



The Handan Offspring Myopia Study

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Abstract: The Handan Offspring Myopia Study (HOMS), whose participants came from 6 villages where all people aged ≥ 30 years had taken part in the Handan Eye Study (HES) in 2006–2007, was designed to obtain the familial associations of myopia between parents and their offspring. From March 2010 to June 2010, of 1,238 eligible individuals, 878 children (70.2%; 52.6% male) from 541 families were recruited. The mean age of the children was 10.5 ± 2.5 years. All the participants had a detailed eye examination and anthropometry examination. All examinations were performed using the same protocols and equipment in both HES and HOMS. Information of the parents was obtained from the HES. The results of the research showed that the myopic shift from parents to children was estimated to be approximately 1 D at 18 years of age. For near work and myopia, no association was found, except for the high near work subgroup with moderate outdoor activity levels. Besides a weak protective effect of outdoor activity on myopia in these rural children was observed. In the future, we plan to follow up these participants and investigate how the refraction of the children change, how myopia-genic activity changes and what effect does it have on myopia. The information will be important for the design of strategies to prevent and reduce myopia.

Keywords: Children; epidemiology; myopia; offspring

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Introduction

Myopia has reached epidemic levels (now 80–90% in school leavers) in some urban areas of East and Southeast Asia (1). And it has also been documented that the prevalence of myopia among juvenile in mainland China has increased from <10–35% to 50–80% over recent decades (2–4). However, the reasons for this rapid increase in myopia are still unclear.

It is believed that both genetic and environmental factors play important roles in myopic onset and its progression. However, genes pools cannot change fast enough to explain the rapid increases in myopia, so it is environmental factors

that probably play a major role in these increases (5). After the second world war, as societies developed in East and Southeast Asia, environmental factors such as family income, education, and lifestyle and so on have also changed, and could have had an important impact on myopia.

In the last 40 years, the Cultural Revolution ended and a formal education system was restored in China, but it is not clear how this has affected refractions in China. Therefore, we launched the Handan Offspring Myopia Study (HOMS) to obtain an insight into the myopic shift in refraction in a rural population in China.

Methods

Participants

The study design, procedures, and demographic characteristics of HOMS are reported elsewhere (6). In brief, a population-based eye study, the Handan Eye Study (HES), including 6,830 adults from 13 randomly selected villages in the Yongnian County of Handan, Hebei Province of Northern China, was conducted in 2006 to 2007 (7). The demographic characteristics of the population in this geographic area were similar to those of many other rural Chinese regions according to the 2000 National Census (7). Six of the 13 villages with adults aged 30 years or older were selected for the HOMS. Subjects who had moved outside the Yongnian County at least 6 months prior to this study either for work or study and all adopted children were excluded from the study. Between March 2010 and June 2010, 878 of 1,238 children eligible for the HOMS (70.9% response rate), aged 6 to 18 years, participated in the study. All participants were self-identified as Han. The age (mean \pm standard deviation) of participants was 10.5 \pm 2.5 years, and 52.6% were male. Compared to non-participants, children who participated were more likely to be boys, younger, and studying or working near the villages. Information of the parents was obtained from the HES. For those who didn't participate in the HES were examined during this time.

This study was approved by the Ethics Committee of the Handan Eye Hospital and adhered to the Declaration of Helsinki. Written, informed consent was obtained from at least one parent/guardian and the children's assent was also obtained.

Examinations

After registration, detailed eye examinations such as visual acuity and best-corrected visual acuity, autorefractometry before and after cycloplegia, subjective refraction and anthropometry examination including height, weight, waist-hip and so on were performed in a mobile clinic set up in the villages (either near the village school or in the village administrative office house). Besides, participants and parents were administered different sets of questionnaires which sought information about living environments, eating habits, maternal obstetric history, the child's birth history, children's near and distance work-related activities, eye exercises, study habits, complaints related to convergence insufficiency and so on. All examinations were performed

using the same protocols and equipment in both HES and HOMS (8). Quality control procedures were performed throughout the study.

