Interventions recommended for myopia prevention and control among children and adolescents in China: a systematic review

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bjophthalmol-2021-319306).

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Received 20 March 2021
Accepted 9 November 2021

Check for updates

To cite: Zhu Z, Chen Y, Tan Z, *et al*. *Br J Ophthalmol* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/bjophthalmol-2021-319306

ABSTRACT

In 2018, a consortium of government bodies in China led by the Ministry of Education released the *Comprehensive Plan to Prevent Nearsightedness among Children and Teenagers* (CPPNCT), aiming to reduce the incidence of myopia and control myopic progression in China. Recommendations span from home-based to school-based interventions, including time outdoors, physical activity, light exposure, near-work activity, screen time, Chinese eye exercises, diet and sleep. To date, the levels of evidence for this suite of interventions have not been thoroughly investigated. This review has summarised the evidence of the interventions recommended by the CPPNCT in myopia prevention and control. Thus, the following statements are supposed by the evidence: (1) Increasing time outdoors and reducing near-work time are effective in lowering incident myopia in school-aged children. (2) All interventions have a limited effect on myopia progression. Ongoing research may lead to a better understanding of the underlying mechanisms of myopia development, the interaction of different interventions and recommendations, confounding variables and their true effect on myopia prevention, and the identification of those most likely to respond to specific interventions. This field may also benefit from longer-term studies of the various interventions or strategies covered within this review article, to better understand the persistence of treatment effects over time and explore more novel approaches to myopia control.

GENERAL INTRODUCTION

Myopia has reached epidemic levels in young adults in some urban areas of East and Southeast Asia.[1] In these areas, 80%–90% of high school graduates now have myopia.[2] Based on current trends in prevalence, myopia is predicted to affect approximately 50% of the world's population by 2050.[3]

The annual economic cost of myopia is estimated to be US$202 billion globally, posing a profound impact on both individuals and society.[4] Of note, myopic maculopathy, due to high myopia, is fast becoming a major cause of irreversible visual impairment and blindness in different parts of the world.[5–8]

In some areas with high prevalence of myopia, myopia control has become a primary priority for health ministries in Asia. In China, a consortium of government bodies in China led by the Ministry of Education released the *Comprehensive Plan to Prevent Nearsightedness among Children and Teenagers* (CPPNCT).[9] The goals of this plan were to decrease the incidence of new cases of myopia in China and reduce the rate of progression among children with existing myopia. Recommendations span from home-based to school-based interventions and pertain to eight interventions.

The CPPNCT combines multiple approaches to myopia prevention, which may limit investigation into the efficacy of individual components of the plan. Previous systematic reviews have summarised the evidence for some parts of the recommended interventions, such as increasing outdoor time,[10] but an up-to-date and comprehensive understanding of the approaches recommended in the CPPNCT remains unknown. The implementation of the suite of interventions recommended by the CPPNCT will require significant social effort and resources, but the effect on myopia control of some interventions, such as diet, sleeping time and Chinese eye exercises, is not yet clear. Additionally, some approaches including acupuncture may have only been included in papers published in languages other than English. The basis on which how public health policy should be made for myopia control thus requires further evidence.

Therefore, we performed a systematic review to summarise the effectiveness of the interventions recommended in the CPPNCT to prevent or delay the onset of myopia or slow myopic progression among children and adolescents in China. Specifically, we examined the impact of time outdoors, physical activity (PA), light exposure, near-work activity, screen time, Chinese eye exercises, diet and sleep on the incidence of myopia and changes in refractive errors and axial lengths among myopes (online supplemental tables 1–7). Further, we assessed the risk of bias for included cohort studies using the Newcastle–Ottawa Scale and for randomised controled trial (RCT) using the Risk of Bias 2 tool (online supplemental tables 8 and 9).

TIME OUTDOORS

Dating back to 1916, Harman[11] accidentally observed that myopic children tended to engage in more indoor activities and spent less time outdoors than emmetropic children. Following this, the relationship between time outdoors and myopia has been extensively studied.

Evidence that time outdoors is a crucial protective factor against onset of myopia has been accumulated from both cohort studies and clinical trials (online supplemental table 1). French *et al*[12] reported that myopic children spent less time outdoors compared with those who remained non-myopic in Australian schools. Similarly, the significant inverse association between outdoor time and incident myopia was noted by Jones *et al*,[13] Tsai *et al*,[14] Guggenheim *et al*,[15] Guo *et al*,[16] Jones-Jordan *et al*[17] and Shah *et al*.[18] Nevertheless, a limited number of cohort studies reported that outdoor time was not associated with incident myopia.[19–25]

The protective effect of time outdoors on the incidence of myopia has been further verified in one non-randomised controlled trial (NRCT) and four RCT. The NRCT conducted by Wu *et al*[26] reported a lower incidence of myopia in the intervention group with an additional 80 min of time outdoors compared with the control group (8.41% vs 17.7%). Three RCTs estimated the effect of time outdoors on incident myopia. He *et al*[27] (40 min outdoor time intervention: 30.4% vs 39.5%) Wu *et al*[28] (80 min: 14.5% vs 17.4%) and Jin *et al*[29] (40 min: 3.70% vs 8.50%) reported that incident myopia decreased with additional outdoor activity time.

Despite growing evidence on the protective effects of time outdoors against incident myopia, it is currently uncertain whether time outdoors slows progression in individuals who are already myopic. As early as 1993, Pärssinen and Lyyra[30] demonstrated that increased time spent outdoors was significantly associated with a lower rate of myopic progression and decreased final degree of myopia at the end of 3-year follow-up. Three other studies suggested a potential protective effect of time outdoors against myopia progression.[31–33] Nevertheless, most available studies are not in favour of the protective effect of time spent outdoors on myopia control. In Taipei, Hsu *et al*[34] reported that time spent in outdoor activities after school on weekdays (reference ≥1 hour/day) or weekends (reference ≥2 hours/day) was not associated with slowed myopia spherical equivalent (SE) progression. Other studies[35–38] indicated no statistically significant associations between outdoor time and myopia progression. In the Correction of Myopia Evaluation Trial, Scheiman *et al*[39] found that outdoor activity hours per week, either considered as a continuous variable or as a categorical variable, was not a significant predictor for the age of myopia stabilisation.

In NRCT and RCT studies, Wu *et al*[26] reported that an additional 80 min of time outdoors for myopic subjects in the intervention group showed similar myopia progression compared with controls (0.12 D/year; 95% CI: −0.06 to 0.31, p=0.183). On the contrary, three RCTs indicated a significant relationship between time outdoors and myopic progression.[28 40 41] Yi and Li[40] reported that the progression of myopia in SE changes was significantly greater in the control group with the intervention of instruction to decrease near-work time and increase outdoor activity (0.52 D vs 0.38 D, p<0.01). Similarly, Li *et al*[41] and Wu *et al*[28] noted that the change of SE and axial length (AL) in myopic children was less with the intervention of increased time outdoors when compared with the control group.

In a recent meta-analysis, Xiong *et al*[10] reviewed 25 articles and found a significant protective effect of time spent outdoors on incidence of myopia (clinical trials: RR: 0.54; 95% CI: 0.34 to 0.85; cohort studies: RR: 0.54; 95% CI: 0.34 to 0.85). Their dose–response analysis indicated an inverse non-linear relationship between time spent outdoors and incident myopia, while no clear dose–response evidence was observed for myopia progression. Ho *et al*[42] pooled data from 13 studies and reported the benefits of outdoor light exposure on myopia incidence (OR: 0.85; 95% CI: 0.80 to 0.91) and slightly greater benefits in SE and AL progression among myopic children in intervention studies. Other meta-analyses performed by Deng and Pang in 2019[43] and Cao *et al* in 2020[44] indicated that there was a reduced risk of developing myopia with more outdoor time (pooled estimates: RR: 0.66; 95% CI: 0.49 to 0.89; and RR: 0.76; 95% CI: 0.67 to 0.87, respectively).

PA TIME

Although evidence has demonstrated the protective effects of time outdoors on myopia management, confusion has been introduced as the majority of studies did not differentiate between the effects of PA (eg, sport and exercise) and time outdoors on myopia. Therefore, the role of PA remains unclear.

To date, no established evidence is apparent in linking levels of PA and the incidence of myopia (online supplemental table 2). A study by Guggenheim *et al*[15] found that there was a borderline association between levels of PA and incident myopia (OR: 0.88; 95% CI: 0.76 to 1.01, p=0.062, per quartile of minutes of moderate-to-vigorous activity per day). In the Beijing Children Eye Study,[16] and a prospective study by Lundberg *et al*,[45] no significant association between incident myopia and time spent outdoors sports was noted.

To the best of our knowledge, only one study exclusively investigated the effects of PA on myopia progression (online supplemental table 2). Sánchez-Tocino *et al*[31] demonstrated that sports activities were marginally associated with a lower likelihood of having progression of more than −0.5 D in 6 months among children.

LIGHT EXPOSURE

Night light

Dating back to 1999, Quinn *et al*[46] first reported that night lights increased the likelihood of having myopia. Since then, a growing number of cross-sectional studies have investigated the relationship between night lights and myopia.[47–51] However, there is limited evidence supporting the relationship between night lights and myopia incidence (online supplemental table 3). A cohort study in Singaporean children reported that the use of night lights before 2 years of age was not associated with incident myopia in multivariate models.[23]

Indoor light

One of the potential mechanisms underlying the protective effects of time outdoors on myopia is that bright light can stimulate the release of dopamine from the retina. This mechanism has been verified in animal studies.[52] Whether increases in the level of indoor light intensity can also boost the release of retinal dopamine, and thereby reduce or slow the progression of myopia, has been a hot topic (online supplemental table 3).

