

Evidence Based Case Report

The Effect of Near-work Activity Time to The Incidence of Myopia in Children

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Abstract

Myopia has been a global problem leading to visual impairment and blinding complications with associated factors including time spent outdoor and near-work activity time. Excessive near-work activities are inevitable in children nowadays. However, the association between near-work activity time and myopia are still inconsistent between studies. The aim of this study is to review whether excessive near-work activities is associated with myopia incidence. A literature search on six different database (Pubmed, Cochrane Library, Scopus, Clinical Key, Google Scholar, and EBSCOhost). Articles matched with inclusion criteria were appraised using Therapeutic Study Critical Appraisal Tool by CEEBM, University of Oxford. Three cohort trials were obtained from the literature search. Incidence of myopia and the hazard ratio (HR) in Ku et al, Tsai et al, and You et al are 27.7%, HR 1.31 (95% CI 1.03-1.68) for ≥ 2 hours/day cram school attendance; 25.2% HR 1.12 (95%CI 1.02-1.22) for ≥ 5 hours/week after-school program; 16% HR 1.05 (0.96-1.16) for $\geq 2.95 \pm 1.72$ hours/day near work time, respectively. The protective factor pointed out by the studies was outdoor time. Tsai et al showed HR 0.90 (95%CI 0.82-0.99, $p < 0.001$) for ≥ 30 minute time spent on outdoor activities after school on weekdays; and Ku et al showed a protective dose-response relationship ($p < 0.001$) between increased outdoor activity time and myopia. Near-work activity is a strong risk factor candidate for myopia incidence, while outdoor activity is a strong protective candidate.

Keywords: near-sightedness, near-work activity, screen time, gadget, children.

Hubungan Aktivitas Jarak Dekat terhadap Insidens Miopia pada Anak

Abstrak

Miopia merupakan penyakit mata terbanyak yang dapat mengakibatkan kebutaan. Faktor yang berpengaruh antara lain aktivitas luar ruangan dan aktivitas jarak dekat. Pada era milenial olahraga luar ruangan jarang dilakukan dan aktivitas jarak dekat sangat melekat dengan kehidupan sehari-hari. Studi ini bertujuan untuk meninjau hubungan aktivitas jarak dekat dengan insidens miopia. Pencarian melalui enam basis data ilmiah (Pubmed, Cochrane Library, Scopus, Clinical Key, Google Scholar, and EBSCOhost) menghasilkan tiga studi kohort yang selanjutnya ditelaah menggunakan Therapeutic Study Critical Appraisal Tool by CEEBM, University of Oxford. Insidens miopia dan hazard ratio (HR) aktivitas jarak dekat pada Ku et al, Tsai et al, dan You et al adalah 27,7%, HR 1,31 (95% CI 1,03-1,68) untuk ≥ 2 jam/hari les akademik; 25,2% HR 1,12 (95% CI 1,02-1,22) untuk ≥ 5 jam/minggu program akademik; 16% HR 1,05 (0,96-1,16) untuk $\geq 2,95 \pm 1,72$ jam/hari aktivitas jarak dekat. Aktivitas luar ruangan merupakan faktor protektif terhadap insidens miopia dengan HR 0,90 (95% CI 0,82-0,99, $p < 0,001$) untuk ≥ 30 menit kegiatan luar ruangan pada hari kerja. Terdapat hubungan dosis-respons protektif ($p < 0,001$) antara aktivitas luar ruangan dan miopia. Aktivitas jarak dekat merupakan faktor risiko kuat untuk miopia sedangkan aktivitas luar ruangan merupakan faktor protektif. **Kata kunci:** rabun jauh, aktivitas jarak dekat, layar digital, gawai, anak.

