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Association Between Maternal Myopia and Myopia in Children Aged 10-12 Years in Karanggondang, Indonesia: A Cross-Sectional Study

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ABSTRACT

Myopia is the most common refractive error among school-aged children and a growing public health concern, particularly in developing countries. Although parental myopia is widely recognized as a genetic risk factor, evidence from Indonesia, especially among children aged 10 to 12 years, remains limited and inconsistent. By focusing on maternal myopia as a single and practical familial indicator in school-based settings, this study also considers a null association as a meaningful context-specific finding. This observational analytic study employed a cross-sectional design and was conducted from August to October 2025 in three public elementary schools in Karanggondang, Indonesia. A total of 88 child-mother pairs were recruited using purposive sampling. Visual acuity in both children and mothers was assessed using a Snellen chart without cycloplegic refraction. Refractive status was classified dichotomously as myopia or non-myopia. Data were analyzed using descriptive statistics and Chi-square tests with Yates' continuity correction, and associations were expressed as odds ratios with 95 percent confidence intervals. The prevalence of myopia was 20.5 percent among children and 59.1 percent among mothers. Childhood myopia was slightly more frequent among children of myopic mothers at 12.5 percent compared with 8.0 percent among those of non-myopic mothers. However, no statistically significant association was found between maternal myopia and childhood myopia, with a p value of 1.000. The estimated odds ratio was 1.12 with a 95 percent confidence interval of 0.385 to 3.209. Maternal myopia was not a significant independent predictor of myopia in children aged 10 to 12 years in this population. This context-specific null finding suggests that maternal myopia alone may have limited explanatory value. Preventive strategies should prioritize modifiable lifestyle factors alongside routine vision screening, and future studies should incorporate cycloplegic refraction and broader familial and environmental measures

Keywords: Childhood myopia; maternal myopia; refractive error; school-aged children; Indonesia

1. INTRODUCTION

Myopia has emerged as a major global eye health challenges of the 21st century and is increasingly common among school-aged children worldwide. Myopia, which causes blurred

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distance vision, is of particular concern in childhood because it can affect long-term ocular health and everyday functioning. Visual function is integral to children's cognitive, social, and emotional development, particularly during the school years when vision supports learning, behavioral regulation, and interaction with the environment (Pactwa et al., 2023). Thus, myopia may negatively affect academic performance and psychosocial well-being (Congdon et al., 2019; D. Li et al., 2024; Pramesti, 2022). Importantly, myopia is increasingly understood as a multifactorial condition shaped by both familial susceptibility and environmental/behavioral exposures.

Globally, more than 90% of individuals with refractive errors live in developing countries, and myopia is the predominant form of these impairments (Alrasheed et al., 2016; Naidoo & Jaggernath, 2012). Projections estimate that by 2050, approximately 4.758 billion individuals (49.8% of the global population) will be affected by myopia, with 938 million (9.8%) experiencing high myopia (above −5.00 diopters), and an increased risk of complications such as glaucoma, retinal detachment, and myopic macular degeneration (Holden et al., 2016; Reddy & Chandekar, 2024).

The increase in myopia incidence is especially acute in East and Southeast Asia, where studies have shown a sharp rises in prevalence among school-aged children (Kızıltoprak & Kocabaş, 2024). For example, national surveys from South Korea report high prevalence across childhood and adolescence, with particularly high rates among those aged 10-12 years (Congdon et al., 2019; Kim et al., 2020; Kim & Choi, 2024). Similarly high prevalence has been reported in Japan, among children and adolescents (Yotsukura et al., 2019). In India, Bhansali et al. (2019) reported a prevalence of 7.3% in schoolchildren in Visakhapatnam, highest in girls and most pronounced at age 12. These patterns highlight the importance of examining both familial and contextual factors within specific populations.

Despite this alarming trend globally, Indonesia exhibits a comparatively lower but variable prevalence of childhood myopia. A rural study in West Java found a prevalence of 4.9% (Barliana et al., 2023), while in Central Java, Nurjanah (2018) reported 14.7%, with the highest cases among sixth graders (23.1%). These discrepancies highlight the heterogeneous distribution of myopia in developing countries and support the need to evaluate risk factors within local settings.

