Refractive Errors Survey in Primary School Children (6-12 Year Old) in 2 Provinces: Bangkok and Nakhonpathom (One Year Result)†

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Background: *Refractive error is an important cause of preventable visual impairment and blindness worldwide. Population-based studies will continue to be a key part in identification of the magnitude and the importance of this common eye disease.*
Objective: *To assess the prevalence of the refractive error in primary school-aged children in Bangkok and Nakhonpathom together with the provision of the appropriately free of charge spectacles.*
Material and Method: *A Population-based cross-sectional analytic study was conducted between October 2008 and September 2009.Random selection of geographically defined clusters was used to identify the study sample. The examination included visual acuity (VA) by Snellen chart and pinhole correction, autorefraction under cycloplegic refraction, ocular motility evaluation, examination of the external eye, anterior segment, media, and fundus. Ophthalmologists screened for ocular abnormalities.*
Results: *Among 2,340 children, 1,100 in Bangkok and 1,240 in Nakhonpathom were examined. The prevalence of refractive error in Bangkok and Nakhornpathom were 12.7% and 5.7% respectively. Refractive error was the cause in 97.6% of eyes with reduced vision, amblyopia in 0.5%, other causes in 0.8%, and unexplained causes in 1.1%.*
Conclusion: *The present study showed a relative high prevalence of uncorrected refractive error in the central part of Thailand especially in Bangkok. Eye health education and screening is recommended to evaluate the need for refractive correction with appropriate prescription of spectacles.*

Keywords: *Refractive Errors, Survey, Primary School Children, Bangkok, Nakhonpathom*

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It has been estimated that 2.3 billion people worldwide have refractive error, but only 1.8 billion people have access to eye examinations and affordable correction[1,2]. This finding is significant considering that non-corrective refractive error is a public health concern[3]. The World Health Organization has launched a campaign for managing refractive errors by the year 2020 and placed it as the fifth position for its urgency[4,5]. School-age children constitute a particularly vulnerable group, because uncorrected refractive error may have a dramatic impact on learning capability and educational potential[6]. Vision screening for schoolchildren can identify children who have a vision problem that might affect physiological or perceptual processes of vision. Reduced vision may affect academic performance, choice of occupation and socio-economic status in adult life. Vision screenings are not diagnostic, but screening results may indicate a potential need for further assessment. The availability of optical correction with spectacles after school vision screening is relatively little cost. The outcome of this intervention will generally improve the children's academic and the quality of life. Visual screening in children provides early diagnosis, therapy, prevention, and health promotion for many eye diseases, such as cataract, glaucoma, and retinal detachment[4]. Vision screening of all children at school entry has been a traditional practice for many years. Recently, decisions have been made to discontinue screening and to rely on parent and teacher referral methods instead. A

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review of the literature suggested that parent and teacher referral methods of screening were less than satisfactory and that professional screening of all children at school entry age should be continued[7].

Material and Method

The present study design was a population-based cross-sectional record of the children between 6-12 years old primary school children in Bangkok and Nakhonpathom between October 2008 and September 2009. Seven primary schools were included. The ethical approval involving human subjects was granted by the Mettapracharak Hospital, Nakhonpathom research ethics committee to carry out the study before its commencement. The research protocol adhered to the tenets of the Declaration of Helsinki. Parents or guardians were provided with an information sheet and requested an outline of known symptoms. Signed consent by parents and their child were required prior to a child's vision screening and the eye examination. Prior to the initiative of the present study, all field investigators were trained with the involved standard protocol. Two thousand three hundred forty children aged 6-12 years were selected through random sampling in these regions (Bangkok and Nakhonpathom). The comprehensive optometric examination was performed by experienced optometrists. The distant vision of a child was tested utilizing Snellen's charts at 20 feet. Refractive error was determined by cycloplegic retinoscopy with 1% cyclopentolate eye drops instilled 5 minutes apart in each eye. After 20 minutes, if a pupillary light reflex was still present, a third drop was administered. The light reflex and pupil dilation were checked after an additional 15 minutes. Cycloplegia was considered complete if the pupil dilated to 6 mm or greater and a light reflex was absent[6]. Other tests included autorefraction, lensometry, slit lamp biomicroscopy examination of the external eye, anterior and posterior segment, ocular motilities, test for strabismus, alignment evaluation, pupil reactions, heterophoria, and indirect fundus ophthalmoscopy. The presence or absence of strabismus was determined by the Hirschberg's test and then cover-uncover test to confirm the diagnosis. The eye movements were tested in six cardinal directions to rule out paralytic or restrictive strabismus. A pilot was conducted to validate the data collection forms to minimize inter-observer variations. If any data was noticed, the concerned authority was contacted at the earliest and the details were rechecked. Children with eye diseases were further investigated and managed at the hospital. The present study results would have been shared with the scientific fraternity and policies for improving eye prevention and promotion strategies in the Ministry of Public Health in Thailand.