Introduction

Myopia has been a global public health problem leading to visual impairment and blinding complications. It also carries high financial costs associated with its correction and treatment of complications (retinal detachment, macular degeneration, posterior vitreous detachment, etc). According to a world-wide study prevalence of myopia in East and Southeast Asia, the prevalence of myopia has rapidly increased in the past half-century.¹ Based on Anyang Childhood Eye Study in China, the rate of myopia in grade 1 was 3.9% and in grade 7 was 67.3%.² In China, myopia prevalence was up to 90% in teenagers and young adult group.³

Dealing with millennials era, near work activities including gadget screen time, computer/TV time, reading and writing various tasks are inevitable for children nowadays. Those are bounded to children's daily activities, both at school and at home. Even babies are introduced to digital screen at early age. American Academy of Paediatrics has established a recommendation of media time for children; children younger than 18 months need to avoid use of screen media other than to video-chatting. Children age 18-24 months should only be introduced to high-quality programming media with parental advisory to help them understand what they are seeing. For children age 2-5 years, screen time is limited to 1 hour per day of high-quality program with parental advisory. As for children age 6 years or more, parents should place consistent time limits spent using media and make sure that it does not take the place of adequate sleep, physical activity and other behaviours essential to health.⁴

Risk factors associated with myopia which have been identified are parental myopia, outdoor time, and near-work activity time.^{5,6} However, the association between near-work activity time and myopia are still inconsistent between studies. This review is intended to elucidate this topic.

Case Illustration

A girl, 8 years old, came to the clinic with parents complaining about her habitual near-work activities. She spent ≥ 8 hours per day on gadgets and papers. It includes doing paper-work assignments, reading books, e-books, and comics.

The patient was a second grade elementary student whose school schedule starts from 06.30 to 12.00. Her activities in school include reading, doing paper-work assignments and examinations. During break at 09.00-09.30, she usually has lunch, prays, talks with her friends while playing with her

phone. There is a 2-hour physical education (PE) class once a week. She also joins basketball extracurricular, every Friday after school.

Patient had never complained of any sight-difficulty. Parents and teachers had never noticed any weird postures, gestures, nor peculiar behaviour when patient was doing near-work activities (e.g. head-tilting during watching TV, squinting). No history of eye trauma and other eye diseases. Patient had never wear any spectacles neither did both parents.

On physical examination, patient weighted 26 kg and was 130 cm in height, thus her nutritional status was normal. Subjective visual acuity examination using Snellen chart showed 6/6 for both eyes. No abnormality was found on general physical examination. Parents asked, *can their child's activities increase the risk for developing myopia?*

Methods

Search Strategy

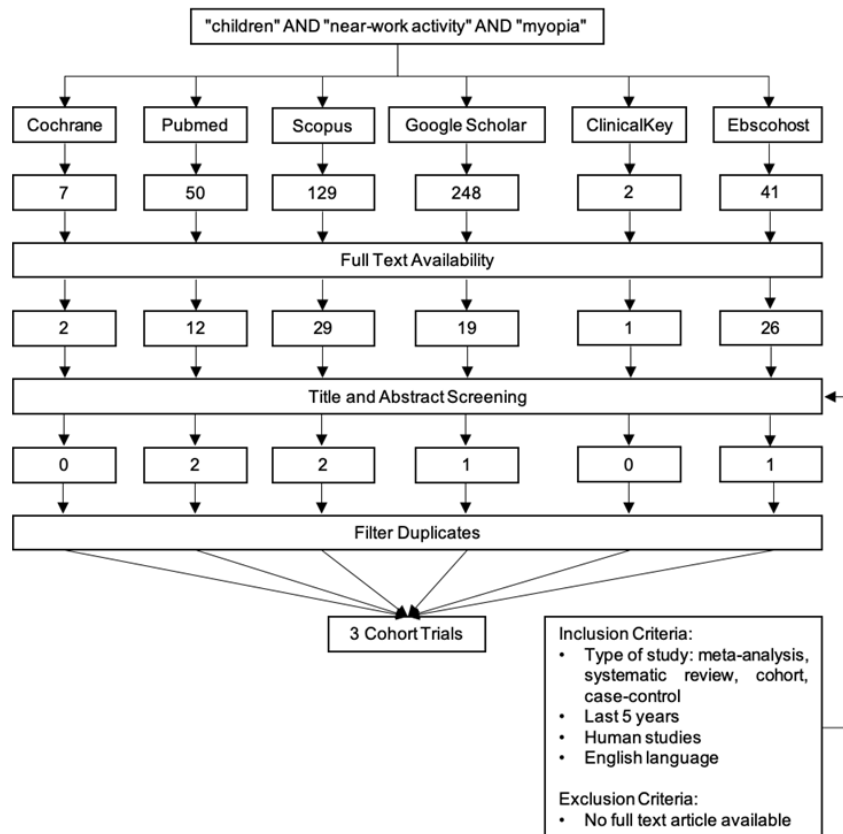
A literature search was conducted from six libraries including Pubmed®, Cochrane Library®, Scopus®, ClinicalKey®, Google Scholar, and Ebscohost®. Keywords used as search terms were "children" as the type of patient, "near-work activity" as the intervention, and "myopia" as the outcome. Complete search terms including synonyms and MeSH terms.

