

The Role of Parenting Style and Dietary PUFA and Zinc Intake in Psychomotor Development among Young Children

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Abstract

Research Objective: Psychomotor development is an essential component of child growth and development. It can be influenced by several factors, including parenting practices and the adequacy of essential nutrients such as polyunsaturated fatty acids (PUFA) and zinc. This study aimed to examine the relationship between parenting style, PUFA intake, zinc intake, and psychomotor development among toddlers. **Methodology:** This analytical cross-sectional study involved 66 toddlers aged 7–72 months. Parenting style was assessed using the Parenting Styles and Dimensions Questionnaire (PSDQ). PUFA and zinc intake were measured using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Psychomotor development was evaluated using the Developmental Pre-Screening Questionnaire (KPSP). Data were analyzed using Chi-square tests and ordinal logistic regression. **Results:** Among the toddlers, 27% were stunted and 26% had mild wasting. Approximately 63% had inadequate PUFA intake, while 68% had inadequate zinc intake. Nearly half of the toddlers (47%) showed questionable psychomotor development. Bivariate analysis showed significant associations between parenting style ($p<0.001$), PUFA intake ($p<0.001$), zinc intake ($p=0.001$), family income ($p=0.002$), and nutritional status with psychomotor development. Multivariate analysis revealed that zinc intake and family income were the strongest predictors of psychomotor development. **Conclusion:** Adequate zinc intake and higher family income play important roles in supporting optimal psychomotor development among toddlers. Parenting practices and PUFA intake also contribute to developmental outcomes, although their effects may be mediated by socioeconomic and nutritional factors.

Keywords: *parenting style, PUFA, zinc, psychomotor development, toddlers*

INTRODUCTION

Early childhood development, particularly psychomotor development, forms a crucial foundation for cognitive capacity, learning ability, and productivity throughout the life course. The first 1,000 days of life represent a sensitive period during which brain development occurs rapidly and is strongly influenced by environmental stimulation, nutrition, and caregiving practices (Black et al 2017, Britto et al, 2017).

Globally, many children still fail to achieve their developmental potential due to inadequate nutrition, poor health, and insufficient psychosocial stimulation (Yousafzai et al, 2018). Nutritional deficiencies, especially in low-and middle-income countries, remain a major public health challenge affecting child growth and neurodevelopment.

Psychomotor development is influenced by multiple factors including parenting practices, socioeconomic conditions, and nutrient intake. Parenting style plays a critical role in providing stimulation and emotional support for children. Authoritative parenting, characterized by warmth and

responsiveness combined with clear guidance, has been associated with better cognitive and behavioral outcomes compared with authoritarian or permissive parenting styles (McKinney et al, 2020).

In addition to parenting practices, adequate nutrient intake is essential for optimal brain development. Polyunsaturated fatty acids (PUFAs), particularly omega-3 fatty acids such as docosahexaenoic acid (DHA), are structural components of neuronal membranes and contribute to synaptogenesis, neurogenesis, and myelination during early brain development (Gould et al, 2021, Shulkin et al, 2018).

Another important micronutrient is zinc, which plays an essential role in cell growth, immune function, and neurological development. Zinc deficiency has been associated with impaired neurodevelopment, behavioral problems, and delayed motor development in children [Kambe et al, 2019]. Recent studies also suggest that zinc status is associated with neurodevelopmental outcomes and cognitive performance among preschool children (Mayo-Wilson et al, 2021).

In addition, socioeconomic factors such as maternal education and household income can influence parenting behavior, food availability, and healthcare access. Families with higher socioeconomic status tend to provide better nutritional intake and developmental stimulation for children, leading to improved developmental outcomes (Jeon et al, 2018, McGregor et al, 2021). In Indonesia, nutritional problems such as stunting and inadequate nutrient intake remain prevalent among children under five. These conditions may negatively affect brain development and psychomotor function, emphasizing the importance of understanding the determinants of early childhood development. The relationship between parenting practices and nutritional intake is likely interconnected. Children raised in supportive family environments are more likely to receive adequate dietary intake and developmental stimulation, both of which are essential for optimal psychomotor development. Conversely, inadequate parenting practices may limit developmental opportunities even when nutritional needs are fulfilled. Therefore, understanding the combined influence of parenting style and key nutrients such as PUFA and zinc is important for developing comprehensive interventions to support child development. Therefore, this study aimed to analyze the association between parenting style, PUFA intake, zinc intake, and psychomotor development among toddlers. We hypothesized that positive parenting practices, adequate PUFA intake, and adequate zinc intake would be associated with better psychomotor development outcomes.

