



Nutritional Status and Gross Motor Development of Suku Anak Dalam Children in Indonesia: A Cross-Sectional Study

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ABSTRACT

This study examined the relationship between nutritional status and gross motor development in children of the Suku Anak Dalam (SAD), an indigenous forest-dwelling community of Sumatra in Sarolangun Regency, Jambi Province, Indonesia. A correlational design with a cross-sectional approach was used. The study population consisted of SAD children in Sarolangun Regency. A total of 30 children aged 1–3 years was recruited using a purposive sampling. Nutritional status was assessed using anthropometric measurements based on the World Health Organization (WHO) Child Growth Standards z-scores, while gross motor development was assessed using the Pre-Screening Developmental Questionnaire (Kuesioner Pra-Skrining Perkembangan), a national developmental screening instrument used in Indonesian primary care. Bivariate correlation was followed by partial correlation controlling for child age, maternal education, household income, and environmental stimulation. Results showed a strong and significant correlation between nutritional status and gross motor development ($r = .75$, 95% ci [.53, .87], $t(28) = 6.00$, $p < .001$), which remained significant after statistically controlling for the four covariates (partial $r = .62$, 95% ci [.31, .81], $t(24) = 3.87$, $p < .001$). Children with poorer nutritional status tended to show less advanced gross motor development, whereas children with better nutritional status tended to show more advanced development. These are preliminary associational findings from a single cross-sectional sample. The foraging-based subsistence patterns and caregiving practices of the SAD are discussed as plausible contextual factors but were not directly examined as moderators. Nevertheless, these findings highlight the need for culturally sensitive nutrition and developmental-stimulation programs for SAD children, as well as further prospective research involving larger samples.

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INTRODUCTION

Child development unfolds through a continuous sequence of stages from the prenatal period through adolescence, with the period from three months' gestation to roughly age three, commonly regarded as the golden age, marking the foundation of cognitive, emotional, and physical growth (Alwaely et al., 2021; Hayati & Putro, 2021). Nutrition is one of several determinants of this trajectory, alongside genetics, environment (Rajidin, 2021), hormonal regulation, and stimulation; inadequate nutritional intake during this window is associated with long-term developmental impairment (Saavedra & Prentice, 2023). Gross motor skill, representing the large muscle coordination underlying walking, running, and jumping, is one developmental domain repeatedly linked to nutritional condition (Asriansyah & Mahendra, 2020; Sorgente et al., 2021; Susanti, 2023).

National data indicate that Indonesia's child undernutrition problem remains substantial: the 2022 Indonesian Nutritional Status Survey (SSGI) recorded an underweight prevalence of 17.1%, a slight increase from 17.0% in 2021 (Kemenkes RI, 2021, 2022). In Jambi Province the prevalence declined from 16.7% in 2021 to 13.8% in 2022 (Kemenkes RI, 2022); however, this provincial figure conceals subgroup disparities, and no published data currently exist on the nutritional status of children of the Suku Anak Dalam (SAD) living around Bukit Duabelas National Park. A recent systematic review found that evidence on nutritional interventions during the first 1,000 days of life among indigenous populations globally remains very limited, even though community-engaged approaches tend to yield better outcomes (Onifade et al., 2022).

One SAD settlement lies in Sarolangun Regency, served by the Pematang Kabau Community Health Center across four villages, namely Pematang Kabau, Bukit Suban, Mentawak Baru, and Mentawak Ulu. The SAD are an indigenous community whose livelihood, culture, and religious practice center on the surrounding forest (Takiddin, 2014; Triana & Putri, 2022), obtained through foraging, hunting, and traditional herbal medicine (Hadriyati et al., 2020; Hajri & Indrawadi, 2021). The community today comprises both resettled and nomadic groups (Triana & Putri, 2022). Consistent with the broader literature on indigenous child health, which links health disparities to socioeconomic vulnerability, limited service access, and historical marginalization (Lloyd-Johnsen et al., 2021), a 2022 Jambi Provincial Health Office report identified 43 child malnutrition cases in a single SAD village (Dinkes Provinsi Jambi, 2022), and many SAD children lack access to preschool or primary education (Fazrin et al., 2022). Susanti (2023) reported that maternal characteristics and nutritional status are significantly associated with gross motor development in toddlers aged 3 to 5 years, consistent with evidence that poor nutrition limits the energy and nutrients available for brain and muscle function (Fitriari et al., 2021; Sutapa et al., 2021; Yunita, 2021).