Study findings are mixed on the effectiveness of indoor lighting on myopia prevention. You *et al*[21] indicated that selecting an adequate lighting environment when reading and writing was not a significant influencing factor on incident myopia. In a non-RCT with 317 Chinese students however, Hua *et al*[53] rebuilt the lighting system in classrooms to increase lighting and reported a decreased incidence of myopia in the intervention group (4% vs 10%, p=0.029). This study also compared myopia progression between the intervention and control group, which indicated that the magnitude of SE change over 1 year was similar between the intervention and control groups.[53] Increased indoor lighting exposure in the intervention group however did lead to slower myopia progression when measured in terms of axial elongation over 1 year (0.20±0.11 vs 0.27±0.10 mm, p=0.0001).

NEAR-WORK-RELATED PARAMETERS

The relationship between near-work-related parameters (including near-work time and near-work-related habits) and myopia have an extensive history. Even though early cross-sectional studies conducted in the 1990s consistently reported a significant association between increased near-work time and the presence of myopia,[54 55] conflicting results have emerged from recent cohort studies (online supplemental table 4).

French *et al*,[12] Lin *et al*[19] and Guo *et al*[16] indicated that near-work time was an independent risk factor for the development of myopia. In a UK cohort of children, Williams *et al*[56] found that reading preference was the strongest predictor of incident myopia. However, recent studies have offered evidence for non-significant associations between near-work time and incident myopia.[13–15 17 20 21 23 24 57]

Studies by Saw *et al*[38 58] reported that weighted and raw time of near-work, books read per week and the eye-to-book distance while reading or writing were not risk factors for myopia progression. Similarly, Jones-Jordan *et al*[35] and Sánchez-Tocino *et al*[31] found that near-work time made negligible contributions to myopia progression. Scheiman *et al*[39] suggested that near-work time was not a significant predictor of myopia stabilisation age. Conversely, Pärssinen and Lyyra[30] noted that more time spent reading and doing close work was associated with a faster myopic progression rate. Saxena *et al*[32] and Öner *et al*[37] reported that reading/writing was only significantly associated with myopic progression when it was done for more than 42 hours per week. A population-based cohort study by Hsu *et al*[34] found that distance of near-work was associated with 1-year progression of myopia. The age of starting near-work and the total amount of time spent on near-work per day however were not found to be related to myopic progression.

A systematic review and meta-analysis quantified the effect of near-work activities on myopia in children.[59] The pooled data indicated that more time spent on near-work activities was associated with higher odds of myopia (OR=1.14; 95% CI: 1.08 to 1.20) and that the odds of myopia increased by 2% (OR=1.02; 95% CI: 1.01 to 1.03) for every one diopter-hour (hr) more of near-work per week. While dioptre-hours spent on near-work activities were not associated with the incidence of myopia (RR=1.00; 95% CI: 0.99 to 1.01).

SCREEN TIME

An obvious feature of modern life is extensive exposure to computers, mobile phones and handheld games. There has been long-standing confusion about whether tremendous increases in screen time are involved in the emergence of the myopia epidemic (online supplemental table 5). A review of survey data in Taiwan demonstrated the prevalence of myopia among school children increased rapidly from 1983 through 2017, mainly attributable to the use of electronic devices.[60]

Studies by Ku *et al*[20] and Jones *et al*[13] aimed at investigating the association between incident myopia and screen time on computers, video games, the internet and television consistently showed that the incidence of myopia did not differ significantly across different levels of screen time. In support of these findings, Saw *et al*[23] and Jones-Jordan *et al*[17] reported that computer use and the number of hours playing video games per day were not associated with incident myopia. On the contrary, Guo *et al*[16] indicated that more time spent watching television increased the risk of incident myopia.

Öner *et al*[37] found that the mean daily time spent on computer use and watching television did not correlate with annual myopia progression rates. Jones-Jordan *et al*[35] and Sánchez-Tocino *et al*[31] reported similar findings. Nevertheless, Saxena *et al*[32] showed a significant positive association between the progression of myopia and the use of computers/video games.

Lanca and Saw[61] performed a meta-analysis covering a total of 20 889 children to determine the association between screen time and myopia in children. A pooled OR of 1.02 (95% CI: 0.96 to 1.08; p=0.48) suggested that screen time was not associated with prevalent or incident myopia.

SLEEP TIME

Associations between sleep and myopia have been reported, but the evidence is inconsistent. Several cross-sectional studies did not show an association between sleep duration and prevalent myopia.[62–65] In contrast, Jee *et al*[66] reported that the adjusted odds for myopia were 41% less in those who slept more than 9 hours per night than in those who slept less than 5 hours nightly, based on data from the Korean National Health and Nutrition Examination Survey. However, the authors were unable to distinguish between whether this effect was due to sleep or confounding factors, such as outdoor activities and near-work. A study by Gong *et al* adjusted important confounding factors in the final models and found low hours of sleep to be an independent risk factor for myopia, where children who slept 7 hours or fewer per night (OR=3.37; 95% CI: 3.07 to 3.70, p<0.001) or about 8 hours (OR=2.12; 95% CI: 1.94 to 2.31, p<0.001) had a higher risk compared with those who slept 9 or more hours.[67] This statistically significant inverse association between sleep duration and myopia was also supported by studies conducted by Zhou *et al*[68] and Xu *et al*[69]

To date, only a few available cohort studies have investigated the association between sleep duration and incident myopia (online supplemental table 7). In the Growing Up in Singapore Towards Healthy Outcomes birth cohort, Sensaki *et al*[70] noted that total sleep duration and the number of night awakenings at 12 months of age were not associated with myopia at the age of 3 years. The Anyang Childhood Eye Study[71] reported that neither sleep duration nor bedtime was associated with the incidence of myopia. Further, they also noted that no statistically significant association was found for sleep duration, bedtime and myopia progression, or axial elongation.

CHINESE EYE EXERCISES

As a compulsory programme in Chinese primary and junior middle schools, Chinese eye exercises have been implemented in China since 1963 for the purposes of relieving visual symptoms and preventing myopia in children.[72] The broad implementation of eye exercises in China has attracted increasing attention regarding their effectiveness for myopia prevention and control during the last decade. However, its effects on childhood myopia are still uncertain due to the lack of suitable evidence from cohort studies and proper adjustments, such as outdoor time and near-work.

Limited evidence supported the protective effects of Chinese eye exercises on myopia prevention (online supplemental table 6). One cohort study conducted by You *et al*[21] reported that doing eye exercises correctly was not significantly associated with incident myopia over a 1-year period. A nested case–control study[73] also supported the finding that there was no association between eye exercises and incident myopia.

The effects of Chinese eye exercises on myopia progression have so far remained unconfirmed (online supplemental table 6). The first randomised control trial on Chinese eye exercises was conducted by Li *et al*,[74] suggesting the potential effect of Chinese eye exercises on accommodative lag alleviation and myopia control. The same team conducted a subsequent nested case–control study to further explore the long-term effects of Chinese eye exercises, where no significant association between eye exercises and myopia progression was observed after a follow-up period of 2 years on 63 cases and 78 controls.[73] In a subgroup analysis, however, the group who performed high-quality exercises had a slightly lower myopia progression of 0.15 D than children who did not perform the exercises.

A recent meta-analysis including 14 590 participants from five studies[75] evaluated the association between Chinese eye exercises and myopia prevention. Results showed that performing high-quality eye exercises were associated with a markedly lower risk of incident myopia than those who did not complete eye exercises according to the protocol (OR=0.27, 95% CI: 0.11 to 0.71). Another meta-analysis found that Chinese eye exercises accounted for 28% greater efficacy of slowing myopia progression. When Chinese eye exercises were done up to five times per week, the effects of myopia control improved to 62%.[76]

DIET

The hypothesis that diet may play a role in myopia was first proposed by Gardiner[77] in 1956, where more protein as well as less fat and carbohydrates were found to be consumed by 251 stationary myopes compared with 33 active myopes. A plausible hypothesis might be that insulin resistance, chronic hyperinsulinaemia, increased circulating insulin-like growth factor 1, decreased circulating growth hormone and decreased retinoid receptor signalling increased scleral growth.[78] However, this hypothesis has gained little support from other studies, and expected associations of height, weight, body mass index and obesity with myopia have not been consistently observed. The complexity and high variability of diet itself as well as the varied dietary assessment methods used in data collection might explain the conflicting results in terms of the association between diet and myopia (online supplemental table 7).

Using data gathered from the Raine Study Gen2, subjects with adequate vitamin A intake during adolescence were found to be less likely to be myopic in early adulthood. However, this association became insignificant when adjusted for confounding factors.[79] In a cohort study performed by Edwards *et al*,[80] children who developed myopia between the ages of 7 to 10 years had lower total energy, protein, fat and cholesterol intakes at 7 years of age than those who remained non-myopic. However, the results of this study are limited due to its small sample size, non-cycloplegic refraction and non-adjustment for important confounders. In a larger scale longitudinal study in Shanghai, no association between maintaining a balanced diet and the incidence of myopia was reported after following more than 4000 school children for 1 year.[21]

Gardiner[81] attempted to arrest myopia progression by increasing protein intake and gained apparently positive results. Moreover, the more severe the myopia and the younger the age at the start of treatment, the bigger the difference between the children with and without supplementary protein intake. Mori *et al*[82] performed a multicentre randomised double-blind placebo-controlled clinical trial to investigate the effect of dietary supplementation of crocetin for myopia control in children aged 6–12 years. After following up for 24 weeks, the change in spherical equivalent refractions (SER) in the crocetin group was significantly smaller compared with that in the placebo group after adjusting for confounders. The adjusted axial length elongation in the crocetin group was also significantly smaller than that in the placebo group. Their findings implied that dietary crocetin might have a suppressive effect on myopia progression in children. However, the small sample size and short-term follow-up time may hinder the interpretation of these findings. More studies are needed to investigate the effect of different diets on myopia control.

DISCUSSION

Outdoor, indoor light, and PA

To date, time outdoors has been verified to have a causal association with myopia prevention. Further, encouraging more time spent outdoors has been translated into a preventive intervention in several countries. However, a number of points should be noted. First, the evidence linking time outdoors to the prevention of myopia is stronger than that linking time outdoors to myopia progression control, with different implications for ocular health management strategies for myopic and non-myopic children.

