact their learning capabilities, and their social and mental development (W. Dusek et al., 2010; Negrel, Maul, Pokharel, Zhao, & Ellwein, 2000). Studies have found that both hereditary and environmental factors play essential roles on the presence of RE and BV anomalies (Goldschmidt & Jacobsen, 2014; Wojciechowski, 2011). Investigation of the prevalence and risk factors of RE and BVA allows for better planning of vision screening programs that can deliver more precise preventive interventions.

Recent data estimate that about 90% of people with uncorrected RE, are living in rural and low-income countries (Naidoo & Jaggernath, 2012). However, other reports suggested large numbers of children can be still affected by uncorrected RE in some high-income countries, despite the availability and accessibility to eye care services (Maul, Barroso, Munoz, Sperduto, & Ellwein, 2000; Vitale, Cotch, & Sperduto, 2006). For example, China (He et al., 2004), Malaysia (Goh, Abqariyah, Pokharel, & Ellwein, 2005), and Chile (Maul et al., 2000) that are considered upper-middle- and high-income economies reported a higher prevalence of uncorrected RE (22%, 17.1% and 4% respectively) compared to lower-income countries such as India (Marmamula, Keeffe, & Rao, 2009) and Nepal (Shrestha, Sujakhu, & Joshi, 2011) (1.8%, and1.4% respectively). Therefore, the prevalence of uncorrected RE seems to be a multifactorial problem with different contributing factors, and the GDP value of a country might be

not a reliable indicator alone.

In Saudi Arabia, the prevalence of RE and BVA and their related impacts on schoolchildren are still not well understood. While limited reports investigated the BVA among schoolchildren in Saudi, several studies indicated that the prevalence of RE in children ranged between 4.5% to up to 18.6% (Al Wadaani, Amin, Ali, & Khan, 2013; Al-Rowaily, 2010; Y. H. Aldebasi, 2014; Alsaqr, Ghayda'a Ibrahim, & Fagehi, 2017). For example, the prevalence of RE in preschool children in Riyadh was reported to be 4.5% (Al-Rowaily, 2010) in 2008 and increased dramatically to 13% (Alsaqr et al., 2017) in 2017. In a larger-scale study, the prevalence of RE in primary school children in Qassim province was reported to be 16.7% of whom only 2.3% wore spectacles, and 3.9% were amblyopic (Y. H. Aldebasi, 2014; 2015). Nevertheless, these studies were mainly conducted in larger cities and urban areas, and little is known about the risk of RE and BVA in rural or smaller urban communities that have limited access to eye care services in Saudi Arabia. This study aimed to determine the prevalence of RE and BVA in small urban communities in Saudi Arabia. The study took place in Uyun AlJawa, a small urban town that has a population of about 26,400 people in the northwest of Qassim province, central of Saudi Arabia.

2. Methods

2.1 Study Setting and Design

This was a cross-sectional study conducted among a group of schoolchildren in Uyun Aljawa, Saudi Arabia. The study included 417 male participants (all the students attended their schools during the screening program), and their age ranged from 6 to 13 years old. This study was approved by the local Ethics Committee at Qassim ministry of health office and was conducted according to the Declaration of Helsinki guidelines. The administration of both schools obtained written parents' consent prior to the study. The study was conducted between November 2019 to January 2020 and delivered by a number of qualified optometrists as part of community service program provided by the department of optometry, Qassim University. Any participant found to have any vision abnormalities were referred for full ocular examination. Also, full details were provided to the school administration explaining the need to inform the parents for further action.

2.2 Clinical Procedures

At first, a measurement of distance visual acuity (VA) which was taken under monocular and binocular conditions using a tumbling E Snellen chart. Uncorrected refractive error was defined as VA worse than 6/12 but improving to at least 6/12 or better on using a pinhole. Children were assumed to be emmetropes if they had distance VA of 6/7.5 or better and were not using optical corrections.

All students with VA of ≤6/9 underwent non-cycloplegic objective refraction with near retinoscopy (Mohindra technique) (Borghi & Rouse, 1985). In this study, spherical equivalent (SE) of ≤−0.5 D was considered myopia while hyperopia was defined as a ≥+2.00 D in one or both eyes. Astigmatism was defined as a cylinder power ≥1.00 DC.