International studies have consistently identify parental myopia as an important familial risk factor for childhood myopia, although the strength of association varies across settings. A meta-analysis by Zhang et al. (2015) involving 31,677 participants demonstrated a significant link between parental and childhood myopia, and Jiang et al. (2021) reported that myopic signs can emerge as early as age one in children with myopic parents. In North India, Rathi et al. (2022) reported a prevalence of 45.2% of childhood myopia among those with maternal myopia. In Indonesia, Nurjanah (2018) observed that children with myopic parents had a 2.41-fold higher risk of developing myopia. However, because paternal contribution is well established yet not always measurable in community surveys, the present study focuses on maternal myopia as a single, pragmatic familial indicator rather than comprehensive parental genetic risk. Yet, these findings have not been consistent across all populations, and their generalizability to Indonesian school-aged children remains uncertain.

Beyond familial susceptibility, environmental factors, including prolonged near-work activities, digital screen exposure, and limited time spent outdoors are also linked to myopia development and progression. Increased educational pressures and reduced outdoor exposure have been highlighted are key contributors, particularly in East and Southeast Asia (Kızıltoprak & Kocabaş, 2024). In this context, familial predisposition may represent background susceptibility, while behavioral and environmental modifiers may play critical roles in certain settings (Flitcroft et al., 2019; Ghorbani-Mojarrad et al., 2020).

Despite abundant international literature on the parental influence, many studies have been conducted in high-income or urban settings, which may limit applicability to Indonesia where

lifestyle, education, and environmental exposure differ. Moreover, relatively few studies focused specifically on children aged 10-12 years, a critical period for myopia onset, further limiting the transferability of global data to local populations. Empirical evidence from Indonesia on maternal myopia in relation to childhood myopia remains limited, making it important to generate context-specific epidemiological data, including the possibility that no association is observed.

This study addresses this gap by evaluating the association between maternal myopia and myopia in children aged 10-12 years in Karanggondang, Indonesia. By focusing on this age range and local population, this study aims to determine whether maternal myopia is a meaningful predictor of childhood myopia within the Indonesian context. The study hypothesizes that children with myopic mothers will have a higher prevalence of myopia than those whose mothers are not myopic; however, a null association is also considered a meaningful outcome in a multifactorial condition where environmental and behavioral factors may modify familial risk.

The findings from this research will contribute to the literature on childhood myopia by providing context-specific evidence on maternal myopia as a familial indicator in a developing country setting. Moreover, it may family-centered screening, early detection, and prevention strategies that consider both familial background and modifiable behavioral risk factors. Ultimately, the study underscores the multifactorial etiology of myopia and the importance of integrating both familial and environmental considerations into public health interventions targeting school-aged children.

2. METHODOLOGY

2.1 Study Design and Setting

This research adopted an observational analytic design using a cross-sectional approach to examine the association between maternal myopia and childhood myopia among children aged 10-12 years. As a cross-sectional study, this design assesses association at a single time point and does not allow causal inference or determination of temporality. The study was conducted over three months, from August to October 2025, in three elementary schools (SD Negeri 2, 3, and 10) located in Karanggondang, Indonesia. These schools were selected based on considerations of accessibility, variability in school accreditation, and feasibility of conducting visual examinations within time constraints. Maternal myopia was used as a pragmatic single familial indicator in this school-based setting.

Cross-sectional designs are commonly employed in school-based myopia research due to their practicality in identifying prevalence and associative patterns in a defined population (Cui et al., 2021; Ekpenyong et al., 2020). This approach is particularly suitable for resource-limited settings and provides timely epidemiological insights for localized public health planning; however, findings should be interpreted as context-specific associations rather than causal relationships.

