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The Impact of the Age of Independent Eating Initiation on Preschool Children's Fine Motor Development: A Case-Control Study

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Abstract

Background: Independent eating requires optimal fine motor development, including hand coordination, chewing, and swallowing. However, research on how the age of independent eating initiation affects fine motor development remains limited. This study aims to investigate the relationship between the age of independent eating initiation and fine motor development in preschool children.

Methods: The sample consisted of 135 preschool children (45 cases and 90 controls) from five kindergartens in Pemecutan. Cases were defined as children with fine motor impairments based on the Denver II test, while controls were children with normal fine motor development. Information on the age at which children started eating independently was obtained through a parent-administered questionnaire. Data were analyzed using binary logistic regression to control for confounding variables.

Results: Both univariate and multivariate analyses indicated a significant association between the age of independent eating initiation and fine motor development. After adjusting for confounding variables, compared to children who started eating independently at 0–12 months, the likelihood of fine motor impairment increased significantly with a later age of independent eating initiation: adjusted odds ratio (AOR) = 3.51 (p = 0.038) at 13–24 months, AOR = 13.77 (p = 0.000) at 25–36 months, and AOR = 17.35 (p = 0.000) at >36 months.

Conclusion: The findings indicate a significant relationship between the age of independent eating initiation and fine motor development in preschool children. A delay in independent eating initiation is associated with an increased likelihood of fine motor impairment. However, this study has limitations, including potential parental recall bias and the inability of the case-control design to establish a causal relationship.

Keywords: preschool children, independent eating, fine motor skills, age of independent eating initiation

Introduction

Motor skills are defined as the nervous system's ability to control movement. The literature classifies motor skills into two categories: gross motor and fine motor skills. Gross motor skills involve large muscles and are associated with locomotion and body balance functions,[1] while fine motor skills focus on coordinating various body parts, such as eye-hand, eye-foot, or eye-hand-foot coordination, and finger dexterity. [2]

National data indicate variations in the prevalence of motor development delays in children. According to the 2018 Basic Health Research survey, in Bali Province, physical developmental delays were observed in 3.7% of children aged 36–47 months and 1.8% of children aged 48–59 months.[3] Sejalan dengan temuan tersebut, studi yang melibatkan 314 anak usia 25-60 bulan melaporkan bahwa sebanyak 7,3% dari total sampel mengalami keterlambatan perkembangan motorik halus[4]. Although the prevalence is relatively low, it still requires serious attention, as fine motor delays can impact overall child development.

Fine motor skills play a crucial role in child development, particularly during the preschool years (3–6 years). At this stage, children must coordinate their movements to perform various daily activities, from self-care to preparing for basic academic skills. These abilities not only support a child's independence but also lay the foundation for future academic achievement. A study in the United States found that children with well-developed fine motor skills at age five tended to perform better in mathematics and reading at ages six, eight, and ten compared to their peers with poorer motor skills.[5]

Factors contributing to children's fine motor development remain a topic of research. One potential contributing factor is independent eating, or the ability of a child to eat without parental assistance. A study by Hua et al.[6] emphasized that self-feeding ability is not only related to overall child development but also reflects the maturation of both fine and gross motor skills.[6]

Self-feeding is a complex process that involves the coordination of various bodily movements, including the arms, fingers, chewing, and swallowing [7]. A study by Song et al. classified self-feeding based on the proportion of

mealtime spent eating independently to assess a child's eating autonomy. Children were categorized as practicing Baby-Led Weaning (BLW) if they ate independently for more than 50% of their mealtime. Conversely, if independent eating accounted for less than 50%, the child was classified under parent-led feeding.[8]

The significance of self-feeding ability as an indicator of child development has been explored in a longitudinal study by Hua et al. providing valuable insights into the relationship between the age of independent eating initiation and motor development in children diagnosed with Developmental Coordination Disorder (DCD). The study found that self-feeding is a predictor of later child development. However, it did not specifically analyze the impact of the age of independent eating initiation on children with fine motor impairments compared to those with normal development.[6]