Cover tests which were performed at far (6 m) and near (40 cm) was used to detect heterophoria with best possible correction. The magnitude of the deviation was measured using alternating cover test and prism bar. Exophoria was defined as near exophoria more than 6 prism diopter and/or distance exophoria more than 3 PD (Abdi, Lennerstrand, Pansell, & Rydberg, 2008). Esophoria was defined as any near esophoria and/or distance esophoria more than 1 PD (Abdi et al., 2008).

Near point of convergence (NPC) was subsequently evaluated with push-up technique by using Royal Air Force (RAF) ruler) (Abdi et al., 2008; Leat et al., 2013). Convergence insufficiency was defined in this study as NPC of 10 cm or greater, accompanied by exophoria greater at near than at distance. Near stereo-acuity was measured by using Titmus-fly Stereotest (Stereo Optical Co., Inc., Chicago, IL, USA), subjects with a stereo-acuity of more than 60 arc seconds are considered subnormal. Finally, colour vision was screened with Ishihara plates (Garnham & Sloper, 2006).

2.3 Statistical Analysis

Statistical analyses were performed with SPSS software package (V. 25.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages. Spearman's rho was used to evaluate associations between variables $P < 0.05$ was considered statistically significant in this study.

3. Results

A total of 417 male schoolchildren (mean age ± SD: 9.2 ± 1.9) were included in this cross-sectional study. Table 1 demonstrates the visual acuities distribution for all children. In this study, 78 (18.4%) students had reduced vision (VA of ≤6/9) of which only 21 (27%) students had spectacles on the day of the examination, and 19.2% had

uncorrected RE (VA of <6/18 and no corrections).

Emmetropia was reported in 80.3% of children where hyperopia was the most common refractive error (8.9%) followed by myopia (7.7%), and simple astigmatism was reported only in 3.1%. Also, as shown in table 2, Binocular vision anomalies were reported in 12.5% of the sample, while 5.2% had convergence insufficiency, and 16.3% showed subnormal results in the stereo test (Table 2). Colour vision tested by Ishihara plats showed only 11 cases affected (out of 417).

Table 1. Prevalence of visual acuities (logMar) in the study sample (n=417)

VA LogMar	**N (%)**
0 – 0.1	335 (80.3%)
0.2	31 (7.4%)
0.3	25 (6 %)
0.4 – 0.5	19 (3.8%)
0.6 – 0.9	7 (1.6%)

Table 2. Prevalence of different clinical outcomes of the study (n=417)

Clinical outcomes	**N (%)**
Emmetropia	80.3%
Myopia	32 (7.7%)
Hyperopia	38 (8.9%)
Simple Astigmatism	13 (3.1%)
Normal BV	365 (87.5%)
esophoria	11 (2.6%)
exophoria	37 (8.8%)
esotropia	3 (0.7)
exotropia	1 (0.2%)
Convergence insufficiency	22 (5.2%)
subnormal stereo-acuity	68 (16.3%)
Color vision deficiency	11 (2.6%)

Correlation analysis

The associations between different clinical variables are listed in Table 3. VA showed a significant strong positive correlation with RE, and significant moderate correlation with the other variables including, heterophoria, and NPC. In addition, Heterophoria, Stereo-acuity, and NPC were all significantly correlated with each other. RE did not correlate with any other parameters.

Table 3. Spearman rho (R) Correlation coefficients (r) analysis of different parameters and their p values

Variable	Correlation analysis	VA	Refractive error	heterophoria	NPC	Stereo-acuity
VA	r	1	**0.61**	**0.21**	**0.33**	**0.307**
	p value	.	<0.01	<0.01	<0.01	<0.01
Refractive error	r	**0.61**	1	0.07	0.06	0.1
	p value	0	.	0.4	0.7	0.2
heterophoria	r	**0.21**	0.07	1	**0.18**	**0.24**
	p value	<0.01	0.4	.	0.001	<0.01
NPC	r	**0.33**	0.06	**0.18**	1	**0.35**
	p value	<0.01	0.7	<0.01	.	<0.01

4. Discussion

The results of this study reveal a high prevalence of RE and other visual disorders among schoolchildren in Uyoun Aljawa, Saudi Arabia. The current data indicate that one of every five children are affected by RE, and both hyperopia and myopia are almost equally common in this sample (8.9% and 7.7% respectively), while simple astigmatism was the least common type of RE (Table 2). Among those with reduced VA, only 27% had spectacles during the examination; and about 19% of those with VA of 6/18 or worse were uncorrected.

