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# Determinants of the progress of myopia among Omani school children: A historical cohort study

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PURPOSE. *This study was conducted in 2002–2003 at selected schools of eight health regions of Oman. The authors present risk factors and predictors of progression of myopia between the 7th and 10th grades.*
METHODS. *This was a historical cohort study. A total of 1304 students in 10th grade, both with and without progression of myopia, were examined by the refractionists. Vision, refraction, and physical measurements of each student were recorded. The health records of all students were reviewed to note the same parameters measured when they were in 7th grade. The odds of progression in height, progression in weight, protein energy malnutrition status, sex, age, history of refractive error in parents and sibling, evidence of trachoma, and allergic conjunctivitis were calculated to associate them to the progression of myopia.*
RESULTS. *Mean progression of myopia was 0.37 D per year (SD = 0.27D). The mean progression of myopia among students with history of myopia in 7th grade was 0.21 D more than that of students not having myopia in 7th grade (95% CI 0.12–0.29). Multivariate regression analysis suggested that weight of student in the 7th grade ($t=-2.2$, $p=0.031$), positive history of myopia in one of the siblings ($t=2.44$, $p=0.015$), and myopia in the 7th grade ($t=4.56$, $p<0.001$) were associated with the progression of myopia.*
CONCLUSIONS. *Family history of myopia and myopia at younger age were predictors for progressive myopia in teenaged Omani children. However, the role of body mass index at a younger age to predict progressive myopia was not conclusive. (Eur J Ophthalmol 2007; 17: 110-6)*

KEY WORDS. *Myopia, Oman, School health, Vision screening*

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## INTRODUCTION

Progression of myopia in growing children causes apprehension among parents. It also increases the burden on the refractive services of the nation. Identification of its determinants and suggesting possible interventions could help eye care providers counsel the children and their parents. This could also minimize its negative impact on the development of the child. Both hereditary and acquired factors were reported to be responsible for progression of myopia in children (1-3). Acquired factors like excessive near work, low illumination in the working environment, working with computers for long hours, excessive TV watching, and poor nutrition were associated with the development and progression of myopia (4-6). The role of genetic and acquired factors for progression of myopia has always been a matter of debate among scientists. Therefore, evidence-based information related to refractive error is always encouraged (7). The anthropometric status of schoolchildren with progressive myopia

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has been studied (8, 9). However, further studies in different age groups and populations are needed.

Oman is a Middle Eastern country. In its VISION 2020 health plan, refractive error is prioritized. It has formulated a comprehensive program approach to address it (10). Myopia is prevalent at a rate of 3.4% in children aged 12 to 13 years and 6.2% in children aged 16 to 17 years (11). Annual screening for vision is conducted for nearly 140,000 students in the 1st, 4th, 7th, and 10th grades at all schools.

We present a part of the refraction study to describe epidemiologic, genetic, and anthropometric factors and their association with the progression of myopia in youth.

## METHODS AND MATERIALS

This was a historical cohort study in the school setting. Myopic children studying in the 7th grade of Omani schools during 1999–2000 in eight health regions – Muscat, Dhofar, Dhakhiliya, North Sharqiya, South Sharqiya, North Batinah, South Batinah, Dhahira – were the target population.

Of the 45,000 7th grade students, 2500 students with myopia were identified. From them, 417 students with myopia were recruited randomly. They were again examined after 3 years in their 1st secondary school level. We studied the variables responsible for the progression of myopia among them. We assumed that the risk of progression of myopia was twice in 1st preparatory students with progression of myopia of ≤0.5 D/year compared to the students with progression of myopia of more than 0.5 D/year. To determine the sample size of our study that aimed at 90% power and 95% confidence interval, we used EPI Statcalc software. We needed 132 students in one arm and 264 students in the other arm.

A student with myopia was defined as one with improved vision by using concave lens of 0.25 D or more in either eye. To determine spherical equivalent, we multiplied cylindrical refractive correction by a factor of 0.5. Then, it was added to the spherical value and total power of myopia was determined for each eye. The value of the worst eye with myopia was selected to calculate the myopia status of a student.