Despite preliminary evidence highlighting the importance of self-feeding in child development, there remains a significant gap in the scientific literature regarding its contribution to fine motor development. Most available research focuses on aspects of nutrition and feeding patterns rather than motor development. This is supported by a systematic review conducted by D'Auria et al. on Baby-Led Weaning (BLW) practices, which primarily examined choking risks, nutritional intake, weight, and food preferences, while giving less attention to motor development. This research gap is even more apparent in Indonesia, where specific studies on the relationship between the age of independent eating initiation and motor development are highly limited, presenting a meaningful opportunity for further research in this field.[9]

In terms of practical implementation, self-feeding has been recommended by the World Health Organization (WHO) in its complementary feeding guidelines.[10] However, its implementation varies across different countries and faces several challenges. In Indonesia, particularly in Bali, gaps in feeding practices persist. Independent eating has not become a common habit, especially during the early stages of complementary feeding, where children are typically spoon-fed by parents.

A study by Susmarini et al.[7] found that out of 123 mothers in Indonesia, only 43.9% consistently practiced independent eating with a frequency of >90%. The majority of mothers implemented self-feeding with a frequency of 50–100%. The proportion of independent eating in this study was assessed through self-rating by mothers.[7] A similar phenomenon was observed in China, where a study by Song et al.[8] reported a very low rate of self-feeding, with only 10% (0–40%) of children practicing it. However, a significant increase was noted after professional guidance, particularly among infants aged 6–11 months.[8]

Based on these findings and the research gaps, we hypothesize that children who begin eating independently at an older age are more likely to experience fine motor development delays compared to those who start self-feeding earlier. This study identifies several potential confounding factors that may influence fine motor development, including child-related factors (age, gender) and maternal characteristics (education level), as identified in previous studies.[11,12]

To test this hypothesis, this study has two primary objectives: (1) to analyze the relationship between the age of independent eating initiation and fine motor development in preschool children at kindergartens in Pemecutan; and (2) to determine the strength of this relationship after adjusting for confounding factors, including child characteristics (age, gender) and maternal characteristics (education level). The study site was selected in Pemecutan kindergartens due to the high number of enrolled students. Based on the Education Data Center (Dapodik), the average number of students per kindergarten in Pemecutan for the 2024/2025 academic year is 81, providing an adequate sample size for statistical analysis.

Methods

This case-control study aims to analyze the relationship between the age at which children start self-feeding and delays in fine motor development among children aged 3–6 years. The study was conducted in kindergartens (TK) in the Pemecutan area, West Denpasar, from April to September 2024. Data were obtained through primary sources, including anamnesis and measurements. Ethical approval for this study was granted by the Research Ethics Committee of FK Unud (No. 0815/UN14.2.2.VII.14/LT/2024).

The sample was selected using purposive sampling, and the sample size was calculated using the G*Power application with the Z-test family, $\alpha = 0.05$, power = 0.8, and an odds ratio (OR) of 2. The OR value was based on a previous study by Hua et al.6, which had a similar population (preschool children) despite being conducted in a different country (China). It was chosen as it is a comprehensive and recent study on a similar topic. The calculation determined a minimum required sample size of 114 children, with a case-control ratio of 1:2. Kindergarten selection in the Pemecutan subdistrict was carried out by identifying six registered kindergartens in the Dapodik system. After submitting participation requests, five kindergartens agreed to take part in the study.[6]

The inclusion criteria for respondents were children aged 3–6 years and parental consent to complete the questionnaire and provide informed consent. Participant recruitment was conducted by directly approaching parents at the kindergartens, where the research team explained the study's objectives and sought participation. In this case-control design, all children meeting the inclusion criteria underwent fine motor skill assessments using the Denver II test and were then classified into either the case or control group based on the test results.

During the initial screening process, 157 children were identified as potential respondents. After applying the exclusion criteria, 135 children qualified as the final study sample. The exclusion criteria included children with a history of genetic disorders affecting development (such as autism and Down syndrome), a history of low birth weight (LBW), physical limitations due to trauma/fracture of both upper limbs that could interfere with measurements, participation in fine motor skill training programs exceeding 66 days (the period required for habit formation through consistent repetition), and incomplete questionnaire responses.

