Protective behaviours of near work and time outdoors in myopia prevalence and progression in myopic children: a 2-year prospective population study

Pin-Chen Huang,[1,2] Ya-Chuan Hsiao,[3,4] Ching-Yao Tsai,[3,4,5] Der-Chong Tsai ,[4,5,6] Chi-Wen Chen,[7] Chih-Chien Hsu ,[4,8] Shier-Chieg Huang,[1] Meng-Hui Lin,[9] Yiing-Mei Liou [1,10]

For numbered affiliations see end of article.

Correspondence to
Professor Yiing-Mei Liou, Institute of Community Health Care, School of Nursing, National Yang-Ming University, Taipei 11221, Taiwan; ymliou@ym.edu.tw

P-CH and Y-CH contributed equally.

Received 24 February 2019
Revised 7 September 2019
Accepted 29 September 2019
Published Online First 15 October 2019

ABSTRACT

Aim To investigate the protective behaviours of longer near work distance, discontinuing near work and more time outdoors in recess from parent self-report in the myopia prevalence and progression among myopic children aged 9–11 years.

Methods Myopia Investigation study in Taipei is a longitudinal population-based study that enrolled elementary school students in Taipei. We provided vision and refraction examination every 6 months. Spherical equivalent (SE) of cycloplegic refraction ≤−0.50 Diopter (D) is defined as myopia. Total 10 743 (70.4%) students completed 2-year refraction data and questionnaire. The myopia prevalence and progression (difference of SE) in baseline, 6, 12, 18 and 24 months were compared by generalised estimating equations.

Results Children with persistent protective behaviour had significant lower prevalence of myopia. The protective impact was statistically significant from 6 to 24 months. In 2 years follow-up, risk ratio after adjusting the background variables and the other two behaviours in near work distance, near work time and outdoor time were 0.71, 0.89 and 0.77. In SE analysis, after adjusting the other two behaviours, near work distance >30 cm (−0.7 vs −1.04 D; p<0.001), discontinuing near work every 30 min (−0.77 vs −0.96 D, p=0.005) and more time outdoors in recess from parent self-report (−0.75 vs −0.98 D; p=0.012) revealed protective impacts on diminishing myopia progression from 6 to 24 months.

Conclusion In myopic children aged around 10 years in Taipei, longer distance in near work, discontinuing near work every 30 min and more outdoor time from parent self-report are protective behaviours in myopia prevalence and progression in 6–24 months.

To cite: Huang P-C, Hsiao Y-C, Tsai C-Y, *et al*. *Br J Ophthalmol* 2020;**104**:956–961.

INTRODUCTION

The epidemic of myopia is a global public-health crisis in modern society. With increasing urbanisation and lifestyle changes worldwide, there will be half of the world population, which is 4758 million people with myopia by the year 2050; and 938 million people with high myopia.[1] In the East Asia country, prevalence of myopia has almost doubled over the last 40 years. East Asians show the highest prevalence with over 90% of East Asians living in Singapore and 72% of East Asians living in China aged 18 years exhibiting myopia.[2] Myopia is a group of disease presentation as spherical error of refraction caused by elongation of the eyeball or overaccommodation. In myopic eye, the focus of a distant object is in front of the retina.[3] Experimental studies reported that the hyperopic defocus induced by accommodative lag during near work powerfully stimulates eye growth and cause elongation of axial length, which is noted in myopic eyes.[3] Complications from pathological myopia are the leading cause of visual impairment and blindness, especially in Asia, including macular choroidal neovascularisation retinal detachment and glaucoma.[4] High myopia affects up to 20% of high school children in East Asia,[5] so intervention and strategies to prevent myopia progression is challenging but important. Shorter reading distance (25,[6] 30,[7 8] 33,[9] 45[10] cm) has been considered as major environmental risk factors for myopia incidence and progression. In elementary school students, fast progression was associated with greater myopic spherical equivalent (SE) at baseline, a shorter reading distance and continuous reading without break in every 30 min.[7] More time spend in near work is highly associated with OR of myopia.[11–13] One systemic review report showed that the odds of myopia increased by 2% (risk ratio (RR): 1.02; 95% CI 1.01 to 1.03) for every 1 Diopter (D)-hour [14] more of near work per week.[14] But some studies were still inconclusive for the protective effect of distance and time on near work for myopia.[15 16] Recent reports showed children who spent more time outdoors had a lower myopia incidence.[17–25] More time spent outdoors was reported to be associated with inhibition of eyeball elongation in children thus causing inhibition of myopia.[8] In animal study, the protective effect seems to be partly mediated by the stimulatory effect of light on retinal dopamine production and release, but the pathophysiology and dose-response function were still inconclusive.

