

Cross-Sectional Study of Near-work and Myopia in Kindergarten Children in Singapore

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Abstract

Introduction: In view of the high and increasing myopia rates amongst young Singaporean children, we aimed to assess the relationship between near-work and myopia in 414 pre-school children aged 4 to 6 years. **Materials and Methods:** We measured near-work indices such as tuition classes outside school and other possible risk factors via a questionnaire. We then measured myopia with a hand-held autorefractor. **Results:** Children who had 3 or more hours per week of near-work classes outside school had a higher rate [odds ratio 1.39 (95% confidence interval 1.02, 2.53)] of myopia. **Conclusions:** This suggests that there may be an association between near-work and myopia, even at such a young age. Given the increasing emphasis on near-work in Singapore, it may be important to call for increased visual health awareness, although further studies will be needed to establish if near-work causes myopia.

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Introduction

Myopia is the commonest eye disease worldwide, and is especially prevalent in certain Asian countries such as Taiwan, Japan and Hong Kong.¹ Physiologic myopia is thought to be a multifactorial disease with both genetic and environmental factors.^{2,3} Twin studies and segregation analysis studies have indicated that myopia is hereditary.⁴ On the environmental front, near-work is the most commonly implicated environmental factor, both by animal studies in monkeys and chicks,⁵⁻⁷ as well as by epidemiological studies in Newfoundland, Hong Kong and Israel.⁸ A cross-sectional study in Hong Kong of 408 fishermen showed an odds ratio of 1.7 for school attendance, whilst the cross-sectional study of 870 Jewish schoolchildren revealed a prevalence rate ratio of 2.97 in Orthodox schoolboys compared to general schoolboys.^{9,10} Other possible risk factors include high socio-economic status and decreased outdoor activities.¹¹⁻¹³

In view of the high prevalence rate of 24.5% of visual problems in 7-year-old children in 1996, we sought to investigate the relationship between near-work and myopia in 4- to 6-year-olds in Singapore.¹⁴ Other objectives are to investigate the relationship between other possible risk factors and myopia, and to determine the prevalence rates of myopia in 4- to 6-year-olds from 2 kindergartens.

Subjects and Methods

Four hundred and fourteen children aged 4 to 6 years from 2 centrally located kindergartens in Singapore were recruited to join a cross-sectional study. There was a response rate of 83.5% after all children in both kindergartens were invited to join the study. Three children were excluded as they had severe congenital eye disease. The children were examined in the 2 kindergartens over a 3-day period in January 1999.

Risk Factor Information

Near-work information, family history of myopia and demographic data were obtained via a self-administered questionnaire distributed to the parents through the class teachers (Appendix A). This questionnaire has been found to be reproducible (intra-class correlation coefficient 0.87, 95% confidence interval 0.85, 0.91) and comparable to four 24-hour diaries (intra-class correlation coefficient 0.50, 95% confidence interval 0.34, 0.66) in a cohort study of Singaporean children.¹⁵ The questionnaire was pilot tested in 30 children aged 4 to 6 years.

The time spent on the different types of near-work activities such as reading, writing, computer and video games was obtained. Information on structured classes outside school involving near-work such as tuition, music,

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as well as art and craft were also assessed.

Demographic data (age, gender and socio-economic status) and parental history of myopia were obtained from the questionnaire.

The distance between the children's eyes and pencil tip was measured while the children were colouring a picture in the classroom, and the average of three readings was taken as the "colouring distance".

Refractive Error Measurements

LogMAR testing was performed on both eyes, with matching tests used in the majority of children. Directional tests (tumbling E) were used for the remaining minority. The 2 types of charts produce comparable results in children over the age of 3.¹⁶ Autorefraction was performed on both eyes for all 414 children using the Nikon K-Plus I (Nikon Co. Ltd., Tokyo, Japan). Two trained operators took 8 readings per eye, with a minimum internal validity (as reported by the autorefractor) of 8 or greater (out of a maximum of 10).