Second, it should be noted that the majority of previous studies assessed outdoor time based on questionnaires, which may be subject to recall bias. Evidence based on objective measures are increasing in recent years. Inverse associations between myopia and sun exposure or light exposure have been reported, which was measured with conjunctival ultraviolet autofluorescence[83 84] or wearable devices including Actiwatch-2[85] and Clouclip.[86] Objective sensors, ideally wearable devices mounted on the arms of spectacles, are encouraged for future use in the collection of outdoor parameter data.

Last but not least, the mechanisms that underlie the protective effects of time outdoors on myopia remain unclear and should be clarified. Levels of light intensity between outdoor and indoor environments are indicated to be the driving factor for the protective effect of outdoor time, by stimulating the release of retinal dopamine.[87–89] Based on this hypothesis, researchers have increased levels of indoor light intensity, but only limited evidence support the protective effect of indoor light against myopia onset or progression. Much more research is needed prior to utilising artificial lighting conditions as a tool for myopia prevention and control. Alternatively, Zhou *et al*[90] proposed a novel Bright Classroom with glass walls and ceilings to expose children to outdoor bright light. They found that this Bright Classroom could be acceptable to teachers and students. This novel classroom may be an efficient way of increasing bright light exposure and managing myopia. However, this requires renovation of existing and new classrooms, which is often expensive and pragmatically challenging.

Another hypothesis for the inverse association between time spent outdoor and myopia prevention may be due to more PA. PA may lead to changes in the intricate signal cascade systems during emmetropisation, and increased blood flow and thickness of the choroid may lead to a reduction in AL growth.[91] Of note, longitudinal and causal evidence for the protective association between PA and myopia onset and development is still limited. Recent studies have suggested non-significant associations between indoor PA and myopia,[92 93] implying that it may be time spent outdoors rather than PA that exert its protective effect in the prevention of myopia. More studies are needed to provide insights into the individual effects and interaction of PA and outdoor time on myopia prevention and control. Accurate and objective measurements of PA, such as with the use of accelerometers, are of critical importance in further investigating the association between PA and myopia.

Near-work and screen time

A weak association between near-work activities and myopia onset and progression has been observed from previous studies. Of note, the majority of previous studies relied on the subjective quantification of near-work activities, although more recent studies have utilised objective sensors to quantify time carried out in near-work activities. Near-work activities based on questionnaire data may be overestimated.[94] Further, wide variation in the definition of near-work activities and habits, and potential residual confounders in the final model (eg, time spent outdoors, parental myopia) may explain controversies in the association between near-work activities and myopia.

Changing patterns in myopia prevalence in the past few decades suggest that the advent of modern technologies and exposure to screen time may represent driving factors underlying the myopia epidemic. Of note, however, the prevalence of myopia had already increased noticeably in Singapore,[95–97] Taiwan[98] and Hong Kong[99] as early as the 1960s, well before the proliferation of these devices. Likewise, the myopia boom in China did not occur in parallel with the popularity of these electronic devices. Conclusions drawn from previous studies also do not support a significant association between screen time and myopia. Data from self-reported measures, varying definitions of screen time and confounding factors (eg, near-work time) adjusted in the models may bias the association. More studies with large-scale sample sizes, objective assessments of screen time, long-term follow-up and comprehensive adjustments in statistical models are needed to clarify the impact of screen time on myopia control.

Night lights and sleep duration

At present, insufficient evidence is available to establish the effect of night lights and sleep on the development or progression of myopia. In theory, the disturbance of the daily light–dark cycle may lead to increased risks of developing myopia among children exposed to greater light intensity at night and those with reduced sleep duration. This hypothesis has been supported by animal studies and population studies, where disruption of light–dark cycles affected the development of eyeball shape, eye growth and refractive error.[70 100–104] On top of this hypothesis, sleep deprivation may represent a behavioural pattern consisting of increased time spent completing near-work, less time outdoors and decreased sleep due to high educational intensity. Inverse associations between sleep duration and myopia may be causally attributed to near-work and outdoor activities, while sleep deprivation itself may be a covariate. However, as the prevalence of myopia can reach a high level in early primary school years before sleep deprivation likely becomes a common problem, this reduces the likelihood that this is a major risk factor for myopia. Longitudinal and causal associations between night lights and sleep with myopia, and their underlying mechanisms remains an open question.

Chinese eye exercises

To date, the level of evidence for the protective effect of Chinese eye exercises on myopia is low. Large-scale and well-designed prospective studies are required to support their use and long-term effect. The most significant challenge in investigating the real effect of Chinese eye exercises on myopia prevention and control relate to managing the quality of the Chinese eye exercises performed. According to a previous survey,[105] completing eye exercises was considered boring for most children, leading to a low percentage of children who performed them. In addition, it remained difficult to standardise the quality of eye exercise performance among children. Improving the quality of Chinese eye exercises may be a priority to enhance their impact on myopia prevention and control.

Diet

There is limited support for associations between diet and myopia. Current limitations in the evidence include difficulty in evaluating the concurrent impact of multiple components of diet at the same time, objectively measuring and capturing diet, and their long-term effects on myopia. The association between micronutrients (eg, vitamin A) and myopia has received increasing scientific attention, but stronger evidence is needed before any micronutrient supplementation is formally recommended for myopia prevention and control.

CONCLUSION

The current myopia epidemic shows no signs of abating. This article has summarised the evidence behind the interventions and strategies recommended by the CPPNCT in myopia prevention and control. The following statements are supposed by the evidence: (1) Increasing time outdoors and reducing near-work time are effective in lowering incident myopia in school-aged children. (2) All interventions have a limited effect on myopia progression. Ongoing research may lead to a better understanding of the underlying mechanisms of myopia development, the interaction of different interventions and recommendations, confounding variables and their true effect on myopia prevention, and the identification of those most likely to respond to specific interventions. Going forward, this field would benefit from longer-term studies of the various interventions or strategies included in this review article, to better understand the persistence of treatment effects over time and explore more novel approaches to myopia control.

Contributors Study concept and design: ZZ, AM. Acquisition, analysis or interpretation: ZZ, YC, AM. Drafting of the manuscript: ZZ, YC. Critical revision of the manuscript for important intellectual content: all authors. Statistical analysis: ZZ, YC. Administrative, technical or material support: AM. Study supervision: AM.

Funding The present work was supported by the Fundamental Research Funds of the State Key Laboratory of Ophthalmology.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

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REFERENCES

1 Morgan IG, Ohno-Matsui K, Saw S-M. Myopia. *Lancet* 2012;379:1739–48.
2 Morgan I, Rose K. How genetic is school myopia? *Prog Retin Eye Res* 2005;24:1–38.
3 Holden BA, Fricke TR, Wilson DA, *et al*. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology* 2016;123:1036–42.
4 Fricke TR, Holden BA, Wilson DA, *et al*. Global cost of correcting vision impairment from uncorrected refractive error. *Bull World Health Organ* 2012;90:728–38.