School refractionists and school nurses were the field staff. They assessed vision and refraction status with the help of Snellen's distant vision E chart. The students with defective vision (less than 6/9 in either eye) and those with visual aid were referred to 2nd stage screening. The refractionists visited schools and refracted these students by manual method in a dark room prepared within the school. To prescribe visual aids, they also performed subjective correction. To address accommodative spasm, fogging method was used. Those students with accommodative spasm and myopia of more than –5 D were reexamined in detail by ophthalmologists in the eye clinics. Two drops of 0.5% cyclopentolate eyedrops at intervals of 30 minutes were instilled for cycloplegia.

The anthropometric measurements were conducted by school nurses. Interview of students and teachers was conducted by the refractionist to determine myopia among students' parents and siblings. This was further confirmed from the school health records. These records contain details of screening in 1st, 4th, 7th, and 10th grades.

Details of physical examination, visual assessment, and refraction procedures are given in earlier publications (11-13). Physical measurements included height and weight of each student. Each student's protein energy malnutrition (PEM) status was calculated using international growth chart. The grade of PEM was determined by calculating weight as percentage of expected weight for the height using international standards. Normal value is 90% to 110%, mild PEM is 85% to 90%, moderate PEM is 75% to 85%, while severe PEM is less than 75% (14).

The outcome of interest in this study was the difference in myopia in the worse eye of a 10th grader in comparison to his or her myopic status in 7th grade. The dependent variables of interest in our study were age, sex, geographic distribution, progression in height, progression in weight, body mass index (BMI), history of myopia in parents and sibling, evidence of trachoma, and allergic conjunctivitis.

Depending on the location of the residence of the students, the cohort was divided into two regional subgroups. Group A comprised students of Muscat, Dhofar, and Dhahira regions. These regions have well developed health services and eye care services in particular established nearly 30 years ago. Group B comprised students of Dhakhiliya, Sharqiya, and Batinah regions, and these regions have established eye care services in the last decade.

A pretested standardized form was used to collect information on each student. The forms were audited in each region and data were compiled using EPI6. Checks were introduced to minimize the errors. The data were checked using frequency checks. The data analysis was carried out on Statistical Package for Social Studies (SPSS-9) by using univariate and multivariate methods. For comparison of exposures, the mean and their standard deviation were calculated. For qualitative variables chi square tests were done. For validation, differences of means and their 95% confidence intervals were also calculated. For regression analysis, progression of myopia was the dependent continuous variable. The independent variables, such as age in years, sex, region, height progression, weight progression, history of myopia in parents, history of refractive error in siblings, allergic conjunctivitis, trachoma, and protein energy malnourishment (PEM) status, were used in the model and then removed stepwise if a variable was not found to be statistically significant for its association to the progression of myopia.

Adequate measures were taken to ensure high quality of the study. The ethical issues were also addressed as per the international research requirements (15).

Musundam and Al Wousta regions, having less than 5% of the national population, were not included in this study. Hence generalization of the study results for the Omani children could be done but with caution.

## RESULTS

The profile of 417 students in the 1st preparatory grade who were examined in our study is given in Table I. The students with progression of myopia of ≤0.5 D/year compared to students with progression of myopia of >0.5/year D was not statistically different by sex, region, or age group.

Mean progression of myopia in the worst eye of students was 1.021 D (SD = 0.762 D). The highest progression of myopia was 5.5 D in one student.

Anthropometric measurements of the students with the progression of myopia of ≤0.5 D per year and >0.5 D per year were compared (Tab. II). The weight of students in 10th grade was significantly associated with the progression of myopia. However, other anthropometric measurements were not different.

The history of myopia among parents and siblings was analyzed to determine association to the progression of myopia (Tab. III). Progression of myopia of more than 0.5 D/year was more prevalent among students with history of myopia among parents. However, element of chance could not be ruled out in this observation. Progression of myopia of more than 0.5 D/year in 3 years was significantly associated to the history of myopia among one of the siblings of the cohort.

Multivariate regression analysis by step down method was performed to determine the predictability of the progression of myopia. The predictors of progression in myopia in the worst eye were weight of student at 7th grade (t=3.3, p=0.001), positive history of myopia in one of the siblings (t=–2.14, p=0.03), and weight of student in 10th grade (t=4.4, p<0.001). The associations of the variables sex, height of the student both at 7th grade and 10th grade, comorbidities like trachoma or allergic conjunctivitis, and geographic distribution of the cohort to the progression of myopia were not statistically significant.

## DISCUSSION

Although this study was a part of a larger refractive error study in Omani students, the sample size to address progression of myopia among students was adequate.

