Risk Factors for Refractive Errors in Primary School Children (6-12 Years Old) in Nakhon Pathom Province

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Background: *Refractive error is one of the leading causes of visual impairment in children. An analysis of risk factors for refractive error is required to reduce and prevent this common eye disease.*
Objective: *To identify the risk factors associated with refractive errors in primary school children (6-12 year old) in Nakhon Pathom province.*
Material and Method: *A population-based cross-sectional analytic study was conducted between October 2008 and September 2009 in Nakhon Pathom. Refractive error, parental refractive status, and hours per week of near activities (studying, reading books, watching television, playing with video games, or working on the computer) were assessed in 377 children who participated in this study.*
Results: *The most common type of refractive error in primary school children was myopia. Myopic children were more likely to have parents with myopia. Children with myopia spend more time at near activities. The multivariate odds ratio (95% confidence interval) for two myopic parents was 6.37 (2.26-17.78) and for each diopter-hour per week of near work was 1.019 (1.005-1.033). Multivariate logistic regression models show no confounding effects between parental myopia and near work suggesting that each factor has an independent association with myopia.*
Conclusion: *Statistical analysis by logistic regression revealed that family history of refractive error and hours of near-work were significantly associated with refractive error in primary school children.*

Keywords: *Risk factors, Refractive Errors, Primary School Children, Nakhon Pathom*

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Uncorrected refractive error is the significant cause of visual impairment in children as suggested by the World Health Organization[1]. Several clinical studies point to increasing rates of myopia in Singapore and other parts of Asia[1-4]. The prevalence of myopia in children with two parents with myopia is 30% to 40%, decreasing to 20% to 25% in children with one parent with myopia, and to less than 10% in children with no parents with myopia[5,6]. Refractive error and the axial length of children's eyes are more closely related to parental refractive error than to children's near-work habits[7]. Some theories about the risk factors of refractive error such as genetic susceptibility, environment factor, and near work have been suggested[8-10]. Children aged 7 to 9 years with a greater current reading exposure were more likely to be myopic[11]. Few population-based studies describe risk factors for refractive error in primary school children in Thailand. Little is known about the role of reading in the development of myopia in Thai children. The author examined the correlation between potential risk factors such as reading and parental myopia with myopia in Thai primary school children (6-12 years old) in Nakhon Pathom.

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Material and Method

The present study was a population-based cross-sectional descriptive study of children between 6-12 years old primary school children in Nakhon Pathom, chosen from three schools between October 2008 and September 2009. The ethical approval involving human subjects was granted by Mettapracharak Hospital, Nakhon Pathom research ethics committee to carry out the present study. 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 eye examination in

accordance with the Declaration of Helsinki. The teachers from each school were trained by the author to complete the structured questionnaire according to the information available, either from the students or from the parents. To ensure the accuracy of the data, the questionnaires were filled by the parents with each child, and the author revised them in a pilot check. Clusters were stratified to ensure an approximately equal sample of female and male primary school children.

Demographic information such as age, gender was completed. The variables in this analysis were children's refractive status measured by cycloplegic procedure (myopic, emmetropic, or hyperopic) and the medical questionnaires included previous ophthalmic problems, family history of consanguinity, and family history of refractive error. The questionnaires also asked how much near-work the children currently practiced in hours per week, such as studying, reading books, watching television, playing with video games, or working on the computer. These activities were analyzed separately. The purpose of these activities was to quantify exposure to near work not just in terms of time, but also in terms of the accommodative effort required during each activity. This diopterhours (Dh) variable was defined as Dh = 3 x (hours spent studying + hours spent reading for pleasure) + 2 x (hours spent playing video games or working on the computer at home) + 1 x (hours spent watching television)[7].

Parents' refractive status was determined for each parent by a survey filled out by parents at study entry asking whether glasses were worn and for what purpose. Each parent was classified as myopic if he or she wore glasses only for distance viewing, or if glasses were worn for both distance and near.

