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The Determinants of Nutritional Adequacy Levels in Toddlers at Klungkung Regional General Hospital Bali

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ABSTRACT

Nutritional adequacy is essential for optimal growth and development in children under five years of age; however, malnutrition remains a significant public health concern in Indonesia. This study aimed to identify factors associated with nutritional adequacy and evaluate changes in nutritional adequacy following nutritional interventions among children aged 1–5 years at Klungkung Regional General Hospital, Bali. The study employed a cross-sectional design to assess nutritional determinants, followed by a three-month nutritional intervention. A total of 127 children were included, and dietary intake was assessed using 24-hour dietary recalls conducted on three nonconsecutive days. Bivariate analyses were performed using comparative and correlation tests. The findings revealed that 81.9% of children had inadequate nutritional intake. Significant associations were identified between nutritional adequacy and birth weight category ($p = 0.033$), upper respiratory tract infections ($p = 0.042$), and gestational age ($p = 0.039$). In contrast, exclusive breastfeeding and immunization history were not significantly associated with nutritional adequacy. Following the three-month intervention involving micronutrient and macronutrient supplementation, 47.2% of children achieved the recommended nutritional intake targets, representing a statistically significant improvement in nutritional adequacy ($Z = -6.647$, $p < 0.001$). These findings highlighted the importance of targeted nutritional monitoring and interventions, particularly for children born prematurely, those with low birth weight, and those experiencing recurrent respiratory tract infections. Comprehensive nutritional assessment and individualized interventions may contribute to improved nutritional status, growth, and overall health outcomes among young children.

INTRODUCTION

Malnutrition remains a significant public health challenge in Indonesia. According to the 2021 Indonesian Nutritional Status Survey (Survei Status Gizi Indonesia, SSGI), the prevalence of stunting among children under five years of age was 24.4%, while the reported prevalence of undernutrition, overnutrition, and severe malnutrition was 17.0%, 3.8%, and 7.1%, respectively (Hussain & Sharma, 2025). Linear growth in children is regulated by complex molecular signaling mechanisms involving genetic, physiological, and nutritional factors (Xu et al., 2026). Globally, inadequate energy intake, often accompanied by recurrent

infections, contributes substantially to impaired childhood growth. Insufficient dietary intake can disrupt normal growth processes, while severe micronutrient deficiencies, particularly those involving vitamin A and iron, may further compromise children's growth and development (Islamiyati et al., 2025; (EM et al., 2022).

Data from the National Nutrition Consumption Monitoring program conducted by the Indonesian Ministry of Health in 10 priority districts for stunting prevention revealed substantial nutritional inadequacies among young children, based on 24-hour dietary recall assessments. Iron, zinc, and folate were identified as the primary nutrients of concern among infants aged 6–11 months, while inadequate calcium intake was additionally observed among children aged 12–23 and 24–35 months. Among children aged 36–59 months, vitamin C and riboflavin were also identified as nutrients of concern. Nutritional assessments using linear programming demonstrated that these dietary inadequacies were consistent with nutritional challenges affecting Indonesian children, particularly stunting and anemia (Fahmida et al., 2024). Furthermore, imbalanced dietary intake may adversely affect children's physical health, cognitive development, and overall well-being. These nutritional challenges can also undermine educational achievement and long-term human development, potentially hindering progress toward the Sustainable Development Goals (SDGs), particularly those related to health, education, and poverty reduction (Amoadu et al., 2024). Therefore, understanding nutritional adequacy among children under five years of age is essential for identifying dietary deficiencies, supporting healthy growth and development, and informing appropriate nutritional interventions.

Despite the availability of national data on childhood malnutrition, evidence regarding the determinants of nutritional adequacy in hospital-based pediatric populations remains limited, particularly in Bali, Indonesia (Munyanyi et al., 2025; Hsu et al., 2024). Furthermore, relatively few studies have simultaneously examined factors associated with nutritional adequacy and assessed changes in dietary adequacy following nutritional interventions within the same pediatric cohort (Caraka et al., 2025). Addressing this research gap is important for identifying vulnerable groups and developing targeted nutritional management strategies. Accordingly, this study aimed to identify factors associated with nutritional adequacy among children aged 1–5 years at Klungkung Regional General Hospital, Bali, and to evaluate changes in nutritional adequacy following a three-month nutritional intervention. (Rahut et al., 2024) Klungkung Regional General Hospital was selected because of its role as a regional referral center for pediatric care and its electronic medical record system, which facilitated the collection of clinical and follow-up data. The novelty of this study lies in its combined assessment of nutritional determinants and postintervention outcomes, providing a more comprehensive understanding of nutritional adequacy and supporting evidence-based nutritional management among children receiving hospital-based care (Sharma et al., 2025; Herlina et al., 2025).

