

EDUCATION AND MYOPIA IN 110,236 YOUNG SINGAPOREAN MALES

K G Au Eong, T H Tay, M K Lim

ABSTRACT

Computerised data of 110,236 Singaporean males aged 15 to 25 (mean 17.75) years who underwent compulsory medical examination from April 1987 to January 1992 were used to estimate the prevalence and severity of myopia among young Chinese, Malay, Indian and Eurasian Singaporean males with different educational levels. The prevalence and severity of myopia amongst the groups with different educational levels were compared. These groups were fairly well-matched for important known confounding factors such as age, sex, race and degree of urbanisation of place of residence. Our data showed a positive association between educational attainment and both the prevalence and severity of myopia. Both the prevalence of myopia and the proportion of myopes with severe myopia were in general higher among those with more years of formal education.

Keywords: education, intelligence, myopia, near work, visual acuity.

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INTRODUCTION

Cohn⁽¹⁾ was the first to observe an increased prevalence of myopia among persons characterised by high intellectual abilities and academic achievement more than a century ago. Since then, many investigators including Goldschmidt⁽²⁾, Teasdale et al⁽³⁾, Rosner and Belkin⁽⁴⁾, Gawron⁽⁵⁾ and Dunphy et al⁽⁶⁾ have produced epidemiological evidences that are consistent with Cohn's findings.

Goldschmidt⁽²⁾ found the frequency of myopia of any degree among male Danish army conscripts in 1964 was 5.7% among unskilled workers, and this increased steadily through groups with intermediate education to 38.7% among men with grammar school or university education. More recently Teasdale et al⁽³⁾, who also studied young men being drafted for military service in Denmark, showed that myopes of all degrees had significantly higher educational levels and intelligence test scores than non-myopes. A strong association of myopia with both years of school attendance and intelligence was also reported by Rosner and Belkin⁽⁴⁾ in a nationwide study involving 157,748 Jewish males aged 17 to 19 years. They found that the prevalence of myopia was significantly higher in the more educated and more intelligent groups. Myopic military recruits were also shown by Gawron⁽⁵⁾ to have completed higher levels of education than those who were not myopic. In the United States, Dunphy et al⁽⁶⁾ found myopia to be more frequent in academic populations than among unselected populations of young men.

Myopia prevalence has also been found to be closely associated with many other factors including age^(7,8), sex^(2,8), race^(8,9) and degree of urbanisation of place of residence^(8,9). To study the relationship between educational attainment and myopia, an

attempt to match as closely as possible the abovementioned variables will reduce the number of confounding factors and produce a more accurate picture of the relationship.

The relationship between educational attainment and myopia among young Singaporean males has been previously analysed in a study first reported by Chew SJ et al⁽¹⁰⁾ and later expanded by Tay MTH et al⁽¹¹⁾. It was demonstrated that males with higher educational levels in general had higher myopia prevalence. However, the different educational groups were not stratified into the different major races and since the racial distributions of males in the different educational groups may not be identical and myopia prevalence is closely related to race^(8,9), some bias may be present due to over-representation of certain races in some of the educational groups. Comparing males of the same race will eliminate this bias.

This paper is part of a retrospective cross-sectional epidemiological study of myopia in 110,236 young Singaporean males who were examined from April 1987 to January 1992. The association between race, culture and myopia in this cohort has been separately reported⁽¹²⁾. This paper examines the relationship between educational attainment and myopia by comparing the prevalence and severity of myopia amongst groups with different educational levels after they have been matched for age, sex, race and degree of urbanisation of place of residence.

SUBJECTS AND METHODS

All Singaporean males are called up for a compulsory pre-enlistment medical examination and classification at an appropriate age. There is no screening of any form prior to the medical examination. The vast majority of males are medically examined at 17 to 18 years of age (mean age 17.75 years) although their age may range from 15 to 25 years.

A standardised ophthalmic examination is done for all subjects as part of the medical examination. This includes the determination of monocular unaided distance visual acuity for both eyes using the Snellen's chart at six metres.