Definitions

According to the Refractive Error Study in Children (RESC), the criteria to define myopia is that a spherical equivalent equal to or more minus than -0.50 D in either eye[12]. Hyperopia was defined as spherical equivalents equal to or greater than +2.0 D in either eye. Thus, emmetropes were children with neither eye myopic or hyperopic in both eyes. The spherical equivalent was calculated by using the following formula, Spherical equivalent = Spherical value + [cylindrical value/2](in diopters)[13].

Statistical analysis

Pearson Chi-squared test was used for univariate analysis. Frequencies (percent), mean $\pm$ SD, rate, and 95% confidence intervals were performed to describe patients' characteristics. Differences were considered significant at $p < 0.05$ with 2-sided. The variables found to be significantly associated with refractive error were entered into multiple linear logistic regression with odds ratio (OR), and 95% confidence interval (CI), adjusting for other confounders.

Results

There were 382 of 467 eligible participants, a participation rate of 81.8%. Of these, five had incomplete examination data, leaving 377 children for the present analysis. The average age (mean $\pm$ SD) of the sample was 9.02 $\pm$ 2.01 years. The sample was 192 females (51%) and 185 males (49%). Female: male ratio was 1.04:1 (Table 1).

Of the 377 children in the sample 64 (17%) were myopia, 31 (8.2%) hyperopes, and 282 (74.8%) emmetropes (Table 2). Children spent much time studying in school as they watched the television. Myopic children spent more time occupying in near activities.

Parents with myopia tended to have children with myopia (Table 3). Of the children with two parents with myopia, 33.3% had myopia compared with 17.1% of children with one parent with myopia and 5.1% of children with no parent with myopia.

Confounding was assessed in a multivariate logistic regression model (Table 4) to evaluate the association among myopia and the number of parents with myopia, near work in diopter-hours per week. Having either one (OR = 3.27, 95% [CI] = 1.68-7.45) or two parents with myopia (OR= 7.16, 95% [CI] = 2.93-16.9) significantly increased the odds of being a

Table 1. Characteristics of 6 to 12 years old children examined in Nakhonpathom (n = 377)

Variant	Nakhon Pathom	
	Number	%
Sex		
Female	192	51
Male	185	49
Baseline age		
6-7	106	28.1
8-9	109	28.9
10-11	106	28.1
$\geq$ 12	56	14.9
Total	377	100

Table 2. Hours spent per week in various activities

Activity	All Subjects (n = 377)	Myopes (n = 64)	Emmetropes (n = 282)	Hyperopes (n = 31)
Studying	9.5 ± 5.6	11.3 ± 7.1*	8.7 ± 5.3	9.5 ± 4.7
Reading for pleasure	4.5 ± 4.4	5.9 ± 4.7+	4.0 ± 4.7	3.5 ± 2.8
Watching TV	8.2 ± 5.8	9.3 ± 6.7	8.1 ± 5.2	6.4 ± 4.4
Video games/computer	2.4 ± 3.1	2.8 ± 4.0	2.0 ± 3.3	1.3 ± 1.7
Diopter-hours	54.2 ± 25.4	66.0 ± 33.7+	50.1 ± 23.7	47.9 ± 20.8

Wilcoxon rank-sum test comparing myopes or hyperopes with emmetropes. Wilcoxon testing was used because of the non-normal distribution of variables. None of the comparisons between emmetropes and hyperopes was significant. Comparisons between myopes and emmetropes were significant as marked. Data are expressed as mean hours ± SD
* $p < 0.05$
+ $p < 0.005$

Table 3. Proportion of children with and without myopia as a function of number of parents with myopia

Parental myopia	Child with myopia		Child without myopia	
	n = 61	%	n = 285	%
None (n = 98)	5	5.1	86	87.8
One parent (n = 164)	28	17.1	136	82.9
Two parent (n = 84)	28	33.3	63	75.0

$\lambda^2 2 = 21.0$; $p = 0.001$; n =346
Data are percentage of each parental myopia group, with the number of children in parentheses

Table 4. Univariate and multivariate odds ratios (OR) and confidence interval (CI) for the risk factor

Risk factor	Univariate	Multivariate	p-value
One myopic parent	3.27 (1.68-7.45)	3.28 (1.59-8.21)	0.021
Two myopic parent	7.16 (2.93-16.9)	6.37 (2.26-17.78)	0.0005
Diopter-hour per week	1.017 (1.007-1.039)	1.019 (1.005-1.033)	0.0017

myope.The odds ratio for near work did not change when adjusted for the number of parents with myopia. Near work appears to have an independent association with myopia that is not explained by myopia in parents.