METHOD

Study design and Sampling

This study employed an analytical observational design with a cross-sectional approach to identify factors associated with nutritional adequacy among children under five years of age at Klungkung Regional General Hospital. The secondary objectives were to

examine the association between nutritional adequacy and intervention outcomes and to assess changes in nutritional adequacy following the intervention. The study included children aged 1–5 years who attended the hospital's pediatric outpatient clinic between 2021 and 2024. Participants were selected using purposive sampling, and data were obtained from electronic medical records. Patients with incomplete medical records were excluded from the analysis.

Variables

The level of nutritional adequacy was defined as the average daily intake of nutrients sufficient to meet the nutritional needs of nearly all (97.5%) healthy individuals within a specific age, sex, and physiological group, assessed using the 24-hour food recall method and recorded over three non-consecutive days. The instruments used to collect data in this study included anthropometric measurements and 24-hour food recalls. The 24-hour food recall was conducted by recording the types and amounts of foods consumed during a 24-hour period. To ensure data accuracy, the 24-hour food recall was conducted three times on non-consecutive days. Nutritional adequacy was assessed based on the 24-hour food recall interviews and classified into three categories: good, adequate, and poor.The medical intervention provided consisted of administering both micronutrients and macronutrients to meet the minimum required caloric intake over a period of three months. Adherence to the intervention was monitored monthly. Exclusive breastfeeding history was defined as providing only breast milk to the infant from birth until six months of age, without any additional food or drink.

Data Analysis

The study began with data collection and sample grouping. The collected data were then processed and categorized into several variables. The data were analyzed to examine the relationships between variables using SPSS (Statistical Package for Social Sciences) software. Univariate analysis was conducted to describe the frequency distribution of respondents' characteristics based on age and sex. Bivariate analysis was performed to test the hypotheses at an alpha level of 0.05. The bivariate analyses included both comparative and correlational tests. The comparative analysis was carried out using Chi-Square test. The correlational analysis in this study was conducted using the Spearman correlation test.

RESULTS AND DISCUSSION

Results

This study involved 127 samples with a mean age of 27.93 ± 14.70 months. Based on the collected data, the study subjects consisted of 65 males (51.2%) and 62 females (48.8%). Most of the children had comorbidities such as diarrhea (63.8%), pneumonia (29.1%), anemia (41.7%), and upper respiratory tract infections (URTI) (68.5%), while only a small proportion had a history of tuberculosis (3.1%). The number of comorbidities varied, with most children having two comorbidities (39.4%), followed by one comorbidity (23.6%), three comorbidities (18.9%), and four comorbidities (11.8%), while only 6.3% had no comorbidities. The majority of children were born at term (89.0%), with a smaller proportion born preterm (9.4%) or post-term (1.6%). The median birth weight was 2,900 grams, ranging from 960 to 4,500 grams. Most of the children had normal birth weight (78.0%); however, there were also children with low birth weight (20.5%), very low birth weight (0.8%), and high birth weight

(0.8%). The mean birth length was 48.30 cm with a standard deviation of 2.69 cm. The majority of children had a history of complete immunization (96.9%) and received exclusive breastfeeding (52.0%). However, most of the children demonstrated inadequate nutritional adequacy levels (81.9%). After the intervention, 47.2% of the children met the target, 42.5% had not yet reached the target, and 10.2% had not returned for evaluation (Table 1).

Based on the analysis of the relationships between various variables and nutritional adequacy levels, most variables were not significantly associated ($p > 0.05$). Exclusive breastfeeding history ($p = 0.345$), immunization history ($p = 0.339$), total comorbidities ($p = 0.139$), diarrhea ($p = 0.874$), pneumonia ($p = 0.879$), tuberculosis ($p = 0.339$), and sex ($p = 0.916$) did not show significant associations with nutritional adequacy. However, several variables were significantly associated with nutritional adequacy, including birth weight category ($p = 0.033$), anemia ($p = 0.062$; approaching significance), URTI ($p = 0.042$), and gestational age ($p = 0.039$). Children with normal birth weight tended to have better nutritional adequacy compared to those with low or extreme birth weight. Similarly, URTI and preterm birth appeared to be associated with a higher risk of inadequate nutrition (Table 1).

The Spearman correlation analysis showed a positive and statistically significant correlation between nutritional adequacy levels and intervention outcomes (Spearman's rho = 0.323, $p < 0.01$). This indicates that as the level of nutritional adequacy improves, the outcomes of the intervention also tend to improve. The correlation coefficient of 0.323 suggests a moderate relationship between these two variables. The significance level ($p = 0.000$) confirms that this correlation is unlikely to be due to chance.

