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Inadequate protein and milk consumption related to stunting in children aged 24–59 months in Tanjung Priok, Jakarta

Konsumsi protein dan susu yang tidak memadai terkait stunting pada anak usia 24-59 bulan di Tanjung Priok, Jakarta

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Abstract

Evidence on the combined association of nutrient intake and specific protein-source foods with stunting in densely populated Indonesian urban communities is limited, hindering the implementation of locally targeted nutritional interventions. This study aimed to examine the association between nutrient intake and protein-source food consumption and stunting among children aged 24–59 months in Tanjung Priok, North Jakarta. Methods: This cross-sectional study included 184 children selected by cluster random sampling from three subdistricts between January and July 2023. Stunting was defined as a height-for-age below −2 standard deviations of the World Health Organization growth standard. Dietary intake was assessed using a 24-hour recall and protein-source food frequency questionnaire. Chi-square tests and logistic regression were used to analyzed. Of the 184 children, 43 (23.4%) were stunted. Rare milk and dairy consumption (<4 times/week) was associated with higher odds of stunting (adjusted odds ratio [aOR], 2.911; 95% confidence interval [CI], 1.260–6.723; p=0.012). Inadequate protein intake was also associated with higher odds (aOR, 2.268; 95% CI, 1.024–5.023; p=0.044). Other adjusted dietary associations were not found to be statistically significant. In conclusion, rare milk and dairy consumption and inadequate protein intake were associated with stunted growth. Improving access to affordable and diverse protein-rich foods, including appropriate dairy products, may support child nutrition in similar urban communities.

Keywords: Child nutrition disorders, Dairy products, Dietary proteins, Growth disorders

Abstrak

Masih terbatasnya bukti terkait hubungan gabungan antara asupan zat gizi dan konsumsi pangan sumber protein tertentu dengan stunting pada masyarakat perkotaan padat penduduk di Indonesia, sehingga intervensi gizi lokal belum sepenuhnya terarah. Penelitian ini bertujuan menganalisis hubungan asupan zat gizi dan konsumsi pangan sumber protein dengan stunting pada anak usia 24–59 bulan di Tanjung Priok, Jakarta Utara. Penelitian potong lintang ini melibatkan 184 anak yang dipilih melalui *cluster random sampling* dari tiga kelurahan pada Januari–Juli 2023. Stunting ditetapkan berdasarkan indeks tinggi badan menurut umur kurang dari −2 simpangan baku standar pertumbuhan Organisasi Kesehatan Dunia. Asupan makanan dinilai menggunakan *recall* 24 jam, sedangkan frekuensi konsumsi pangan sumber protein diukur dengan kuesioner frekuensi pangan. Data dianalisis menggunakan uji chi-kuadrat dan regresi logistik. Dari 184 anak, 43 anak (23,4%) mengalami stunting. Konsumsi susu dan produk olahannya yang jarang (<4 kali/minggu) berhubungan dengan peluang stunting yang lebih tinggi (aOR=2,911; IK95%: 1,260–6,723; p=0,012). Asupan protein yang tidak memadai juga berhubungan dengan peluang stunting yang lebih tinggi (aOR=2,268; IK95%: 1,024–5,023; p=0,044). Faktor makanan lainnya tidak menunjukkan hubungan bermakna setelah penyesuaian. Kesimpulan, peningkatan akses terhadap pangan kaya protein yang terjangkau dan beragam dapat mendukung perbaikan gizi anak di wilayah perkotaan serupa.

Kata Kunci: Gangguan gizi anak, gangguan pertumbuhan, produk susu, protein makanan

Introduction

Stunting, defined as a height-for-age more than two standard deviations below the World Health Organization Child Growth Standards median, remains a major public health concern among children younger than five years. In 2024, an estimated 150.2 million children worldwide, or 23.2% of the global population in this age group, were affected by stunting, with the greatest burden concentrated in Asia and Africa (United Nations Children's Fund [UNICEF], World Health Organization [WHO], & World Bank Group, 2025). Beyond impaired linear growth, stunting is associated with adverse long-term outcomes, including poorer cognitive development, lower educational attainment, and reduced economic productivity in adulthood (UNICEF, WHO, & World Bank Group, 2023).