Selection

Articles were screened by their title and abstract following the inclusion and exclusion criteria. Inclusion criteria are meta-analysis, systematic review, cohort, case-control studies on human subjects, published in the last 5 years (2014-2018), and were written in English. Studies with no full-text article available; opinion paper, cross-sectional, and case reports were excluded. Duplicate articles were filtered following initial selection. Each paper was analysed to assess its relevance to the clinical question.

Critical Appraisal

Critical appraisal of the selected articles was conducted using appraisal instrument adapted from Levine M, Walter S, Lee H, Haines T, Holbrook A, Moyer V. Users' guides to the medical literature. How to use an article on harm. JAMA. 1994;271:1615-9. (obtained from https://www.gla.ac.uk/media/media_64043_en.pdf by Univeristy of Glasgow, UK)



Scheme 1. Literature Search and Selection Flowchart

Results

A literature search of articles (English only) on Cochrane, Pubmed, Scopus, Google Scholar, ClinicalKey, Ebscohost database, was conducted using the following keywords: "children" and "near-work activity" and "myopia" or "near-sightedness". The article selection was portrayed in. Three selected articles were three cohort prospective studies which are Ku et al,⁷ Tsai et al,⁸ and You et al,⁹ summarized in Table 1. Critical appraisal of validity, importance, and applicability were presented (Table 2). Number needed to harm (NNH) is counted using the formula:

$$NNH = \frac{PEER(OR - 1) + 1}{PEER(OR - 1)(1 - PEER)}$$

PEER = patient's expected event rate

Of all three studies, only Tsai et al⁸ provide adequate variables NNH count; NNH counted from Tsai et al⁸ is 25.

Discussion

Near work activities are now bounded to modern daily lifestyle. Three selected articles, Ku et al,⁷ Tsai et al,⁸ You et al⁹ showed similar characteristics of population in each study. All three articles defined myopia as spherical equivalent ≤ 0.5 dioptre. While the near-work activities were

different for each study, all included reading, writing, and screen related activities.

Ku et al⁷ was a 4-year follow-up study to examine the prospective association between the near visual activities and the incident myopia in Taiwanese children aged 7-12 years old. The population includes 1,958 children aged 7-12 from >99% coverage in Taiwan nation-wide with a multivariate regression analysis adjusting the important covariates which were age, parental educational levels, household income, and eye disorders, in 2009 the incidence of myopia was 27.7%. Incident myopia was defined as those who had ≥ 2 ambulatory care claims for myopia during the 4-year follow up period after excluding the prevalent cases. Risk factors were assessed through questionnaires. This study did not demonstrate clearly the type of measurement used to examine the myopia, yet they imply subjective measurements during school eye health screening. They classified near-work activities into ≥ 2 hours/day cram school attendance, ≥ 1 hour/day time spent on computer/internet/video game, ≥ 2 hours/day time spent on reading.⁷

Tsai et al⁸ displayed the first year results of a 3 year prospective cohort study. This was a city-wide population-based study in Taipei recruited all second grade school children in the city. They aimed

to investigate the annual incidence of myopia and associated factors. This study includes 11,590 second grade school children in Taipei City (born between September 2005 and August 2006; with the first eye examination in July-September 2013). Subjective eye examination was performed by ophthalmologists, preceded by two drops of cycloplegic agents. Incident myopia was defined as school children who were

emmetropic/hyperopic at baseline and had myopia (spherical equivalent ≤ 0.5 Dioptre) in either eye at follow-up. Behavioural risk factors were assessed through questionnaires. Near-work activities were divided into ≥ 5 hours/week after-school program, ≥ 2 hours/day time spent on near work. The incidence of myopia in this study was 25.2%.⁸