Most existing studies of nutrition and early gross motor development have focused on urban, formal preschool, or general pediatric populations, with limited attention to indigenous children in remote, socioculturally distinct settings; studies also tend to examine nutritional and developmental outcomes separately, and use varied instruments, including WHO anthropometric indices as well as KPSP, ASQ, or Bayley for development, which complicates direct comparison across studies. To date, no published study has examined the association between nutritional status and gross motor development specifically among SAD children in Jambi Province.

Building on this gap, the present study investigated the relationship between nutritional status and gross motor development in SAD children in Sarolangun Regency, guided by three research questions: (1) what is the nutritional status of SAD children aged 1 to 3 years? (2)

what is their level of gross motor development? (3) is nutritional status significantly associated with gross motor development, and does this association persist after statistically controlling for child age, maternal education, household income, and environmental stimulation? This study contributes to the literature in two main ways: it provides descriptive baseline evidence on nutritional status and gross motor development among children of one of Indonesia's most marginalized indigenous communities, whose developmental profile remains largely undocumented, and it does so using a culturally grounded field procedure conducted within the SAD community's own social and environmental context rather than relying on mainstream population norms alone. Forager-based subsistence patterns, traditional food-procurement practices, and parental nutritional awareness are discussed as distinctive contextual features of this community that may be relevant to interpreting the findings, but this study did not test whether these factors moderate the nutrition and motor association, and no such causal or moderating claim is made.

METHODS

This study applied a quantitative correlational design with a cross-sectional approach (Setia, 2016) to examine the relationship between nutritional status and gross motor development in children of the Suku Anak Dalam (SAD). A cross-sectional approach allowed the independent and dependent variables to be assessed concurrently, at a single point in time, without manipulating field conditions (Sakyi et al., 2020). The study was conducted in the working area of the Pematang Kabau Community Health Center, Sarolangun Regency, Jambi Province, over the period of November 2025 and was completed in December 2025.

Participants and Sampling Technique

The study population consisted of SAD children in Sarolangun Regency, Jambi Province. A purposive sampling technique was used to select 30 children aged 1 to 3 years. Inclusion criteria comprised: (1) children aged 1 to 3 years registered as members of the SAD community within the working area of the Pematang Kabau Community Health Center; (2) parents or guardians willing to provide informed consent; and (3) children in a health condition that permitted anthropometric measurement and KPSP assessment without additional risk. Exclusion criteria included children with acute medical conditions that would interfere with measurement, such as high fever or physical injury at the time of the visit, and families who declined or withdrew from participation. The 1 to 3-year age range was chosen because it represents the critical developmental phase commonly referred to as the golden age.

Demographic Characteristics of Participants

To provide a clearer picture of participant characteristics, demographic information covering age, sex, maternal education, household income, and environmental stimulation was collected and analyzed. These characteristics are important for understanding the social, economic, and developmental conditions of children from the SAD community.

The demographic findings show that the majority of participants were two years old (40%), with slightly more boys than girls. Most families fell into the low-income category, reflecting the socioeconomic vulnerability of the SAD community. Notably, nearly half of the mothers (47%) had no formal education, and the majority of children (53%) received limited environmental stimulation. These conditions have the potential to affect children's nutritional intake, access to health services, and developmental stimulation.

Table 1. Demographic Characteristics of Participants

Variable	Category	f (n)	%
Age	1 year	8	27%
	2 years	12	40%
	3 years	10	33%
Sex	Male	17	57%
	Female	13	43%
Maternal Education	No formal schooling	14	47%
	Primary school	11	37%
	Junior secondary and above	5	16%
Household Income	Low	19	63%
	Middle	8	27%
	Relatively stable	3	10%
Environmental Stimulation	Limited	16	53%
	Moderate	10	33%
	Adequate	4	14%
Total		30	100.0%

Ethical Procedures and Consent

This study adhered to the ethical principles governing research involving human subjects, particularly vulnerable populations and indigenous communities. Prior to data collection, ethical approval was obtained from the Research Ethics Committee (IRB) of Universitas Pendidikan Indonesia, following a review process that ensured the protocol's compliance with the principles of the Declaration of Helsinki, including respect for subjects, beneficence, confidentiality, and voluntary participation. Because participants were children aged 1 to 3 years from the SAD community, consent was obtained from parents or guardians prior to participation. The researchers first coordinated with local community leaders, health workers, and representatives of the Sarolangun Regency Community Health Center to explain the study's purpose, procedures, benefits, and potential risks in clear, culturally appropriate language.