The researchers measuring visual acuity, colouring distance, and operating the autorefractor were masked from each other's results and the questionnaires. The parents also completed the questionnaires without knowing the results of the testing.

Myopia was defined as a spherical equivalent of greater than or equal to -1.50 D in the non-cycloplegic right and left eye. This allows for an average of -1.0 D difference in the non-cycloplegic reading because of residual accommodation.

Data Analysis

Descriptive and univariate analyses were performed on the data using Statistical Package for Social Sciences (SPSS) version 8.0. Spherical equivalent was calculated as sphere plus half cylinder. Analysis was conducted using right eye data, as the results from the right and left eye were similar (Pearson's correlation coefficient 0.837). The P values were two-sided.

Results

We examined a total of 414 subjects. There were 196 kindergarten level 1 students and 218 kindergarten level 2 students, who were mostly 4 and 5 years old respectively (Table I). Males made up 227 (54.8%) and females 187 (45.2%) of the study population. There were 383 (92.5%) Chinese students (compared to 70.4% of the Singapore population aged 0 to 9 years).¹⁷ With regards to socio-economic status, 354 (83.5%) lived in private housing (6 times the national average of 14%) and 60 (16.5%) lived in public housing.¹⁸ Of the parents, 294 (71%) fathers and 274 (66.2%) mothers were myopic.

TABLE I: DESCRIPTION OF STUDY POPULATION OF 414 KINDERGARTEN CHILDREN AGED 3 TO 6 YEARS FROM 2 KINDERGARTENS IN SINGAPORE IN 1999

	No.	(%)
Age (y)		
3	2	(0.5)
4	188	(45.4)
5	218	(52.7)
6	6	(1.4)
Gender		
Male	227	(54.8)
Female	187	(45.2)
Race		
Chinese	383	(92.5)
Non-Chinese	31	(7.5)
Housing type		
1-3 room HDB flat	9	(2.2)
4 room HDB flat	51	(12.3)
Condominium/Private apartment	167	(40.3)
Landed property	187	(45.2)
Parental history of myopia		
No myopic parent	61	(14.7)
1 myopic parent	135	(32.6)
2 myopic parents	210	(50.7)
Father myopic	294	(71.0)
Mother myopic	274	(66.2)
	Mean	(SD)
Outdoor activity (hours/week)	5.11	(4.7)

TABLE II: DESCRIPTION OF NEAR-WORK INDICES OF KINDERGARTEN CHILDREN AGED 3 TO 6 YEARS FROM 2 KINDERGARTENS IN SINGAPORE IN 1999

Characteristics of near-work indices	No.	(%)
Type of near-work classes outside school		
Tuition	203	(49.0)
Music	159	(38.4)
Art and craft	70	(16.9)
Computer	10	(2.4)
	Mean	(SD)
All near-work classes outside school (hours/week)	2.0	(2.3)
Type of near-work activities (hours/day)		
Reading and writing	1.5	(1.1)
Computer	0.6	(0.6)
All near-work activities (reading, writing, etc)	4.0	(1.9)
Distance of object from eyes while colouring (cm)	23.6	(4.5)

Of the study population, 49.0% attended tuition classes outside kindergarten hours, 38.4% music classes, 16.9% art and craft classes, and 2.4% computer classes (Table II). The mean number of hours of classes attended outside school per week was 2.0. The mean number of hours spent outside school on near-work per week was 4.0.

