

THE INFLUENCE OF OUTDOOR ACTIVITIES AND NEAR-WORK ACTIVITIES ON MYOPIA IN CHILDREN IN SAMBENG DISTRICT, LAMONGAN REGENCY

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Abstract: Myopia is predicted to affect around 49.8% of the world's population by 2050. Lack of outdoor activity and excessive near-work activity are believed to be modifiable risk factors for myopia. This study aims to see the influence of outdoor and near-work activity on myopia in children in Sambeng District, Lamongan using the translated WHO RESC-25 questionnaire. The average duration of outdoor activity was 159.32 ± 86.02 minutes/day and 346.77 ± 97.26 in the myopia and emmetropia group, respectively. There was a negative association between outdoor activity and the incidence of myopia ($p=0.000$). Near-work activity was not associated with myopia. A positive association was found between near-work/outdoor time ratio and myopia ($p=0.000$). The risk of myopia was 19.74 times greater in individuals with a severe near-work/outdoor time ratio compared to those with a mild to moderate ratio. Outdoor activities have been shown to influence myopia in children in Lamongan.

Keywords: Outdoor activities; Near-work activities; Myopia; WHO RESC-25 questionnaire

I. INTRODUCTION

Refractive errors are the leading cause of visual impairment in children worldwide. Myopia, or nearsightedness, is the most common refractive error in children and young adults. (Subudhi & Agarwal, 2023). The prevalence of myopia has increased significantly in recent decades globally, especially in Asian countries (Wong *et al.*, 2020). Myopia is predicted to affect around 49.8% of the world's population by 2050, and about 20% will have high myopia (Holden *et al.*, 2016).

Children with significant, uncorrected refractive errors perform worse on visio-cognitive and visio-motor tests than children without refractive errors (Maduka-Okafor *et al.*, 2021). This will undoubtedly impact the child's overall development and academic performance.

Various studies have been conducted previously to find risk factors for myopia with varying results. Lack of outdoor activities and excessive near-work activities are believed to be modifiable risk factors for myopia. Risk factor analysis is important to determine effective myopia intervention efforts and strategies. However, studies on the relationship between children's activities and myopia in Indonesia are still limited (Barliana *et al.*, 2023). This study aims to analyze the influence of outdoor activities and near-work activities on myopia in children in Sambeng District, Lamongan Regency.

II. METHODS

The study is an observational analytical study with a case-control design conducted in October 2024 in Sambeng District, Lamongan. The WHO RESC-25 (Refractive Error in School Children) questionnaire, translated into Indonesian, was used to determine the duration of children's outdoor and near-work activities (Moafa, 2019). The duration of outdoor and near-work activities is measured in minutes per day, and presented in interval scales. The near-work/outdoor time ratio was divided into tertiles based on severity (low, moderate, and high).

Sampling in this study was conducted using total sampling for the myopia case group, with the stipulation that the dry refraction of at least one eye was ≤ -0.50 diopters (D). The control group was randomly sampled from the emmetropic population with an allocation ratio of 1:1.

The inclusion criteria for this study were elementary school children in grades 4-6, aged 9-13, residing in Sambeng District, Lamongan Regency, who were able to complete the refraction examination and questionnaire. The study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Airlangga University (No. 149/ ED/ KEPK/ FKUA/ 2024) in accordance with the seven WHO 2011 Standards. Written informed consent for each child was obtained from a parent/carer.

III.RESULTS

The total sample of this study was 88 subjects. From the four elementary schools involved in this study, 44 children with myopia were found, with 22 boys and girls each. In the case group, 40 children had low myopia, and four children had high myopia ($SE \leq -6.00$ D). The mean age in the case group was 10.52 ± 0.90 years old, while in the control group it was 10.75 ± 0.78 years old (Table 1). The mean Uncorrected Visual Acuity (UCVA) of the myopia group was 0.46 ± 0.23 . The mean spherical equivalent (SE) of the myopia group was -1.76 ± 2.60 D, with a minimum value of -14.5 D and a maximum value of -0.5 D

		Myopia (n=44)	Emmetropia (n=44)
Sex	Male	22	22
	Female	22	22
Age	9 y.o.	5	2
	10 y.o.	18	14
	11 y.o.	14	21
	12 y.o.	7	7
	<i>Mean ± SD</i>	<i>10,52 ± 0,90</i>	<i>10,75 ± 0,78</i>