Table 1. Patient Characteristic

Variable	Frequency	Percentage (%)
Sex		
Male	65	51.2
Female	62	48.8
Comorbidities		
Diarrhea		
No	46	36.2
Yes	81	63.8
Pneumonia		
No	90	70.9
Yes	37	29.1
Tuberculosis (TB)		
No	123	96.9
Yes	4	3.1
Anaemia		
No	74	58.3
Yes	53	41.7
Upper Respiratory Tract Infections (URTI)		
No	40	31.5
Yes	87	68.5

Variable	Frequency	Percentage (%)
Amount of Comorbidities		
0	8	6.3
1	30	23.6
2	50	39.4
3	24	18.9
4	15	11.8
Gestational Age		
Preterm	12	9.4
Term	113	89.0
Post-term	2	1.6
Birth Weight (Median (min–max)) (grams)	2900 (960–4500)	
Normal (2,500–4,000g)	99	78.0
Low (1,500–2,499g)	26	20.5
Extremely low (<1,000g)	1	0.8
High (>4,000g)	1	0.8
Birth Length (Mean ± SD) (cm)	48.30 ± 2.69	
Immunization History		
Incomplete	4	3.1
Complete	123	96.9
Exclusive Breastfeeding History		
No	61	48.0
Yes	66	52.0
Nutritional Adequacy Level		
Inadequate	104	81.9
Adequate	23	18.1
Intervention Outcome		
Had not reached the target	54	42.5
Target reached	60	47.2
Had not returned for evaluation	13	10.2

Discussion

This study involved 127 children with a balanced gender distribution. Statistical analysis showed that birth weight, acute respiratory tract infection (ARTI), and gestational age were significantly associated with the children's nutritional adequacy levels. Anemia also showed a near-significant association ($p = 0.062$). Other variables such as gender, exclusive breastfeeding history, immunization status, and most comorbidities did not show significant associations. These findings indicate that perinatal factors and children's health conditions play an important role in determining their nutritional adequacy. Following the intervention, there was a significant improvement in the children's nutritional adequacy levels. This demonstrates that the intervention provided significantly improved the children's nutritional status. Therefore, these results provide strong evidence that the intervention was effective in enhancing the overall nutritional adequacy of the children.

Individuals experiencing malnutrition are more susceptible to infections and related complications. Both acute and chronic infections have detrimental effects on an individual's nutritional status and can trigger malnutrition. Acute infections can drastically reduce a child's nutritional adequacy due to acute inflammatory responses, increased energy requirements, and decreased nutrient intake. Chronic infections such as tuberculosis (TB) and human immunodeficiency virus (HIV) infection are associated with anorexia and cachexia. Proinflammatory cytokine responses and metabolic changes are the main causes of these conditions. Other factors, such as drug side effects, may also contribute and worsen the condition. Conversely, patients with poor nutritional status also experience increased severity of infections, thus forming a bidirectional relationship between infection and malnutrition. Parasitic infestations also have a serious impact on an individual's nutritional adequacy (Paramashanti et al., 2024). This was in line with a cross-sectional study that was conducted in four stunting locus villages in East Nusa Tenggara Province from January to March 2022. The study found that the risk of stunting in children under five years old who had a history of infectious diseases and frequent illnesses was 2.86 times higher compared to children who were rarely sick (adjusted odds ratio (AOR): 2.863; 95% CI: 1.112–7.371). (Rudin et al., 2024) The study also found that upper respiratory tract infections were associated with nutritional adequacy. In addition to the effects of acute inflammatory processes, children often experienced symptoms such as painful swallowing, which led to a reduced food intake. On the other hand, other comorbidities did not show a significant association. This was likely due to the frequent overlap between comorbid conditions, making it difficult to assess their effects comprehensively. Moreover, the small sample size may have limited the statistical power of the analysis.

The study provided strong evidence that low birth weight (LBW) was an independent risk factor for malnutrition. Infants with LBW often also experienced being small for gestational age, reflecting intrauterine growth restriction. This explained the delayed postnatal growth observed. In the absence of congenital malformations or chromosomal abnormalities, fetal size could result from two distinct processes: constitutionally small size or pathological growth restriction. Fetuses with growth restriction were generally small due to pathological conditions such as uteroplacental dysfunction, hypertensive disorders, or exposure to harmful substances during pregnancy, including smoking. A prospective longitudinal cohort that followed infants from birth to one year of age reported a prevalence of LBW of 13% (115 infants). At one month of age, among 743 infants analyzed, 10% were stunted and 4% were underweight. Both stunting and underweight were associated with LBW, with an adjusted odds ratio (AOR) of 2.6 (95% CI: 1.4–4.9) for stunting and 4.5 (95% CI: 2.5–8.1) for underweight. Preterm birth was also associated with stunting (AOR: 2.7; 95% CI: 1.2–6.3) and underweight (AOR: 5.4; 95% CI: 1.7–16.1) at one month of age. Additionally, infants with LBW had a higher risk of mortality during the first year of life, with an adjusted hazard ratio of 4.6 (95% CI: 1.2–17.0). (Dessie et al., 2025) Another cross-sectional study involving children aged 22 to 38 months who were born with a birth weight of ≤ 2000 grams found that six out of ten children with low birth weight were at risk of undernutrition in early childhood. The prevalence of underweight and stunting in this group was reported to be higher than the national average. (Miranda et al., 2024) This was