Myopia was more common in children who had attended 3 or more hours of near-work classes outside school per

TABLE III: ASSOCIATION OF INDICES OF NEAR-WORK WITH MYOPIA IN STUDY POPULATION OF CHILDREN AGED 3 TO 6 IN 2 KINDERGARTENS IN 1999

Characteristics of near-work indices	Myopes (n = 119)		Non-myopes (n = 292)		Odds ratio	95% CI
	No.	(%)	No.	(%)		
Total duration of near-work classes outside school						
Less than 3 hours per week (n = 289)	75	(26.0)	214	(74.0)		
Equal or more than 3 hours per week (n = 122)	44	(36.1)	78	(63.9)	1.61	1.02, 2.53
Colouring distance						
Less than 26.7 cm (n = 315)	91	(28.9)	224	(71.1)		
Equal or more than 26.7 cm (n = 97)	28	(28.9)	69	(71.1)	0.97	0.59, 1.60

CI: confidence interval

TABLE IV: CHARACTERISTICS OF MYOPIC AND NON-MYOPIC CHILDREN IN 2 KINDERGARTENS IN SINGAPORE IN 1999

	Myopes		Non-myopes		Prevalence rate ratio	95% CI
	No.	(%)	No.	(%)		
Gender						
Male (n = 227)	66	(29.1)	161	(70.9)	1.00	
Female (n = 187)	53	(28.3)	134	(71.7)	0.97	0.63, 1.48
Housing type						
Government housing (n = 60)	15	(25.0)	45	(75.0)	1.00	
Private housing (n = 354)	104	(29.4)	250	(70.6)	1.25	0.67, 2.33
Parental history of myopia						
None (n = 61)	17	(27.9)	44	(72.1)	1.00	
One parent (n = 135)	37	(27.4)	98	(72.6)	0.98	0.50, 1.92
Two parents (n = 210)	62	(29.5)	148	(70.5)	1.08	0.58, 2.04
Outdoor activity						
Less than 7 hours per week (n = 295)	88	(29.8)	207	(70.2)	1.00	
Equal or more than 7 hours per week (n = 117)	30	(25.6)	87	(74.4)	0.81	0.50, 1.32

CI: confidence interval

week compared to those with less than 3 hours per week (odds ratio 1.61, 95% confidence interval 1.02, 2.53) (Table III). Colouring distance was not found to be associated with myopia.

Both LogMAR testing as well as autorefraction were performed. The Spearman's correlation coefficient between visual acuity and spherical equivalents for the right eye was -0.163 and the two-sided *P* value was 0.001.

The mean right logMAR reading for myopes was 0.27, while that for the non-myopes was 0.22, which suggests that myopes as defined by autorefraction perform poorer on visual acuity testing.

Children living in private houses and those with less than 7 hours of outdoor activity per week had a higher prevalence of myopia (Table IV), although this was not statistically significant. Gender was not related to myopia.

Children with 1 myopic parent had a prevalence rate ratio of 0.98 for myopia when compared to those with no parental history of myopia. Those whose parents were both myopic had a prevalence rate ratio of 1.08, suggesting a

familial component to myopia. However, this was not statistically significant.

The prevalence rate of myopia in the 2 kindergartens was 28.7%. Amongst 4-year-olds, the prevalence rate was 26.8% while it was 30.4% for 5-year-olds. Chinese had a slightly higher prevalence rate of myopia (29.8%) compared to non-Chinese (16.1%). As for males and females, myopia prevalence rates were 29.1% and 28.3% respectively.

Discussion

The association between near-work and myopia is known largely from cross-sectional studies and limited longitudinal investigations. However, few studies have dealt with myopia prevalence and onset in children below the age of 6 years.

Screening of 48,075 7-year-old children by the School Health Services in 1996 found that 24.47% of them had a visual acuity of worse than 6/12, making visual problems the commonest health problem amongst students in Singapore.¹⁴ It would also appear that myopia begins early in life.¹⁹ There are an increasing number of children attending kindergarten classes, and an increasing amount of near-

work being done in kindergarten as well as outside of school in the form of enrichment classes. Young children with myopia are more likely to progress to high myopia in adulthood, and this is associated with a greater risk of complications such as retinal detachment, glaucoma and cataract.²⁰

Our study findings show that there may be an association between attending 3 or more hours of near-work classes outside school per week and myopia. This was consistent with results obtained in a cross-sectional study done in 1993 in Hong Kong, which described a positive association (odds ratio 1.7) between myopia and more than 3 hours per day spent reading and writing.⁹ Other cross-sectional studies carried out in Newfoundland in 1980 and Israel in 1993 reached similar conclusions, as did a case-control study in Singapore in 1987, which found statistically significant associations between myopia and tasks that required prolonged and excessive accommodation.^{8,10,21}