Discussion

Despite much study, it has been difficult to associate quantitative measures of near work activity with myopia in epidemiologic studies[14]. The typical epidemiologic assessments of near work attempt to measure time spent in near work activities. Little if any information is available in the myopia epidemiology literature about how survey-derived time-based near work measures actually correlate with ocular use. A near work measure that quantifies near work accomplishment rather than near work time may prove a useful physiologic parameter to assess myopia risk. Near work activities may be confounded by other varying factors such as the size of font, the type of font, or type of characters (Thai versus English). The most important potentially confounding association is between near work and parental refractive error. Perhaps parents with myopia have children with myopia only because they pass along a myopigenic environment with intense near work demands. An important factor to consider is the near work done

before the age of onset of myopia. A recently reported significant odds ratio for near work in Chinese schoolchildren is difficult to interpret because it is unclear whether it represents the effect of near work or an urban versus rural site. Location may be an important confounding variable.

The diopter hours, a time-weighted score devised to weigh the amount of accommodation required for different near work tasks. Besides the need to assess time, the concept of the score, diopter hours, also may be limited by intersubject differences in task-specific accommodative needs. Time-based near work measures, such as reading in hours per day or near-vision task index, may be inaccurate because the child may not be actively reading during the entire documented period. The parent may find it difficult to recall the exact amount of time a child reads in a usual day to the nearest half hour. A possible limitation of the present study is that information on whether the children habitually wore spectacles while reading was not available. The regular use of spectacles during near work activity may result in a state of chronic hyperopic defocus and disrupt normal refractive error development in young children[15].

The likelihood of myopia was higher in children with two myopic parents than those with one myopic parent. This finding is consistent with studies in the United States in which the odds ratio was 6.42 for children with two myopic parents compared with those with one myopic parent[16]. Data on parental myopia was limited by rather indirect estimates from a questionnaire rather than refractive error measurements, and this may have lead to misclassification bias. Parents may influence the incidence of myopia, not through their genetic contributions to their offspring, but by creating visual environments that are conductive to myopia development[17]. Other risk factor such as socio-economic status may be a surrogate for environmental lifestyle factors with academic achievement, intellectual ability and near work activities[18,19].

Comparison between examinations reported by several studies showed a considerable increase in the incidence of myopia and decrease of hyperopia among those seven years of age or older, and changes in mean refractive errors. It also demonstrated a greater shift toward myopia, especially in students older than 10 years[20]. The prevalence of hyperopia falls in older schoolchildren[21]. There are very few data in the literature on risk factors for this common eye condition. Glasses are usually unnecessary for low amounts of hyperopia, because children have a tremendous capacity to accommodate (14 diopters for an average 8 year old). Hyperopic children may compensate by accommodation. One study showed that there is no significant reduction in children's visual acuity until uncorrected hypermetropia is 4.5 diopters or more[22]. Outdoor activity (20 hours per week) was much more frequently undertaken by children with moderate hyperopia than by children with myopia, a finding confirmed in the 6-year-olds and 12-year-olds[23]. It is difficult to provide a cohesive summary of these studies, given that the papers examined various options (*e.g.*, screening versus eye examinations, newborn screening versus preschool screening versus school screening, and so on) and were based on different economic systems. To estimate the costs and effects of alternative strategies for annual screening of school children for refractive errors, and the provision of spectacles, in different WHO sub-regions in Africa, Asia, America, and Europe. In these regions, screening of 5-15 years old children yields most health effects, followed by screening of 11-15 years old, 5-10 years old, and screening of 8 and 13 years old[24]. Further research would also need to take into consideration the national children's vision screening program.