5 Neelam K, Cheung CMG, Ohno-Matsui K, *et al*. Choroidal neovascularization in pathological myopia. *Prog Retin Eye Res* 2012;31:495–525.
6 Wong TY, Klein BEK, Klein R, *et al*. Refractive errors, intraocular pressure, and glaucoma in a white population. *Ophthalmology* 2003;110:211–7.
7 Iwase A, Araie M, Tomidokoro A, *et al*. Prevalence and causes of low vision and blindness in a Japanese adult population: the Tajimi study. *Ophthalmology* 2006;113:1354–62.
8 Xu L, Wang Y, Li Y, *et al*. Causes of blindness and visual impairment in urban and rural areas in Beijing. *Ophthalmology* 2006;113:1134.e1–1134.e11.
9 Eight departments including the Ministry of Education. Notice of the Ministry of Education and other eight departments on printing and distributing the "Implementation Plan for Comprehensive Prevention and Control of Children and Adolescent Myopia", 2018. Available: http://www.moe.gov.cn/srcsite/A17/moe_943/s3285/201808/t20180830_346672.html
10 Xiong S, Sankaridurg P, Naduvilath T, *et al*. Time spent in outdoor activities in relation to myopia prevention and control: a meta-analysis and systematic review. *Acta Ophthalmol* 2017;95:551–66.
11 Harman NB. *The eyes of our children*. London: Methuen and Co. Ltd, 1916.
12 French AN, Morgan IG, Mitchell P, *et al*. Risk factors for incident myopia in Australian schoolchildren: the Sydney adolescent vascular and eye study. *Ophthalmology* 2013;120:2100–8.
13 Jones LA, Sinnott LT, Mutti DO, *et al*. Parental history of myopia, sports and outdoor activities, and future myopia. *Invest Ophthalmol Vis Sci* 2007;48:3524–32.
14 Tsai D-C, Fang S-Y, Huang N, *et al*. Myopia development among young schoolchildren: the myopia investigation study in Taipei. *Invest Ophthalmol Vis Sci* 2016;57:6852–60.
15 Guggenheim JA, Northstone K, McMahon G, *et al*. Time outdoors and physical activity as predictors of incident myopia in childhood: a prospective cohort study. *Invest Ophthalmol Vis Sci* 2012;53:2856–65.
16 Guo Y, Liu LJ, Tang P, *et al*. Outdoor activity and myopia progression in 4-year follow-up of Chinese primary school children: the Beijing children eye study. *PLoS One* 2017;12:e0175921.
17 Jones-Jordan LA, Mitchell GL, Cotter SA, *et al*. Visual activity before and after the onset of juvenile myopia. *Invest Ophthalmol Vis Sci* 2011;52:1841–50.
18 Shah RL, Huang Y, Guggenheim JA, *et al*. Time outdoors at specific ages during early childhood and the risk of incident myopia. *Invest Ophthalmol Vis Sci* 2017;58:1158–66.
19 Lin Z, Vasudevan B, Mao GY, *et al*. The influence of near work on myopic refractive change in urban students in Beijing: a three-year follow-up report. *Graefes Arch Clin Exp Ophthalmol* 2016;254:2247–55.
20 Ku P-W, Steptoe A, Lai Y-J, *et al*. The associations between near visual activity and incident myopia in children: a nationwide 4-year follow-up study. *Ophthalmology* 2019;126:214–20.
21 You X, Wang L, Tan H, *et al*. Near work related behaviors associated with myopic shifts among primary school students in the Jiading district of Shanghai: a school-based one-year cohort study. *PLoS One* 2016;11:e0154671.
22 Ma Y, Zou H, Lin S, *et al*. Cohort study with 4-year follow-up of myopia and refractive parameters in primary schoolchildren in Baoshan district, Shanghai. *Clin Experiment Ophthalmol* 2018;46:861–72.
23 Saw S-M, Shankar A, Tan S-B, *et al*. A cohort study of incident myopia in Singaporean children. *Invest Ophthalmol Vis Sci* 2006;47:1839–44.
24 Chua SYL, Ikram MK, Tan CS, *et al*. Relative contribution of risk factors for early-onset myopia in young Asian children. *Invest Ophthalmol Vis Sci* 2015;56:8101–7.
25 Zadnik K, Sinnott LT, Cotter SA, *et al*. Prediction of juvenile-onset myopia. *JAMA Ophthalmol* 2015;133:683–9.
26 Wu P-C, Tsai C-L, Wu H-L, *et al*. Outdoor activity during class recess reduces myopia onset and progression in school children. *Ophthalmology* 2013;120:1080–5.
27 He M, Xiang F, Zeng Y, *et al*. Effect of time spent outdoors at school on the development of myopia among children in China: a randomized clinical trial. *JAMA* 2015;314:1142–8.
28 Wu P-C, Chen C-T, Lin K-K, *et al*. Myopia prevention and outdoor light intensity in a school-based cluster randomized trial. *Ophthalmology* 2018;125:1239–50.
29 Jin J-X, Hua W-J, Jiang X, *et al*. Effect of outdoor activity on myopia onset and progression in school-aged children in northeast China: the Sujiatun eye care study. *BMC Ophthalmol* 2015;15:73.
30 Pärssinen O, Lyyra AL. Myopia and myopic progression among schoolchildren: a three-year follow-up study. *Invest Ophthalmol Vis Sci* 1993;34:2794–802.
31 Sánchez-Tocino H, Villanueva Gómez A, Gordon Bolaños C, *et al*. The effect of light and outdoor activity in natural lighting on the progression of myopia in children. *J Fr Ophtalmol* 2019;42:2–10.
32 Saxena R, Vashist P, Tandon R, *et al*. Incidence and progression of myopia and associated factors in urban school children in Delhi: the North India myopia study (NIM study). *PLoS One* 2017;12:e0189774.
33 Pärssinen O, Kauppinen M, Viljanen A. The progression of myopia from its onset at age 8-12 to adulthood and the influence of heredity and external factors on myopic progression. A 23-year follow-up study. *Acta Ophthalmol* 2014;92:730–9.
34 Hsu C-C, Huang N, Lin P-Y, *et al*. Risk factors for myopia progression in second-grade primary school children in Taipei: a population-based cohort study. *Br J Ophthalmol* 2017;101:1611–7.
35 Jones-Jordan LA, Sinnott LT, Cotter SA, *et al*. Time outdoors, visual activity, and myopia progression in juvenile-onset myopes. *Invest Ophthalmol Vis Sci* 2012;53:7169–75.
36 Li S-M, Li H, Li S-Y, *et al*. Time outdoors and myopia progression over 2 years in Chinese children: the Anyang childhood eye study. *Invest Ophthalmol Vis Sci* 2015;56:4734–40.
37 Öner V, Bulut A, Oruç Y, *et al*. Influence of indoor and outdoor activities on progression of myopia during puberty. *Int Ophthalmol* 2016;36:121–5.
38 Saw SM, Nieto FJ, Katz J, *et al*. Factors related to the progression of myopia in Singaporean children. *Optom Vis Sci* 2000;77:549–54.
39 Scheiman M, Zhang Q, Gwiazda J, *et al*. Visual activity and its association with myopia stabilisation. *Ophthalmic Physiol Opt* 2014;34:353–61.
40 Yi J-H, Li R-R. [Influence of near-work and outdoor activities on myopia progression in school children]. *Zhongguo Dang Dai Er Ke Za Zhi* 2011;13:32–5.
41 Li J, Liu Q, Li C. Comparison of outdoor activities and 0.1 g·L-1 atropine in preventing myopia progression in children. *Recent Adv Ophthalmol* 2019;39:158–61.
42 Ho C-L, Wu W-F, Liou YM. Dose-Response relationship of outdoor exposure and myopia indicators: a systematic review and meta-analysis of various research methods. *Int J Environ Res Public Health* 2019;16. doi:10.3390/ijerph16142595. [Epub ahead of print: 21 07 2019].
43 Deng L, Pang Y. Effect of outdoor activities in myopia control: meta-analysis of clinical studies. *Optom Vis Sci* 2019;96:276–82.
44 Cao K, Wan Y, Yusufu M, *et al*. Significance of outdoor time for myopia prevention: a systematic review and meta-analysis based on randomized controlled trials. *Ophthalmic Res* 2020;63:97–105.
45 Lundberg K, Suhr Thykjaer A, Søgaard Hansen R, *et al*. Physical activity and myopia in Danish children-The CHAMPS eye study. *Acta Ophthalmol* 2018;96:134–41.
46 Quinn GE, Shin CH, Maguire MG, *et al*. Myopia and ambient lighting at night. *Nature* 1999;399:113–4.
47 Czepita D, Gosławski W, Mojsa A, *et al*. Role of light emitted by incandescent or fluorescent lamps in the development of myopia and astigmatism. *Med Sci Monit* 2004;10:CR168–71.
48 Zadnik K, Jones LA, Irvin BC, *et al*. Myopia and ambient night-time lighting. *Nature* 2000;404:143–4.
49 Saw SM, Wu HM, Hong CY, *et al*. Myopia and night lighting in children in Singapore. *Br J Ophthalmol* 2001;85:527–8.
50 Saw S-M, Zhang M-Z, Hong R-Z, *et al*. Near-work activity, night-lights, and myopia in the Singapore-China study. *Arch Ophthalmol* 2002;120:620–7.
51 Saw S-M, Chua W-H, Hong C-Y, *et al*. Nearwork in early-onset myopia. *Invest Ophthalmol Vis Sci* 2002;43:332–9.
52 Ashby R, Ohlendorf A, Schaeffel F. The effect of ambient illuminance on the development of deprivation myopia in chicks. *Invest Ophthalmol Vis Sci* 2009;50:5348–54.
53 Hua W-J, Jin J-X, Wu X-Y, *et al*. Elevated light levels in schools have a protective effect on myopia. *Ophthalmic Physiol Opt* 2015;35:252–62.
54 Zylbermann R, Landau D, Berson D. The influence of study habits on myopia in Jewish teenagers. *J Pediatr Ophthalmol Strabismus* 1993;30:319–22.
55 Zadnik K, Satariano WA, Mutti DO, *et al*. The effect of parental history of myopia on children's eye size. *JAMA* 1994;271:1323–7.
56 Williams C, Miller LL, Gazzard G, *et al*. A comparison of measures of reading and intelligence as risk factors for the development of myopia in a UK cohort of children. *Brit J Ophthalmol* 2008;92:1117–21.
57 Ma Y, Zou H, Lin S, *et al*. Cohort study with 4-year follow-up of myopia and refractive parameters in primary schoolchildren in Baoshan district, Shanghai. *Clin Exp Ophthalmol* 2018;46:861–72.
58 Saw SM*et al*. Eye growth changes in myopic children in Singapore. *Br J Ophthalmol* 2005;89:1489–94.
59 Huang H-M, Chang DS-T, Wu P-C, . The association between near work activities and myopia in Children-A systematic review and meta-analysis. *PLoS One* 2015;10:e0140419.
60 Tsai T-H, Liu Y-L, Ma I-H, *et al*. Evolution of the prevalence of myopia among Taiwanese schoolchildren: a review of survey data from 1983 through 2017. *Ophthalmology* 2021;128:290–301.
61 Lanca C, Saw S-M. The association between digital screen time and myopia: a systematic review. *Ophthalmic Physiol Opt* 2020;40:216–29.
62 Guo JL, Huang XL, FC Y. Epidemiological survey of preschool children with myopia in foshan and the analysis of related factors 2010:1191–2.
63 Zhou Z, Morgan IG, Chen Q, *et al*. Disordered sleep and myopia risk among Chinese children. *PLoS One* 2015;10:e0121796.
64 Zhou R, Zhang W-F, Yang Y. Analysis of myopia prevalence and influencing factors among primary school students in the urban area of Lanzhou City. *International Eye Science* 2014;14:903–7.
65 Jin L-W, Li J-X LZ-H, Li C. Investigation report of myopia and related factors in high school students of Fuxin City. *Int J Ophthalmol* 2010;10:586–7.