Our study showed a positive correlation between the degree of myopia and number of parents with myopia, although this was not statistically significant. Other studies have indicated that there is a familial component to myopia.⁴

Our response rate of 83.5% was high, thus decreasing non-response bias. Because the parents of myopic children might have taken better note of their children's reading habits than parents of non-myopes, we included a greater number of objective indices of near-work (such as structured tuition classes) in our questionnaire. This reduced the inevitable inaccuracies in information obtained by proxy, inherent in the responses of parents with myopic children. Recall bias was also minimised because the parents were masked to the results of the autorefraction examination.

The very young age of the subjects in the study minimised temporal bias, as there had been little time for near-work habits to change in the 2 to 3 years since the development of literacy in these children. We would have thus proxies for very early reading habits that may result in myopia in the 4- to 5-year-olds in our study.

The prevalence of myopia in our study population was 28.7% which was higher than the population prevalence rate of 12.2% for 7-year-old children in 1996.¹⁴ However, our study is limited to information from 2 kindergartens and may not be generalisable to the whole Singapore population.

Our study has several other limitations. No cycloplegia was administered, due to logistical difficulties and the side effects of cycloplegia; thus residual accommodation may still be present. Mutti et al²² found in 1994 that the use of tropicamide in children aged 6 to 12 years added $0.74 \text{ D} \pm$

0.44 D to the autorefraction. This was taken into account by using a relatively stringent criterion for myopia (-1.50 Diopters).

It has been suggested that stand-alone autorefractors or retinoscopy would have been more reliable. However, 2 studies have found that the results of hand-held autorefractors are comparable. Harvey et al²³ performed retinoscopy and autorefraction with the Retinomax on 47 children up to 93 months of age. They found that Retinomax reproducibility averaged 0.43 D , while unbiased Retinomax and retinoscopy measurements differed by an average of 0.82 D , concluding that the Retinomax is a useful instrument for measuring refractive errors in children. Another study by Cordonnier et al²⁴ of 276 children using both the Retinomax and an on-table autorefractor after cycloplegia found no significant bias between the 2 types with regards to spherical equivalent (95% limits of agreement $\pm 1 \text{ D}$).

Future prospective longitudinal studies will still be needed to establish a causal relationship between near-work and myopia in this age group. Similar measurements taken at birth to establish if such a state is congenital may provide further insight into the inheritance of myopia.²⁵ Future studies should involve large sample sizes, long follow-up periods, and the use of cycloplegic subjective refraction, autorefraction and ultrasonic measurements of axial length and vitreous chamber depth in a large number of children followed up for a few years.

Though we cannot make a definite deduction of causality between near-work and myopia, our study findings suggest that near-work activity may be related to myopia onset. The strong emphasis on academic excellence in Singapore's educational system may call for more visual health awareness and promotion in parents with pre-school children.

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APPENDIX A

Selected items from the questionnaire:

Type of activities	Average number of hours <u>per day</u> (to the nearest half-hour)
1. Reading, writing, drawing and colouring	_____ hours <u>PER DAY</u>
2. Computer use (including computer games and internet use)	_____ hours <u>PER DAY</u>

My child is attending these CLASSES OUTSIDE SCHOOL HOURS:

Type of classes	Average number of hours <u>per week</u>
3. Tuition classes ☐ ¹ Yes ☐ ² No	_____ hours <u>PER WEEK</u>
4. Music classes ☐ ¹ Yes ☐ ² No	_____ hours <u>PER WEEK</u>
5. Art and craft classes ☐ ¹ Yes ☐ ² No	_____ hours <u>PER WEEK</u>
6. Computer classes ☐ ¹ Yes ☐ ² No	_____ hours <u>PER WEEK</u>

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