The computerised data of all subjects who were examined from April 1987 to January 1992 were retrieved and reviewed. Only the results for the right eye were analysed. Although refractions for right and left eyes may differ, they are known to be highly correlated. All subjects except those with impaired unaided vision which could not be corrected by refraction were included in this study. This made up a total of 110,236 males. This sample represents almost the entire male Singaporean population who were required to report for medical examination from April 1987 to January 1992 and may therefore be considered to be fairly representative of the general population of young Singaporean males in that age group.

Medical Classification Centre
Central Manpower Base
Singapore Armed Forces
Depot Road Camp
Depot Road
Singapore 0410

K G Au Eong, MBBS
Medical Officer

T H Tay, MBBS, FRCS (Glas), FCOphth (UK), FAMS
Ophthalmologist

M K Lim, MBBS, FAMS, DAvMed, MSc (OM), MPH
Chief Medical Officer

Correspondence to: Dr K G Au Eong
Singapore National Eye Centre
11 Third Hospital Avenue
Singapore 0316

As all subjects with impaired unaided vision not corrected by refraction were excluded from this study, the cause of impaired unaided vision of all males in this study is ametropia. Since myopia has an overwhelming preponderance over hyperopia in this age group in the local context, the estimated prevalence rate of myopia can be taken to be very close to the prevalence rate of ametropia in this study.

Unaided visual acuity of 6/12 or better was considered adequate. Myopia was defined as unaided visual acuity of 6/18 or worse in this study. Unaided visual acuity of worse than 6/60 was used as an indicator of severe myopia.

The highest level of education attained at the time of examination of all subjects was determined and classified into one of the following categories in approximately increasing order of educational attainment:

- i) NFE No formal education
- ii) PRI Have begun but not completed 6 to 8 years of primary education
- iii) PSLE Passed the Primary School Leaving Examination ie successfully completed 6 to 8 years of primary education
- iv) SEC Have begun but not completed 4 years of secondary education
- v) GCE 'N' Passed the General Certificate of Education 'N' Level Examination ie successfully completed 4 years of secondary education
- vi) GCE 'O' Passed the General Certificate of Education 'O' Level Examination ie successfully completed 4 to 5 years of secondary education
- vii) GCE 'A' Passed the General Certificate of Education 'A' Level Examination ie successfully completed 2 to 3 years of pre-university education
- viii) DIP Successfully completed a 3 year diploma course
- ix) UNIV Successfully completed 3 to 5 years of university education

The different educational groups were fairly well-matched in each of the following factors:

a) Age

The prevalence of myopia varies with age^(7,8). Myopia is rare among infants of industrialised countries. However, in a birth cohort, it increases in prevalence and severity through the end of adolescence and then stabilises⁽¹³⁾. Although the age range of our sample is from 15 to 25 years, the vast majority of males were examined at 17 to 18 years of age and this small age range minimises any variation in myopia prevalence that may occur due to age variation.

b) Sex

Some studies have found females to have a slightly higher myopia prevalence than males^(2,8). Since only males are included in this study, gender is not a confounding factor in our analysis.

c) Race

Race is an expression of genetic constitution⁽⁹⁾ and has been shown to be a major influence in myopia prevalence observed amongst the different races in this study cohort⁽¹²⁾. Of the 110,236 males in our study, there were 88,315 (80.1%) Chinese, 12,854 (11.7%) Malays and 8,138 (7.4%) Indians (Table I). The bulk of the 929 (0.8%) males of other races were Eurasians. Comparison amongst groups with the same racial background removes this confounding factor.

d) Degree of urbanisation of place of residence

Some studies have suggested an association between myopia and the degree of urbanisation of place of residence^(8,9). The population of Singapore can be considered homogenous in this respect since Singapore is a very small country and is almost wholly urbanised.

RESULTS

1) Estimated prevalence rate of myopia

The estimated prevalence rates of myopia amongst the Chinese, Indians, Malays and Eurasians with different educational levels are as shown in Tables II, III, IV and V. The rates for all males regardless of their race by educational levels are as shown in Table VI.