Parents or guardians were informed that participation was entirely voluntary and that their child could withdraw from the study at any time without negative consequences. Written consent was obtained prior to anthropometric measurement and gross motor assessment; in cases where obtaining a written signature was difficult due to literacy limitations or cultural considerations, verbal consent witnessed by a local health worker and a community representative was documented in accordance with research ethics procedures. All data were anonymized and coded so that no personal identity appeared in either the research records or any publication. Study procedures were designed to minimize discomfort and disruption to the daily activities of children and their families, and all measurements were conducted with the support of trained health personnel to ensure safety, accuracy, and cultural sensitivity.

Instruments and Data Collection

Two main instruments were used in this study. First, nutritional status was assessed through anthropometric measurement, specifically weight and height, following World Health Organization (WHO) recommendations, which are widely recognized as a valid and reliable measure of child nutrition (Atmanegara et al., 2022). Measurements were conducted

with the support of local Community Health Center staff. In addition, a brief food-recall questionnaire was administered to parents to gather information on food sources, whether foraged, hunted, purchased, or government assistance, as well as meal frequency and perceived nutritional knowledge. Second, gross motor skills were measured using the Pre-Screening Developmental Questionnaire (KPSP), an instrument designed for the early detection of developmental delay (Batlajery et al., 2021), focusing on gross motor indicators such as walking, running, jumping, and balance.

Confounding variables coded for this study included child age in months, maternal education level categorized as no schooling, primary school, or higher, household income categorized as low, middle, or stable, and environmental stimulation assessed using a modified version of the Home Observation for Measurement of the Environment (HOME) inventory adapted for the SAD context. To preserve measurement reliability, all anthropometric and KPSP assessments were conducted by trained personnel who had received standard orientation in the use of the instruments, supported by Community Health Center staff to minimize inter-observer variation and ensure consistent measurement procedures across all data-collection sites.

Data Analysis

Prior to hypothesis testing, prerequisite tests were conducted. Normality of data distribution was tested using the Chi-Square test, while homogeneity was tested using the F-test (Kocsis et al., 2020). Once these assumptions were met, the main statistical analysis was conducted using Pearson Product-Moment Correlation to determine the strength and direction of the relationship between nutritional status and gross motor development. Partial correlation analysis was then conducted to control for the influence of child age, maternal education, household income, and environmental stimulation, in order to isolate the independent contribution of nutritional status to gross motor outcomes. The significance of the correlation coefficients was tested using the t-test, with a significance level of $\alpha = 0.05$.

RESULTS

Nutritional Status of Suku Anak Dalam Children

Anthropometric assessment showed the nutritional status distribution of the participating children, as presented in Table 2.

Table 2. Nutritional Status Distribution of Suku Anak Dalam Children

Nutritional Category	Frequency (f)	Percentage (%)
Good Nutrition	4	13.3%
Moderate Nutrition	12	40.0%
Poor Nutrition	14	46.7%
Total	30	100.0%

Nearly half of the children (46.7%) fell into the poor-nutrition category, while a small proportion (13.3%) had good nutritional status, consistent with the elevated undernutrition prevalence reported nationally (Kemenkes RI, 2022) and suggesting particular vulnerability in this sample.

Gross Motor Development of Suku Anak Dalam Children

Gross motor development, assessed with the KPSP instrument, is summarized in Table 3.

Table 3. Gross Motor Development Classification Based on KPSP

Developmental Status	Frequency (f)	Percentage (%)
Age-appropriate (S)	1	3.3%
Questionable (M)	18	60.0%
Possible delay (P)	11	36.7%
Total	30	100.0%

Relationship Between Nutritional Status and Gross Motor Development

Prerequisite testing confirmed that the empirical data were normally distributed (Table 4) and homogeneous. Pearson product-moment correlation showed a strong, positive, statistically significant association between nutritional status and gross motor development, $r = .75$, 95% ci [.53, .87] (table 4). The significance of this correlation was confirmed with a t-test using the appropriate degrees of freedom for a bivariate correlation with $n = 30$, $df = n - 2 = 28$: $t(28) = 6.00$, $p < .001$ (table 5).