66 Jee D, Morgan IG, Kim EC. Inverse relationship between sleep duration and myopia. *Acta Ophthalmol* 2016;94:E204–10.
67 Gong Y, Zhang X, Tian D, *et al*. Parental myopia, near work, hours of sleep and myopia in Chinese children. *Health* 2014;06:64–70.
68 Zhou J, Zhou J, Ma Y. Prevalence of myopia and influencing factors among primary and middle school students in 5 provinces of China. *Chinese Journal of Endemiology* 2016;37:29–34.
69 Xu SJ, Wan YH, Xu ZH, *et al*. [Association between time spent on physical exercise, sleep, homework and suspected myopia among students]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2016;37:183–6.
70 Sensaki S, Sensaki S, Sabanayagam C. Sleep duration in infants was not associated with myopia at 3 years. *Asia Pac J Ophthalmol* 2019;7:102–8.
71 Wei S-F, Li S-M, Liu L, *et al*. Sleep duration, bedtime, and myopia progression in a 4-year follow-up of Chinese children: the Anyang childhood eye study. *Invest Ophthalmol Vis Sci* 2020;61:37.
72 Zhang X. Are Chinese eye exercises ineffective? no. *Fam Sci Health* 2012;9:24–5.
73 Kang M-T, Li S-M, Peng X, *et al*. Chinese eye exercises and myopia development in school age children: a nested case-control study. *Sci Rep* 2016;6:28531.
74 SM L, Kang MT, Peng XX. Efficacy of Chinese eye exercises on reducing accommodative lag in school-aged children: a randomized controlled trial. *Plos One* 2015;10.
75 ZP L, Ouyang MZ, Zhang R. Association between Chinese eye exercises and onset of myopia: a meta-analysis. *Int J Clin Exp Med* 2019;12:4580–8.
76 Sangvatanakul P, Tangthianchaichana J, Tasanarong A. Influence of Chinese eye exercises on myopia control in an East Asian population: a meta-analysis. *medRxiv* 2019;19011270.
77 Gardiner PA. The diet of growing myopes. *Trans Ophthalmol Soc U K* 1956;76:171–80.
78 Cordain L, Eaton SB, Brand Miller J, *et al*. An evolutionary analysis of the aetiology and pathogenesis of juvenile-onset myopia. *Acta Ophthalmol Scand* 2002;80:125–35.
79 Ng FJ, Mackey DA, O'Sullivan TA, *et al*. Is dietary vitamin A associated with myopia from adolescence to young adulthood? *Transl Vis Sci Technol* 2020;9:29.
80 Edwards MH, Leung SSF, WTK L. Do variations in normal nutrition play a role in the development of myopia? *Optom Vis Sci* 1996;73:638–43.
81 Gardiner PA. Dietary treatment of myopia in children. *Lancet* 1958;1:1152–5.
82 Mori K, Torii H, Fujimoto S, *et al*. The effect of dietary supplementation of crocetin for myopia control in children: a randomized clinical trial. *J Clin Med* 2019;8. doi:10.3390/jcm8081179. [Epub ahead of print: 07 08 2019].
83 McKnight CM, Sherwin JC, Yazar S, *et al*. Myopia in young adults is inversely related to an objective marker of ocular sun exposure: the Western Australian Raine cohort study. *Am J Ophthalmol* 2014;158:1079–85.
84 Sherwin JC, Hewitt AW, Coroneo MT, *et al*. The association between time spent outdoors and myopia using a novel biomarker of outdoor light exposure. *Invest Ophthalmol Vis Sci* 2012;53:4363–70.
85 Read SA, Collins MJ, Vincent SJ. Light exposure and physical activity in myopic and emmetropic children. *Optom Vis Sci* 2014;91:330–41.
86 Wen L, Cao Y, Cheng Q, *et al*. Objectively measured near work, outdoor exposure and myopia in children. *Br J Ophthalmol* 2020;104:1542–7.
87 Megaw PL, Morgan IG, Boelen MK. Dopaminergic behaviour in chicken retina and the effect of form deprivation. *Aust N Z J Ophthalmol* 1997;25 Suppl 1:S76–8.
88 Megaw P, Morgan I, Boelen M. Vitreal dihydroxyphenylacetic acid (DOPAC) as an index of retinal dopamine release. *J Neurochem* 2001;76:1636–44.
89 Megaw PL, Boelen MG, Morgan IG, *et al*. Diurnal patterns of dopamine release in chicken retina. *Neurochem Int* 2006;48:17–23.
90 Zhou Z, Chen T, Wang M, *et al*. Pilot study of a novel classroom designed to prevent myopia by increasing children's exposure to outdoor light. *PLoS One* 2017;12:e0181772.
91 Fitzgerald MEC, Wildsoet CF, Reiner A. Temporal relationship of choroidal blood flow and thickness changes during recovery from form deprivation myopia in chicks. *Exp Eye Res* 2002;74:561–70.
92 Dirani M, Tong L, Gazzard G, *et al*. Outdoor activity and myopia in Singapore teenage children. *Br J Ophthalmol* 2009;93:997–1000.
93 Rose KA, Morgan IG, Ip J, *et al*. Outdoor activity reduces the prevalence of myopia in children. *Ophthalmology* 2008;115:1279–85.
94 Williams R, Bakshi S, Ostrin EJ, *et al*. Continuous objective assessment of near work. *Sci Rep* 2019;9:6901.
95 Chew SJ, Chia SC, Lee LK. The pattern of myopia in young Singaporean men. *Singapore Med J* 1988;29:201–11.
96 Tay MT, Au Eong KG, Ng CY, *et al*. Myopia and educational attainment in 421,116 young Singaporean males. *Ann Acad Med Singap* 1992;21:785–91.
97 Au Eong KG, Tay TH, Lim MK. Education and myopia in 110,236 young Singaporean males. *Singapore Med J* 1993;34:489–92.
98 Lin LLK, Shih YF, Hsiao CK. Prevalence of myopia in Taiwanese schoolchildren: 1983 to 2000. *Ann Acad Med Singap* 2004;33:27–33.
99 Goh WSH, Lam CSY. Changes in refractive trends and optical components of Hong Kong Chinese aged 19–39 years. *Oph Phys Optics* 1994;14:378–82.
100 Stone RA, Lin T, Desai D, *et al*. Photoperiod, early post-natal eye growth, and visual deprivation. *Vision Res* 1995;35:1195–202.
101 Li T, Howland HC, Troilo D. Diurnal illumination patterns affect the development of the chick eye. *Vision Res* 2000;40:2387–93.
102 Nickla DL, Wildsoet CF, Troilo D. Endogenous rhythms in axial length and choroidal thickness in chicks: implications for ocular growth regulation. *Invest Ophthalmol Vis Sci* 2001;42:584–8.
103 Kearney S, O'Donoghue L, Pourshahidi LK, *et al*. Myopes have significantly higher serum melatonin concentrations than non-myopes. *Ophthalmic Physiol Opt* 2017;37:557–67.
104 Volkow ND, Tomasi D, Wang G-J, *et al*. Evidence that sleep deprivation downregulates dopamine D2R in ventral striatum in the human brain. *J Neurosci* 2012;32:6711–7.
105 Xiaoxiao W, Jingjing W. Investigation and analysis on health care knowledge attitude and behavior of university students for myopia. *Chinese General Nursing* 2011;25.

Supplemental Table 1. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Time Outdoors and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Time Outdoors Definition	Main Findings	Lost to Follow-up Rate
Myopia Prevention											
Lin, et al. (2016)	China	Cohort	3	6-17	Cycloplegic auto-refraction	SE<−0.5 D		Questionnaire	Baseline outdoor activity (h/d)	Multivariate: 0.15~ : HR=0.39 (0.12, 1.31) 1.02~ : HR=1.28 (0.42, 3.90) 1.64~ : HR=2.34 (0.76, 7.19) 2.50~ 8.66 : Ref	42.5%
Ku, et al. (2018)	Taiwan	Cohort	4	7-12		ICD 367.1		Questionnaire	Frequency of outdoor leisure (session/wk)	<1: n=371, 29.1 % 1-2: n=502, 28.5 % 3-5: n=204, 25.5 % ≥6: n=351, 26.5 %	6.1%
You, et al. (2016)	China	Cohort	1	6-10	Cycloplegic refraction	SE ≤-0.50 D		Questionnaire	Baseline outdoor activity (hours/d)	Multivariate: aOR=1.08 (0.92, 1.27)	31.1%
Ma, et al. (2018)	China	Cohort	2-4	8.1+/-1.1	Cycloplegic autorefraction	SE ≤-0.50 D in the right eye		Questionnaire	time spent outdoors per week: low (<4 h), moderate (≥4 to <9 h) high (≥9 h).	L:37.9% OR=1.12 (0.77-1.64) M:32.9% OR=0.82 (0.57-1.18) H: 41.0% OR=Ref	11.7%
Saw, et al. (2006)	Singapore	Cohort	3	7-9	Cycloplegic autorefraction	SE ≤-0.75D		Questionnaire	hours spent on outdoor games and activities per	RR=1.01 (0.98, 1.04)	2.4%

									week		
Chua, et al. (2015)	Singapore	Cohort	3	3 m	Cycloplegic autorefraction	SE ≤-0.50 D		Questionnaire	Outdoor activities h/d (separately for weekdays and weekends)	Playing time: OR:0.59 (0.32, 1.07) Leisure time: OR=1.00 (0.70, 1.44) Total: OR=0.84 (0.61, 1.17)	14.8%
Zadnik, et al. (2015)	USA	Cohort	1.9-5.4	6-13	Cycloplegic autorefraction	SE ≤-0.75D		Direct measures and parental reports	Time spent outdoors, h/wk	Univariate Analysis Grade1:OR=0.98 (0.97-1.00) Grade3:OR=0.97 (0.95-0.98) Grade6:OR=0.96 (0.94-0.99)	
French, et al. (2013)	Australian	Cohort	5-6	Younger cohort:6 Older cohort:12	Cycloplegic autorefraction	SE ≤-0.50 D		Questionnaire	Spent outdoors per week: younger cohort: low (≤16 h), moderate (>16 ≤23 h), high (>23 h); older cohort: low (≤ 13.5 h), moderate (>13.5≤22.5 h),high (>22.5 h).	Younger Cohort H:Ref M: OR=1.14 (0.59-2.21) L: OR=2.84 (1.56-5.17) Older Cohort H: Ref M: OR=2.00 (1.28-3.14) L: OR=2.15 (1.35-3.42)	
Jones, et al. (2007)	USA	Cohort	Third grade-eighth grade	8.63±0.39	Cycloplegic autorefraction.	SE ≤-0.75D		Questionnaire	Baseline sports/outdoor activity (h/wk)	OR=0.91 (0.87-0.95)	50.5%
Tsai, et al. (2016)	Taiwan	Cohort	1	grade 2	Cycloplegic autorefraction	SE ≤-0.5D		Questionnaire	Baseline outdoor activities after	<30 min/d Ref	7.8%