It will be noted that in general, the myopia prevalence rate was higher among groups with higher educational levels (Tables II, III, IV and V). Within each racial group, myopia prevalence was lowest in males with no formal education except in Eurasians where the NFE group was very small. Myopia prevalence rate rose steadily from the groups with no formal education through groups with intermediate educational levels to those with GCE 'A' level, diploma and university education in whom the rates were highest. For example, among Chinese males, 16.4% of those with no formal education were myopic (Table II). The rate for those with PSLE and GCE 'N' and 'O' level education were 21.3%, 35.0% and 48.3% respectively. Those with GCE 'A' level and university education had 68.0% and 66.2% myopia prevalence rates respectively.

2) Estimated prevalence of severe myopia and proportion of myopes with severe myopia

Using unaided visual acuity of worse than 6/60 as an indicator of severe myopia (and excluding other ocular pathology), the estimated prevalence rate of severe myopia was in general higher among the more educated groups (Tables II, III, IV and V). The proportion of myopes with severe myopia was also generally higher among the more educated groups (Tables II, III, and IV). For example, 32.5% of all Chinese myopes who began but did not complete primary education (PRI group) had unaided visual acuity of worse than 6/60 (Table II). This proportion was 33.9%, 46.7% and 53.1% for those with PSLE and GCE 'N' and 'O' level education respectively. The highest proportions were found among those with GCE 'A' level and university education with 63.3% and 64.6% respectively. Interestingly, although the prevalence rates of both myopia and severe myopia in the Chinese NFE group were lower than the corresponding rates in the PRI and PSLE groups, the proportion of myopes with severe myopia in the NFE group was higher than that in the latter two groups (Table II). The trend among Eurasians was not clear because of the small numbers of myopes in some of the educational groups (Table V).

Table I – Racial distribution of young Singaporean males

Race	Number	Percentage distribution (%)
Chinese	88,315	80.1
Malay	12,854	11.7
Indian	8,138	7.4
Others	929	0.8
Total	110,236	100.0

Table II – Myopia among young Chinese Singaporean males by educational attainment

Educational attainment	No.	Myopia		Severe myopia		
		No.	Prevalence (%)	No.	Prevalence (%)	Percentage of myopes (%)
NFE	843	138	16.4	56	6.6	40.6
PRI	7,790	1,644	21.1	535	6.9	32.5
PSLE	6,816	1,449	21.3	491	7.2	33.9
SEC	5,031	1,437	28.6	598	11.9	41.6
GCE 'N'	4,563	1,596	35.0	671	14.7	46.7
GCE 'O'	26,523	12,800	48.3	6,801	25.6	53.1
GCE 'A'	20,834	14,168	68.0	8,968	43.0	63.3
DIP	13,471	7,954	59.0	4,546	33.7	57.2
UNIV	2,444	1,618	66.2	1,045	42.8	64.6
Total	88,315	42,804	48.5	23,711	26.8	55.4

Table III – Myopia among young Malay Singaporean males by educational attainment

Educational attainment	No.	Myopia		Severe myopia		
		No.	Prevalence (%)	No.	Prevalence (%)	Percentage of myopes (%)
NFE	116	12	10.3	1	0.9	8.3
PRI	2,194	280	12.8	51	2.3	18.2
PSLE	1,596	193	12.1	43	2.7	22.3
SEC	959	154	16.1	46	4.8	29.9
GCE 'N'	1,625	341	21.0	112	6.9	32.8
GCE 'O'	4,467	1,288	28.8	505	11.3	39.2
GCE 'A'	1,311	626	47.7	343	26.2	54.8
DIP	565	235	41.6	107	18.9	45.5
UNIV	21	15	71.4	9	42.9	60.0
Total	12,854	3,144	24.5	1,217	9.5	38.7