METHODS

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Diponegoro (No. 2415/EC/FK/2024). Written informed consent was obtained from all participants before data collection. This research employed an analytical quantitative design with a cross-sectional approach. The study was conducted in Brangj, Ungaran Barat District, Semarang Regency, Central Java, between November and December 2024. The study population consisted of toddlers aged 7–72 months living in the working area of Lerep Primary Health Center. A total sampling method was used, resulting in 66 toddlers and their mothers being included in the study. Inclusion criteria were: 1). Parents who agreed to participate and signed informed consent, 2). Toddlers residing in the study area, and 3). Mothers who were able to read and communicate effectively. Exclusion criteria included toddlers who moved away, were unable to participate due to health conditions, or whose parents refused participation. Psychomotor development was the dependent variable. Independent variables included parenting style, PUFA intake, and zinc intake. Potential confounding variables included child age, sex, maternal nutritional status, family income, and infection history. Parenting style was measured using the Parenting Styles and Dimensions Questionnaire–Short Version (PSDQ), which assesses three parenting styles: authoritative, authoritarian, and permissive. Responses were recorded using a Likert scale ranging from 1 to 5. PUFA and zinc intake were assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Nutrient intake data were

analyzed using NutriSurvey software and compared with the Indonesian Recommended Dietary Allowances (RDA). Intake was categorized as adequate ($\geq 77\%$ RDA) or inadequate ($< 77\%$ RDA). Psychomotor development was assessed using the Developmental Pre-Screening Questionnaire (KPSP), which evaluates gross motor, fine motor, language, and social-personal domains. Scores were categorized as normal (9–10), questionable (7–8), or delayed (≤ 6).

The PSDQ, SQ-FFQ, and KPSP are standardized instruments that have been widely used in child development and nutrition research. The PSDQ has demonstrated acceptable validity and reliability for assessing parenting practices, while the KPSP is a nationally recommended developmental screening tool in Indonesia. Nutrient intake estimation using SQ-FFQ has also been widely applied in nutritional epidemiology studies.

Anthropometric measurements were taken using digital scales and a microtoise/stadiometer. Nutritional status was determined according to WHO growth standards. Data were analyzed using SPSS version 26. Univariate analysis described the distribution of variables. Bivariate relationships were examined using Chi-square tests. Multivariate analysis was performed using ordinal logistic regression to identify the most influential factors. Ordinal logistic regression was selected because psychomotor development outcomes were categorized into ordered levels (normal, questionable, and delayed). This approach allows simultaneous assessment of multiple predictors while accounting for the ordinal nature of the outcome variable.

RESULTS

Characteristics of subject

Table 1 presents the baseline characteristics of the study participants. A total of 66 children were included, with a slightly higher proportion of females (54.5%) compared to males (45.5%). Regarding psychomotor development, 53.0% of children were categorized as having appropriate development, while 47.0% were classified as doubtful.

In terms of parenting style, authoritarian parenting was the most prevalent (56.1%), followed by permissive (25.8%) and authoritative (18.2%). Most children had inadequate nutrient intake, with 62.1% and 68.2% showing low intake of PUFA and zinc, respectively.

The majority of mothers had a middle level of education (60.6%), while only a small proportion had higher education (6.1%). Family income was relatively evenly distributed, with 51.5% below the minimum wage.

Regarding nutritional status, 27.3% of children were stunted based on height-for-age (HAZ), while 25.8% experienced mild wasting based on weight-for-height (WHZ). Only 1.5% of children were classified as overweight. Overall, these findings indicate that suboptimal nutrient intake and non-ideal parenting practices remain common among the study population.

Correlation between parenting style, PUFA intake, zinc intake, maternal education, family income, and nutritional status with psychomotor development

Table 2 shows the results of the bivariate analysis examining the association between independent variables and psychomotor development. Parenting style was significantly associated with psychomotor development ($p < 0.001$), with children raised under authoritarian parenting showing a higher proportion of doubtful development compared to those raised with authoritative parenting.

Nutritional intake also demonstrated strong associations. Children with low PUFA intake had a substantially higher proportion of doubtful development (49.0%) compared to those with adequate intake (6.0%) ($p < 0.001$). Similarly, low zinc intake was significantly associated with doubtful psychomotor development (47.0% vs 10.0%, $p = 0.001$).

Maternal education, however, was not significantly associated with psychomotor development ($p = 0.134$), although a trend toward better outcomes was observed among children of mothers with higher education. Family income showed a significant relationship ($p = 0.002$), with children from lower-income families more likely to have doubtful development.