2.2 Population and Sampling

The study population comprised children aged 10-12 years enrolled in the selected elementary schools and their biological mothers. Participants were recruited through purposive sampling based on specific eligibility criteria. Because purposive sampling is non-random, it may introduce selection bias and may limit the representativeness and generalizability of the findings. Inclusion criteria included enrollment of the child in one of the selected schools, willingness of both the child and mother to participate in visual acuity examinations, and the provision of informed consent by the parent. Participants were excluded if either the child or mother had diagnosed ocular diseases or acute visual impairments that could influence refractive assessment results, or if the mother had disabilities, such as speech impairment, that impeded participation in vision testing.

The study adhered strictly to ethical standards for pediatric research, ensuring informed consent was obtained in accordance with best practices for child protection and cultural sensitivity. As

highlighted by Chukwuneke and Ezenwugo (2022), research involving minors requires transparency, respect for participants, and protection from potential harm. Ethical approval for the study protocol was secured from the Health Research Ethics Committee of the Faculty of Nursing, Universitas Islam Sultan Agung (KEPK FIK Unissula).

2.3 Sample Size Estimation

The sample size for this study was determined using G*Power 3.1 software. Parameters included a significance level (α) of 0.05, statistical power (1-β) of 0.80, and an effect size derived from an odds ratio (OR) of 2.41, as reported by Nurjanah (2018), reflecting elevated risk of childhood myopia in relation to parental myopia. Based on this calculation, a minimum of 88 child-mother pairs was required. While Jiang et al. (2020) reported a higher odds ratio of up to 3.39 for children with two myopic parents, the selection of the more conservative OR from an Indonesian context allowed for greater contextual relevance. Given that the present analysis examined maternal myopia alone (rather than combined parental myopia), smaller effects and null associations remained plausible and were considered informative within this context.

2.4 Data Collection and Variables

Primary data collection involved direct visual acuity testing using the Snellen Chart for both children and mothers, conducted under standardized conditions. Although Snellen charts are widely used in epidemiological research (Cholera et al., 2020; Iqbal et al., 2020), recent findings suggest that newer digital tools such as PEEK Acuity may provide improved accuracy, especially when administered by non-clinicians (Andayani et al., 2021; Aritonang et al., 2022). Because cycloplegic refraction was not performed, classification based on visual acuity screening may have introduced misclassification of refractive status, which should be considered when interpreting associations. The main variables assessed in this study included both primary and secondary indicators. The primary variables comprised the refractive status of children and their mothers, each classified dichotomously as either myopic or non-myopic. This dichotomization was used to support a simple school-based analysis; however, it may reduce sensitivity to detect associations compared with grading myopia severity. Secondary variables included the child's age, categorized into 10, 11, or 12 years; the child's sex; maternal age group; maternal occupation; and maternal education level. Key potential confounders such as near-work duration, screen time, outdoor activity, socioeconomic indicators beyond education/occupation, and paternal refractive status were not measured in this study and are therefore addressed as limitations.

2.5 Data Analysis

Descriptive statistics were applied to summarize the demographic characteristics and refractive status distribution among the participants. To examine the association between maternal myopia and childhood myopia, bivariate analysis was conducted using the Chi-Square test. Given the use of a 2×2 contingency table for the primary analysis, Yates' continuity correction was applied to reduce the likelihood of overestimating statistical significance in this small-sample context. The magnitude of association was expressed as an odds ratio (OR) accompanied by a 95% confidence interval (CI). A p-value of less than 0.05 was considered indicative of statistical significance. Because key environmental/behavioral covariates and paternal refractive status were not measured, multivariable adjustment for confounding was not performed, and results are presented as unadjusted associations. The analytical framework employed in this study is consistent with methodological standards for clinical myopia research, as emphasized by Flitcroft et al. (2019), particularly in maintaining uniformity in definition and rigor in statistical evaluation.

3. RESULTS

3.1 Characteristics of Children and Mothers

Table 1 presents the frequency distribution of child and maternal characteristics. A total of 88 child-mother pairs were included in the final analysis. Among the children, males constituted 54.5% (n = 48), while females represented 45.5% (n = 40). The mean age of the children was 10.74 ± 0.74 years, with the largest proportion aged 10 years (43.2%), followed by 11 years (39.8%) and 12 years (17.0%).