Table IV – Myopia among young Indian Singaporean males by educational attainment

Educational attainment	No.	Myopia		Severe myopia		
		No.	Prevalence (%)	No.	Prevalence (%)	Percentage of myopes (%)
NFE	174	26	14.9	14	8.0	53.8
PRI	969	148	15.8	36	3.7	24.3
PSLE	876	145	16.6	44	5.0	30.3
SEC	652	130	19.9	53	8.1	40.8
GCE 'N'	681	145	21.3	49	7.2	33.8
GCE 'O'	2,585	863	33.4	385	14.9	44.6
GCE 'A'	1,709	798	46.7	456	26.7	57.1
DIP	316	131	41.5	66	20.9	50.4
UNIV	176	88	50.0	44	25.1	50.0
Total	8,138	2,474	30.4	1,147	14.1	46.4

DISCUSSION

The fact that there is an association between the prevalence and severity of myopia and educational levels does not necessarily imply a cause-and-effect relationship as each of these may correlate with some common but unidentified factors.

One factor which may correlate with both myopia and education is near work. Goldschmidt⁽²⁾ studied the relationship between myopia prevalence and different occupational categories which grouped subjects according to the amount of near work performed. He found that those who performed a greater amount of near work such as students and clerks had higher prevalence of myopia than those who did a lesser amount of near work such as labourers, chauffeurs, farmers and fishermen.

Table V – Myopia among young Eurasian Singaporean males by educational attainment

Educational attainment	No.	Myopia		Severe myopia		
		No.	Prevalence (%)	No.	Prevalence (%)	Percentage of myopes (%)
NFE	9	2	22.2	0	0	0
PRI	59	6	10.2	0	0	0
PSLE	53	9	17.0	2	3.8	22.2
SEC	74	15	20.3	9	12.2	60.0
GCE 'N'	64	18	28.1	6	9.4	33.3
GCE 'O'	350	110	31.4	50	14.3	45.5
GCE 'A'	236	123	52.1	77	32.6	62.6
DIP	47	22	46.8	10	21.3	45.5
UNIV	37	17	45.9	13	35.1	76.5
Total	929	322	34.7	167	18.0	51.9

Table VI – Myopia among young Singaporean males of all races by educational attainment

Educational attainment	No.	Myopia		Severe myopia		
		No.	Prevalence (%)	No.	Prevalence (%)	Percentage of myopes (%)
NFE	1,142	178	15.6	71	6.2	39.9
PRI	11,012	2,078	18.9	622	5.6	29.9
PSLE	9,341	1,796	19.2	580	6.2	32.3
SEC	6,716	1,736	25.8	706	10.5	40.7
GCE 'N'	6,933	2,100	30.3	838	12.1	39.9
GCE 'O'	33,925	15,061	44.4	7,741	22.8	51.4
GCE 'A'	24,090	15,715	65.2	9,844	40.9	62.6
DIP	14,399	8,342	57.9	4,729	32.8	56.7
UNIV	2,678	1,738	64.9	1,111	41.5	63.9
Total	110,236	48,744	44.2	26,242	23.8	53.8

It is difficult if not impossible at the present moment to determine if near work induces myopia or that myopic individuals choose to do near work. It is possible that the gradual loss of efficient distance vision in myopes tends to concentrate the interests and energies of these individuals more and more on near tasks⁽⁸⁾. However, some investigators have implicated accommodation as a cause of myopia. Association of myopia with reading has been shown in the United States population⁽¹³⁾. One hypothesis is that of the laying down of new lens fibres as the ciliary muscle holds the lens steady in the accommodative position. This leads to a permanent increase in the convexity of the lens surface⁽¹⁴⁾. There is also some evidence of increased vitreous pressure during accommodation which could cause the axial length of the globe to increase^(8,15).

A rough indicator of the amount of near work done is the number of years of formal education attended. It is possible that those who are more educated, and hence exposed to more years of formal education and its requirements for reading and close work, are more predisposed to the development and progression of myopia than the less educated.