Outdoor Activity on Myopia

Based on data collection, the average duration of outdoor activities such as playing with friends, fishing, gardening, going to the rice fields, and exercising was 159.32 ± 86.02 minutes/day in the myopia group and 346.77 ± 97.26 in the emmetropia group (Table 2). A significant difference was found between the means of the two groups with the Independent Sample T-test analysis ($p=0.000$). Logistic regression analysis showed a negative association between outdoor activities and the incidence of myopia ($p=0.000$) (Table 3).

Furthermore, with Spearman Rho statistical analysis, we found a strong positive correlation between spherical equivalent and the duration of outdoor activities ($r=0.730$, $p=0.01$) (Table 4). It indicates that the higher the duration of outdoor activities, the smaller the refractive error (higher spherical equivalent).

	Myopia (n=44)	Emmetropia (n=44)
Outdoor activity duration (minutes/day)	$159,32 \pm 86,02$	$346,77 \pm 97,26$
Near-work activity duration (minutes/day)	$299,69 \pm 139,99$	$299,21 \pm 139,61$

Near-work Activity on Myopia

In this study, the average duration of near-work activities such as reading, playing with gadgets and computers, watching TV, drawing, and making crafts was 299.69 ± 139.99 minutes/day in the myopia group and 299.21 ± 139.61 minutes/day in the emmetropia group (Table 2). There was no significant difference between the means of the two groups. The results of the logistic regression analysis did not find any effect of near-work activities on myopia in this study (Table 3).

	B	P value
Outdoor activity	-0,023	0,000*
Near-work activity	0,000	0,987
Near-work / outdoor time ratio	1,853	0,000*

* $p < 0,05$

Near-Work/Outdoor Time Ratio with Myopia

A positive association was found between the near-work/outdoor time ratio and myopia ($p=0.000$) (Table 3). The statistical analysis results using Spearman's Rho showed a strong negative correlation between the spherical equivalent and the near-work/outdoor time ratio ($r=-0.600$, $p=0.000$) (Table 4). The risk estimation analysis found that the risk of myopia was 19.74 times greater in individuals with a high near-work/outdoor time ratio compared to those with a mild to moderate near-work/outdoor time ratio, with a lower limit of 5.29 and an upper limit of 73.7 (Table 5).

	P value	Correlation Coefficient
Outdoor activity	0,000*	0,730**
Near-work / outdoor time ratio	0,000*	-0,600**

* $p < 0,05$
 **Strong Correlation

Tabel 5 Near-work/outdoor time ratio with myopia			
		Myopia (n=44)	Emmetropia (n=44)
Near-work / outdoor time ratio	Low (0,09-0,85)	8 (9,09%)	21 (23,86%)
	Moderate (0,86-1,61)	10 (11,36%)	20 (22,73%)
	High (1,62-12,93)	26 (29,55%)	3 (3,41%)
	Mean \pm SD ^{1*}	2,86 \pm 2,78	0,92 \pm 0,47
Odds Ratio	19,741		
Min	5,288		
Max	73,700		
¹ Mann-Whitney U test * $p < 0,05$			

IV. DISCUSSION

In this study, refractive status examinations were conducted on 230 elementary school students, and it was found that 44 students (19.13%) had myopia, of which four students (1.74%) were categorized as high myopia and 40 students (17.39%) were categorized as low myopia. A study from Qingdao found a prevalence of myopia of 22.61% in 10-year-old children (Sun et al., 2018). It is in contrast to a 2017 study in Yogyakarta that reported a prevalence of myopia and high myopia of 32.68% and 8.54%, respectively, in elementary school students (Mahayana et al., 2017).

It should be emphasized that this study refraction examination was conducted without the use of cycloplegics. A meta-analysis showed very significant heterogeneity between the two study groups using refraction with and without cycloplegics ($p < 0.001$) found a higher prevalence of myopia in studies using cycloplegic refraction (5.95%, 95% CI: 4.0–8.0%) (Alrasheed & Alghamdi, 2024). It contradicts the theory that non-cycloplegic refraction can cause overestimation of the prevalence of myopia; therefore, cycloplegic refraction is still used as the gold standard for myopia assessment (Alrasheed & Alghamdi, 2024).