The reported prevalence of uncorrected RE seems to be high when compared to other countries such as Chile or India, but these findings are in line with previous reports of uncorrected RE in Saudi Arabia. For example, about 13% of schoolchildren in Riyadh (Alsaqr et al., 2017) and Alahssa (Al Wadaani et al., 2013) had RE, and 10% of them were uncorrected while 18.3% of the schoolchildren in Qassim had RE and 16.3% of them were uncorrected (Y. H. Aldebasi, 2014). Thus, the prevalence of uncorrected RE seems to be, to some extent, comparable across different regions of Saudi Arabia. This is despite the differences in demographic and socioeconomic conditions and the accessibility to the health care system in different regions of the country.

In addition, subnormal stereo-acuity was reported in 16% of the schoolchildren, and 5.3% of had convergence insufficiency while 12.5% had heterophoria in which exophoria was the most common disorder. All these visual disorders were significantly and positively correlated to each other (Table 3), which may indicate that those affected schoolchildren are at higher risk of binocular dysfunction, amblyopia and then potentially permanent visual impairment (Birch, 2013). Several studies found that schoolchildren with heterophoria, convergence insufficiency, subnormal streo-acuity are more likely to have reading and learning difficulties (Bedwell, Grant, & McKeown, 1980; W. Dusek et al., 2010; W. A. Dusek, Pierscionek, & McClelland, 2011; Palomo-Álvarez & Puell, 2010; Ponsonby et al., 2013). This highlights the importance of a full of binocular visual assessment in any future vision screening programs to prevent the visual abnormalities that impact upon educational development.

There might be several reasons behind the high prevalence of uncorrected RE and other visual disorder among schoolchildren in Saudi Arabia. First and most important, is the lack of efficient national vision screening program of children in Saudi Arabia. While the vision exam is part of preschool prerequisites, this role seems not to be strictly implemented, as the vast majority of children commence their schools without being examined by optometrist or ophthalmologist (Y. H. Aldebasi, Ahmed, & Monaco, 2018). Second, several reports reveal that general public in Saudi Arabia showed low levels of awareness and knowledge of the RE and other visual problems (Al-Lahim, Al-Ghofaili, Mirghani, & ALBalawi, 2018; Y. Aldebasi, 2011). Also, another study (Y. H. Aldebasi, 2013) found that compliance rate of spectacle wear in primary school children was only 33.4%. Therefore, vision screening of children for RE and BVA should be conducted at the community level and integrated into school health programmes, accompanied by public awareness campaigns to guarantee that the corrections are used, and cultural barriers to compliance are overcome.

Limitations of this study include cycloplegic refraction was not performed in all children, but nevertheless, several studies suggested that Mohindra technique can be a useful substitute in the vision screening programs (Borghi & Rouse, 1985; e Cruz, Sampaio, & Vargas, 1990). In our study, only male students were included; but all previous reports of RE in Saudi showed no significant differences between genders, and this might suggest that our data can be generalised (Al Wadaani et al., 2013; Al-Rowaily, 2010; Y. H. Aldebasi, 2014; Alsaqr et al., 2017).