The remarkable academic success of the myopic population has naturally raised questions regarding the association of myopia and intelligence⁽⁸⁾. A number of studies have demonstrated a measurable difference in the intelligence quotient (IQ) of persons with various refractive states^(3,4,16). Rosner and Belkin⁽⁴⁾ showed a strong association between the rate of myopia and intelligence in 157,748 male Jewish recruits aged 17 to 19 years. The prevalence rate of myopia in males with an IQ of 80 or less was 8.0%. This rate became gradually higher with an increase in IQ until it reached 27.3% among those with an IQ of 128 or more.

Among 5,943 myopic and 9,891 non-myopic 18-year-old men being drafted for military service, Teasdale et al⁽³⁾ showed that myopes of all degrees had significantly higher IQ test scores than non-myopes. A real association between high IQ and myopia was also shown by Sofaer and Emery⁽¹⁶⁾ in a study on British members of Mensa, the international society for the highly intelligent.

Although IQ assessment was not performed on the subjects in our study, it is probable that those who achieved higher educational levels were in general more intelligent and hence intelligence is a possible common factor that correlates with both myopia and educational attainment in our study. Given the hereditary background of myopia, scholarship reinforcement was also more likely to be present at home⁽⁸⁾. The myopic student more often has a similarly affected parent, often also of similar academic achievement, who would stress intellectual pursuits and academic hobbies⁽⁸⁾. However, because both myopia and IQ are to some extent inherited, there may be purely genetic explanations for the observed association^(8,16).

As the genesis of myopia is highly complex, further analyses are needed to explain how these various factors and possibly other yet unidentified factors are related to one another and to myopia.

CONCLUSION

Our data confirm findings from other studies that the prevalence and severity of myopia are associated with educational attainment. It goes further by confirming this association after suitably matching the study groups for known confounding factors such as age, sex, race and degree of urbanisation of place of residence. A variety of factors both genetic and environmental probably underlie the reasons for this observation.

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REFERENCES

1. Cohn H, cited by Karlsson JL. Influence of the myopia gene on brain development. *Clin Genet* 1975; 8:314-8.
2. Goldschmidt E. On the etiology of myopia: An epidemiologic study. *Acta Ophthalmol* 1968;98 (suppl): 1-172.
3. Teasdale TW, Fuchs J, Goldschmidt E. Degree of myopia in relation to intelligence and educational level. *Lancet* 1988; ii(8624):1351-4.
4. Rosner M, Belkin M. Intelligence, education and myopia in males. *Arch Ophthalmol* 1987;105 :1508-11.
5. Gawron VJ. Differences among myopes, emmetropes and hyperopes. *Am J Optom Physiol Opt* 1981;58:753-60.
6. Dunphy E, Stoll M, King S. Myopia among American male graduate students. *Am J Ophthalmol* 1968;65 : 518-21.
7. Slataper FJ. Age norms of refraction and vision. *Arch Ophthalmol* 1950;43:466-81.
8. Curtin BJ. The myopias: Basic science and clinical management. United States of America: Harper and Row, 1985.
9. Mann I. Culture, race, climate and eye disease: An introduction to the study of geographical ophthalmology. Springfield, Illinois, United States of America: Thomas. 1966.
10. Chew SJ, Chia SC, Lee L. Pattern of myopia in young Singapore men. *Singapore Med J* 1988;29:202-11.
11. Tay MTH, Au Eong KG, Ng CY, Lim MK. Myopia and educational attainment in 421, 116 young Singaporean males. *Ann Acad Med Singapore* 1992; 21:785-91.
12. Au Eong KG, Tay TH, Lim MK. Race, culture and myopia in 110,236 young Singaporean males. *Singapore Med J* 1993;34:29-32.
13. Angle J, Wissmann DA. The epidemiology of myopia. *Am J Epidemiol* 1980;111:220-8.
14. Coleman DJ. Unified model for accommodative mechanism. *Am J Ophthalmol* 1970;69:1063-79.
15. Young FA. The nature and control of myopia. *J Am Optom Assoc* 1977;48:451-7.
16. Sofaer JA, Emery AE. Genes for super-intelligence? *J Med Genet* 1981: 18:410-3.