consistent with the findings of the present study, which showed that preterm infants and those born with low birth weight were associated with poor nutritional adequacy.

Anemia could both be a cause and a consequence of poor nutritional adequacy, reflecting a bidirectional relationship. A case-control study among adolescents aged 15–19 years found a significant association between macronutrient intake and nutritional status with the incidence of anemia. Low energy intake was associated with a 3.3 times higher risk of anemia [p = 0.048; OR = 3.3 (95% CI: 0.965–11.28)]. Similarly, low protein intake was associated with a 3.98 times higher risk of anemia [p = 0.036; OR = 3.98 (95% CI: 1.018–15.57)]. Moreover, poor nutritional status was associated with a 5.35 times higher risk of anemia [p = 0.024; OR = 5.35 (95% CI: 1.088–26.32)]. (Pibriyanti et al., 2021) Similarly, iron deficiency accounted for approximately 50% of all anemia cases and was fundamentally linked to inadequate dietary intake. Studies showed that anemia was often accompanied by deficiencies of other essential micronutrients as well as general nutritional problems. As a result, affected children could experience impaired neurodevelopment and difficulties performing tasks that required cognitive abilities. These findings were supported by a multi-center study conducted in Burkina Faso, Ghana, and Mali. (FB et al., 2023) On the other hand, anemia could also contribute to poor nutritional adequacy. Emerging evidence showed that iron deficiency and low serum iron levels (hypoferremia) could impair adaptive immunity and reduce vaccine effectiveness. Adequate iron was crucial for optimal production of plasmablasts and IgG responses by human B cells, both in vitro and in vivo. The heightened metabolism of activated lymphocytes heavily relied on sufficient iron acquisition, and hypoferremia particularly when it occurred during the lymphocyte expansion phase could negatively impact various aspects of adaptive immunity, potentially causing long-term impairment of T cell memory. In mice, hypoferremia suppressed adaptive immune responses to influenza infection, resulting in more severe lung disease. Among infants in Africa, anemia and/or iron deficiency at the time of vaccination was associated with reduced responses to diphtheria, pertussis, and pneumococcal vaccines. Notably, the response to the measles vaccine was even enhanced with iron supplementation. These findings demonstrated that iron deficiency could limit adaptive immunity and vaccine responsiveness (Zoleko-Manego et al., 2021).

This study had several limitations that needed to be considered. The cross-sectional study design used limited the ability to draw causal conclusions between the variables examined. In addition, the use of secondary data from electronic medical records carried the risk of incomplete and inaccurate data, although incomplete data were excluded. The method of measuring nutritional intake using a 24-hour food recall, although conducted three times, still had weaknesses such as recall bias and the possibility of inaccurate reporting by parents. This study also did not collect or control for socioeconomic factors such as parental education level or family income, which could potentially have acted as confounding variables in the nutritional adequacy analysis. Furthermore, 10.2% of subjects did not return for evaluation, which may have caused bias due to loss of follow-up data (attrition bias). These limitations may have affected both the internal and external validity of the study results.

CONCLUSION

This study revealed that most children under five years of age at Klungkung Regional General Hospital had inadequate nutritional intake. Birth weight, gestational age, and a history of acute respiratory tract infections were significantly associated with nutritional adequacy. The three-month nutritional intervention involving micronutrient and macronutrient supplementation was associated with a statistically significant improvement in nutritional adequacy, although not all children achieved the recommended nutritional targets. These findings highlighted the importance of regular nutritional monitoring and targeted interventions for children at increased risk of malnutrition, particularly those born prematurely, those with low birth weight, and those with a history of recurrent respiratory tract infections (Jokhu & Syauqy, 2024).

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest whether personal, commercial, or financiaL that could influence the objectivity of this research.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the entire research process, including conceptualization, data collection and analysis, as well as the writing and editing of the final manuscript.

GENERATIVE AI STATEMENT

During the preparation of this manuscript, the authors used Artificial Intelligence (AI) strictly for grammar checking and language editing purposes. AI was not utilized in the data collection process, substantive analysis, or the formulation of research conclusions.

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