The primary focus of this study was the evaluation of fine motor status, measured using the Denver II instrument. This instrument was selected based on its psychometric quality. Studies have indicated that Denver II has specificity ranging from 43% to 80% and a reliability rate of 90%, with usability ranging from 80% to 95%.[13] Standardized training was provided to Denver II assessors before the study commenced, following a structured guideline developed in

collaboration with physiotherapists to ensure standardized procedures. During the measurement process, a physiotherapist supervised the assessments to ensure accuracy and improve the reliability of the results.

Assessment results were classified as normal or abnormal, which determined the categorization of children into the control or case group. Children were categorized as normal (control group) if they showed no delays (F) or had a maximum of one caution (C). Children were classified as abnormal (case group) if they were identified as suspected or abnormal in the fine motor domain. The abnormal category was assigned to those with two or more delays, while the suspected category was assigned to those with two or more cautions (C) and at least one delay (F).

The primary independent variable was the age at which children began self-feeding, defined as the age when a child spent more than 50% of mealtime feeding independently. To enhance reporting accuracy and minimize recall bias, the questionnaire development process involved formulating clear operational definitions and establishing age categories based on the literature: (1) 0–12 months, (2) 13–24 months, (3) 25–36 months, and (4) >36 months6. These categories were adapted from Hua et al.6, whose study had a similar population. A modification was made to the first age category, adjusting the range to 0–12 months to improve respondent comprehension.[6]

To ensure instrument validity and reduce potential parental recall errors regarding their child's self-feeding age, the researchers standardized respondent understanding through video demonstrations of children self-feeding, written explanations of operational definitions, and direct assistance during questionnaire completion to address any queries. These efforts aimed not only to enhance respondents' understanding but also to guide their memory recall for greater accuracy and consistency.

Reliability testing of the instrument was conducted using the test-retest method on the same group of respondents with a maximum interval of one week to minimize memory bias. The reliability test used intraclass correlation (ICC) analysis, yielding a coefficient of 1, which is considered excellent reliability (>0.9).[14]

Confounding variables in this study included factors that could influence the relationship between self-feeding age and fine motor development. Based on a literature review, identified confounding variables included child characteristics (age and gender) and maternal characteristics (educational level). Child age was classified into annual age groups within the 3–6-year range. Maternal education level was categorized into three groups: primary education (elementary or junior high school graduates), secondary education (senior high school or vocational school graduates), and higher education (college graduates). Data were collected through an assessment form and a parental questionnaire.

This study employed a complete case analysis approach, analyzing only participants who completed the questionnaire and underwent measurements. Data analysis was conducted in three stages using IBM SPSS Statistics 22. First, cross-tabulation was performed to examine the distribution of maternal and child characteristics in the case and control groups. Second, univariate analysis using binary logistic regression was conducted to determine the relationship between risk factors and outcomes. Variables with a p-value <0.25 were included in the multivariate analysis. The p <0.25 cutoff was adopted from previous studies that used a similar data analysis approach.[15]

Third, multivariate logistic regression analysis was performed to analyze multiple variables simultaneously, estimate the OR, and control for confounding variables through adjusted OR (AOR) calculations. Model fit evaluation was conducted using several approaches. The Hosmer-Lemeshow goodness-of-fit test was applied, where the model was considered a good fit if p >0.05. Additionally, Pseudo-R^2 values (Nagelkerke R^2 and Cox & Snell R^2) were calculated to assess the proportion of variance in the dependent variable explained by the model, along with the Likelihood Ratio Test to evaluate overall model significance. All model fit assessments were derived from the logistic regression analysis output in SPSS.

Since fine motor assessment items vary by child age, subgroup analysis was conducted if child age was statistically significant (p <0.05) to assess its moderating effect on the relationship between independent and dependent variables. Subgroup analysis was not performed for gender, as the Denver II instrument applies the same scoring standards for boys and girls within each age group in the fine motor domain, making gender moderation analysis unnecessary.

Results

This study involved 135 samples that met the inclusion and exclusion criteria. The overall sample recruitment process is illustrated in Figure 1.