The mothers had a mean age of 38.52 ± 5.99 years, with more than half within the 31-40 year age group (55.7%). Most mothers were not formally employed (69.3%), and the highest proportion had attained elementary-level education (26.1%). With respect to refractive status, myopia was identified in 20.5% of children (n = 18), while a higher prevalence was observed among mothers, with 59.1% (n = 52) classified as myopic. These estimates should be interpreted in light of the school-based screening approach used in this study.

Table 1. Frequency Distribution of Child and Maternal Characteristics (n = 88)

Characteristic	Category	N	%	Mean ± SD
Child sex	Male	48	54.5	-
	Female	40	45.5	-
Child age (years)	10	38	43.2	10.74 ± 0.74
	11	35	39.8	-
	12	15	17.0	-
Maternal age (years)	27-30	10	11.4	38.52 ± 5.99
	31-40	49	55.7	-
	41-50	26	29.5	-
	51-56	3	3.4	-
Maternal occupation	Not working	61	69.3	-
	Trader	9	10.2	-
	Laborer	14	15.9	-
	Farmer	1	1.1	-
	Private employee	2	2.3	-
	Civil servant	1	1.1	-
Maternal education	No formal education	20	22.7	-
	Elementary school	23	26.1	-
	Junior high school	21	23.9	-
	Senior high school	22	25.0	-
	Higher education	2	2.3	-
Child refractive status	Myopia	18	20.5	-
	Non-myopia	70	79.5	-
Maternal refractive status	Myopia	52	59.1	-
	Non-myopia	36	40.9	-

3.2 Association Between Child Demographic Factors and Childhood Myopia

As shown in Table 2, childhood myopia was more frequently observed among boys than girls, with proportions of 11.4% and 9.1%, respectively. With respect to age, the highest proportion of myopia cases was found among children aged 10 years (13.6%), followed by those aged 11 and 12 years (each 3.4%). However, Chi-square analysis demonstrated no statistically significant association between childhood myopia and sex (p = 1.000). Similarly, no significant association was

identified between childhood myopia and age group, although the result approached statistical significance (p = 0.052). Overall, these findings indicate that differences by sex and age group were small and statistically uncertain within this sample.

Table 2. Association Between Child Demographic Factors and Childhood Myopia (n = 88)

Variable	Category	Myopia n (%)	Non-myopia n (%)	p-value
Sex	Male	10 (11.4)	38 (43.2)	1.000
	Female	8 (9.1)	32 (36.4)	
Age (years)	10	12 (13.6)	26 (29.5)	
	11	3 (3.4)	32 (36.4)	0.052
	12	3 (3.4)	12 (13.6)	

3.3 Association Between Maternal Demographic Factors and Maternal Myopia

As shown in Table 3, maternal myopia was more prevalent among mothers aged 27 to 40 years (37.5%) compared with those aged 41 to 56 years (21.6%). Regarding occupation, mothers who were not employed exhibited a higher proportion of myopia (35.2%) than those who were employed (23.9%). In terms of educational attainment, the highest proportion of maternal myopia was observed among mothers with elementary-level education (19.3%). Statistical analysis demonstrated a significant association between maternal occupation and maternal myopia (p = 0.033). In contrast, no statistically significant associations were identified between maternal myopia and maternal age (p = 0.390) or education level (p = 0.223). These bivariate findings describe patterns within the sample and should not be interpreted as causal relationships.