Conclusion

The present results provide somewhat stronger near work and parental myopia correlate with myopia, but do not unambiguously resolve whether near work is a risk factor for the development of myopia.

Limitations of this study

The risk factors may be interrelated and statistical adjustment may not explain or completely remove the influence of one environmental risk factor on another. Reading and myopia were both measured at one time point in this cross-sectional study, it is not concluded that there is a cause–effect relationship. Sport activities should be added to establish such a relative effect. Role of parental myopia in the progression of myopia and its interaction should be further investigated. Prospective longitudinal study with larger sample size might give more precise information.

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ปัจจัยเสี่ยงของภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษา (อายุ 6-12 ปี) ในจังหวัดนครปฐม

เพ็ญพิมล ยิ่งยง

***ภูมิหลัง**: ภาวะสายตาผิดปกติเป็นสาเหตุนำของสายตาพิการในเด็ก การวิเคราะห์ปัจจัยเสี่ยงต่อภาวะสายตาผิดปกติเป็นสิ่งจำเป็นเพื่อลดจำนวนและป้องกันภาวะดังกล่าว*

***วัตถุประสงค์**: เพื่อประเมินปัจจัยเสี่ยงต่อภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษา อายุ 6-12 ปี ในจังหวัดนครปฐม*

***รูปแบบ**: การวิเคราะห์ประชากรแบบภาคตัดขวาง*

***วัสดุและวิธีการ**: โครงการเริ่มดำเนินการตั้งแต่ตุลาคม พ.ศ. 2551 ถึง กันยายน พ.ศ. 2552 ในจังหวัดนครปฐม โดยสำรวจภาวะสายตาผิดปกติ ประวัติครอบครัวที่มีสายตาผิดปกติ กิจกรรมการใช้สายตา ในระยะใกล้เป็นจำนวนชั่วโมงที่ใช้ในหนึ่งสัปดาห์ ได้แก่ การอ่านหนังสือเรียน การอ่านหนังสือเพื่อความเพลิดเพลิน การดูโทรทัศน์ การเล่นวิดีโอเกมส์ และคอมพิวเตอร์ในเด็กนักเรียน 377 คน ในโครงการวิจัย*

***ผลการศึกษา**: ภาวะสายตาผิดปกติในเด็กนักเรียนชั้นประถมศึกษาที่พบบ่อยที่สุด คือ สายตาสั้น เด็กที่มีสายตาสั้นมักมีบุคคลในครอบครัวสายตาสั้นด้วย และมักใช้เวลาในการใช้สายตาในระยะใกล้มากกว่าอัตราเสี่ยงทางสถิติในครอบครัว ที่มีภาวะสายตาสั้นทั้งบิดา และมารดาเมื่อเทียบกับครอบครัวที่มีภาวะสายตาสั้นคนเดียว (บิดาหรือมารดา) คือ 6.37 เท่า (2.26-17.78) เมื่อเทียบกับจำนวนชั่วโมงที่ใช้ในหนึ่งสัปดาห์ ในกิจกรรมการใช้สายตาในระยะใกล้ เท่ากับ 1.019 เท่า (1.005-1.033) ตามลำดับ วิเคราะห์ในปัจจัยเสี่ยงทางสถิติ เมื่อตัดปัจจัยกระทบตัวอื่น พบว่าครอบครัวที่มีสายตาผิดปกติ และกิจกรรมการใช้สายตาในระยะใกล้เป็นปัจจัยที่เสี่ยงต่อภาวะสายตาสั้นอย่างเป็นอิสระต่อกัน*

***สรุป**: การวิเคราะห์ทางสถิติพบว่า ครอบครัวที่มีสายตาผิดปกติ และกิจกรรมการใช้สายตาในระยะใกล้เป็นปัจจัยที่เสี่ยงต่อภาวะสายตาสั้นอย่างมีนัยสำคัญทางสถิติ และเป็นอิสระต่อกัน*