									school (min/d)	≥30 min/d aHR==0.90 (0.82, 0.99)	
Guggenheim, et al. (2012)	England	Cohort	8	7	Noncycloplegic autorefraction	SE ≤-1.0D		Questionnaire	Time spent outdoors on a weekend day in summer (h/d)	HR=0.76 (0.60, 0.96)	
Guo, et al. (2017)	China	Cohort	4	6.3±0.4 years	Non-cycloplegic state by auto-refractometry	SE ≤-1.0D		Questionnaire	Baseline time spent outdoors(h/d)	Time Spent Outdoors OR=0.62 (0.41, 0.95) Time Spent Outdoors Leisure OR=0.56 (0.37, 0.84)	20.2%
Jones-Jordan et al. (2011)	USA	Cohort	5	6-14	Cycloplegic autorefraction	SE ≤-0.75 D		Questionnaire	Hours per Week spent in outdoor/sports activities	Hours/wk spent in outdoor/sports activities were significantly fewer for children who became myopic 3 years before onset.	
Wu, et al. (2013)	Taiwan	Interventional study	1	7-11	Cycloplegic autorefraction	SE ≤-0.5D	A recess outside the classroom (ROC) program			Intervention group: 16.1%; Control group: 35.7%;	
Shah, et al. (2017)	England	Cohort	13	2	Noncycloplegic autorefraction	SE ≤1.00 D (“likely myopic”)		Questionnaire	Time outdoors on an average day	Age=4.5 HR=0.94(0.83-1.03) Age=5.5 HR=0.91(0.83-0.99) Age=6.5 HR=0.87(0.80-0.95) Age=8.5 HR=0.87(0.80-0.95)	

Wu, et al. (2018)	Taiwan	RCT	1	6.34±0.48	Cycloplegic refraction	SE ≤-0.5D	11 hours or more of outdoor time every 7 days			OR=0.65 (0.42-1.01)	25.5%
He, et al. (2015)	China	RCT	3	6.6±0.34	Cycloplegic refraction	SE ≤-0.5D	40 min class of outdoor activities			Difference=−9.1 (−14.1−4.1)	4.8%
Jin, et al. (2015)	China	RCT	1	6-14	Cycloplegic refraction	SE ≤-0.5D	Two additional 20-min recess programs outside			Intervention group: 3.70 %; Control group: 8.50 %;	
Myopia Control											
Pärssinen et al. (1993)	Finland	Cohort	3	8.8-12.8	Cycloplegic refraction			Questionnaire	Sports and outdoors activity(h/d)	Boys: β=0.23, SE=0.09	7.14%
Pärssinen et al. (2014）	Finland	Cohort	23	8.7-12.8	Cycloplegic auto-refraction			Questionnaire	Sports and outdoor activity(h/d)	P=0.041	39.2%
Sánchez-tocino et al. (2018)	Spain	Cohort	1.5	6-15	Cycloplegic auto-refraction	SE≤-0.5D		Questionnaire	Outdoor leisure and outdoor sport activity(h/d)	OR=0.229(0.084, 0.620)	23.4%
Saxena et al.(2017)	India	Cohort	1	5-15	Cycloplegic auto-refraction	SE≤-0.5D		Questionnaire	Entire time spent outdoors/wk	Multivariate: ≤14:Ref >14:OR=0.54(0.37, 0.79)	3.84%
Hsu et al. (2017)	Taiwan	Cohort	1	7-8	Cycloplegic auto-refraction	SE≤-0.5D		Questionnaire	Time spent playing outdoors	Multivariate: Weekdays:	22.7%

									after school(h/d)	<1,moderate progression OR=0.98(0.79, 1.22); Fast progression OR=1.21(0.95, 1.55) Weekend: <2,moderate progression OR=1.01(0.84, 1.22); Fast progression OR=0.90(0.74, 1.10)	
Jones-jordan et al. (2012)	USA	Cohort	≥1	6-14	Cycloplegic autorefraction	SE<-0.75D		Questionnaire	Outdoor/sports activities (h/w)	Not have significant associations with progression: β=0.03 (99% CI: -0.03 to 0.08)	
Li et al. (2015)	China	Cohort	2	12.7±0.5 (10.9–15.6)	Cycloplegic autorefraction	SE<-0.50D		Questionnaire	Outdoor activity(h/d)	Time outdoors: Middle: β=0.000 (0.018, 0.018); High: β=0.005 (0.024, 0.014)	16.6%
Öner et al. (2015)	Turkey	Cohort	17-55 m	9-14	Cycloplegic autorefraction	-		Interview	Outdoor activity(i.e., Sports,games,or being outdoor with no activities) h/d	β=0.037 (-0.001, 0.002)	
Saw et al. (2000)	Singapore	Cohort	13-40 m	6-12	Cycloplegic autorefraction	-		Questionnaire	Outdoor Activities (number of h/wk of outdoor activity)	Hours/wk of outdoor activities: β=0.013 (-0.013, 0.04)	

Scheiman et al. (2014)	USA	Cohort	11	6–11	Non-cycloplegic refractions	-		Questionnaire	Baseline outdoor Activity (h/wk): ≤9.0 & >9.0 h/wk; Mean h/wk	Stabilisation status by age 15 Baseline outdoor Activity (h/wk)≤9.0: References; Baseline outdoor Activity (h/wk)>9.0: OR=0.93 (0.53, 1.65); Mean h/wk: β=1.02 (0.99, 1.06)	50.3%
Wu et al. (2013)	Taiwan	NRCT	1	7-11	Cycloplegic autorefraction	SE≤-0.5D	80-Minute time outdoors			ROC program (yes vs. No) β=0.12 (0.06, 0.31)	
Yi et al. (2011)	China	RCT	2	7-11	Cycloplegic retinoscopy	-	More outdoor activities than 14-15 hrs per week			Control group: 0.52±0.19 D/yrs; Intervention group: 0.38±0.15 D/yrs; Multivariate: β=-0.517,P<0.001	17.5%
Li et al. (2019)	China	RCT	1	7-13	Cycloplegic autorefraction	SE≤-0.75	11-hours additional outdoor time			Diopter changes: intervention group: -0.20±0.18 D/yrs; control group: -0.68±0.21 D/yrs; P<0.001 Eye axis changes: intervention group: 0.13±0.12 D/yrs; control group: 0.38±0.13 D/yrs; P<0.001	
Wu et al. (2018)	Taiwan	RCT	1	6.34±0.48	Cycloplegic autorefraction	SE≤-0.5D	11 hours or more of outdoor time every 7 days			Changes from baseline SER(D): Estimated difference: 0.23 (0.06, 0.39) Changes from baseline AXL(mm):	25.5%

	Estimated difference: -0.15 (-0.28, -0.02)

Supplemental Table 2. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Physical Activity and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Physical Activity Definition	Main Findings	Lost to follow-up rate
Myopia prevention											
Guggenheim et al. (2018)	England	Cohort	4	11	Noncycloplegic autorefraction	SE ≤−1.00 D		Actigraph accelerometer	Mean counts/ min/wk; Moderate to vigorous Activity (MVPA); Sedentary;	Cox model: Mean counts/min/wk: HR=0.877 (0.772, 0.996); Time with MVPA: HR=0.868 (0.764, 0.987); Time with sedentary: HR=1.106 (0.978, 1.250);	
Guo et al. (2017)	China	Cohort	4	6.3±0.4	Noncycloplegic auto-refraction	SE ≤−1.00 D		Questionnaire	The average number of h/d on outdoors sports	P=0.87	20.16%
Lundberg et al. (2018)	Denmark	Cohort	7	9.7±0.7	Cycloplegic autorefraction	SE ≤ -0.50 D		ActiGraph accelerometer	Sedentary activity Light physical activity Moderate physical activity Vigorous physical activity	Sedentary activity OR=1.02 (0.47, 2.21); Light physical activity OR=0.92 (0.45, 1.86); Moderate physical activity OR=0.83 (0.32, 2.15); Vigorous physical activity OR=0.62 (0.25, 1.58);	

Myopia control

H.Sánchez-Tocinoa (2019)	Spain	Cohort study	1.5	10.3±2.3	Cycloplegic autorefraction	SE ≤ -0.50 D	Questionnaire	The number of h/d on sporting activities	OR=0.428 (0.189, 0.971);

Supplemental Table 3. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Light Exposure and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Light Exposure Definition	Main Findings	Lost to follow-up rate
Night light exposure											
Myopia prevention											
Saw et al. (2006)	Singapore	Cohort	3	7-9	Cycloplegic autorefraction	SE ≤-0.75 D		Questionnaire	Night lighting before 2 years of age	Night lighting before 2 years of age was not associated with incident myopia.	2.4%
Indoor light exposure											
Myopia prevention											
You et al.(2016)	China	Cohort	1	6-10	Cycloplegic autorefraction	SE≤-0.50 D		Questionnaire	Adequate lighting environment when reading and writing	aOR=0.86 (0.73, 1.02)	
Hua et al. (2015)	China	NRCT	1	6-14	Cycloplegic refraction	SE≤-0.50 D	Rebuilt elevated lighting systems in classrooms			Intervention group: 4%; Control group: 10%;	13.6%
Myopia control											

Hua et al. (2015)	China	NRCT	1	6-14	Cycloplegic refraction	SE≤-0.50 D	Rebuilt elevated lighting systems in classrooms	SE progression: Intervention group: -0.25±0.47; Control group: -0.31±0.46 D. AL progression: Intervention group: 0.20±0.11; Control group: 0.27±0.10 mm.	13.6%