The ratio of male to female subjects with myopia in this study was 1:1. A study by Sun et al. (2018) also found no statistically significant difference in the prevalence of myopia between men and women. Other studies have found a higher incidence of myopia in women than in men. The higher prevalence of myopia is associated with earlier maturation or with women spending less time outdoors than men (Alrasheed & Alghamdi, 2024). Furthermore, significant choroidal thinning, which is associated with the progression of myopia, has been reported to be more pronounced in women (Xu et al., 2022).

Outdoor Activity on Myopia

This study found a significant difference between the mean duration of outdoor activities such as playing with friends, fishing, gardening, going to the rice fields, and exercising, in the myopia group and the emmetropia group, with a duration of 159.32 ± 86.02 minutes/day and 346.77 ± 97.26 minutes/day, respectively. Our study also found that the shorter the outdoor activity, the smaller the spherical equivalent of myopia. This supports the previous theory that increasing time outdoors effectively reduces the risk of developing myopia. Previous studies have found that children exposed to less than 60 minutes/day of sunlight are at risk of developing myopia, while children exposed to at least 2 hours/day of sunlight can be protective against the development of myopia (Read et al., 2015; Wong et al., 2020). The protective effect of outdoor activities on myopia is believed to be due to children being more exposed to natural light, focusing more on distant objects, or spending less time on near-work activities (Guan et al., 2019). Dopamine release in the retina can be stimulated by sunlight exposure, thus inhibiting axial elongation (Rose et al., 2008; Biswas et al., 2024).

A study by Wu et al. (2018) found that increasing outdoor time during school breaks by approximately 80 minutes per day can reduce the incidence of myopia by up to 50% over one year in school children. The study found a protective effect of outdoor time on myopia changes in children with pre-existing myopia and emmetropia. (Wu et al., 2018). On the other hand, a randomized intervention trial in China found that increasing outdoor sunlight exposure could prevent myopic changes in emmetropic children, but not in children who already had myopia (He et al., 2022).

In addition to the duration of outdoor activity, the intensity of sun exposure, and the time of exposure also need to be considered. He et al. (2022) found that a 21% to 30% relative myopia risk reduction required approximately 700,000 to 850,000 cumulative lux per day at an outdoor light intensity of approximately 5,000 lux with approximately 140–170 minutes of outdoor exposure, and 156–189 minutes at a lower intensity (4,500 lux). This increased to. Guan et al. (2019) found that only midday outdoor activity time was associated with a 0.016 LogMAR unit better uncorrected visual acuity (UCVA) compared to children who did not spend time outdoors during midday.

Near-work Activity on Myopia

This study found no significant difference between myopic and emmetropic groups' average duration of near-work activities such as reading, using gadgets and computers, watching TV, drawing, and making crafts. This study also found no association between near-work activities and myopia. Other research conducted in Indonesia also found no effect of near-work activities on myopia (Nora et al., 2010). On the other hand, a study conducted by Ip et al. (2008) found that children who frequently engage in near-work activities have an 80% higher risk of developing myopia.

Furthermore, it can be considered that the primary determinant of myopia development due to near-work activities is not the total duration, but rather the viewing distance and the duration per session of the near-work activity. In Australia, a study of over 2,000 12- and 13-year-old children found that reading at a close distance (<30 cm) and reading for long periods (>30 minutes) increased the risk of myopia by 2.5- and 1.5-fold, respectively. (Ip et al., 2008). Based on previous studies, increased eye growth through continuous accommodation in myopia is associated with continuous activity, longer reading duration, and shorter reading distance, which is believed to be due to greater peripheral defocus in closer activities (Ip et al., 2008; Guan et al., 2019). Guan et al. (2019) found that near-work activities such as watching television and doing household chores did not affect refractive error. However, in the same study, digital screen use for more than 60 minutes daily was associated with greater refractive error.

Meanwhile, a systematic review found no significant difference between reading on paper (accommodation at a distance of 50 cm) and working in front of a computer screen (accommodation at a distance of 80 cm) (Dutheil et al., 2023). A hypothesis that is still controversial is that computer use can prevent myopia due to the release of dopamine induced by the brightness of the digital screen, thus inhibiting eye growth and ultimately preventing myopia (McCarthy et al., 2007).