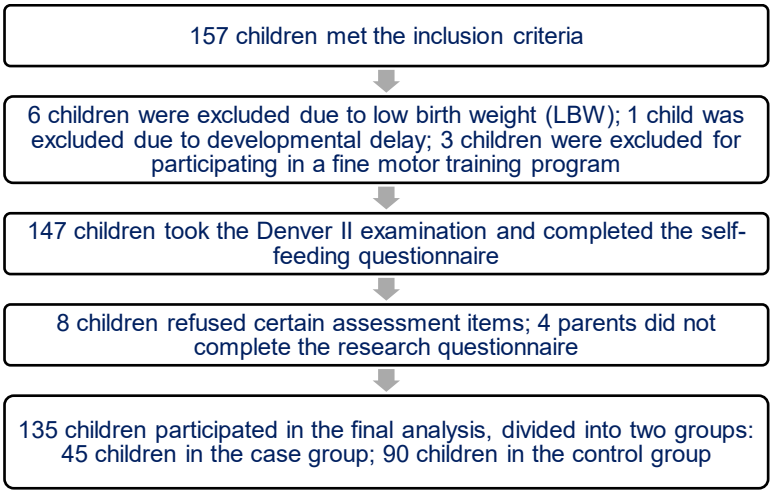

Figure 1. Flowchart of the Sample Recruitment Process

The recruitment process conducted in five kindergartens identified 157 children who met the inclusion criteria. After screening based on the exclusion criteria, 22 children were excluded for the following reasons: participation in an external fine motor training program for more than 66 days (n = 3), history of low birth weight (n = 6), developmental delay (n = 1), incomplete questionnaires (n = 4), and refusal to undergo assessment (n = 8). The final eligible sample consisted of 135 children, who were then allocated in a 1:2 ratio into the case group (n = 45) and the control group (n = 90).

The following tables present the findings of the study, beginning with a descriptive analysis of sample characteristics, followed by statistical evaluations using logistic regression models. Table 1 displays the cross-tabulation of sociodemographic and clinical characteristics between the case and control groups. Table 2 summarizes the results of univariate logistic regression analyses to identify potential factors associated with the outcome. Finally, Table 3 presents the multivariate logistic regression model, highlighting the variables that remained significant after controlling for confounders.

Table 1. Cross-Tabulation of Sample Characteristics in the Case and Control Groups

Characteristic	Fine Motor Development	
	Control (n (%)) Normal	Case (n (%)) Impaired
Age		
4 years	13 (14.4)	8 (17.8)
5 years	77 (85.6)	37 (82.2)
Total	90 (100)	45 (100)
Gender		
Female	59 (65.6)	21 (46.7)
Male	31 (34.4)	24 (53.3)
Total	90 (100)	45 (100)
Age at Onset of Self-Feeding		
0-12 months	45 (50)	5 (11.1)
13-24 months	29 (32.2)	14 (31.1)
25-36 months	9 (10)	11 (24.4)
>36 months	7 (7.8)	15 (33.3)
Total	90 (100)	45 (100)
Maternal Education		
Higher Education	28 (31.1)	10 (22.2)
Secondary Education	50 (55.6)	21 (46.7)
Primary Education	12 (13.3)	14 (31.1)
Total	90 (100)	45 (100)