Table 1. Summary of Selected Studies

Studies Characteristics	Ku et al ⁷	Tsai et al ⁸	You et al ⁹
Study design	Prospective cohort.	Prospective cohort.	Prospective cohort.
Follow-up period	4-year.	3-year.	1-year.
Subjects	1,958 children age 7-12.	11,590 grade 2 school children.	4,814 primary students age 6-10.
Study scope	>99% coverage in Taiwan nation-wide with a multivariate regression analysis.	City-wide population-based study in Taipei.	Cluster randomization based on probability proportion to size in Jiading. District of Shanghai.
Source	Secondary data (from National Health Insurance program compulsory for all citizen since birth).	Primary data.	Primary data.
Measuring method	Annual vision screening at school, any abnormality found during screening was referred to ophthalmologists.	Biannual UCVA, BCVA with two drops of cycloplegic agents by ophthalmologists.	Complete eye examination at baseline and at one-year follow-up.
Examiner	N/A	Ophthalmologists.	A team composed of 5 optometrists, 2 public health doctors, 1 ophthalmologist, 1 field assistant, 1 school nurse, and 1 study manager.
Tools	N/A	Autorefractometer. Two drops of cycloplegic agents.	Ocular biometry system Autorefractometer. A drop of cycloplegic agent and a drop of topical anaesthetic agent, retro-illuminated early treatment of diabetic retinopathy study (ETDRS) charts, a slit-lamp, ophthalmoscope, cover-testing
Parameter	Incident myopia: had ≥ 2 ambulatory care claims for myopia during the 4-year follow up period. Prevalent myopia: had ≥ 2 ambulatory care claims for myopia before the follow up.	Incident myopia: nonmyopic/hyperopic subjects at baseline and had myopia in either eye during the 3-year follow up period.	Incident myopia: subjects who were not myopic at baseline and subsequently developed myopia in either eye during the 1-year follow up period.
Incidence of myopia	27.7%	25.2%	16%
Exposure variable	≥ 2 hours/day cram school attendance (HR: 1.31; 95%CI: 1.03-1.68). ≥ 1 hour/day time spent on computer/internet/video game (HR: 1.14; 95%CI: 0.89-1.48). ≥ 2 hours/day time spent on reading (HR: 1.07; 95%CI: 0.82-1.40).	≥ 5 hours every week on after - school tutoring programs (HR: 1.12; 95% CI: 1.02–1.22). ≥ 2 hours/day time spent on near-work activity (HR: 1.06; 95%CI: 0.97-1.16). ≥ 30 minutes/day time spent on outdoor activities after school on weekdays (HR 0.9; 95%CI 0.82-0.99).	$\geq 2.95 \pm 1.72$ hours/day near work time (HR: 1.05; 95%CI: 0.96-1.16)

Table 2. Appraisal of Studies

Studies	Level of Evidence	Subjects	Validity			Importance	Applicability
			Data Source	Measuring Method	Follow-up Period		
Ku et al ⁷	Ila	1,968	Secondary	N/A	4 years	+	+
Tsai et al ⁸	Ila	11,590	Primary	Autorefracton	3 years	+	+
You et al ⁹	Ila	4,814	Primary	Ocular biometry Autorefracton	1 year	+	+

You et al⁹ was a one-year prospective cohort study aiming to investigate the characteristics of various near-work activity related behaviours and their associations with changes in myopia related ocular biometric parameter. This study include 4,814 primary students aged 6-10 years old, grade 1-4, selected by cluster randomization based on probability proportion to size in 2013. Incident myopia was defined as children who were classified as not myopic at baseline and myopic in either eye at one-year follow-up. This was the only study which used objective measurements and comprehensive eye examinations for all participants. The incidence of myopia in this study was 16%.⁹