Nutritional status indicators were also significantly associated with psychomotor outcomes. Stunted children had a higher proportion of doubtful development compared to normal children ($p = 0.001$). Likewise, mild wasting was significantly associated with poorer psychomotor development ($p = 0.019$). Overall, these findings suggest that both nutritional factors (PUFA, zinc, nutritional status) and environmental factors (parenting style, family income) play important roles in influencing psychomotor development.

Table 1. Characteristics of Subject (n = 66)

Characteristics	Category	n (%)
Sex	Male	30 (45.5)
	Female	36 (54.5)
Psychomotor Development	Doubtful	31 (47.0)
	Appropriate	35 (53.0)
Parenting Style	Authoritative	12 (18.2)
	Authoritarian	37 (56.1)
	Permissive	17 (25.8)
PUFA Intake	Low (<77%)	41 (62.1)
	Adequate ($\geq 77\%$)	25 (37.9)
Zinc Intake	Low (<77%)	45 (68.2)
	Adequate ($\geq 77\%$)	21 (31.8)
Maternal Education	Low	22 (33.3)
	Middle	40 (60.6)
	High	4 (6.1)
Family Income	< Minimum wage	34 (51.5)
	$\geq$ Minimum wage	32 (48.5)
Height-for-Age (HAZ)	Stunted	18 (27.3)
	Normal	48 (72.7)
Weight-for-Height (WHZ)	Mild wasting	17 (25.8)
	Normal	48 (72.7)
	Overweight	1 (1.5)

Data are presented as n (%).

Table 2. Bivariate Analysis of Parenting Style, PUFA Intake, Zinc Intake, Maternal Education, Family Income, and Nutritional Status with Psychomotor Development

Variable	Category	Doubtful n (%)	Appropriate n (%)	Total n (%)	p-value
Parenting Style	Authoritative	2 (3.0)	10 (15.0)	13 (21.0)	<0.001*
	Authoritarian	26 (40.0)	11 (16.0)	37 (53.0)	
	Permissive	9 (13.0)	8 (12.0)	16 (26.0)	
PUFA Intake	Low (<77%)	32 (49.0)	9 (13.0)	41 (63.0)	<0.001*
	Adequate ($\geq 77\%$)	4 (6.0)	20 (30.0)	25 (37.0)	
Zinc Intake	Low (<77%)	31 (47.0)	14 (21.0)	45 (69.0)	0.001*
	Adequate ($\geq 77\%$)	7 (10.0)	13 (20.0)	21 (31.0)	

Maternal Education	Low	12 (18.0)	10 (15.0)	22 (33.0)	0.134
	Middle	17 (26.0)	22 (33.0)	40 (61.0)	
	High	0 (0.0)	4 (6.0)	4 (6.0)	
Family Income	< Minimum wage	25 (38.0)	9 (13.0)	34 (56.0)	0.002*
	≥ Minimum wage	10 (15.0)	21 (32.0)	32 (44.0)	
Height-for-Age (HAZ)	Stunted	14 (21.0)	4 (6.0)	18 (27.0)	0.001*
	Normal	18 (27.0)	23 (35.0)	48 (73.0)	
Weight-for-Height (WHZ)	Mild wasting	10 (15.0)	7 (10.0)	17 (26.0)	0.019*
	Normal	13 (20.0)	34 (52.0)	48 (73.0)	
	Overweight	0 (0.0)	1 (1.0)	1 (1.0)	

Data are presented as **n (%)**; Chi-square test; $p < 0.05$ considered statistically significant, Bold values indicate significant associations

Table 3. Multivariable Logistic Regression Analysis of Factors Associated with Psychomotor Development

Variables	Category	β (SE)	Adjusted OR (95% CI)	p-value
Parenting Style	Authoritative	0.180 (1.437)	1.20 (0.07–19.97)	0.901
	Authoritarian	-4.042 (1.698)	0.02 (0.001–0.49)	0.017*
	Permissive	Reference	1.00	–
PUFA Intake	Low (<77%)	-4.479 (1.434)	0.01 (0.001–0.19)	0.012*
	Adequate (≥77%)	Reference	1.00	–
Zinc Intake	Low (<77%)	-16.054 (2.474)	~0.00 (<0.001)	0.009*
	Adequate (≥77%)	Reference	1.00	–
Family Income	< Minimum wage	4.317 (1.844)	75.01 (2.02–2775.1)	0.019*
	≥ Minimum wage	Reference	1.00	–

β : regression coefficient, SE: standard error, OR: odds ratio, CI: confidence interval, Reference category indicated as Reference, $p < 0.05$ considered statistically significant, Model adjusted for all variables listed in the table

Multivariable logistic regression analysis (**Table 3**) demonstrated that several factors remained significantly associated with psychomotor development after adjustment. Authoritarian parenting was associated with a significantly lower likelihood of appropriate psychomotor development (AOR = 0.02; 95% CI: 0.001–0.49; $p = 0.017$).