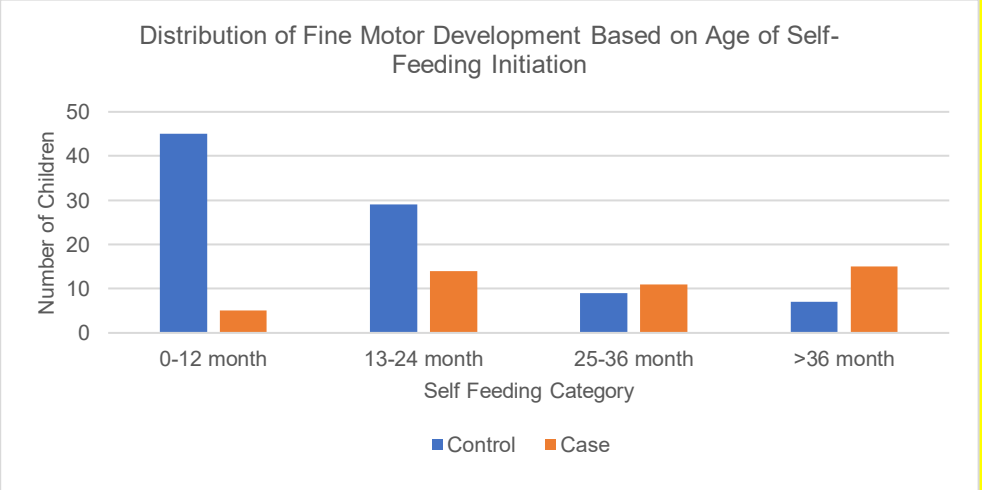

Figure 2. Bar Chart of Fine Motor Development Based on Age at Onset of Self-Feeding

Table 1 presents the characteristics of the sample in both groups, dominated by children aged 5 years. The gender distribution in the control group was predominantly female (65.6%), whereas the case group was predominantly male (53.3%). The maternal education levels in both groups showed a similar pattern, with the majority having a secondary education (case = 55.6%; control = 46.7%).

A key finding from the sample characteristics was the difference in the age at which self-feeding began between groups. In the control group, the majority of children started self-feeding at an early age (0–12 months, 50%), whereas in the case group, the largest proportion started self-feeding at a much later age (>36 months, 33.3%). Figure 2 visualizes this pattern, clearly indicating that children with normal fine motor development (control group) tended to start self-feeding at an earlier age, while those with impaired fine motor development (case group) tended to start self-feeding at a later age.

Table 2. Univariate Analysis Using Logistic Regression Model

Characteristic	OR (95% CI)	p-value
Age		
4 years	Reference	Reference
5 years	0.78 (0.298 – 2.048)	0.615
Gender		
Female	Reference	Reference
Male	2.17 (1.049 – 4.511)	0.037
Age at Onset of Self-Feeding		
0-12 months	Reference	Reference
13-24 months	4.34 (1.414 – 13.353)	0.010
25-36 months	11,00 (3.069 – 39.429)	<0.001
>36 months	19.28 (5.320 – 69.910)	<0.001
Maternal Education		
Higher Education	Reference	Reference
Secondary Education	1.17 (0.486 – 2.846)	0.719
Primary Education	3.26 (1.136 – 9.394)	0.028

Table 2 presents the univariate analysis results using logistic regression. Male children were 2.17 times more likely to have impaired fine motor development than females (OR = 2.17; p = 0.037). Children who started self-feeding at 13–24 months had a 4.34 times higher likelihood of impaired fine motor development (OR = 4.34; p = 0.010), increasing to 11,00 times higher at 25–36 months (OR = 11,00; p < 0.001). The highest risk was observed in children who started self-feeding after 36 months, who were 19.28 times more likely to have impaired fine motor development (OR = 19.28; p < 0.001) compared to those who started at 0–12 months. Children of mothers with only primary education were 3.26 times more likely to have impaired fine motor development than those whose mothers had higher education (OR = 3.26; p = 0.028).

Based on the univariate analysis results in Table 2, variables with a significance level of <0.25 were included in the multivariate analysis, namely gender, age at onset of self-feeding, and maternal education. A subgroup analysis was not performed for two reasons: first, the child's age variable was not statistically significant in the univariate analysis. Second, based on previous research using the Denver II instrument, there was an overlap in the 4–5 year age group (41–56 months and 57–82 months), with the same assessment items, including drawing a circle, copying an arrow, and drawing a person. This overlap rendered subgroup analysis by age irrelevant.

Table 3. Multivariate Analysis Using Logistic Regression Model

Characteristic	Adjusted OR (95% CI)	p-value
Gender		
Female	Reference	Reference
Male	2.35 (0.975 – 5.687)	0.057
Age at Onset of Self-Feeding		
0-12 months	Reference	Reference
13-24 months	3.51 (1.073 – 11.481)	0.038
25-36 months	13.77 (3.579 – 53.009)	<0.001
>36 months	17.35 (4.621 – 65.185)	<0.001
Maternal Education		
Higher Education	Reference	Reference
Secondary Education	1.31 (0.476 – 3.631)	0.598
Primary Education	3.41 (0.997 – 11.669)	0.051

The multivariate analysis results presented in Table 3 indicate that only the age at onset of self-feeding was significantly associated with fine motor development. Children who started self-feeding after 12 months had a higher likelihood of impaired fine motor development. The likelihood increased to 3.51 times (AOR = 3.51; p = 0.038) for children who started at 13–24 months, 13.77 times (AOR = 13.77; p < 0.001) for those at 25–36 months, and 17.35 times (AOR = 17.35; p < 0.001) for those who started after 36 months, compared to children who started self-feeding at 0–12 months.