Table 3. Association Between Maternal Demographic Factors and Maternal Myopia

Variable	Category	Myopia n (%)	Non-myopia n (%)	p-value
Maternal age (years)	27-40	33 (37.5)	26 (29.5)	0.390
	41-56	19 (21.6)	10 (11.4)	
Occupation	Not working	31 (35.2)	30 (34.1)	0.033
	Working	21 (23.9)	6 (6.8)	
Education level	No formal education	9 (10.2)	11 (12.5)	
	Elementary school	17 (19.3)	6 (6.8)	0.223
	Junior high school	10 (11.4)	11 (12.5)	
	Senior high school	15 (17.0)	7 (8.0)	
	Higher education	1 (1.1)	1 (1.1)	

3.4 Association Between Maternal Myopia and Childhood Myopia

As shown in Table 4, among mothers classified as myopic (n = 52), 12.5% of their children were found to have myopia. In comparison, among mothers without myopia (n = 36), 8.0% of their children were myopic. Despite this difference in proportions, inferential analysis using the Chi-Square test with Yates' continuity correction demonstrated no statistically significant association between maternal myopia and childhood myopia ($\chi^2 = 0.000$; p = 1.000). The chi-square value of 0.000 and p = 1.000 indicate an almost identical distribution of childhood myopia between the two maternal myopia groups.

Risk estimation further showed that children with myopic mothers had 1.12 times higher odds of developing myopia compared with children of non-myopic mothers. However, the 95% confidence interval (0.385 to 3.209) crossed the null value, confirming that the observed increase in risk was not statistically significant. This context-specific null association may reflect the influence of unmeasured confounding factors, such as screen time, near-work activities, outdoor exposure, and paternal refractive status, as well as potential misclassification due to non-cycloplegic screening.

Table 4. Association Between Maternal Myopia and Childhood Myopia (n = 88)

Maternal myopia status	Child myopia n (%)	Child non-myopia n (%)	χ^2	p-value	OR (95% CI)
Myopia	11 (12.5)	41 (46.6)	0.000	1.000	1.12 (0.385-3.209)
Non-myopia	7 (8.0)	29 (33.0)			

4. DISCUSSION

This study examined the association between maternal myopia and the occurrence of myopia in children aged 10-12 years in Karanggondang, Indonesia. The findings demonstrated no statistically significant relationship between maternal myopia and childhood myopia. Although a higher proportion of myopia was observed among children of myopic mothers compared to those with non-myopic mothers, the magnitude of this association was small and not statistically meaningful. The odds ratio of 1.12, accompanied by a wide 95% confidence interval (0.385-3.209), suggests that maternal myopia contributed only weakly to childhood myopia risk within this population. This null association is interpreted as a meaningful, context-specific epidemiological finding rather than evidence against familial influence more broadly.

The absence of a significant association indicates that maternal myopia alone, as assessed in this school-based survey, is insufficient to explain childhood myopia in this sample. These results support the widely accepted view that childhood myopia is a multifactorial condition arising from complex interactions between familial susceptibility and environmental exposures. In this context, susceptibility may function as a background risk factor that requires specific environmental or behavioral triggers (e.g., intensive near-work or limited outdoor activity) to manifest clinically. This interpretation aligns with contemporary frameworks emphasizing gene-environment interaction in myopia development (Flitcroft et al., 2019; T. Li et al., 2024). However, because key environmental exposures were not directly measured in this study, this interpretation should be considered inferential.

The findings of this study are consistent with previous reports that did not identify a strong or consistent relationship between parental myopia history and childhood myopia severity or occurrence. Marisa Surya et al. (2023) similarly reported no significant association between parental myopia and the degree of myopia in children. Xiang et al. (2012) also demonstrated inconsistent associations between the number of myopic parents and childhood myopia in Chinese populations, suggesting substantial variability across settings. Conversely, studies from other contexts, such as North India, have reported stronger associations between maternal myopia and childhood myopia (Rathi et al., 2022), underscoring that familial effects may be context-dependent and influenced by population-specific characteristics. Taken together, these findings support positioning the present study as context-specific epidemiological evidence rather than genetic inference.

Variations in study outcomes across populations may be attributable to differences in age ranges, sample sizes, ethnic backgrounds, refractive assessment methods, and environmental exposures. For example, large-scale cohort studies using cycloplegic refraction tend to report stronger genetic associations than school-based screening studies relying on non-cycloplegic visual

acuity measurements. Methodological heterogeneity, including differences in myopia definitions and statistical approaches, further contributes to inconsistent findings in the literature. These factors likely contribute to the weak association observed in the present study, conducted in a semi-rural Indonesian setting using school-based screening methods. In addition, the current study assessed maternal myopia only; therefore, potential paternal contribution and combined parental risk could not be evaluated.