The purpose is to compare the impact of three protective behaviours on myopia progression among children aged 9–11 years and to investigate the

trend analysis of time period in a longitudinal, large population-based study in Taiwan.

MATERIALS AND METHODS

Design and subjects

The Myopia Investigation study in Taipei (MIT study) is a population-based cohort study that enrolled almost all elementary school students in Taipei City since 2013. We provided free vision and cycloplegic refraction examination every 6 months and multiple interventions for at least 3 years. The study design, rationale and methods of the MIT have been published in 2015.[25] All eligible children with parental consent received standard examinations at an MIT-associated medical facility. This cohort was from students who received their first evaluation in June 2015, when they were grade 2 students. The less hyperopic eye was collected for study. We analysed the 2-year progression (until October 2017) among more myopic eyes, focusing on protective effectiveness of myopia progression between reading behaviours and outdoor time.

Refraction assessment and questionnaire

For myopia prevalence, myopia was defined as an SE of cycloplegic refraction ≤ −0.50 D. The more myopic eye in each student was included for analysis. The MIT parent questionnaire regarding potential myopia risk factors was composed of 42 questions, and parents answered the questionnaire each year before vision examination.[20] Questions included the average time spent on near work each day, the distance from objects when doing near work, with/without a break when doing near work over 30 min. Questions about outdoor behaviour were the average time spent playing outdoors in school recess on weekdays. From parents' answers, children were divided into two groups: never/seldom do outdoor activities and usually do outdoors during recess in weekday. The three results of questionnaire and five cycloplegic refraction each 6 months in 2 years of each child were analysed to see the effectiveness of the protective behaviour of myopia progression. According to the answers from their parent's observation in 2-year follow-up, children were divided into two groups as persistent in protective group and persistent in risk group. Children who had behaviour change during the follow-up period were excluded. Children in protective group indicated children maintained studying behaviours of more distance when doing near work, discontinuing near work time every half an hour and more outdoor activity in recess in 2 years. On the other hand, children in risk group indicated that they had risk factors of myopia—shorter distance and continuing near work time, and less outdoor activity.

Statistical analysis

We collected data from a population-based 2-year study since May 2015 until December 2017. The known associated risk factors of myopia progression including gender, parental high myopia and myopia treatment were analysed and are listed in table 1, online supplementary file 1. Children were divided into two groups according to their myopia-associated behaviour reported from parental questionnaire. A generalised estimating equation (GEE) is a statistical method used for estimating the parameters of a generalised linear model with a possible unknown correlation between outcomes. We used a multinomial logistic regression model to investigate the association between myopia progression and different impact of protective behaviours. We compared the myopia prevalence, myopia progression (difference of spherical equivalent) of two groups in baseline, 6, 12, 18 and 24 months (T1, T2, T3, T4, T5) by linear regression using GEE to investigate the quantitative effectiveness of maintenance of protective behaviour including longer near work distance, discontinuing during near work and more outdoor activity. The standard coefficient beta, their 95% CI value and two-tailed p values were calculated. Statistical analysis was performed using SPSS software (V.24). P values <0.05 were considered statistically significant.