Definitions

Clinical evidence by Refractive Error Study in Children (RESC) suggests that subjective refraction was performed on children with an uncorrected visual acuity equal to or worse than 20/40 each eye[8]. If uncorrected was equal to or worse than 20/40 in each eye, the child was declared to have defective vision. The preferred criterion to define myopia in the present study was that a spherical equivalent equal to or more minus than -0.50 D in either eye[9]. Hyperopia was defined as spherical equivalents equal to or more greater than +2.0 D. Thus, emmetropes were children with neither eye myopic or hyperopic. The prevalence of astigmatism was assessed at two levels: greater than or equal to 0.75 to less than 2 cylinder diopters and greater than or equal to 2 diopters. The spherical equivalent was calculated by using the following formula: Spherical equivalent = Spherical value + [cylindrical value/2](in diopters)[10]

Amblyopia was reported as the cause of impairment only for children with no apparent organic lesion and satisfying one or more of the following criteria: 1) esotropia, exotropia, or vertical tropia at 4 meters fixation, or esotropia or vertical tropia at 0.5 meters (strabismic amblyopia), 2) anisometropia 2 spherical equivalent diopters or greater (anisometropic amblyopia) or 3) bilateral ametropia of 16 spherical equivalent diopters or greater[6].

Cases with uncorrectable vision loss designated by the examiner as "amblyopia" in the absence of any organic lesion were tabulated as being of unexplained causes if they did not meet these explicit criteria[6].

Statistical analysis

Univariate analyses of frequencies (percent), rate and 95% confidence intervals were performed to describe patients' characteristics. $P < 0.05$ was considered statistically significant. To achieve 95% confidence limit and 90% of power in the present study, having Bangkok to Nakhonpathom ratio of 1:1.1. Bangkok and Nakhonpathom significantly differed by proportion of students in "age groups". The author determined that cluster-adjusted rates in Bangkok and Nakhonpathom were needed before comparing their refractive error status.

Results

Two thousand three hundred forty children of ages in the range of 6 to 12 years were randomly selected and examined from seven primary schools. The characteristics of children in Bangkok and Nakhonpathom were compared (Table 1).

The frequencies (percent), rate, myopia, hyperopia, astigmatism, and their 95% confidence intervals were compared for children of Bangkok and Nakhonpathom and for the sub-groups like gender and age groups. The prevalence of myopia, hyperopia and astigmatism in Bangkok were 11.1% (95% CI, 10.90-12.71), 1.4% (95% CI, 1.24-1.61), and 0.3% (95% CI, 0.17-0.36), respectively. The prevalence of myopia, hyperopia, and astigmatism in Nakhonpathom were 4.3% (95% CI, 4.18-4.46), 1.3% (95% CI, 1.22-1.41), and 0.2% (95% CI, 0.15-0.25), respectively (Table 2).

The causes of uncorrected refractive error in children of Bangkok and Nakhonpathom were evaluated (Table 3). Refractive error was the cause in 97.6%, unexplained causes (1.1%), amblyopia in 0.5%, corneal opacity (0.32%), optic nerve disease (0.22%), cataract (0.11%), and retinal disorders (0.11%).