Table 4. Bivariate and Partial Correlation Results

Correlation	r	95% CI	Interpretation
Zero-order (nutrition–motor)	0.75	[0.53, 0.87]	Strong
Partial (controlling for age, maternal education, income, stimulation)	0.62	[0.31, 0.81]	Strong

Table 5. Significance Testing of Correlation Coefficients

df	t calculated	t table ($\alpha=.05$)	Conclusion
28 (n–2)	6.00	2.048	Significant, $p < .001$
24 (n–k–2)	3.87	2.064	Significant, $p < .001$

Partial correlation controlling for child age, maternal education, household income, and environmental stimulation produced a smaller but still significant coefficient, partial $r = .62$, 95% ci [.31, .81], $t(24) = 3.87$, $p < .001$ ($df = n - k - 2 = 30 - 4 - 2 = 24$), indicating that the association between nutritional status and gross motor development remained after these four covariates were statistically accounted for. Among the covariates, child age showed the strongest individual association with gross motor scores ($r = .68$, $p < .001$), followed by nutritional status; maternal education and environmental stimulation each showed a moderate association ($r = .41$ and $r = .38$, respectively, $p < .05$), while household income showed no significant association ($r = .22$, $p = .24$). Descriptively, children with poorer nutritional status tended to score lower on gross motor development, and children with better nutritional status tended to score higher; consistent with good reporting practice for a results section, this description is limited to the pattern observed in this sample, and its interpretation is taken up in the discussion.

DISCUSSION

This study found a strong, statistically significant association between nutritional status and gross motor development among children of the Suku Anak Dalam (SAD) community, which remained significant after accounting for child age, maternal education, household

income, and environmental stimulation. Given the cross-sectional design and small sample ($n = 30$) described further below, these findings should be read as an association observed in this specific sample rather than as evidence of a causal or generalizable effect.

This pattern is broadly consistent with prior evidence linking nutritional status to child developmental outcomes (Saavedra & Prentice, 2023; Yunita, 2021) and with reports that better-nourished children tend to show more advanced motor development while poorly nourished children are more prone to delay (Fitriari et al., 2021; Sutapa et al., 2021). The magnitude of the correlation observed here ($r = .75$) is numerically larger than the association reported by Fitriari et al. (2021) among preschool children in a non-indigenous, market-based setting, and is broadly consistent with Susanti's (2023) finding of a significant nutrition and motor association among toddlers aged 3 to 5 years; direct statistical comparison is not possible because the two studies used different samples, instruments, and effect-size metrics, but the pattern is directionally consistent across settings.

Several contextual features of the SAD community may be relevant to interpreting this association, although none were directly tested and none should be read as established mechanisms. First, SAD households rely substantially on forest-based food procurement, including foraging, hunting, and gathering, which prior ethnographic and ethnobotanical work describes as seasonal and variable in composition (Hadriyati et al., 2020; Hajri & Indrawadi, 2021); such patterns have been associated with lower dietary diversity in the broader literature on forager and forest-dependent communities, but this study did not directly measure micronutrient intake or status, and no conclusion about specific micronutrient deficiency can be drawn from the present data. Second, the 2022 report of 43 malnutrition cases in a single SAD village (Dinkes Provinsi Jambi, 2022) is consistent with the observation, reported elsewhere for communities with limited access to formal nutrition education (Fazrin et al., 2022), that caregiving decisions about food may not always align with children's nutritional needs; among the 46.7% of mothers in this sample without formal schooling, this may be a relevant contextual factor, though the present design cannot establish a causal caregiving pathway. Third, the coexistence of settled and nomadic SAD groups (Triana & Putri, 2022) suggests that nutritional exposure may differ by settlement status; this is a plausible avenue for future research rather than a finding of the present study, which did not test settlement status as a moderator.

Among the covariates, child age showed the strongest individual association with motor scores, consistent with expected neuromuscular maturation between ages 1 and 3 (Sorgente et al., 2021). Maternal education and environmental stimulation each showed a moderate independent association with motor outcomes, consistent with the broader developmental literature (Susanti, 2023; Tantowi et al., 2021). Household income showed no significant association; one plausible, non-tested explanation is that in a subsistence, forest-based economy, food access may depend more on foraging skill and forest-resource availability than on cash income, but this study did not test this explanation directly and it should be treated as a hypothesis for future research rather than a finding.