RESULTS

Of the 19 439 eligible students in Taipei in 2015, 15 250 children provided informed consent from their parents and received 2-year follow-up. Among them, 198 (1.3%) students were excluded for under orthokeratology treatment. Total

Table 1 Demographics, refraction status and myopia prevalence of children

		T1		T2		T3		T4		T5		
		SE	Myopia	SE	Myopia	SE	Myopia	SE	Myopia	SE	Myopia	
	n (%)	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	P value
All students*	15 052	−0.23±1.24	34.05	−0.46±1.32	42.37	−0.65±1.44	48.50	−0.84±1.52	54.29	−1.01±1.59	58.30	–
Study sample	10 743	−0.22±1.21	33.72	−0.45±1.29	42.10	−0.65±1.41	48.26	−0.82±1.49	54.03	−0.99±1.57	57.90	–
Gender												
Female	5078 (47.26)	−0.15±1.22	31.49	−0.39±1.29	40.36	−0.60±1.40	47.69	−0.78±1.47	53.70	−0.95±1.56	57.19	<0.001
Male	5665 (52.73)	−0.27±1.19	35.72	−0.51±1.29	43.63	−0.69±1.41	48.78	−0.86±1.5	54.32	−1.03±1.58	58.54	
Paternal high myopia												
None	8280 (77.07)	−0.14±1.17	31.25	−0.36±1.25	39.21	−0.55±1.37	45.49	−0.72±1.44	50.99	−0.88±1.51	55.03	<0.001
High myopic	2177 (20.26)	−0.49±1.30	43.23	−0.79±1.39	53.24	−1.01±1.50	59.20	−1.23±1.58	65.56	−1.46±1.72	69.19	
Maternal high myopia												
None	7832 (72.90)	−0.11±1.14	30.74	−0.34±1.22	38.65	−0.51±1.33	44.20	−0.70±1.41	50.10	−0.85±1.48	54.04	<0.001
High myopic	2644 (24.61)	−0.52±1.35	42.87	−0.78±1.43	52.47	−1.04±1.57	60.09	−1.20±1.65	65.09	−1.41±1.76	68.79	
Myopia treatment												
No	1684 (15.67)	−0.30±1.26	37.37	−0.52±1.33	44.72	−0.72±1.43	51.30	−0.90±1.51	57.49	−1.08±1.59	62.11	*<0.001*
Yes	9011 (83.87)	0.21±0.75	14.98	−0.04±0.92	25.33	−0.15±1.08	26.35	−0.30±1.19	28.47	−0.39±1.28	27.56	

Following time: T1=July–October 2015, T2=January–May 2016, T3=July–October 2016, T4=January–May 2017, T5=July–October 2017.
The demographics, changes of refraction status and myopia prevalence of children aged 9–11 years in Myopia Investigation study in Taipei. The mean SE at baseline was −0.22 D, and SEs were −0.45, −0.65, −0.82 and −0.99 at 6, 12, 18 and 24 months follow-up, respectivel. The comparisons of SE showed significant difference between subgroups: students with/without family history of high myopia and with/without myopia treatment.
*All students underwent cycloplegic refraction examination when they were included in the programme in 2014. Students using orthokeratology were excluded.
SE, spherical equivalent.