Discussion

Recently reported prevalence of refractive error in primary school children vary greatly in different regions of the world. The prevalence of refractive error is changing over time depend on sex, age, and different geographic areas. It is difficult to compare due to different methodologies, different definitions of refractive error, and different techniques for measuring refractive error. This present study based on the RESC (The Refractive Error Study in Children) protocol that was supported by WHO[8]. Population-based, cross-sectional studies in children aged 5 to 15 years show that 8% of rural Chinese, 9% of urban Chinese, and 7% of urban Chilean would benefit from spectacles[11]. There have been a few studies regarding refractive errors in primary school

Table 1. Characteristics of 6 to 12 years old children examined in Bangkok and Nakhonpathom (n = 2,340)

Variant		Bangkok		Nakhonpathom		Validation
		No. (cases)	%	No. (cases)	%	
Sex	Female	570	51.8	640	51.6	$p < 0.05$
	Male	530	48.2	600	48.4	
Age group	6-8 yrs	501	45.5	618	49.8	
	9-12 yrs	599	54.5	622	50.2	
Total		1,100	100	1,240	100	

CI = confidence intervals

Table 2. Prevalence of refractive error in children of Bangkok and Nakhonpathom

	Bangkok				Nakhonpathom			
	Examine	Refractive error	Rate	95%CI	Examine	Refractive error	Rate	95%CI
Female	570	78	13.7	13.59-13.81	640	39	6.1	6.02-6.67
Male	530	62	11.7	11.68-11.84	600	32	5.3	5.13-5.57
6-8 yrs	501	56	11.2	11.09-11.26	618	36	5.8	5.76-5.93
9-12 yrs	599	84	14.0	13.95-14.11	622	35	5.6	5.58-5.64
Myopia	1,100	122	11.1	10.90-12.71	1,240	53	4.3	4.18-4.46
Hyperopia		15	1.4	1.24-1.61		16	1.3	1.22-1.41
Astigmatism		3	0.3	0.17-0.36		2	0.2	0.15-0.25
Total	1,100	140	12.7	11.10-13.50	1,240	71	5.7	5.61-5.79

CI = confidence intervals
Validation: p-value < 0.05

Table 3. Causes of uncorrected refractive error, defined as a visual acuity of 20/40 or worse in one or both eyes

Cause	No (%), eyes with uncorrected visual acuity 20/40 or worse		Total number (%), eyes with uncorrected visual acuity 20/40 or worse
	Right eye	Left eye	
Refractive error	451	455	906 (97.6)
Amblyopia	3	2	5 (0.5)
Corneal opacity	2	1	3 (0.32)
Cataract	1	-	1 (0.11)
Retinal disorders	1	-	1 (0.11)
Optic nerve disorders	1	1	2 (0.22)
Unexplained causes	9	1	10 (1.1)
Any cause	468 (100.0)	460 (100.0)	928 (100.0)

* Children with visual acuity of 20/40 or worse in both eyes may represent 2 different causes of reduced vision - a different cause for each eye

children in Thailand. Studies of refractive error in Thailand have been conducted with different selection criteria and nonuniform measurements. Refractive errors in children studied in Bangkok were 27.4% (15.8% hyperopia, 11.6% myopia) and 73.9% (61.3% hyperopia, 12.6% myopia) respectively[12,13]. Among 3,467 children in a northern province, Chiang Mai, 522 children (15.06%) had a visual acuity of 20/30 and lower. 71.69% had a visual acuity of 20/20 after eyeglasses trial wearing[14]. The prevalence of refractive error in Bangkok and Nakhornpathom in this present study was 12.7% (95% CI, 11.1-13.5) and 5.7% (95% CI, 5.61-5.79) respectively (Table 2). This study aimed at uncorrected refractive error with appropriately free spectacle correction provision. These prevalence rates of refractive error were significantly different between schoolchildren in Bangkok and Nakhonpathom. The difference could be influenced by the following factors, 1) The refractive services and compliance in wearing spectacles in two different areas. 2) The distribution of different racial variation, education, intelligence, and family history that may influence the refractive error status. 3) More near work compared to the students in Bangkok than in Nakhonpathom.

The element of chance in this observation could not be ruled out. The prevalence of uncorrected refractive error, especially myopia in primary school children was significantly higher in Bangkok than Nakhonpathom rural school areas. The Andra Pradesh Eye Disease Study (AEPDS) in India, 15.2% prevalence rate of myopia, noted that urban location was a predictor of myopia and children of urban area had a 2.5 times higher risk compared to rural areas[15]. In the RESC surveys in Chile[5], China[16], and urban India[17], where the corresponding prevalence of uncorrected refractive error were 15.8%, 12.8%, and 9.0%, respectively and more comparable to the 5.0% found in rural India[18] or the 2.9% in rural Nepal[11]. Myopia was the main type of uncorrected refractive error in the present study (11.1% in Bangkok and 4.3% in Nakhonpathom). Prevalence of myopia varies in different parts of the world depend on geography, ethnicity, sex, age[19], environmental factors and lifestyle[20]. In Chile, myopia was present in 3.4% of 5-year-old children, increasing to 19.4% in males and 14.7% in females by the age 15[5]. Whites had the lowest prevalence of myopia (4.4%), which was not significantly different from African Americans (6.6%)[21].