Supplemental Table 4. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Near Work and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Near Work Definition	Main Findings	Lost to follow-up rate
Myopia prevention											
French et al. (2013)	Australia	Cohort	5-6	6-12	Cycloplegic autorefraction	SE≤ -0.50 D		Questionnaire	Diopter hours of near work/wk Younger cohort: low (<13 h), moderate (>13-<19.5 h), and high (>19.5 h); Older cohort: low (<17 h), moderate (>17-<25.5 h), and high (>25.5 h))	Younger cohort: Low: Ref; Moderate: OR=1.68 (0.89, 3.16); High: OR=2.35 (1.30, 4.27); Older cohort: Low: Ref; Moderate: OR=1.43 (0.93, 2.21); High: OR=1.31 (0.83, 2.06);	
Lin, et al. (2016)	China	Cohort	3	6-17	Cycloplegic auto-refraction	SE<−0.5 D		Questionnaire	Near work hours/wk	Near work: 0.35~: Ref; 2.93~: HR=4.08 (1.39, 11.94); 3.79~: HR=3.85 (1.13, 13.10); 4.86~10.29: HR=5.19(1.49,18.13);	42.5%
Guo, et al. (2017)	China	Cohort	4	6.3±0.4	Non-cycloplegic state by auto-	SE≤-1.0D		Questionnaire	Time spent indoors/wk	Univariate: Studying:OR=1.38(1.02,1.86); Watching:OR=0.61(0.44,0.86);	20.2%

					refractometry					Multivariate: Studying: n.s. Watching: n.s.	
Williams et al. (2008)	UK	Cohort	3	7 years	Non-cycloplegic autorefraction	SE≤ -1.50 D	-	Questionnaire	Parental report of reading habit	Does not like: Ref; Quite likes: OR=3.17 (0.98, 10.27); Likes a lot: OR=4.05(1.27,12.89);	
Tsai et al. (2016)	Taiwan	Cohort	1	grade 2	Cycloplegic autorefraction	SE≤-0.5D		Questionnaire	Time spent on near work/d; Distance in doing near work	Time spent on near work: <2 h/d: Ref; ≥2 h/d: HR=1.06(0.97, 1.16); Distance in doing near work: ≥30cm:Ref; <30 cm: HR=1.01 (0.91, 1.11);	7.8%
Guggenheim, et al. (2012)	UK	Cohort	8	7	Noncycloplegic autorefraction	SE≤-1.0D		Questionnaire	Time reading	Low/high: OR=1.213 (0.957, 1.538);	
You, et al. (2016)	China	Cohort	1	6-10	Cycloplegic refraction	SE≤-0.50 D		Questionnaire	Time spent on near work	OR=1.05 (0.96, 1.16);	31.1%
Ma, et al. (2018)	China	Cohort	2-4	8.1+/-1.1	Cycloplegic autorefraction	SE≤-0.50 D in the right eye		Questionnaire	Time spent in near work/wk: Low (≤26.5 h), Moderate (≥27 to <37.4 h) High (≥37.5 h);	Near work: L: Ref M: OR=1.18 (0.81-1.72); H: OR=1.11 (0.75-1.63);	11.7%

Jones-Jordan et al. (2011)	USA	Cohort	5	6-14	Cycloplegic autorefraction	SE≤-0.75 D	Questionnaire	H/wk spent reading	H/wk spent reading did not differ between the groups before myopia onset; H/wk spent reading were significantly greater in myopes than in emmetropes at onset and in 4 of the 5 years after onset	
Chua, et al. (2015)	Singapore	Cohort	3	3 m	Cycloplegic autorefraction	SE≤-0.50 D	Questionnaire	Near-work activities, h/d	Reading or writing: OR=1.26(0.80,1.98); Coloring or drawing: OR=0.71(0.28,1.78); Handheld devices: OR=1.04(0.67,1.61); Computer: OR=0.92(0.31,2.74); Total: OR=1.03(0.81,1.31);	14.8%
Saw, et al. (2006)	Singapore	Cohort	3	7-9	Cycloplegic autorefraction	SE≤-0.75D	Questionnaire	Books Read/wk	RR=1.01 (0.97, 1.05);	2.4%
Jones, et al. (2007)	USA	Cohort	Third grade-eighth grade	8.63±0.39	Cycloplegic autorefraction.	SE≤-0.75D	Questionnaire	Reading; Studying; Diopter h/wk	Reading: OR=1.04 (0.99, 1.10); Studying: OR=0.98 (0.93-1.04); Diopter h/wk: OR=1.00(0.99-1.01)	50.5%
Ku, et al. (2018)	Taiwan	Cohort	4	7-12		ICD 367.1	Questionnaire	Reading h/d	Reading (h/d): <0.5: Ref; 0.5-0.9 h/d: HR=1.30 (1.01, 1.67);	6.1%

										≥1:HR=1.10 (0.85, 1.42);	
Myopia control											
Saw et al. (2000)	Singapore	Cohort	13-40 m	6-12	Cycloplegic Autorefraction	-		Questionnaire	Raw total near work h/d on school weekday; Weighted time on near work h/d; Raw total reading and writing h/d on school weekday; Weighted time on total reading and writing h/d; Distance of eye from book while reading or writing	Raw total near work on weekday: β=0.023 (-0.18, 0.063); Weighted time on near work: β=0.013 (-0.023, 0.048); Raw total reading and writing on weekday: β=0.028 (-0.027, 0.083); Weighted time on total reading and writing: β=0.043 (-0.020, 0.11); Distance of eye: β=0.0087 (-0.0043, 0.022);	
Saw et al. (2005)	Singapore	Cohort	3	7-9	Cycloplegic refraction	SE≤-0.50 D		Questionnaire	Books read/wk	2 or less: Ref; >2: β=0.01 (-0.08 to 0.10), P=0.80	18.3%
Jones-Jordan et al. (2012)	USA	Cohort	≥1	6-14	Cycloplegic Autorefraction	SE<-0.75D		Questionnaire	Reading for pleasure; Studying; Diopter-hours	Reading for pleasure: β=-0.07 (-0.14, 0.003); Studying: β=0.004 (-0.06, 0.07); Diopter-hours: β=-0.007 (-0.02, 0.004)	

Sánchez-Tocino et al.(2018)	Spain	Cohort	1.5	6-15	Cycloplegic auto-refraction	SE≤-0.5D	Questionnaire	Close work (h/d)	OR=0.783 (0.4335-1.409);	23.4%
Scheiman et al (2014)	USA	Cohort	11	6–11	Non-cycloplegic refractions	-	Questionnaire	Baseline Near Work (h/d); Mean h/wk	≤21.0: Ref; >21.0: OR=0.74 (0.43, 1.29); Mean h/wk: β=0.98 (0.96,1.00)	50.3%
Pärssinen et al.(1993)	Finland	Cohort	3	8.8-12.8	Cycloplegic refraction		Questionnaire	Close work (h/day)	Boys: β=-0.16, SE=0.09, P>0.05; Girls: β=-0.18, SE=0.08, P<0.05	7.14%
Pärssinen et al. (2014）	Finland	Cohort	23	8.7-12.8	Cycloplegic Auto-refraction		Questionnaire	Reading and close work time	Time spent on reading and close work was related to myopic progression during the first 3 years.	39.2%
Saxena et al. (2017)	India	Cohort	1	5-15	Cycloplegic auto-refraction	SE≤-0.5D	Questionnaire	Reading/writing h/wk	Multivariate: 28–35:Ref 36–42:OR=1.62 (0.98, 2.67); >42:OR=2.10(1.24, 3.56);	3.84%
Öner et al. (2015)	Turkey	Cohort	17-55 m	9-14	Cycloplegic autorefraction	-	Interview	Reading and writing (h/d)	β=-0.379 (-0.002, 0.000);	
Hsu et al. (2017)	Taiwan	Cohort	1	7-8	Cycloplegic auto-refraction	SE≤-0.5D	Questionnaire	Age when starting near work; Time spent on near work daily;	Multivariate: Age starting near work<6 years,moderate progression: OR=1.00 (0.76, 1.33);	22.7%

Distance from near work; 10-min rest period after 30min of near work	fast progression: OR=0.81 (0.61, 1.08); Time spent on near work daily: ≥2 hours,moderate progression: OR=0.94 (0.78, 1.12); fast progression: OR=1.17 (0.97, 1.42); Distance from near work <30 cm,moderate progression: OR=1.13 (0.93, 1.37); fast progression: OR=1.45 (1.18, 1.78); 10min rest period after 30min of near work:moderate progression: OR=0.95 (0.78, 1.17); fast progression: OR=1.07 (0.86, 1.32);