Discussion

Our study examines the relationship between the age at which children begin to feed themselves and their fine motor development, along with confounding variables that influence both factors. The analysis results indicate a significant relationship between these two main variables. Univariate analysis revealed that boys were 2.17 times more likely to experience abnormal motor development compared to girls (p=0.037). Compared to children of mothers with higher education, children of mothers with only a basic education were 3.26 times more likely to have abnormal fine motor development (p=0.028). Compared to children who started feeding themselves between 0-12 months, the likelihood of abnormal motor development increased for those who started at 13-24 months (OR=4.34; p=0.010), 25-36 months (OR=11; p<0.001), and >36 months (OR=19.28; p<0.001). Multivariate analysis confirmed that only the variable of self-feeding age remained significant. Children who started feeding themselves at 13-24 months, 25-36 months, and >36 months had a higher likelihood of abnormal motor development than those who started at 0-12 months (adjusted OR=3.51; 13.77; and 17.35, respectively).

Relationship Between Age and Children's Fine Motor Development

A child's characteristics vary at each age level, highlighting the importance of adapting educational activities to suit their developmental needs. A study by Jozsa et al.11 involving 3,050 children aged 4-8 years in Slovakia and Hungary reported a significant relationship between age and fine motor development, with improvements in fine motor skills occurring as age increased. Our findings, however, differed, showing no significant relationship between a child's age and fine motor development (p=0.615).

This discrepancy may be explained by the limited age range in our study, which is linked to the use of the Denver II instrument. The fine motor assessment using Denver II for children aged 4-5 years covers overlapping age ranges (41-56 months and 57-82 months) with identical assessment items, such as drawing a circle, copying an arrow, and drawing a person with body parts[12]. The similarity in assessment items reduces the visibility of skill variation across age groups. Based on our analysis, future studies should use a broader age range to more accurately identify differences in fine motor development as children age.

Relationship Between Gender and Children's Fine Motor Development

Our study showed differing results between univariate and multivariate analyses regarding the relationship between gender and children's fine motor development. Univariate analysis showed a significant relationship, with an OR of 2.17, while multivariate analysis indicated a non-significant relationship (p=0.057) after adjusting for other variables. This difference in significance occurs due to confounding effects, primarily from the age at which children begin self-feeding, which strongly correlates with fine motor development. When all variables were included in the multivariate model, the strength of the relationship between gender and fine motor development diminished, suggesting that gender's influence is partially explained by other factors in the model.

These findings align with a study by Jozsa et al. in Hungary, which reported no significant relationship between gender and fine motor skills.[11] Although some previous studies suggest that girls excel in certain fine motor aspects, there is no significant difference between genders in aiming and catching skills.[12,16] Jozsa et al.emphasized that fine motor development differences cannot be solely explained by gender but should also consider environmental factors such as parenting style and socioeconomic status, which likely play a more significant role in fine motor development. Therefore, interventions aimed at improving fine motor development should focus on stimulation rather than relying on assumptions about gender-based differences.[11]

Relationship Between Maternal Education and Children's Fine Motor Development

Our study results indicated that in multivariate analysis, there was no significant relationship between low maternal education and children's fine motor development after adjusting for other variables (p=0.051). Although significant in univariate analysis (OR=3.26), this relationship became non-significant in multivariate analysis due to mediation by other variables, particularly the age of self-feeding initiation.