Ku et al⁷ conducted a cox regression analysis with adjusted covariates of age, parental educational levels, household income, and eye disorders. They found that ≥ 1 hour/day spent on computer/internet/video game (HR 1.14; 95%CI: 0.89-1.48) and ≥ 2 hours/day time spent on reading (HR 1.07; 95%CI: 0.82-1.40) were insignificant to myopia incidence. However, individual who attended cram school ≥ 2 hours/day develop greater risk for incident myopia (HR 1.31 95%CI 1.03-1.68) compared to those who spend < 2 hours/day (HR 1.19 95%CI 0.85-1.67). Cram school is a common method on enhancing academic learning in Taiwan, it includes doing homework, assignments, examinations, and attendance at private classes in the evening after regular school or on weekends. Thus intensive near work activities with ≥ 2 hours/day exposure, showed greater risk of myopia development in children (HR 1.31; 95%CI: 1.03-1.68).⁷ Attending cram school might indirectly affect children's time allocation for other beneficial activities such as outdoor activity and resting time.^{7,8}

Tsai et al⁸ who found that both time spent on near work ≥ 2 hours/day (HR 1.06; 95%CI: 0.97-1.16) and time spent on watching TV ≥ 2 hours/day ($p=0.247$) were not significant to develop myopia in non-myopic baseline population. However, this study did not state clearly the types of activities

included in the near work category. On the other hand, time spent on after-school tutoring programs ≥ 5 hours/week established a statistically significant factor to develop myopia ($p<0.001$) with hazard ratio of 1.12 (95%CI 1.02-1.22). These programs include intensive near visual activities such as reading and writing.⁸ From this study, the NNH was 25 meaning that in every 25 persons exposed to near-work activity, 1 person might develop myopia incidence.

The only study which used ocular biometry system to measure the axial length of each subject was You et al.⁹ They did not demonstrate clearly the near-work time cut-off time and its relationship towards the outcome of myopia, yet they collected the information from questionnaire to calculate the average time by the formula of: $([\text{hours spent on weekday} \times 5] + [\text{hours spent on weekend} \times 2])/7$. The average time spent on near work was 2.95 ± 1.72 hours/day which increased as the grade level increased (HR 1.05 95%CI: 0.96-1.16).⁹

From other previous studies, published articles reporting myopia incidence were still limited compared to those reporting on myopia prevalence.^{1,2,7-9} In all those studies with various population, design, variables observed, and length of study, there were large variation results of near-work activity and myopia incidence.^{1,2,5-9} However, there was another commonly observed factor which was found to have a protective role to the incidence and prevalence of myopia which was outdoor activity.⁵⁻⁹ Tsai et al⁸ showed ≥ 30 minutes time spent on outdoor activities after school on weekdays had HR of 0.90 (95%CI 0.82-0.99, $p<0.001$). Ku et al⁷ showed increase outdoor time had protective dose-response relationship with myopia ($p<0.001$). This findings were consistent with the Orinda Longitudinal Study of Myopia (OLSM) found that children who became myopic ($SE<0.75D$) but the 8th grade spent less time in outdoor activity (hours per week) at the 3rd grade compared to those who did not become myopic.¹⁰ It was consistent with

a cross-sectional study in Singapore which after confounding factors adjustment, found that for each hour increase in outdoor activity per day the axial length decreased by 0.06 mm.¹¹ Therefore we recommend to increase outdoor activity time to each patient as a preventive measure for myopia incidence and as inhibitor of myopia progression.

Patient in this case was an 8 years old non-myopic baseline who has habitual excessive near-work activity throughout the day. However, she also participates in basketball extracurricular each Friday and participates in physical education class once a week. We support and advise these activities to be continued and to be increased in terms of frequency and duration. Although the evidences remain limited towards causal relationship between near-work activity and the incidence of myopia, 2 out of 3 articles appraised in this study exhibited positive correlation towards the two variables. Therefore, we advise the patient to reduce her near-work activity as much as she can and to change her leisure time to be spent on outdoor activities rather than near-work activities.

Conclusion

Near-work activity is a strong risk factor on myopia incidence, while outdoor activity is a strong protective factor. There are still very limited studies reporting on the incidence of myopia, with large heterogeneity results among the studies. We advise children to occupy their leisure time by doing outdoor activity (i.e. sports) rather than near-work activity (i.e. TV/video games/phone). Further longitudinal studies with longer follow-up period on non-myopic baseline children are advised to establish the causal relationship between near-work activity and incident myopia.

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