Supplemental Table 5. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Screen Time and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Screen Time Definition	Main Findings	Lost to follow-up rate
Myopia prevention											
Ku et al. (2018)	Taiwan	Cohort	4	7-12		ICD 367.1		Questionnaire	Hours spent on computer/internet/ video game, TV watching.	Computer/Internet/Video game (h/d): <0.5: Ref; 0.5~0.9: HR=1.00 (0.76, 1.31); ≥1: HR=1.14 (0.89-1.48); TV watching (h/d): <2: 403 (27.8%); 2.0-2.9: 384 (30.0%); ≥3: 614 (26.4%); P=0.473	6.1%
Jones et al. (2007)	USA	Cohort	Third grade-eighth grade	8.63±0.39	Cycloplegic autorefraction.	SE ≤-0.75D		Questionnaire	Hours spent in watching TV; computer/video games	Hours of watching TV: OR=0.97 (0.93-1.01); Hours of computer/video games: OR=1.01 (0.94-1.09);	50.5%
Saw, et al (2006)	Singapore	Cohort	3	7-9	Cycloplegic autorefraction	SE ≤-0.75D		Questionnaire	Hours/d spent in computer use, playing video games, watching television.	Computer use: RR=0.94 (0.77,1.15); Playing video games: RR=0.94 (0.80,1.09); Watching television per day: RR=0.96 (0.87,1.06)	2.4%
Jones-Jo	USA	Cohort	5	6-14	Cycloplegic	SE ≤-0.75 D		Questionnaire	Hours spent in	Reading or using a	

rdan et al. (2011)					autorefraction			front of screen	computer/playing video games/TV watching time did not differ between the groups before myopia onset;	
Guo, et al. (2017)	China	Cohort	4	6.3±0.4	Non-Cycloplegic autorefraction	SE ≤-1.0D	Questionnaire	Watching time	Univariate: OR=0.61 (0.44-0.86); Multivariate: n.s.	20.2%
Myopia control										
Öner et al. (2015)	Turkey	Cohort	17-55 m	9-14	Cycloplegic autorefraction	-	Interview	Watching/on computer use	Multivariate Time spent on computer use(h/d): β=-0.089 (-0.001 to 0.001); Time spent on watching TV(h/d): β==0.027, (-0.001, 0.002);	
Jones-Jordan et al. (2012)	USA	Cohort	≥1	6-14	Cycloplegic autorefraction	SE<-0.75D	Questionnaire	Watching TV/playing computer/video games	Computer/video games: β=-0.05, 99% CI (-0.13, 0.04); TV: β=-0.006, 99% CI (-0.05, 0.04);	
Sánchez-Tocino et al.(2018)	Spain	Cohort	1.5	6-15	Cycloplegic autorefraction	SE≤-0.5D	Questionnaire	TV/computer	Multivariate: OR=0.845 (0.449, 1.589);	23.4%
Saxena et al. (2017)	India	Cohort	1	5-15	Cycloplegic autorefraction	SE≤-0.5D	Questionnaire	Watching television and using computers and video games	Multivariate: Watching TV: ≤14: Ref (15-21):OR=1.0 (0.57, 1.71);	3.84%

(≥22h):OR=1.6 (0.92, 2.83); Computers and video games: ≤4: Ref; (4-7h):OR=1.89(1.42, 2.49); (>7h):OR=3.53(2.51, 4.95);

Supplemental Table 6. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Chinese Eye Exercises and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Chinese Eye Exercise Exposure Definition	Main Findings	Lost to follow-up rate
Myopia prevention											
You et al. (2016)	China	Cohort	1	6-10	Cycloplegic refraction	SE ≤-0.50 D		Questionnaire	Doing eye exercises in the right way	Multivariate aOR=0.89 (0.76, 1.04)	31.1%
Kang et al. (2016)	China	Nested case-control	2	12.7 ± 0.5	Cycloplegic refraction	SE ≤−0.50 D		Questionnaire	Eye exercises users; High quality of eye exercise	Multivariate Non-users: Ref; Eye exercises users: OR=1.35 (0.52, 2.56); Doing high quality eye exercises in the myopia onset case group was less than in the control group (5.6% vs. 26.2%)	
Myopia control											
Kang et al. (2016)	China	Nested case-control	2	12.7 ± 0.5	Cycloplegic refraction	SE ≤−0.50 D		Questionnaire	Eye exercises users; High quality of eye exercise	Multivariate Non-users: Ref; Eye exercises users: OR=0.64 (0.27-1.47);	

			Doing high quality exercises had a slightly lower myopia progression of 0.15 D than the children who did not perform the exercise over 2 years.

Supplemental Table 7. A Summary of Results From Previous Longitudinal Studies Investigating the Relationship between Diet, Sleep, and Myopia.

Author (Year)	Study Location	Study Design	Follow-Up (Yrs)	Age at Baseline	Cycloplegia	Myopia Definition	Intervention	Information	Exposure Definition	Main Findings	Lost to follow-up rate
Diet											
Myopia prevention											
Fletcher J. Ng et al. (2020)	Australia	Cohort	6	14	Cycloplegic refraction	SE < -0.50 D		Questionnaire	Total daily dietary vitamin A intake.	Multivariable: Adequate vitamin A: OR=1.569(0.975, 2.524)	
You, et al. (2016)	China	Cohort	1	6-10	Cycloplegic refraction	SE ≤-0.50 D		Questionnaire	Keeping a balanced diet	Multivariable: aOR=1.04 (0.93, 1.16)	31.1%
Edwards et al. (1996)	Hong Kong, China	Cohort	3	7	Noncycloplegic retinoscopy	SE ≤-0.50 D		Questionnaire	Protein, fat, carbohydrate, vitamin A,B1,B2,B3,C,D, calcium, phosphorus, iron, zinc, dietary fiber, cholesterol intake.	Incident myopes tended to have a generally lower food intake than control group; Incident myopes had a significantly lower intake of protein, fat, cholesterol vitamin B1, vitamin B2, vitamin C, phosphorus and iron than control group subjects.	

Myopia control											
Gardiner et al.(1958)	UK	NRCT	1	⩾5			Taking 10% of one's calorie intake as animal protein			Those in treatment group most assiduously tended to deteriorate more slowly than their more casual fellows.	
Mori et al. (2019)	Japan	RCT	24 wk	6-12	Cycloplegic refraction		Crocetin (7.5 mg of crocetin and safflower oil)			Change in SER Crocetin:−0.33 ± 0.05 D Placebo: −0.41 ± 0.05 D (p = 0.049). AL elongation Crocetin:0.18 ± 0.02 mm Placebo: 0.21 ± 0.02 mm (p = 0.046).	2.9%
Sleep											
Myopia prevention											
Sensaki et al. (2018)	Singapore	Cohort	3	3	Cycloplegic autorefraction	SE<-0.5D		Questionnaire	Total sleep	Total sleep duration and number of night wakings were not associated with myopia in a multivariate model.	32.3%
Wei et al. (2020)	China	Cohort	4	7.09±0.41	Cycloplegic autorefraction	SE<-0.5D		Questionnaire	Night-time Sleep duration (h/d)	≤9.56: Ref; 9.57-10.00: OR=1.012 (0.769, 1.333); ≥10.01: OR=0.944 (0.711, 1.253);	19.5%

Supplemental Table 8. Risk of Bias Assessment of Nonrandomized Studies Using the Newcastle-Ottawa Scale (NOS).

First author	**Quality evaluation**	**Representativeness of exposed cohort**	**Selection of non exposed cohort**	**Ascertainment of exposure**	**Outcome not present before study**	**Comparability**	**Assessment of outcome**	**Follow-up long enough**	**Non-response rate**
Lin, et al. (2016)	7	1	1	1	1	1	1	1	0
Ku, et al. (2018)	8	1	1	1	1	1	1	1	1
You, et al. (2016)	6	1	1	1	1	1	1	0	0
Ma, et al. (2018)	8	1	1	1	1	1	1	1	1
Saw, et al. (2006)	8	1	1	1	1	1	1	1	1
Chua, et al. (2015)	8	1	1	1	1	1	1	1	1
Zadnik, et al. (2015)	7	1	1	1	1	1	1	1	0
Jones, et al. (2007)	7	1	1	1	1	1	1	1	0
Tsai, et al. (2016)	7	1	1	1	1	1	1	0	1
Guggenheim, et al.	7	1	1	1	1	1	1	1	0

(2012)									
Jones-Jordan et al. (2011)	6	1	1	1	1	0	1	1	0
Shah, et al. (2017)	7	1	1	1	1	1	1	1	0
Pärssinen et al. (1993)	8	1	1	1	1	1	1	1	1
Pärssinen et al. (2014）	7	1	1	1	1	1	1	1	0
Hsu et al. (2017)	6	1	1	1	1	1	1	0	0
Jones-jordan et al. (2012)	7	1	1	1	1	1	1	1	0
Li et al. (2015)	7	1	1	1	1	1	1	0	1
Öner et al. (2015)	5	0	0	1	1	1	1	1	0
Saw et al. (2000)	5	0	0	1	1	1	1	1	0
Scheiman et al. (2014)	7	1	1	1	1	1	1	1	0

French et al. (2013)	7	1	1	1	1	1	1	1	0
Guo, et al. (2017)	8	1	1	1	1	1	1	1	1
Wei et al. (2020)	7	1	1	0	1	1	1	1	1
Sensaki et al. (2018)	6	0	1	1	1	1	1	1	0
Gardiner et al.(1958)	4	0	0	1	1	0	1	0	1
Edwards et al. (1996)	5	0	1	1	1	0	1	1	0
Fletcher J. Ng et al. (2020	7	1	1	1	1	1	1	1	0
Saxena et al. (2017)	7	1	1	1	1	1	1	0	1
Sánchez-Tocino et al.(2018)	5	0	1	1	1	1	1	0	0
Saw et al. (2005)	8	1	1	1	1	1	1	1	1
Williams	7	1	1	1	1	1	1	1	0

et al. (2008)									
Hua et al. (2015)	7	1	1	1	1	1	1	0	1
Lundberg et al. (2018)	7	1	1	1	1	1	1	1	0
Wu et al. (2013)	6	1	1	1	1	1	1	0	0
First author	**Quality evaluation**	**Case definition**	**representativeness**	**Selection of controls**	**Definition of controls**	**comparability**	**Ascertainment of exposures**	**Same method?**	**Non-response rates**
Kang et al. (2016)	7	1	1	1	1	1	1	1	0

Supplemental Table 9. Risk of Bias Assessment of Randomized Controlled Trials Using the Cochrane Risk Of Bias 2 Tool.

	Randomization	Assignment to Intervention	Adhering to Intervention	Missing Outcome Data	Measurement of the Outcome	Selection of Reported Results	Overall
Wu, et al. (2018)	Low	Low	Low	Low	Low	Low	Low
He, et al. (2015)	Low	Low	Low	Low	Low	Low	Low
Jin, et al. (2015)	Some concerns	Some concerns	Low	Low	Low	Low	Some concerns
Mori et al. (2019)	Low	Low	Low	Low	Low	Low	Low
Li et al. (2019)	High	High	Low	Some concerns	Low	Some concerns	High
Yi et al. (2011)	Low	high	high	low	low	low	High