Although not statistically significant (p=0.051), this value is close to the significance threshold, suggesting a possible relationship, albeit not strong enough in the multivariate model. This finding aligns with previous research by Warseno et al.17, which reported a weak correlation between maternal education and children's fine motor skills. This relationship is indirect and mediated by other factors such as environmental stimulation, parent-child interactions, and socioeconomic conditions.[17]

Environmental factors play a crucial role in mediating the relationship between maternal education and children's fine motor development. A study by Geest et al. found that neglectful parenting was more common among mothers with lower education levels, whereas authoritative (democratic) parenting was more prevalent among mothers with medium to high education levels.[18] Research by Iwo et al.4 confirmed that parenting quality positively correlates with children's fine motor skills. Democratic parenting provides optimal stimulation for fine motor development by balancing rights and responsibilities.[4] In practice, democratic parents offer structured freedom, constructive guidance, and objective attention while maintaining control over children's behavior to ensure optimal development.[19]

Furthermore, our study identified several mechanisms through which maternal education contributes to children's fine motor development. First, higher maternal education improves the quality of stimulation and parenting behaviors.[20] A study by Kusuma et al. found that mothers with higher education levels are more likely to provide optimal stimulation for their children. Higher education enables mothers to better understand information about child health and development and adopt appropriate stimulation strategies.[21] Second, higher maternal education enhances problem-solving skills in responding to children's needs, allowing mothers to tailor parenting strategies to individual child development needs.[22] Third, better socioeconomic status among highly educated mothers provides greater access to developmental resources23, such as educational toys, books, and an environment conducive to sensorimotor exploration.[23]

However, it is essential to note that quality time with children also plays a vital role. In some cases, mothers with lower education levels but more flexible working hours may provide more intensive interaction with their children, positively contributing to their fine motor development.[24] Based on these findings, intervention programs should adopt a comprehensive approach that focuses on modifiable factors such as the quality of stimulation and parent-child interactions rather than solely on maternal education level, which is a non-modifiable factor.

The Relationship Between the Age of Self-Feeding Initiation and Children's Fine Motor Development

A child's readiness to self-feed is influenced by both gross and fine motor development.[6] This development begins with gross motor skills, where by around six months of age, the stability of the sitting position enables infants to explore their environment through reaching and manipulating objects, marking the initial milestone of fine motor development.[25] These fundamental abilities optimally develop by four to five months, with complexity depending on the

characteristics of the manipulated objects.[26] Fine motor development is one of the five crucial stages in fostering a child's ability to self-feed.[27]

In the context of self-feeding, the behavior of bringing the hand to the mouth, which emerges early, serves as a foundational skill for using a spoon.[25] This development occurs gradually, where by nine months, a child can hold a spoon, albeit not proficiently, and reaches maturity at 18 months with the ability to plan the movement of scooping food. Before mastering the use of utensils, the introduction of finger foods from seven months serves as a transitional approach toward independent eating.[28]

The importance of introducing self-feeding at an appropriate age is supported by the findings of this study. The results consistently reveal a significant relationship between the age of self-feeding initiation and children's fine motor development, even after controlling for other variables such as the child's gender and maternal education in multivariate analysis. Statistical findings show Adjusted Odds Ratios (AOR) for each self-feeding initiation age category: 3.51 for ages 13-24 months, 13.77 for ages 25-36 months, and 17.35 for ages >36 months compared to children who started self-feeding at 0-12 months. These findings indicate that the later a child begins self-feeding, the greater the likelihood of experiencing abnormal fine motor development.

Empirical evidence from various studies supports these findings. Campeau et al.29 reported that self-feeding ability positively contributes to children's fine motor development, particularly through the Baby-Led Weaning (BLW) approach.[29] Comparative analysis results show that children following BLW have higher grasping skill scores and fine motor quotients than non-BLW children. BLW is a feeding method that strategically uses large-sized food pieces,[30] which fosters motor skills such as grasping, holding, and bringing food to the mouth during the transition to complementary feeding.[29]

Arslan et al. identified two key factors influencing a child's self-feeding ability: motor development stage and training intensity.[30] The importance of initiating self-feeding training at an appropriate age is supported by Remijin et al. who evaluated the effectiveness of introducing finger foods on fine motor development. Measurements using the Bayley-III-N revealed that the majority of subjects (57%) who started consuming finger foods at six to eight months exhibited good fine motor skills, with an average score of 11 (range 7-14).[31]