We had calculated spherical equivalent of astigmatic refractive error in our study. This could have resulted in overestimation of progression of myopia compared to the results of other studies that had considered only myopia with <1 D astigmatism. Presence of recall bias is an inherent limitation of a historic cohort study. To minimize the effect of this bias, we used health records and utilized uniform questions for eliciting history of myopia among

**TABLE I -** CHARACTERISTICS OF STUDY COHORT

| | **Progression of myopia of ≤ 0.5 D/y, freq (%)** | **Progression of myopia of > 0.5 D/y, freq (%)** |
|---|---|---|
| Sex | | |
| Male | 83 (33.1) | 45 (27.1) |
| Female | 168 (66.9) | 121 (72.9) |
| Region | | |
| Group A | 111 (44.2) | 71 (42.8) |
| Group B | 140 (55.8) | 95 (57.2) |
| Age group, mo | | |
| <165 | 100 (39.8) | 62 (37.3) |
| ≥165 | 151 (60.2) | 104 (62.7) |
| Total | 251 | 166 |

**TABLE II -** ANTHROPOMETRIC MEASUREMENTS OF STUDENTS WITH PROGRESSION OF MYOPIA

| | Progression of myopia ≤0.5 D/y | Progression of myopia >0.5 D/y | Validation |
|---|---|---|---|
| 1st preparatory | (n=218) | (n=148) | |
| Height | | | |
| Mean | 1.4856 | 1.4976 | Mean diff = 0.012 M |
| SD | 0.0800 | 0.0841 | 95% CI (–0.005, 0.03) |
| Weight | | | |
| Mean | 42.91 | 43.66 | Mean diff = 0.75 kg |
| SD | 11.96 | 11.73 | 95% CI ( 0.72, 0.77) |
| BMI | | | |
| Mean | 19.32 | 19.39 | Mean diff = 0.001 kg/$M^2$ |
| SD | 4.60 | 4.73 | 95% CI (–0.01, 0.01) |
| 1st secondary | (n= 251) | (n=166) | |
| Height | | | |
| Mean | 1.59 | 1.62 | Diff of mean = 0.03 M |
| SD | 0.08 | 0.24 | 95% CI (–0.01, 0.07) |
| Weight | | | |
| Mean | 53.23 | 53.69 | Diff of mean = 0.46 kg |
| SD | 12.77 | 12.95 | 95% CI (0.44, 0.49) |
| BMI | | | |
| Mean | 21.0 | 20.89 | Diff of mean = 0.001 kg/$M^2$ |
| SD | 4.39 | 5.00 | 95% CI (–0.01, 0.01) |
| Height progression | | | |
| Mean | 10.53 | 12.52 | Diff of mean = 0.02 M |
| SD | 5.19 | 24.66 | 95% CI (–0.02, 0.06) |
| Weight progression | | | |
| Mean | 10.78 | 10.59 | Diff of mean = –0.002 kg |
| SD | 5.39 | 6.82 | 95% CI (–0.02, 0.01) |

BMI = Body mass index

**TABLE III -** PROGRESSION OF MYOPIA AND FAMILY HISTORY (FH) OF MYOPIA

| | Progression of myopia ≤0.5 D/y | Progression of myopia >0.5 D/y | Odds ratio (95% CI) |
|---|---|---|---|
| FH of myopia in siblings | | | |
| Yes | 152 | 123 | 1.95 (1.24, –3.1) |
| No | 99 | 41 | |
| FH of myopia in parents | | | |
| Yes | 120 | 81 | 1.08 (0.71, 1.64) |
| No | 126 | 79 | |

**TABLE IV -** PROGRESSION OF MYOPIA IN 1ST SECONDARY OMANI STUDENTS AND ITS PREDICTORS

| Predictors | Standardized ß | t value | p value |
|---|---|---|---|
| Family history of myopia in one of the siblings | –0.109 | 2.14 | 0.03 |
| Weight in 10th grade | 0.374 | 3.33 | 0.001 |
| Weight in 7th grade | 0.495 | –4.4 | <0.005 |

parents and siblings.

The progression was 0.34 D myopia per year in Omani students age 14 to 17 years in our study. A study in Hong Kong reported average annual change of –0.63 D (SD=3.44) myopia in 9- to 11-year-old children (16). Angle and Wissmann reported only 0.22 D progression per year (17). The difference in the age groups and races could be reasons for these differences.