Similarly, children with low PUFA intake had markedly reduced odds of appropriate psychomotor development compared to those with adequate intake (AOR = 0.01; 95% CI: 0.001–0.19; $p = 0.012$). Low zinc intake showed an even stronger association ($p = 0.009$), indicating a substantial reduction in developmental outcomes. In contrast, children from families with income below the minimum wage had significantly higher odds of doubtful psychomotor development (AOR = 75.01; 95% CI: 2.02–2775.1; $p = 0.019$).

The wide confidence intervals observed for several variables suggest a degree of statistical uncertainty, likely related to the relatively small sample size and the limited number of observations within some categories. Therefore, the magnitude of these associations should be interpreted with caution.

DISCUSSION

The results of this study showed that nearly half of the toddlers had questionable psychomotor development. This finding highlights the importance of environmental and nutritional factors in early childhood development.

Parenting style was significantly associated with psychomotor development. Parenting practices influence the level of stimulation and emotional support provided to children, both of which are

essential for brain development (Gauvain et al., 2021). Previous studies have demonstrated that children raised with authoritative parenting tend to show better social, cognitive, and motor development outcomes compared with those raised with authoritarian or permissive parenting styles (Bush et al, 2020).

Nutritional intake also plays an important role in neurodevelopment. PUFAs, particularly DHA, are critical for neuronal membrane structure and synaptic function. Adequate intake of omega-3 fatty acids during early childhood has been associated with improved cognitive function, visual acuity, and motor development (Swanson et al, 2021, Sherzai et al, 2021, Hu et al, 2024).

Zinc intake was identified as one of the strongest predictors of psychomotor development in this study. Zinc is involved in DNA synthesis, neuronal differentiation, and neurotransmitter metabolism (King et al, 2020). Zinc deficiency during early childhood may impair brain development and increase susceptibility to infection, which indirectly affects child growth and development (Prado et al, 2022). Evidence from clinical studies also indicates that zinc status is associated with neurodevelopmental outcomes and metabolic pathways related to growth and brain function in infants and young children (Chamakioti et al, 2024).

The stronger association observed for zinc intake compared with PUFA intake may be explained by the fundamental role of zinc in cellular growth, neurogenesis, and neurotransmitter regulation. Zinc deficiency may directly impair cognitive and motor development, whereas the effects of PUFA may be influenced by other dietary and environmental factors. This finding suggests that improving zinc adequacy should be considered a priority within child nutrition programs.

Socioeconomic factors such as family income also play an important role in determining child development outcomes. Families with higher income generally have better access to nutritious foods, healthcare services, and educational resources that support early childhood development (Sudfeld et al, 2022, Bush et al, 2020). These findings highlight the complex interaction between parenting behavior, nutrition, and socioeconomic conditions in shaping early childhood development.

From a public health perspective, these findings support the integration of nutrition education, parenting education, and developmental monitoring within primary healthcare services. Community-based interventions targeting low-income households may be particularly beneficial in improving developmental outcomes among young children.

LIMITATIONS

This study has several limitations. First, the cross-sectional design does not permit causal inference between exposures and psychomotor development outcomes. Second, the relatively small sample size may have contributed to unstable estimates and wide confidence intervals in the regression model. Third, dietary intake was assessed using caregiver recall through an SQ-FFQ, which may be subject to recall bias. Finally, residual confounding from unmeasured factors such as home stimulation quality, parental mental health, and childcare practices cannot be excluded.

CONCLUSION

Parenting style, PUFA intake, zinc intake, family income, and nutritional status were associated with psychomotor development among toddlers. Multivariable analysis identified zinc intake and family income as the strongest predictors of developmental outcomes. These findings highlight the importance of integrating nutrition improvement strategies with parenting support programs to optimize child development. Health professionals and policymakers should prioritize interventions that improve dietary quality, strengthen caregiver education, and support vulnerable families to promote optimal psychomotor development during early childhood.

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Ethical Approval Statement: This study was conducted in accordance with ethical principles involving human participants. Ethical approval was obtained from the Ethics Committee of the Health Research Ethics Committee of the Faculty of Medicine, Universitas Diponegoro (No. 2415/EC/FK/2024)).

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical and privacy considerations.

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