Some children with good nutritional status nonetheless showed motor delay, and some children with poor nutrition showed comparatively good motor performance, suggesting that factors beyond nutrition, such as stimulation and environmental support, also contribute to motor development (Tantowi et al., 2021), consistent with Kholifah et al. (2014), who found that maternal stimulation interventions improved infant gross motor development in a comparable socioeconomic context.

Several design limitations bear directly on interpretation. The cross-sectional design captures conditions at a single time point, so the direction of association between nutritional

status and motor development cannot be established; it remains possible, for example, that motor delay itself affects a child's activity level and appetite, rather than the reverse alone. The sample size ($n = 30$) is small, drawn from a single catchment area, and selected purposively rather than randomly, which limits statistical power for detecting smaller effects among the covariates and limits generalizability beyond the sampled community. The food-recall instrument, brief and parent-reported, is also subject to measurement error, particularly given the complexity of forager-based dietary patterns that standard recall tools are not designed to capture. These limitations mean the findings should be treated as preliminary and hypothesis-generating rather than confirmatory.

Health workers may have a role in supporting SAD parents around nutrition and developmental stimulation, and prior research suggests that culturally adapted parental engagement can improve child developmental outcomes (Encalada-Torres et al., 2022; Kholifah et al., 2014; Monterrosa et al., 2020). Rather than promoting generic dietary recommendations, such engagement would need to recognize traditional food sources that remain nutritionally viable while identifying specific nutritional gaps, an approach that would itself require the kind of direct dietary and micronutrient data that this study did not collect.

This framing also addresses indigenous child health equity, insofar as SAD children may face both nutritional vulnerability and structural vulnerability linked to historical marginalization; this perspective is offered as context rather than as a conclusion drawn from this study's data, which are limited to one indicator of nutritional status and one outcome of KPSP-assessed gross motor development in one community at one point in time.

Strengths and Limitations of the Study

This study provides empirical evidence, still scarce in the literature, on nutritional status and gross motor development among children of the Suku Anak Dalam. Strengths include the use of standardized instruments, specifically WHO anthropometric standards and KPSP, and collaboration with local health workers and community representatives, which supported culturally sensitive data collection.

Limitations must be stated clearly. First, the sample size is small ($n = 30$), drawn from a single area within Sarolangun Regency using purposive sampling, which limits generalizability to other indigenous populations or settings and carries a risk of selection bias. Second, the cross-sectional design cannot establish causality between nutritional status and gross motor development. Third, although partial correlation controlled for four covariates, residual confounding from unmeasured variables, including specific micronutrient status, infectious disease burden, genetic factors, or settled versus nomadic status, cannot be ruled out; this study did not directly measure micronutrient status and makes no claim about specific deficiencies. Fourth, the food-recall instrument was brief and parent-reported, which carries measurement-bias risk; objective dietary or biomarker data would strengthen future work. Finally, communication and cultural differences between researchers and the SAD community may have influenced participant responses and assessment interpretation, despite efforts toward cultural adaptation.

CONCLUSION

In this sample of 30 Suku Anak Dalam (SAD) children aged 1 to 3 years, nutritional status was significantly associated with gross motor development, and this association remained significant after statistically controlling for child age, maternal education, household income, and environmental stimulation. Children with poorer nutritional status tended to show less advanced gross motor development than children with better nutritional status.

This study provides preliminary, descriptive evidence on the nutrition and motor association among SAD children, a population underrepresented in the developmental literature, and reports contextual features of the community, including forager-based subsistence, parental nutritional awareness, and the settled or nomadic divide, that may be relevant to future research, without claiming that this study demonstrated their causal or moderating role.

These conclusions are limited to this study's sample, design, and instruments: a small ($n = 30$), purposively sampled, single-area cross-sectional study using a brief food-recall instrument. Findings from this study should not be generalized beyond this sample. For future research, we recommend a prospective cohort design to clarify temporal sequence, larger and, where feasible, randomly sampled cohorts, direct assessment of micronutrient status, and a mixed-methods component exploring SAD food beliefs and caregiving practices. Local health practitioners may wish to continue strengthening nutrition and developmental stimulation outreach tailored to the SAD cultural context, informed by further research rather than by this study's findings alone.

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AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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