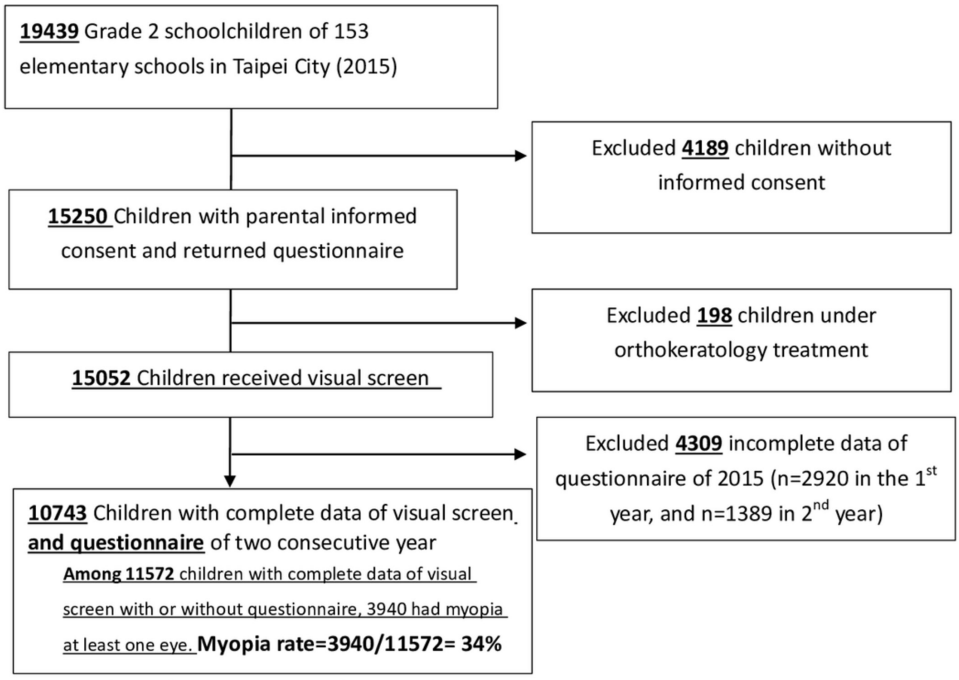

Figure 1 Flow chart of ascertainment of Myopia Investigation study in Taipei, Out of 19 439 students aged round 10 years in Taipei in 2015, 15 250 children provided informed consent from their parents and received 2-year follow-up of myopia control. One hundred ninety-eight (1.3%) students were excluded for under orthokeratology treatment. Total 10 743 (70.4%) students with complete 2-year data were recruited in cohort 2.

10 743 (70.4%) students, including myopic and non-myopic children with complete 2-year data were recruited in figure 1. The demographics, refraction and myopia prevalence of children are listed in table 1. The baseline mean SE was −0.22 D, and SEs were –0.45, –0.65, −0.82 and −0.99 at 6, 12, 18 and 24 months follow-up, respectively. The majority of myopic children received myopia treatment with treatment rate of 37.4%, 44.7%, 51.3%, 57.5% and 62.1%, respectively. Children with persistent protective behaviour had significant lower prevalence rate, and the RRs were near work distance as 0.70 (95% CI 0.62 to 0.80), discontinuing near work as 0.77 (95% CI 0.68 to 0.88) and time spent outdoors as 0.78 (95% CI 0.67 to 0.91), respectively (table 2). Three factors showed effects on myopia prevention. Longer near work distance, discontinuing near work and more outdoor activity showed statistically significant difference on myopia prevalence in 6-month follow-up, after adjusting the gender, and parental high myopia. The difference was still significant after adjusting the other two correlation behaviours.

The mean ocular cycloplegic refractions (SE) of children with different behaviour are described in figure 2. In the baseline examination, students with near work distance <30 cm were more myopic than those with near work distance ≥≥30 cm (figure 2A, −0.33±1.39 D, p<0.001). Students with continuous near work >30 min were more myopic than those with continuous near work ≤30 min (figure 2B, −0.21±1.27 D, p<0.001). Students with less outdoor activity in recess were more myopic than those with more outdoor activity in recess (figure 2C, −0.20±1.13 D, p=0.016). Comparison of SE changes between groups of with or without vision-protective behaviours after controlling the background variables (gender, parents' high myopia and myopia treatment or not), and the other two vision-protective behaviours is described in figure 3A. Students with near work distance <30 cm had significantly more myopia progression than

Table 2 Association between protective behaviour and myopia prevalence

	Near work distance* (≧30 cm) (n=5880)		Continuous near work† (≦30 min) (n=5170)		More outdoor activity in recess‡ (n=7337)	
	RR	RR 95% CI	RR	95% CI	RR	95% CI
Time	(ref: <30 cm)		(ref: >30 min)		(ref : less outdoor)	
T1	0.71	(0.63 to 0.80)	0.76	(0.67 to 0.86)	0.76	(0.66 to 0.88)
T2	0.70	(0.62 to 0.80)	0.77	(0.68 to 0.88)	0.78	(0.67 to 0.91)
T3	0.75	(0.66 to 0.85)	0.89	(0.78 to 1.02)	0.77	(0.65 to 0.90)
T4	0.74	(0.65 to 0.84)	0.89	(0.78 to 1.03)	0.77	(0.65 to 0.90)
T5	0.71	(0.63 to 0.82)	0.89	(0.77 to 1.02)	0.77	(0.66 to 0.91)

Association between protective behaviour and myopia prevalence: RR showed significant protective effect on myopia prevalence of three behaviors: near work distance≧30 cm, continuous near work≦30 min and more outdoor activity in recess. Model had adjusted for sex, paternal high myopia, maternal high myopia, myopia treatment and other two behaviours.