In conclusion, the results of this study reveal a high prevalence of RE and other BV anomalies among

schoolchildren in smaller urban areas in Saudi Arabia. Vision Screening of children for refractive errors should be conducted at the community level and integrated into school health programmes.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

References

Abdi, S., Lennerstrand, G., Pansell, T., & Rydberg, A. (2008). Orthoptic findings and asthenopia in a population of Swedish schoolchildren aged 6 to 16 years. *Strabismus, 16*(2), 47. https://doi.org/10.1080/09273970802020243

Al Wadaani, F. A., Amin, T. T., Ali, A., & Khan, A. R. (2013). Prevalence and pattern of refractive errors among primary school children in Al Hassa, Saudi Arabia. *Global journal of health science, 5*(1), 125. https://doi.org/10.5539/gjhs.v5n1p125

Al-Lahim, W. A., Al-Ghofaili, R. S., Mirghani, H., & ALBalawi, H. (2018). Evaluation of awareness and attitudes towards common eye diseases among the general population of Northwestern Saudi Arabia. *The Egyptian Journal of Hospital Medicine, 70*(11), 1983-1989. https://doi.org/10.12816/0044854

Al-Rowaily, M. A. (2010). Prevalence of refractive errors among pre-school children at King Abdulaziz Medical City, Riyadh, Saudi Arabia. *Saudi Journal of Ophthalmology, 24*(2), 45-48. https://doi.org/10.1016/j.sjopt.2010.01.001

Aldebasi, Y. (2011). Young public's awareness to refractive error deficiency. *International journal of health sciences, 5*(1), 9.

Aldebasi, Y. H. (2013). A descriptive study on compliance of spectacle-wear in children of primary schools at Qassim Province, Saudi Arabia. *International journal of health sciences, 7*(3), 291. https://doi.org/10.12816/0006057

Aldebasi, Y. H. (2014). Prevalence of correctable visual impairment in primary school children in Qassim Province, Saudi Arabia. *Journal of Optometry, 7*(3), 168-176. https://doi.org/10.1016/j.optom.2014.02.001

Aldebasi, Y. H. (2015). Prevalence of amblyopia in primary school children in Qassim province, Kingdom of Saudi Arabia. *Middle East African journal of ophthalmology, 22*(1), 86. https://doi.org/10.4103/0974-9233.148355

Aldebasi, Y. H., Ahmed, M. I., & Monaco, W. A. (2018). Are optometrists necessary in primary health care centres in Saudi Arabia? *African Vision and Eye Health, 77*(1), 1-10. https://doi.org/10.4102/aveh.v77i1.402

Alsaqr, A. M., Ghayda'a Ibrahim, A. A. S., & Fagehi, R. (2017). Investigating the visual status of preschool children in Riyadh, Saudi Arabia. *Middle East African journal of ophthalmology, 24*(4), 190. https://doi.org/10.4103/meajo.MEAJO_123_17

Bedwell, C., Grant, R., & McKeown, J. (1980). Visual and ocular control anomalies in relation to reading difficulty. *British Journal of Educational Psychology, 50*(1), 61-70. https://doi.org/10.1111/j.2044-8279.1980.tb00798.x

Birch, E. E. (2013). Amblyopia and binocular vision. *Progress in retinal and eye research, 33*, 67-84. https://doi.org/10.1016/j.preteyeres.2012.11.001

Borghi, R. A., & Rouse, M. W. (1985). Comparison of refraction obtained by "near retinoscopy" and retinoscopy under cycloplegia. *American journal of optometry and physiological optics, 62*(3), 169-172. https://doi.org/10.1097/00006324-198503000-00004

Dusek, W., Pierscionek, B. K., & McClelland, J. F. (2010). A survey of visual function in an Austrian population of school-age children with reading and writing difficulties. *BMC ophthalmology, 10*(1), 16. https://doi.org/10.1186/1471-2415-10-16

Dusek, W. A., Pierscionek, B. K., & McClelland, J. F. (2011). An evaluation of clinical treatment of convergence insufficiency for children with reading difficulties. *BMC ophthalmology, 11*(1), 21. https://doi.org/10.1186/1471-2415-11-21

e Cruz, A. A. V., Sampaio, N. M. V., & Vargas, J. A. (1990). Near retinoscopy in accommodative esotropia. *Journal of Pediatric Ophthalmology and Strabismus, 27*(5), 245-249.