Definitions

Myopia was defined as spherical equivalent refraction (SEq) < -0.5 diopters (D), high myopia was defined as SEq < -5.0 D, and hyperopia was defined as SEq $> +0.5$ D. Astigmatism > 0.5 D (analyzed in minus cylinder) was considered significant without reference to the axis. Anisometropia was defined as a SEq difference between the right and left eyes ≥ 1.0 D. The children's refractive error was defined as the combined average of the cycloplegic SE (sphere +1/2 cylinder) of both eyes. Other parameters have been defined elsewhere before (6,9-11).

Statistical analyses

Statistical analyses were performed using standard statistical software (SAS 9.1.3, SAS Institute, Cary, NC, USA). Prevalence for all outcomes were performed using age and sex subgroups. Differences in the prevalence between the subgroups were analyzed using χ^2 tests. For risk factor analysis (e.g., near work and outdoor activity with myopia), we compared frequency of the risk factors for participants with and without the outcome of interest (e.g., myopia) using χ^2 tests. Multiple logistic regression was used to control potential confounders such as age, sex, and other factors. For continuous traits, *t*-tests, analysis of variance (ANOVA), analysis of covariance (ANCOVA), and linear regression models were used. The correlation between parents and offspring were conducted using generalized estimating equation (GEE) models.

Major findings

Visual impairment

Of 878 participants, 837 (95.3%) completed cycloplegic autorefractometry. The crude prevalence of myopia was 23.5%. The prevalence of low vision in the better eye and worse eye was 7.1% and 10.6%, respectively. Females had a significantly higher rate of low vision than males (9.2% *vs.* 5.2%, $P=0.02$; 14.9% *vs.* 6.7%, $P<0.001$) in the two conditions. The majority of visual impairment in better-seeing eye (56/62, 90.3%) as well as in worse-seeing eye (84/93, 90.3%) could be corrected with glasses.

Generational difference of refractive error and risk factors

The refractive error difference (RED) was -1.33 D in children aged 6 to 7 years, that is the parents were more myopic than the children. As myopia developed in the children, the children became more myopic than their parents, and for children aged 16 to 17 years, the difference was 0.81 D. The predicted age when a child's SE approached that of the parents was 14 years, which is 3 years later than in the urban children. Moreover, the generational myopic shift from parents to their children would be 1.03 D, which is approximately 1 D less than that in the urban children (12). In multiple linear regression analysis, a higher RED was associated with older children ($\beta=0.23$ D/year, $P<0.0001$) and girls ($\beta=0.24$, $P=0.01$). However, besides older age ($\beta=0.46$ D/year, $P<0.0001$), it was also associated with less time on outdoor activity ($\beta=0.21$ D/hours per day, $P=0.02$), less paternal education ($\beta=0.26$, $P=0.027$), and less maternal education ($\beta=0.27$, $P=0.033$), after adjusting for the children's age and sex (for variable age, only sex was adjusted) in urban areas.

Near work, outdoor activity, and myopia

In these Chinese rural children, no association between near work and myopia was found, except for children with high near work and moderate outdoor activity load. A weak protective effect of outdoor activity on myopia in Chinese rural children was also observed. Similarly, our previous study [Beijing Myopia Progression Study (BMPS)] showed that near work activity was not found to be associated with refraction in the urban children and higher levels of outdoor activity were associated with less myopic refraction in primary school students.

Eye exercises of acupoints: their impact on myopia and visual symptoms

Multiple analysis demonstrated that the traditional eye exercises of acupoints had a modest protective effect on myopia among students aged 6–17 years in the rural area. However, there was no association found between the eye exercises and near vision symptoms. In contrast, our previous urban study (BMPS) showed that the protective effect of these eye exercises for myopia was not significant. However, students who performed the eye exercises seriously, followed the instructions when performing the eye exercises, and were acquainted with the eye exercises,

tended to have less vision symptoms such as eyestrain, headaches, blurred vision and so on (13).

Outlook

Several years has passed since the HOMS was begun. How is the refraction of the children changing? How much time do they spend on near work and outdoor activities? In the future, we plan to follow up the Handan offspring and investigate: (I) difference between the cycloplegic SE and the non-cycloplegic SE and its association with progression of refractive error; (II) myopigenic activity change and myopia risk factors; (III) the influence of near work and outdoor activities on myopic refractive change.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of the Handan Eye Hospital (HandanTH200901). Written informed consent was obtained from at least one parent/guardian and the children's assent was also obtained.

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