Environmental and behavioral factors may play an important role in shaping childhood myopia risk in this population. Activities involving prolonged near work, increased digital screen exposure, reduced outdoor time, and academic pressure have been consistently associated with myopia development. Evidence suggests that even among children with myopic parents, adequate outdoor activity can reduce myopia risk (Jiang et al., 2021; Yu et al., 2023). In rural or semi-rural Indonesian settings, where outdoor activity may be relatively more common and educational pressures less intense than in highly urbanized East Asian regions, environmental exposures may attenuate the expression of familial susceptibility. Because these exposures were not measured in the present study, this explanation should be interpreted cautiously.

The observed prevalence of childhood myopia in this study (20.5%) was higher than some reports from rural Indonesia, such as the 4.9% prevalence reported in West Java (Barliana et al., 2023), but remained considerably lower than rates documented in East Asian countries, where prevalence frequently exceeds 60%. These differences likely reflect variations in lifestyle, urbanization, educational intensity, and visual behavior patterns. Lower prevalence relative to East Asia may be attributable to less intensive near-work demands and greater opportunities for outdoor activities among Indonesian children.

Maternal myopia in this study was more common among non-working mothers and those with lower educational attainment. This pattern contrasts with studies from developed or urban settings, where higher education levels are often associated with increased myopia prevalence. One possible explanation is high daily exposure to digital devices and near-work activities among mothers regardless of formal employment or educational status. Dennis et al. (2022) documented substantial screen use among adults across sociodemographic groups, suggesting that modern lifestyle factors may override traditional associations between education and myopia. Nevertheless, because detailed maternal near-work and screen-time exposure were not measured, this explanation remains speculative.

LIMITATIONS

Limitations should be considered when interpreting these findings. The cross-sectional design precludes causal inference and limits the ability to assess temporal relationships between risk factors and myopia onset. The relatively small sample size may have reduced statistical power to detect modest effects. Purposive sampling may have introduced selection bias and limits generalizability beyond the study schools. Refractive assessment using Snellen charts allowed only dichotomous classification of myopia without grading severity, which may have obscured more nuanced associations. Because cycloplegic refraction was not performed, misclassification of refractive status is possible. Additionally, only maternal refractive status was assessed; paternal refractive status and combined parental risk were not evaluated, and detailed environmental exposures (e.g., screen time, near-work duration, and outdoor activity) were not directly measured.

Despite these limitations, the findings have implications for practice and public health policy. Myopia prevention strategies in school-aged children should prioritize modifiable environmental and behavioral factors rather than focusing solely on familial background. Family-based education promoting healthy visual habits, balanced screen use, and increased outdoor activity is recommended. Regular vision screening during late childhood may facilitate early detection and timely intervention, potentially reducing the long-term burden of visual impairment. Overall, this

study reinforces the multifactorial nature of childhood myopia and highlights the need for integrated prevention strategies that address both familial susceptibility and environmental risk factors. Future studies using longitudinal designs, cycloplegic refraction, and measurement of environmental exposures, including paternal refractive status are needed to clarify gene-environment contributions in Indonesian settings.

CONCLUSION

This study found no statistically significant association between maternal myopia and myopia in children aged 10-12 years in Karanggondang, Indonesia. Although myopia was slightly more common among children of myopic mothers, the effect was weak and statistically non-significant. This context-specific null finding supports the multifactorial nature of childhood myopia, while acknowledging that environmental exposures and paternal refractive status were not measured and may modify familial associations. Accordingly, prevention should prioritize modifiable lifestyle interventions, family-based education on healthy visual habits, and routine vision screening during late childhood. Future longitudinal studies incorporating cycloplegic refraction, paternal refractive status, and detailed environmental measurements are needed to clarify gene-environment contributions.

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