*Model adjusted for sex, paternal high myopia, maternal high myopia, myopia treatment, the time of continuous near work and the time of outdoor activity in recess.

†Model adjusted for sex, paternal high myopia, maternal high myopia, myopia treatment, near work distance and outdoor activity in recess.

‡Model adjusted for sex, paternal high myopia, maternal high myopia, myopia treatment, near work distance and the time of continuous near work.

RR, risk ratio.

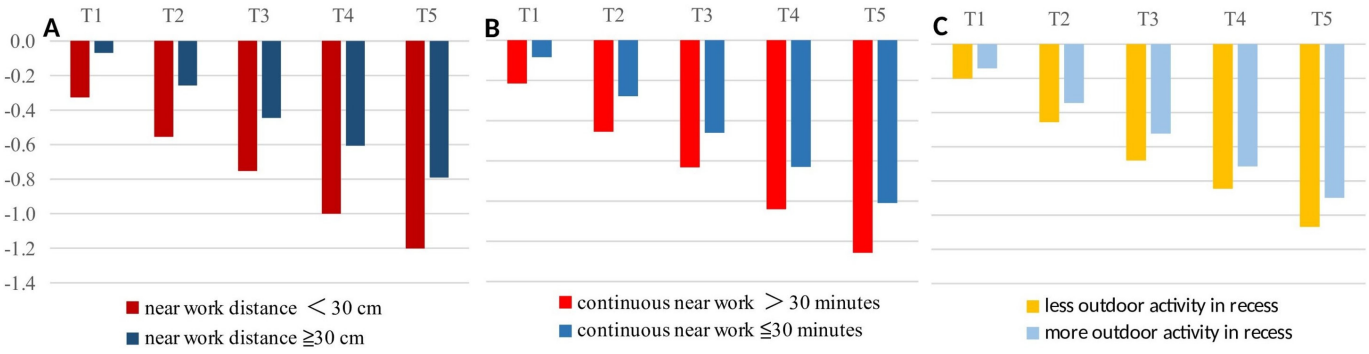

Figure 2 Longitudinal trend of refraction status of myopic children aged around 10 years with or without protective behaviours: the p value in generalised estimating equations model represents a significant difference or not in the slopes of the spherical equivalent change between groups at different time points.

those with near work distance >30 cm in 6 months (p=0.001) when controlling background variables, continuing near work and the time of outdoor activity in recess (figure 3B). Students with continuous near work >30 min had significantly more myopia progression than those with continuous near work ≤≤30 min in 6 months (p=0.023) when controlling background variables, near work distance and the time of outdoor activity in recess (figure 3C). Students with less outdoor activity in recess had significantly more myopia progression than those with more outdoor activity in 6 months (p=0.005) when controlling background variables, near work distance and the time of continuous near work. The longer near work distance plays a key role in prevention of myopia progression and is as important as more time spent outdoors, and discontinuing near work every 30 min. In brief, students with near work distance <30 cm (figure 3A, −0.38±0.08 D, p<0.001) with continuous near work >30 min (figure 3B, −0.36±0.08 D, p=0.023), and with less time spent on outdoor activity in recess (figure 3C, −0.35±0.08 D, p=0.005) showed statistically significant more myopic refraction and more myopia progression only after 6 months. In 2-year follow-up, the impact of three risk factors remained statistically significant.

Near work distance >30 cm decreased prevalence of myopia, and the impact was as obvious as discontinuing near work every 30 min and more time spent outdoors in recess. In conclusion, in preventing myopia progression in Taiwan, longer distance when doing near work (>30 cm) had very significant impact (β=0.27, p<0.001), as important as more time spent outdoors in recess (β=0.17, p<0.001) and discontinuing near work every 30 min (β=0.13, p<0.001) (table 3).