Indonesia continues to experience a substantial burden of childhood stunting with marked geographic and socioeconomic disparities. According to the 2023 Indonesian Health Survey, the prevalence of stunting among children aged 24–59 months was 12.9% nationally and 12.6% in Jakarta (Kementerian Kesehatan Republik Indonesia, 2023). Despite Jakarta's status as the national capital and its relatively extensive health infrastructure, stunting remains an important concern in economically disadvantaged, urban communities. In North Jakarta, the reported prevalence reached 18.5%, exceeding the overall provincial estimate for the Special Capital Region of Jakarta (Kementerian Kesehatan Republik Indonesia, 2022). Data from the Jakarta Provincial Health Office further indicated that Tanjung Priok had the second highest number of stunted children among the districts in North Jakarta in 2022. These patterns illustrate that proximity to health services does not necessarily eliminate the nutritional disadvantages associated with poverty, household food insecurity, and unequal access to diverse nutrient-dense foods.

Adequate dietary intake and appropriate child feeding practices are immediate determinants of child nutritional status (UNICEF, 2020). Both the quantity and quality of food consumed are important for supporting growth in early childhood. Inadequate complementary feeding practices, including limited dietary diversity and insufficient feeding frequency, have been associated with stunting in children aged 6–59 months (Babys et al., 2022). Indonesian studies have also reported an association between inadequate nutrient intake and stunting among young children (Fajri et al., 2024; Napitupulu et al., 2024). These findings underscore the importance of examining not only the total nutrient intake but also the types and frequency of foods consumed.

Protein is particularly important for linear growth because it provides essential amino acids required for the synthesis of muscle and bone tissues and supports the insulin-like growth factor-1 pathway. Low circulating concentrations of essential amino acids have been observed in children with stunting, suggesting a biologically plausible relationship between inadequate protein availability and impaired growth (Semba et al., 2016). Animal-source foods, including milk, eggs, fish, poultry, and meat, provide high-quality proteins with favorable amino acid profiles and high digestibility. Their consumption has been associated with improved growth outcomes among young children in low- and middle-income countries (Parikh et al., 2022). In Indonesia, limited access to animal-source foods among low-income households may contribute to inadequate protein intake and increased vulnerability to stunting (Hermawan et al., 2023).

Milk and dairy products are especially relevant because they provide high-quality protein, calcium, phosphorus, zinc, and other nutrients involved in skeletal growth. Previous studies in Indonesia have reported associations between milk consumption, protein intake, and stunting in children aged 24–59 months (Sari et al., 2016; Sjarif et al., 2019). However, much of the available evidence has focused on total protein intake or individual food groups. Few studies have simultaneously assessed overall nutrient intake and the frequency of multiple protein-source food groups using complementary dietary assessment methods, particularly in densely populated and economically disadvantaged urban settings.

Tanjung Priok is a densely populated district in North Jakarta, characterized by substantial socioeconomic inequality and limited household access to diverse foods. Local health data indicate that stunting remains elevated among children younger than five years of age in this area (Puskesmas Tanjung Priok, 2023). Children aged 24–59 months may be particularly vulnerable because this period involves a continued transition from breastfeeding and complementary feeding to family foods. In low-income urban households, restricted purchasing power may reduce access to adequate quantities of protein-rich and nutrient-dense food. Nationally representative evidence also indicates that socioeconomic disparities continue to shape childhood stunting in both urban and rural areas of Indonesia (Siramaneerat et al., 2024).

Therefore, this study aimed to examine the association between nutrient intake and protein-source food consumption and stunting among children aged 24–59 months in Tanjung Priok, North Jakarta. By assessing both nutrient adequacy and the frequency of specific protein-source foods, this study aims to provide evidence relevant to community-based nutrition programs, caregiver counseling, and local strategies to improve child feeding practices in high-risk urban populations.