This present study (Table 3) showed that refractive error was the main cause of the uncorrected visual acuity. One of the most remarkable findings in the United States is that even in economically advantaged societies, refractive errors can also go undetected or uncorrected in children[22]. Amblyopia was 0.5% of the cause of uncorrected refractive error in this present study.Some studies in Thailand noted that the prevalence of amblyopia was 1-2%[12,13]. It is much lower than the studies in Nepal (2.9%)[11], the rural areas in India (5.0%)[18] and urban areas in India (9.0%)[17]. This difference can partly be attributed to the samplings methods and the difference in populations. Furthermore, amblyopia should be reduced and prevented by health education, health promotion, and screening surveys. More extensive studies toward the causes of uncorrected refractive error are recommended. A key global challenge is the

promotion of early detection of ophthalmological disorders in children, so that specific treatment can be started within the critical periods of visual maturation, together with the provision of appropriate developmental and educational interventions, genetic counseling and advice, and support to families of affected children[23].

Conclusion

Screening refractive error in children should be regularly done at community level and integrated into school health programmes with awareness and education to ensure that its correction is accomplished.

Limitations of the current study

It is possible that the school-based sampling strategy resulted in prevalence estimates not fully representative of the country population as a whole. Prospective longitudinal study with a larger sample size might give more precise information. Identifying risk factors involving the refractive status in children will add more accurate data in the assessment of its progression and prevention.

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การสำรวจสภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษา (อายุ 6-12 ปี) ใน 2 จังหวัด คือ กรุงเทพมหานคร และนครปฐม (รายงานผลการทำงาน 1 ปี)

เพ็ญพิมล ยิ่งยง

วัตถุประสงค์: *เพื่อหาอุบัติการณ์ของสภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษา (อายุ 6-12 ปี) ใน 2 จังหวัด คือ กรุงเทพมหานคร และนครปฐมร่วมกับการจัดหา และแจกแว่นสายตาโดยไม่คิดมูลค่า*

วัสดุและวิธีการ: *โครงการเริ่มดำเนินการตั้งแต่เดือนตุลาคม พ.ศ. 2551 ถึง กันยายน พ.ศ. 2552 โดยคัดเลือกจำนวนตัวอย่างแบบสุ่มตามลักษณะพื้นที่ที่กำหนด ตรวจวัดระดับสายตาด้วยแผ่นสเนลเลน ระดับสายตาเมื่อแก้ไขด้วยการมองผ่านรูเล็ก ๆ วัดสายตาด้วยเครื่องวัดสายตาระบบอัตโนมัติภายหลังการขยายม่านตา ตรวจการเคลื่อนไหวของกล้ามเนื้อตา ตรวจตาตั้งแต่ส่วนนอก ระดับช่องหน้าลูกตา องค์ประกอบในตา และจอประสาทตา ทำการคัดกรองเพื่อหาความผิดปกติในตาโดยจักษุแพทย์*

ผลการศึกษา: *นักเรียนในกรุงเทพมหานคร 1,100 คน และนครปฐม 1,240 คน จากจำนวนทั้งหมด 2,340 คน อุบัติการณ์ของสภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษาในกรุงเทพมหานคร และนครปฐมเป็น 12.7% และ 5.7% ตามลำดับ สภาวะสายตาผิดปกติเป็นสาเหตุของอาการตามัว 97.6% รองลงมาคือโรคสายตาขี้เกียจ 0.5% สาเหตุอื่น ๆ 0.8% และสาเหตุที่ไม่ระบุ 1.1%*

สรุป: *การศึกษานี้แสดงว่าอุบัติการณ์ของสภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษา ในกรุงเทพมหานคร ซึ่งเป็นเมืองหลวงที่ยังไม่ได้รับการแก้ไขสูงกว่านครปฐมมาก ควรมีการให้การศึกษา และการคัดกรองสภาวะดังกล่าวเพื่อประเมินความจำเป็นในการแก้ไขร่วมกับการให้แว่นสายตาที่เหมาะสม*