A longitudinal study by Hua et al.6 further reinforces these findings through a comparison between typically developing children and those at risk for Developmental Coordination Disorder (DCD). The study results indicate that delayed self-feeding can serve as an early predictor of motor impairment, as children with DCD characteristics consistently struggle with daily motor activities.[6]

According to Hua et al.,6 the relationship between self-feeding initiation age and fine motor development can be explained through two main mechanisms. First, self-feeding skills are more easily automated when practiced early, so a delayed start reduces practice opportunities, ultimately affecting motor performance. Second, active parental involvement in providing training and feedback during the learning process significantly contributes to overall motor skill enhancement in children.[6]

The impact of delayed self-feeding on child development is further supported by recent studies. Ren et al.32 reported that children aged one to three years who experience feeding difficulties exhibit poor fine motor function.[32] Measurements using the Ages and Stages Questionnaires (ASQ) confirm that children with feeding problems have a higher risk of fine motor delays, with this relationship strengthening with age. This creates a cycle where poor fine motor skills exacerbate feeding difficulties by impairing self-feeding ability.[33]

The findings of this study have practical implications for parents in supporting their children's fine motor development. The importance of fine motor stimulation extends beyond independent practice and can also be facilitated through structured clinical guidelines. Recent studies indicate that clinical guidelines on self-feeding can increase the proportion of children who begin eating independently.[8]

Therefore, a concrete recommendation for healthcare professionals is to provide and disseminate self-feeding guidelines that include developmental stages of self-feeding skills, responsive feeding strategies, and appropriate motor stimulation techniques according to a child's age. Fine motor stimulation can serve as an effective strategy for improving self-feeding ability and reducing feeding difficulties.[32]

Additionally, parents play a crucial role in encouraging children to self-feed from an early age by creating a mealtime environment that supports exploration and independence. This approach not only helps children develop self-feeding skills but also strengthens the fine motor development necessary for the eating process.[34]

The primary limitation of this study lies in the case-control design, which may introduce recall bias, particularly in remembering the exact time children began self-feeding. Efforts to mitigate this were made through two measurement sessions conducted one week apart, yielding a reliability value of 1. Although the short measurement interval could introduce a testing effect that influences response consistency, this timeframe was chosen to minimize memory bias and the risk of loss to follow-up.

This study also has limitations in the measurement instrument, where the eating independence questionnaire lacks specificity because it only assesses from one item, namely the time of starting to eat alone, without covering other aspects such as the ability to use cutlery or food pouring skills. The category ‘self-feeding’ used is also too broad and poorly defined, not distinguishing levels of independence such as eating with minimal assistance, with supervision, or fully independent. In addition, the use of Denver II as a measurement tool has limitations in describing fine motor development in detail, as it is a general screening tool that is not specifically designed to measure fine motor aspects comprehensively.

Furthermore, this study does not report absolute risk, as the case-control design does not allow for the estimation of disease incidence or prevalence in the population. Absolute risk interpretation requires additional information from cohort studies or population data, which were not available in this study. Therefore, the Odds Ratio (OR) was used as a more relevant association measure in this analysis.

For future research, a prospective study design with more systematic documentation of child development is recommended. Child development documentation can be conducted using the Maternal and Child Health (KIA) book, digital growth monitoring applications, or developmental tracking cards regularly completed by parents. To ensure more accurate and consistent records, healthcare professionals can provide periodic education to parents on the importance of recording child development and verifying data during health visits. Implementing these methods allows for more objective and continuous measurement, thereby reducing recall bias, improving data accuracy, and providing a more valid and comprehensive picture of children's motor development.

Conclusion

This study found a significant relationship between delayed self-feeding initiation and an increased likelihood of abnormal fine motor development in preschool children at kindergartens in the Pemecutan subdistrict. This result remained consistent after controlling for variables such as age, gender, and maternal education. The practical implications highlight the importance of healthcare professionals providing structured self-feeding guidelines and the need for parents to encourage early self-feeding by creating an environment that supports children's exploration. However, this study has limitations, including the potential for parental recall bias and the inability to report absolute risk due to the case-control study design.

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