Methods

This cross-sectional study was conducted between January and July 2023 in the Tanjung Priok District of North Jakarta, Indonesia. Data were collected from three sub-districts: Kebon Bawang, Sunter Jaya, and Warakas. Tanjung Priok was selected because it is a densely populated urban area with a relatively high burden of childhood stunting, based on the 2022 Indonesian Electronic Community-Based Nutrition Recording and Reporting System (e-PPGBM).

A total of 184 children aged 24–59 months were selected using cluster-random sampling. Children were eligible if they were aged 24–59 months and lived with their biological mother or primary caregiver in one of the selected clusters in the Tanjung Priok District during the data collection period. Children were excluded if they had physical disabilities, congenital abnormalities, chronic diseases, severe acute illnesses, or other medical conditions that could affect their anthropometric measurements or dietary intake. Children with incomplete anthropometric measurements or dietary recall data were excluded from the final analysis.

The primary outcome was stunting, defined as a height-for-age or length-for-age z-score below −2 standard deviations from the median of the World Health Organization Child Growth Standards. The children were categorized as stunted or non-stunted. Sociodemographic and health-related information were collected using an interviewer-administered questionnaire. The variables included the child's age, sex, history of infectious diseases, exclusive breastfeeding history, and continued breastfeeding status.

Daily dietary intake was assessed using a 24-hour dietary recall. Reported food and beverage consumption was analyzed using the NutriSurvey software to estimate the energy, protein, fat, and carbohydrate intakes. Each nutrient was categorized as adequate when the intake was at least 90% of the reference intake and inadequate when the intake was below 90% (Herrera-Cuenca et al., 2024). The weekly frequency of protein food consumption was assessed using a food frequency questionnaire. The food groups included meat, fish and seafood, poultry, eggs, milk and dairy products, nuts, and legumes. Meat included beef, lamb, and goats. Fish and seafood included fish, shrimp, squid, crabs, clams, and scallops. Poultry included chickens and ducks. The eggs included chicken, duck, and quail eggs. Milk and dairy products included liquid or powdered cow and goat milk, cheese, yogurt, and butter.

Nuts and legumes included kidney beans, peanuts, mung beans, cashews, tempeh, tofu, and soymilk. The consumption frequency for each protein-source food group was categorized as rare when consumed fewer than four times per week and frequent when consumed four or more times per week (Basri et al., 2021).

Data were analyzed using IBM SPSS Statistics version 25.0. Continuous variables are summarized as means and standard deviations, whereas categorical variables are presented as frequencies and percentages. Differences in categorical variables between stunted and non-stunted children were assessed using the chi-square test or Fisher's exact test, as appropriate. The mean age was compared between the groups using an independent-samples *t-test*. Binary logistic regression was used to examine the association between nutrient intake, protein source food consumption, and stunting. The dietary exposure variables included energy, protein, fat, and carbohydrate adequacy, and the consumption frequency of meat, fish and seafood, poultry, eggs, milk and dairy products, and nuts and legumes. Each dietary exposure was analyzed using a separate regression model because the dietary variables were conceptually and statistically correlated. In particular, milk and dairy products contributed to the total protein intake. Multicollinearity among dietary exposure variables was assessed using variance inflation factor. Variables with high collinearity were not simultaneously entered into the same multivariable model. For each exposure, Model 1 provided the unadjusted association, whereas Model 2 was adjusted for sex, exclusive breastfeeding history, history of infectious disease, and continued breastfeeding status. Associations were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test, and the influential observations were evaluated using standardized residuals and Cook's distance. Statistical significance was defined as a two-sided p-value of < 0.05.

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Health Research Ethics Committee of the Faculty of Public Health, Universitas Indonesia (approval no. Ket-284/UN2.F10.D11/PPM.00.02/2023). Written informed consent was obtained from the biological mother or primary caregiver of each child before data collection. Participation was voluntary, and all personal information was kept confidential and used only for research purposes.