DISCUSSION

We compared the impacts of three behaviours in myopia prevention in children aged 9–11 years. After controlling background variables and the other two confounders, the results showed distance >30 cm when doing near work, discontinuing near work every 30 min and doing outdoor activity during recess, all had significant protective effect on myopia prevalence in as early as 6 months. Additionally, comparing the SE of different time points with those of baseline, we found distance of near work had obvious protective effect (figure 2A) with more statistically significant difference at every time point in 2 years. Students with shorter near work distance revealed the most myopic shift in SE after adjusting background variables, such as gender, parental high myopia (figure 3A). Our results from 10 743 children paralleled to findings of Hsu's study of 3256 myopic children (mean age=7.49) in 1-year follow-up. In subgroup analysis, they found children with fast progression of myopia had a shorter reading distance.[26] Recent reports showed children who spent more time outdoors had a lower incidence of myopia in different ages (6–7, 6–14 years). The protective impact was believed to be mediated by the stimulatory effect of sunlight on retinal dopamine receptor thus inhibited eyeball elongation in animal study.[17 18 22 25] Wu *et al* in Taiwan showed a reduction in incident myopia of 50% in school-based randomised trial after 1 year intervention, possibly delivering as much as 80 min spent outdoors per day on school days.[18] In younger children aged 6 years in China, the intervention of addition of 40 min of outdoor activity at school showed statistically significant protective effect in the 3-year cumulative incidence of myopia and SE.[22] The limitation of this study

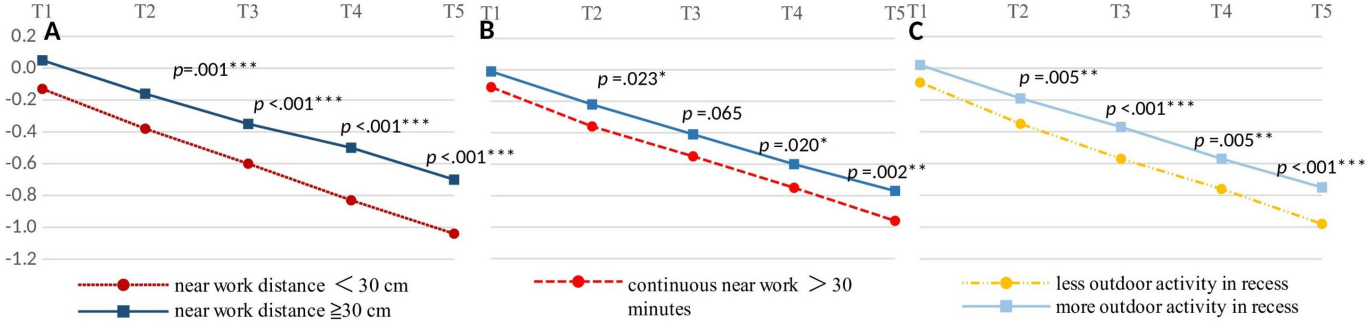

Figure 3 Longitudinal trend of change of spherical equivalent (SE) of myopic children aged around 10 years with or without protective behaviours: students with near work distance <30 cm (A, −0.38±0.08 D, p<0.001) with continuous near work >30 min (B, −0.36±0.08 D, p=0.023) and with less time spent on outdoor activity in recess (C, −0.35±0.08 D, p=0.005) showed statistically significant more myopic refraction and more myopia progression after only 6 months. The impacts lasted for 2 years.

Table 3 Association between refraction status change and following time by groups

	β	95% CI	P value
Behaviour			
Near work distance≧30 cm (ref: <30 cm)	**0.27**	0.20 to 0.34	**<0.001**
Continuous near work≦30 min (ref: >30 min)	**0.13**	0.06 to 0.21	**<0.001**
More outdoor activity in recess (ref: less outdoor)	**0.17**	0.08 to 0.26	**<0.001**
Time (ref=T1)			
T2	**−0.23**	−0.24 to −0.21	**<0.001**
T3	**−0.42**	−0.44 to −0.41	<0.001
T4	**−0.62**	−0.63 to −0.60	<0.001
T5	**−0.81**	−0.83 to −0.79	<0.001

Linear regression using generalised estimating equations.
Association between refraction status change and following time by different behaviour: in linear regression using generalised estimating equations, the standardised beta showed near work distance ≧ 30 cm had the highest association, followed by more outdoor activity in recess and continuous near work ≦ 30 min. The impacts of two latter behaviours were similar.
*Model adjusted for sex, paternal high myopia, maternal high myopia and myopia treatment.

was that analysis of behaviour of time spent outdoors in recess came from questionnaire and might not be very precise. This may contribute to the possible underestimate of the impact of outdoor activities in myopia. From parents' answers, children were divided into two groups: never/seldom do outdoor activities and usually do outdoors during recess in weekday. Because this is a population study with large sample size, the true outdoor time was not recorded and presented in this study. The other limitation of this study was that it did not include the myopia treatment as a covariate. Further study is necessary.