Various studies' definitions of near-work activities make it difficult to compare results and draw conclusions about near-work and myopia. Even after studies that included intermediate-distance activities, such as TV viewing or computer time, and studies examining preschool children, there is still no clear picture (Philipp et al., 2022). It is believed that the intensity of near work with constant accommodation seems to have a greater effect on the genesis of myopia than the frequency of near work. (Ip et al., 2008; Philipp et al., 2022). It is in line with the findings of Huang et al. (2015), where taking breaks to stop near work activities lasting >30 minutes resulted in significantly less myopia compared to the case of children who did not stop long near work sessions (>30 minutes) after 6 months. However, it is important to consider that studies related to near work generally use questionnaires as their research instruments, so the possibility of recall or reporting bias needs to be considered.

Near-Work/Outdoor Time Ratio with Myopia

Statistical analysis using Spearman's Rho showed a strong negative correlation between spherical equivalent and the near-work/outdoor time ratio in our study. Other studies have also found that shorter time spent outdoors and longer time spent indoors studying are associated with greater axial length elongation (Sun et al., 2018). The mean near-work/outdoor time ratio in our study was 2.86 ± 2.78 in the myopia group and 0.92 ± 0.47 in the emmetropic group. After stratification, 29.55% of myopic subjects were in the high category, and 23.86% of emmetropic subjects were in the mild category. Another study found that children with myopia spent more time reading ($p = 0.001$), writing ($p = 0.001$), using computers ($p = 0.001$), and playing video games ($p = 0.037$) on weekdays, and less time spent on outdoor activities per week compared to children without myopia ($p = 0.001$) (Atowa et al., 2020).

Our study showed a 19.74-fold greater risk of myopia in individuals with a high near-work/outdoor time ratio compared to those with mild-moderate myopia. Similar results were found in the study by Gopalakrishnan et al. (2023), where there was a significant difference in refractive status between populations with a low near-work/outdoor time ratio compared to those with a high near-work/outdoor time ratio. Myopia was also found to be significantly associated with longer near work duration in a single session (>3 hours versus <1 hour: OR 3.71, CI 1.43–9.61, $p < 0.01$) and less frequent physical activity (“once a week” versus “twice a week or more” OR 4.35, 95% CI 1.89–9.98, $p < 0.01$) (Philipp et al., 2022). However, the study did not find a significant association between myopia and the duration of outdoor activity or the frequency of near work.

It remains unclear which activity has a greater effect on myopia progression, outdoor activity or near-work time. Our study found significant associations between outdoor activity duration and near-work/outdoor time ratio, but not near-work time, with myopia. On the other hand, a study by Biswas et al. (2024) found that, regardless of the duration of outdoor activity, excessive near-work time worsened myopia onset. The substitution effect, where increased outdoor activity leads to decreased near-work time, must be considered (Karthikeyan et al., 2022). Increased hours spent working near work can be a risk factor for myopia, but our research suggests that increased time spent outdoors can offset this effect. A balance between near and outdoor activities is important, as both influence the development and progression of myopia.

Limitations

This study has a potential risk of bias, as there is no instrument to measure time other than respondents' reports, which can be inaccurate. This study has limitations, including the lack of a light intensity meter that could guarantee the reliability of respondents' answers. Furthermore, this study did not use measurements such as distance and viewing angle, body posture, and ambient lighting to evaluate close-up activities.

The respondents were elementary school-aged children who sometimes struggled to understand the questionnaire and easily became bored. Although when answering the questionnaire, they were guided by the research team, respondents still frequently engaged in discussions with each other and may have imitated their answers. The possibility of social desirability bias, where respondents answered in a way they believed would be perceived favorably by others, cannot be eliminated entirely.

V. CONCLUSIONS

There is a strong positive correlation between outdoor activity duration and spherical equivalent in children in Sambeng District, Lamongan. There is an association between the near-work/outdoor time ratio and myopia in children in Sambeng District, Lamongan Regency. Children with a high near-work/outdoor time ratio are 19.74 times more likely to develop myopia than those with a low-to-moderate near-work/outdoor time ratio.

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