Result and Discussion

Participant Characteristics

A total of 184 children aged 24–59 months were included in the analysis, of whom 43 were stunted and 141 were non-stunted, corresponding to a stunting prevalence of 23.4% (Table 1). The mean age of the participants was 40.95 ± 9.25 years. Children with stunting were younger than non-stunted children (37.30 ± 8.47 vs. 42.06 ± 9.22 months; $p = 0.002$).

Among children with stunting, 53.5% were boys, 72.1% had not been exclusively breastfed, 86.0% were no longer breastfed, and 65.1% had no reported history of infectious disease. Sex, exclusive breastfeeding history, and infectious disease history were not significantly associated with stunting. Continued breastfeeding was more common among children with stunting than among non-stunted children (14.0% vs. 2.1%; $p = 0.006$).

Inadequate energy, protein, and fat intakes were more frequent among children with stunting than among non-stunted children. Specifically, 53.5% of the stunted children had inadequate energy intake, 34.9% had inadequate protein intake, and 44.2% had inadequate fat intake. The corresponding proportions among non-stunted children were 34.0%, 19.1%, and 26.2%, respectively. These differences were statistically significant for energy ($p = 0.031$), protein ($p = 0.039$), and fat intake ($p = 0.036$). Inadequate carbohydrate intake was more common among children with stunting, although the difference was not statistically significant ($p = 0.076$).

Rare fish and seafood consumption was reported in 83.7% of stunted children and 66.7% of non-stunted children ($p = 0.036$). Rare milk and dairy consumption was more common among children with stunting than among non-stunted children (32.6% vs. 14.9%; $p = 0.014$). No statistically significant differences were observed in the consumption frequencies of meat, poultry, eggs, or nuts and legumes.

Tabel 1. Characteristics of study participants according to stunting status (n = 184), were stunted (n = 43) and non-stunted (n = 141)

Characteristics	Category	Total; n (%)	Stunted; n (%)	Non-stunted; n (%)	p-value
Sex	Boy	84 (45.7)	23 (53.5)	61 (43.3)	0.294
	Girl	100 (54.3)	20 (46.5)	80 (56.7)	
Age, months	Mean ± SD	40.95 ± 9.25	37.30 ± 8.47	42.06 ± 9.22	0.002*
Exclusive breastfeeding	No	115 (62.5)	31 (72.1)	84 (59.6)	0.154
	Yes	69 (37.5)	12 (27.9)	57 (40.4)	
Continued breastfeeding	Yes	9 (4.9)	6 (14.0)	3 (2.1)	0.006*
	No	175 (95.1)	37 (86.0)	138 (97.9)	
History of infectious disease	Yes	70 (38.0)	15 (34.9)	55 (39.0)	0.721
	No	114 (62.0)	28 (65.1)	86 (61.0)	
Energy intake	Inadequate	71 (38.6)	23 (53.5)	48 (34.0)	0.031*
	Adequate	113 (61.4)	20 (46.5)	93 (66.0)	
Protein intake	Inadequate	42 (22.8)	15 (34.9)	27 (19.1)	0.039*
	Adequate	142 (77.2)	28 (65.1)	114 (80.9)	
Fat intake	Inadequate	56 (30.4)	19 (44.2)	37 (26.2)	0.036*
	Adequate	128 (69.6)	24 (55.8)	104 (73.8)	
Carbohydrate intake	Inadequate	110 (59.8)	31 (72.1)	79 (56.0)	0.076
	Adequate	74 (40.2)	12 (27.9)	62 (44.0)	
Meat consumption	Rare (<4 times/week)	179 (97.3)	42 (97.7)	137 (97.2)	1
	Frequent (≥4 times/week)	5 (2.7)	1 (2.3)	4 (2.8)	
Fish and seafood consumption	Rare (<4 times/week)	130 (70.7)	36 (83.7)	94 (66.7)	0.036*
	Frequent (≥4 times/week)	54 (29.3)	7 (16.3)	47 (33.3)	
Poultry consumption	Rare (<4 times/week)	133 (72.3)	32 (74.4)	101 (71.6)	0.846
	Frequent (≥4 times/week)	51 (27.7)	11 (25.6)	40 (28.4)	
Egg consumption	Rare (<4 times/week)	45 (24.5)	11 (25.6)	34 (24.1)	0.452
	Frequent (≥4 times/week)	139 (75.5)	32 (74.4)	107 (75.9)	
Milk and dairy product consumption	Rare (<4 times/week)	35 (19.0)	14 (32.6)	21 (14.9)	0.014*
	Frequent (≥4 times/week)	149 (81.0)	29 (67.4)	120 (85.1)	
Nut and legume consumption	Rare (<4 times/week)	65 (35.3)	14 (32.6)	51 (36.2)	0.718
	Frequent (≥4 times/week)	119 (64.7)	29 (67.4)	90 (63.8)	