Near work behaviour played a role in myopia and myopia progression. In MIT by Hsu in 1-year follow-up, myopia fast progression was associated with a greater myopic SE at baseline (RR 0.67, 95% CI 0.61 to 0.72) and a shorter eye-object distance when doing near work.[8] In teenagers aged 12 years, in 2353 Australian children, close reading distance (30 cm) were associated with a more myopic refraction after adjustment for age, sex, ethnicity and school type.[7] In one study in China, from total 1770 students (mean age=12.7), close reading distance were significantly associated with greater myopia ($p<0.01$).

One study reported that continuous reading over 45 min was associated with greater RR.[10] Our study proved another fact that longer distance >30 cm had a prompt protective effect in reducing myopic progression in 6 months follow-up.

After literature review, most reported results of myopia risk factors were from cross-sectional studies. This is a large, prospective population study to report longitudinal comparison of protective behaviours on myopia by cycloplegic refraction every 6 months for 2 years. The value of this study is to identify the impacts of near work distance, continuous near work and outdoor activity on myopia prevalence and progression in children. With wide spread of message from our results, emphasis on proper study behaviour, the public health associated institutes could have practical method on myopia prevention.

One limitation of this study lied on absence of refraction of students who were not enrolled, but a majority of students (78%) participated in the city-wide study reduced the bios of absence of control group. The other limitation was that study behaviours of near working distance and near work time might change in each student, so the results from questionnaire might have bias. But in this study, the myopia-associated habits of 74.3% of students remained unchanged throughout the study. To simplify the impact, only children who maintained the same behaviours for 2 years were investigated in this study. Here, we presented evidence of significant protective effects of three behaviours in myopic children. We found longer distance >30 cm when doing near work, discontinuing near work every 30 min and more outdoor activity during recess in weekday could decrease myopia prevalence and reduced progression in 6 months to 2 years. Longer near work distance presented the most obvious impact than the other two behaviours.

In conclusion, near work distance played a key role in accelerating myopia progression in certain paediatric group. Given the widespread emphasis on maintenance of proper distance when doing near work in childhood could be helpful in myopia prevention worldwide.

Author affiliations
[1]Institute of Community Health Care, School of Nursing, National Yang-Ming University, Taipei, Taiwan
[2]Department of Nursing, National Cheng Kung University Hospital, Tainan, Taiwan
[3]Department of Ophthalmology, Taipei City Hospital, Taipei, Taiwan
[4]Faculty of Medicine, National Yang-Ming University, School of Medicine, Taipei, Taiwan
[5]Institution of Public Health, National Yang-Ming University, Taipei, Taiwan
[6]Department of Ophthalmology, National Yang-Ming University Hospital, Yilan, Taiwan
[7]School of Nursing, National Yang-Ming University, Taipei, Taiwan
[8]Department of Ophthalmology, Taipei Veterans General Hospital, Taipei, Taiwan
[9]Department of Health, Taipei City Government, Taipei, Taiwan
[10]School Health Research Center, National Yang-Ming University, Taipei, Taiwan

Correction notice This article has been amended since it was published online. The affiliations have been updated for the second and third authors.

Contributors Study supervision: Y-ML, C-YT, S-CH, M-HL. Conception and design: Y-ML, P-CH, C-YT. Conduct of the study: P-CH, Y-ML, C-YT, Y-CH, C-CH. Analysis and interpretation data: P-CH, Y-ML, Y-CH. Writing of manuscript: Y-CH, P-CH, Y-ML, C-YT, D-CT, C-CH, C-WC. Approval and revision of manuscript: Y-CH, Y-ML, P-CH, C-YT, D-CT, C-CH, C-WC, S-CH, M-HL.