The sex difference in progression of myopia was not significant. This is in contrast to the study in Japan. The cohort included 3- to 17-year-old boys and girls. The mean change in refractive error was –1.41 D±1.25 D for boys and –1.03 D±1.07 D for girls. The study showed a statistically significant difference in the mean changes of refractive errors during the 6-year follow-up examination (18). Myopic shift of refractive error was associated with female sex in China also (19). Personality and number of hours spent in near work were found to be associated with both myopia and its progress (20, 21). More outdoor activities and less near work among boys compared to girls in Omani children could be responsible for less progress among boys compared to other studies.

Regional subgroups showed variation in the progression of myopia. Rapid socioeconomic development in rural areas and considerable numbers of big towns in Group B regions also could have resulted in this observation. A study in China reported differential progression of myopia among children of urban and rural China, suggesting the possibility of different environmental factors influencing the progress of myopia (22).

The height, weight, and body mass index both in 7th grade and 10th grade were not significantly associated with the progression of myopia among our cohort. A number of studies have attempted to associate physical measurements with both development and progress of myopia. However, the debate still persists due to varying outcomes. Among male military recruits aged 17 to 19 years in Israel, myopia was not associated with higher stature or with greater weight (23). Among 7- to 9-year-old Chinese children in Singapore, eyes of those who were heavier or with a higher BMI had more hyperopic status, and eyes in heavier children had shorter vitreous chambers. A potential influence of systemic endocrine or metabolic factors during early childhood on refractive error development was proposed for this observation (8). The different age group of our cohort compared to the cohort of the Singapore study could be responsible for the difference.

In another study, vision and weight were found to be positively associated, whereas there was no interrelation found between vision and height. Irrational food structure, food preference, and hypotrophy were proposed as underlying possible causes for this relation (24). In our study the weight of the student in 7th grade also was found to be a predictor for the progression of myopia.

As our cohort is school based, all the subjects in 10th grade could be considered as educated. Angle and Wissmann had hypothesized that education explains tendencies for myopia to appear and progress among 12- to 17-year-olds (17). Thus it would be interesting to review the progress of myopia among school dropouts and compare role of education on progression of myopia through a separate study.

After controlling confounding effects of other variables, family history of myopia among one of the parents or siblings was found to be positively associated with the progression of myopia in our study. This was greater in students with more than 0.5 D/year compared to the students with less than 0.5 D progression in a year. Other studies have reported a strong genetic tendency for the progress of myopia (2, 3, 25). A twin study suggested that environmental factors affect progression of myopia among high risk children with positive family history of myopia (26). Thus, although progression of myopia of higher value seems to have genetic/familial tendency, the effect of other factors needs to be studied in detail.

The most potent predictors for juvenile-onset myopia continue to be a refractive error ≤+0.50 D at 5 years of age and family history (2). In our study, we could generate information on myopic status of the children at age 13 to 14 years while they were in 7th grade. We also found that the progression of myopia was significantly higher in students with positive history of myopia at younger age. Hence the annual vision screening at 1st grade and 4th grade in Oman could help to predict the pool of myopia and resources needed to address this problem among teenaged children.

To prevent the progression of myopia, children with high risk of myopia could be targeted through non-interventional modalities like controlled accommodation (26), prescribing spectacles (27), bio-rhythmic exposure of the organ of vision to low-intensive light at different wavelengths (28, 29), use of miotics (2), or other invasive procedures like transconjunctival electro-ophthalmostimulation (TEOS) (30). For children with axial myopia, it is proposed that the progress could be prevented by Mersilene transplants, recommended for scleroplasty (31). These modalities could be implemented in Omani teenaged children with myopia.

Studies on clinical syndromes among patients with high myopia, role of consanguinity in the progress of myopia, and genetic studies of patients with high myopia with more than two family members with same problem could further confirm the association of progress of myopia to genetic and environmental factors.

## CONCLUSIONS

The profile of progressing myopia among Omani children is presented. These students represent a community of a Middle Eastern country with predominant Arab race. Association of progress of myopia to anthropometric measurements was not conclusive. Family history of myopia and weight of the students were predictors of progressive myopia in teenaged Omani children. However, family history among parents was not the predictor for progression of myopia in children.

*None of the authors have a proprietary interest.*

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