Notes: Values are presented as n (%) unless otherwise indicated. SD: standard deviation. Categorical variables were compared using the chi-square or Fisher's exact test, as appropriate. The mean age was compared using an independent samples t-test. Statistical significance was set at $p < 0.05$.

Associations of Nutrient Intake and Protein-Source Food Consumption with Stunting

The associations between dietary exposure and stunting are presented in Table 2. In the unadjusted analyses, rare fish and seafood consumption was associated with higher odds of stunting than frequent consumption (OR = 2.571, 95% CI [1.064, 6.212], p = 0.036). However, this association was attenuated after adjusting for sex, exclusive breastfeeding history, infectious disease history, and continued breastfeeding status (adjusted OR [aOR] = 2.312, 95% CI [0.924, 5.786], p = 0.073).

Table 2. Association of nutritional intake and protein-source food consumption with stunting among study participants

Variables	Category	Model 1: Crude OR (95% CI)	p-value	Model 2: Adjusted OR (95% CI)	p-value
Meat consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	1.226 (0.133–11.273)	0.857	1.180 (0.124–11.268)	0.886
Fish and seafood consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	2.571 (1.064–6.212)	0.036*	2.312 (0.924–5.786)	0.073
Poultry consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	1.152 (0.530–2.505)	0.721	1.112 (0.492–2.515)	0.799
Egg consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	1.082 (0.493–2.375)	0.845	1.015 (0.422–2.334)	0.971
Milk and dairy product consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	2.759 (1.254–6.069)	0.012*	2.911 (1.260–6.723)	0.012*
Nut and legume consumption	Frequent	1.00 (Ref.)		1.00 (Ref.)	
	Rare	0.852 (0.413–1.758)	0.665	0.712 (0.327–1.550)	0.392
Energy intake	Adequate	1.00 (Ref.)		1.00 (Ref.)	
	Inadequate	2.228 (1.114–4.456)	0.023*	2.019 (0.982–4.147)	0.056
Protein intake	Adequate	1.00 (Ref.)		1.00 (Ref.)	
	Inadequate	2.262 (1.064–4.810)	0.034*	2.268 (1.024–5.023)	0.044*
Fat intake	Adequate	1.00 (Ref.)		1.00 (Ref.)	
	Inadequate	2.225 (1.095–4.523)	0.027*	2.081 (0.978–4.427)	0.057
Carbohydrate intake	Adequate	1.00 (Ref.)		1.00 (Ref.)	
	Inadequate	2.027 (0.963–4.270)	0.063	1.886 (0.872–4.077)	0.107

Notes: = odds ratio, = adjusted odds ratio,= confidence interval; Ref. = reference category. Model 1 was unadjusted. Model 2 was adjusted for sex, exclusive breastfeeding history, history of infectious disease, and continued breastfeeding. Statistical significance was set at p <0.05.

Rare milk and dairy consumption was associated with higher odds of stunting in both the unadjusted 2.759, 95% CI [1.254, 6.069], p = 0.012) and adjusted models (aOR = 2.911, 95% CI [1.260, 6.723], p = 0.012).