Funding This study was funded by the Department of Health, Taipei City Government (TCHIRB-1020501/10603111). This project, an investigation of myopia in Taipei, was supported by grants H10237, P10303, 104HM01L and W105004 from the Taipei City Government.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The Institutional Review Board of Taipei City Hospital approved the protocols of this study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

ORCID iDs
Der-Chong Tsai http://orcid.org/0000-0002-2239-1132
Chih-Chien Hsu http://orcid.org/0000-0003-2354-2999
Yiing-Mei Liou http://orcid.org/0000-0001-7150-9347

REFERENCES

1 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.
2 Rudnicka AR, Kapetanakis V, Wathern AK, *et al*. Global variations and time trends in the prevalence of childhood myopia: a systematic review and meta-analysis. *Lancet* 2016;386:882–90.
3 Wallman J, Winawer J. Homeostasis of eye growth and the question of myopia. *Neuron* 2004;43:447–68.
4 Chen M, Wu A, Zhang L, *et al*. The increasing prevalence of myopia and high myopia among high school students in Fenghua City, eastern China: a 15-year population-based survey. *BMC Ophthalmol* 2018;18:159–68.
5 Morgan IG, French AN, Ashby RS, *et al*. The epidemics of myopia: aetiology and prevention. *Prog Retin Eye Res* 2018;62:134–49.

6 Guo L, Yang J, Mai J, *et al*. Prevalence and associated factors of myopia among primary and middle school-aged students: a school-based study in Guangzhou. *Eye* 2016;30:796–804.
7 JM I, Saw SM, Rose KA, *et al*. Role of near work in myopia: findings in a sample of Australian school children. *Invest Ophthalmol Vis Sci* 2008;49:2903–10.
8 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.
9 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.
10 SM L, SY L, Zhou Y, *et al*. Near work related parameters and myopia in Chinese children: the Anyang childhood eye study. *PloS One* 2015;10:1–13.
11 Scheiman M, Zhang Q, Gwiazda J, *et al*. Visual activity and its association with myopia stabilisation. *Ophthalmic Physiol Opt* 2014;34:353–61.
12 Hepsen IF, Evereklioglu C, Bayramlar H. The effect of reading and near-work on the development of myopia in emmetropic boys: a prospective, controlled, three-year follow-up study. *Vision Res* 2001;41:2511–20.
13 Arunthavaraja M, Vasudevan B, Ciuffreda KJ. Nearwork-induced transient myopia (NITM) following marked and sustained, but interrupted, accommodation at near. *Ophthalmic Physiol Opt* 2010;30:766–75.
14 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.
15 Lin Z, Vasudevan B, Jhanji V, *et al*. Near work, outdoor activity, and their association with refractive error. *Optom Vis Sci* 2014;91:376–82.
16 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;15:73–84.
17 Zhou Z, Morgan IG, Chen Q, *et al*. Disordered sleep and myopia risk among Chinese children. *PLoS One* 2015;10:e0121796–10.
18 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.
19 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.
20 PC W, Tsai CL, HL W, *et al*. Outdoor activity during class recess reduces myopia onset and progression in school children. *Ophthalmol* 2013;120:1080–5.
21 He M, Xiang F, Zeng Y, *et al*. Effect of time spent outdoors at school on the development of myopia among children in China. *JAMA* 2015;314:1142–8.
22 Sherwin JC, Reacher MH, Keogh RH, *et al*. The association between time spent outdoors and myopia in children and adolescents: a systematic review and meta-analysis. *Ophthalmol* 2012;119:2141–51.
23 Saw S-M, Matsumura S, Hoang QV. Prevention and management of myopia and myopic pathology. *Invest Ophthalmol Vis Sci* 2019;60:488–99.
24 Tsai D-C, Lin L-J, Huang N, *et al*. Study design, rationale and methods for a population-based study of myopia in schoolchildren: the myopia investigation study in Taipei. *Clin Exp Ophthalmol* 2015;43:612–20.
25 Feldkaemper M, Schaeffel F. An updated view on the role of dopamine in myopia. *Exp Eye Res* 2013;114:106–19.
26 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.