Garnham, L., & Sloper, J. (2006). Effect of age on adult stereoacuity as measured by different types of stereotest. *British journal of ophthalmology, 90*(1), 91-95. https://doi.org/10.1136/bjo.2005.077719

Goh, P.-P., Abqariyah, Y., Pokharel, G. P., & Ellwein, L. B. (2005). Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *Ophthalmology, 112*(4), 678-685. https://doi.org/10.1016/j.ophtha.2004.10.048

Goldschmidt, E., & Jacobsen, N. (2014). Genetic and environmental effects on myopia development and progression. *Eye, 28*(2), 126-133. https://doi.org/10.1038/eye.2013.254

He, M., Zeng, J., Liu, Y., Xu, J., Pokharel, G. P., & Ellwein, L. B. (2004). Refractive error and visual impairment in urban children in southern China. *Investigative ophthalmology & visual science, 45*(3), 793-799. https://doi.org/10.1167/iovs.03-1051

Leat, S., Chan, L., Maharaj, P., Hrynchak, P., Mittelstaedt, A., Machan, C., & Irving, E. (2013). Binocular vision and eye movement disorders in older adults. *Investigative ophthalmology & visual science, 54*(5), 3798. https://doi.org/10.1167/iovs.12-11582

Marmamula, S., Keeffe, J. E., & Rao, G. N. (2009). Uncorrected refractive errors, presbyopia and spectacle coverage: results from a rapid assessment of refractive error survey. *Ophthalmic epidemiology, 16*(5), 269-274. https://doi.org/10.1080/09286580903144720

Maul, E., Barroso, S., Munoz, S. R., Sperduto, R. D., & Ellwein, L. B. (2000). Refractive error study in children: results from La Florida, Chile. *American journal of ophthalmology, 129*(4), 445-454. https://doi.org/10.1016/S0002-9394(99)00454-7

Naidoo, K. S., & Jaggernath, J. (2012). Uncorrected refractive errors. *Indian journal of ophthalmology, 60*(5), 432. https://doi.org/10.4103/0301-4738.100543

Negrel, A. D., Maul, E., Pokharel, G. P., Zhao, J., & Ellwein, L. B. (2000). Refractive error study in children: sampling and measurement methods for a multi-country survey. *American journal of ophthalmology, 129*(4), 421-426. https://doi.org/10.1016/S0002-9394(99)00455-9

Palomo-Álvarez, C., & Puell, M. C. (2010). Binocular function in school children with reading difficulties. *Graefe's Archive for Clinical and Experimental Ophthalmology, 248*(6), 885-892. https://doi.org/10.1007/s00417-009-1251-y

Ponsonby, A.-L., Smith, K., Williamson, E., Bridge, D., Carmichael, A., Dwyer, T., . . . Keeffe, J. (2013). Poor stereoacuity among children with poor literacy: Prevalence and associated factors. *Optometry and Vision Science, 90*(1), 75-83. https://doi.org/10.1097/OPX.0b013e3182780dd0

Resnikoff, S., Pascolini, D., Mariotti, S. P., & Pokharel, G. P. (2008). Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bulletin of the World Health Organization, 86*, 63-70. https://doi.org/10.2471/BLT.07.041210

Schneider, J., Leeder, S. R., Gopinath, B., Wang, J. J., & Mitchell, P. (2010). Frequency, course, and impact of correctable visual impairment (uncorrected refractive error). *Survey of ophthalmology, 55*(6), 539-560. https://doi.org/10.1016/j.survophthal.2010.02.004

Shrestha, G. S., Sujakhu, D., & Joshi, P. (2011). Refractive error among school children in Jhapa, Nepal. *Journal of Optometry, 4*(2), 49-55. https://doi.org/10.1016/S1888-4296(11)70041-3

Vitale, S., Cotch, M. F., & Sperduto, R. D. (2006). Prevalence of visual impairment in the United States. *Jama, 295*(18), 2158-2163. https://doi.org/10.1001/jama.295.18.2158

Wojciechowski, R. (2011). Nature and nurture: the complex genetics of myopia and refractive error. *Clinical genetics, 79*(4), 301-320. https://doi.org/10.1111/j.1399-0004.2010.01592.x