Inadequate protein intake was also associated with higher odds of stunting before adjustment (OR = 2.262, 95% CI [1.064, 4.810], p = 0.034) and after adjustment (aOR = 2.268, 95% CI [1.024, 5.023], p = 0.044) adjustment. Inadequate energy and fat intakes were associated with stunting in the unadjusted analyses; however, the estimates were attenuated after adjustment and did not meet the prespecified threshold for statistical significance. The adjusted estimates were aOR = 2.019 (95% CI [0.982, 4.147], p = .056) for energy intake and aOR = 2.081 (95% CI [0.978, 4.427], p = 0.057) for fat intake.

No statistically significant associations were observed for the intake of meat, poultry, eggs, nuts, legumes, or carbohydrates (p > 0.05). The estimate for meat consumption was imprecise because only five children were classified as frequent meat consumers, resulting in a wide confidence interval (aOR = 1.180 [95% CI 0.124, 11.268]).

This study examined the association between nutrient intake and protein-source food consumption with stunting among children aged 24–59 months in Tanjung Priok, North Jakarta. The prevalence of stunting was 23.4%, which was higher than the overall estimate reported for the Special Capital Region of Jakarta and was consistent with the comparatively high burden documented in North Jakarta (Kementerian Kesehatan Republik Indonesia, 2022). After adjusting for the specified covariates, rare consumption of milk and dairy products and inadequate protein intake remained significantly associated with higher odds of stunting.

Children who consumed milk and dairy products less than four times per week had approximately 2.9 times the odds of stunting compared to those who consumed these products more frequently. This finding is consistent with a cross-sectional study conducted in Cakung, East Jakarta, which reported an association between lower dairy consumption and stunting in children aged 24–

30 months (Rahmi et al., 2022). This is also broadly consistent with cross-country evidence showing that increases in population-level milk consumption are associated with reductions in childhood stunting prevalence over time (Haile & Headey, 2023). However, the present cross-sectional findings should not be interpreted as evidence that milk consumption prevents this condition.

Several biological mechanisms may explain this association. Milk and dairy products provide high-quality protein, calcium, phosphorus, zinc, and, in fortified products, vitamin D, all of which contribute to skeletal development and growth-related metabolic pathways (Sjarif et al., 2019). Essential amino acids in milk proteins may also support the insulin-like growth factor-1 pathway, which is involved in linear bone growth (Beal et al., 2018; Hoppe et al., 2004). Nevertheless, the current study measured only weekly consumption frequency and did not assess the intake volume, nutrient dose, product type, fortification, or duration of consumption. Therefore, these mechanisms provide a biological context rather than direct explanations demonstrated by the study data.

Milk and dairy products may also contribute to the calcium and vitamin D required for bone mineralization. Calcium is a major component of hydroxyapatite, and vitamin D supports intestinal calcium absorption and phosphate homeostasis. Inadequate availability of these nutrients may compromise skeletal development in childhood (Kusumajaya et al., 2023). Zinc also supports cell division, protein metabolism, immune function, and growth-related processes (Sihotang et al., 2023). Although milk can provide bioavailable zinc, the present study did not measure micronutrient intake or biochemical status of the participants. Consequently, the roles of calcium, vitamin D, and zinc remain plausible mechanisms rather than mediators of the observed association (Azriani et al., 2024).

Most of the milk consumed by the participants was reportedly growing-up milk or young-child formula. These products commonly contain protein and multiple fortified micronutrients that may help address dietary gaps in early childhood (Sunardi et al., 2024). Previous Indonesian research found that growing-up milk consumption was associated with lower odds of stunting and better height-for-age indicators in toddlers (Sjarif et al., 2019). However, public health recommendations should not consider commercial milk products as the sole or primary strategy for addressing stunting. Affordability, accessibility, individual tolerance, breastfeeding recommendations, and availability of culturally acceptable alternatives should also be considered.

Inadequate protein intake was associated with approximately 2.3 times higher odds of stunting after adjustment for confounding factors. This finding is consistent with previous research showing lower protein intake among stunted than among non-stunted Indonesian children aged 24–59 months (Sari et al., 2016). Proteins provide the essential amino acids required for the synthesis of muscle tissue, enzymes, immune proteins, and the organic matrix of bones. It may also influence skeletal growth through growth-related hormonal pathways, including the insulin-like growth factor-1 pathway (Sari et al., 2016; Semba et al., 2016).

Animal-source foods, such as milk, eggs, fish, poultry, and meat, generally provide complete amino acid profiles and greater digestibility than many plant-based protein sources (Semba et al., 2016). Branched-chain amino acids, including leucine, isoleucine, and valine, are involved in anabolic signaling and protein synthesis (Anafah & Winarti, 2022). However, the absence of significant associations for several individual protein-source food groups in this study indicates that total diet quality, portion size, preparation practices, household food access, and food combinations may be more important than the frequency of any single food group.

Rare fish and seafood consumption was associated with stunting in the unadjusted analysis but not after covariate adjustment. Fish are an important source of high-quality protein and essential fatty acids, and previous Indonesian research has linked dietary diversity and fish consumption with child growth outcomes (Basri et al., 2021). The attenuation of the association after adjustment suggests that the crude relationship may have been partly explained by the measured covariates. Unmeasured socioeconomic conditions, household food security, and overall dietary diversity may also influence both fish consumption and stunting. However, this explanation remains speculative as these factors were not assessed.

The adjusted associations for inadequate energy and fat intakes approached, but did not reach, statistical significance. These estimates may indicate potentially meaningful relationships that the study lacked sufficient precision to confirm. However, they should not be considered statistically significant or established determinants based on the present analysis.

These findings have practical implications for community nutrition programs. Counseling for caregivers should emphasize adequate total protein intake and dietary diversity, rather than reliance on a single commercial food product. Affordable and locally available protein sources, including eggs, fish, poultry, tempeh, tofu, legumes, and dairy products, where accessible and tolerated, may be incorporated into age-appropriate feeding guidance. Nutritional interventions should also consider household purchasing power and food availability, particularly in densely populated low-income urban communities. Protein- and nutrient-rich diets may also support nutritional rehabilitation and catch-up growth, although intervention studies are needed to determine their effectiveness in children who are already stunted (Endrinikapoulos et al., 2023).

This study had several strengths. It evaluates both nutrient adequacy and the frequency of several protein-source food groups, providing a broader assessment of dietary patterns than analyses restricted to total protein intake. It also focused on a densely populated urban community in which economic and dietary constraints may differ from those in rural settings.

Furthermore, this study has several limitations that warrant consideration. The cross-sectional design precluded temporal inference and allowed for possible reverse causation. A single 24-hour recall and FFQ without portion sizes may not reflect the usual intake. Cluster effects were not modeled, some exposure groups were small, and key socioeconomic confounders were unavailable. Milk and protein were analyzed separately because of their collinearity. Community programs should promote affordable and diverse protein sources, and future longitudinal studies should use repeated dietary assessments and cluster-adjusted models.

Conclusion

Among children aged 24–59 months in Tanjung Priok, North Jakarta, infrequent milk and dairy consumption and inadequate protein intake were associated with higher odds of stunting after adjustment for the specified covariates, whereas the other dietary exposures examined did not remain statistically significant in adjusted models. These findings support community-based nutrition counseling that promotes adequate protein intake through affordable, locally available animal- and plant-source foods, including dairy products, where accessible and appropriate. Because of the cross-sectional design and potential residual confounding, longitudinal studies using repeated dietary assessments and cluster-adjusted analyses are needed to clarify the temporal relationship between dietary intake and child growth.

Recommended practical implications: Community nutrition programs in Tanjung Priok should incorporate caregiver counseling to meet children's protein needs through affordable and locally available foods, such as fish, eggs, poultry, tempeh, tofu, legumes, and dairy products, where accessible and tolerated. Counseling should emphasize overall age-appropriate feeding rather than presenting commercial milk products as the sole strategy for addressing child stunting.

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