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Parental Nutritional Knowledge and Its Association with Child Growth and Development: Evidence from Bengkalis District, Indonesia

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Abstract

Nutrition plays a crucial role in supporting children's overall growth, development, and bodily functions. A balanced nutritional intake provides the energy and essential nutrients necessary to sustain life and promote children's physical, social, emotional, and cognitive advancement. This study aims to explore the relationship between parents' nutritional knowledge and child growth and development in Bengkalis Regency, Indonesia. Employing an associative quantitative approach, data were collected through questionnaires and documentation. The sample consisted of 100 parents of children aged 5–6 years, selected using simple random sampling. Data analysis included descriptive statistics (univariate and bivariate analyses), with variable relationships tested using the Chi-Square method. The findings revealed that most parents had moderate nutritional knowledge (54%), while 23% had low knowledge and 23% had high knowledge. Regarding children's nutritional status, 53% were categorized as usual, 25% as undernourished, and 22% as severely malnourished. Further analysis indicated that children of parents with low nutritional knowledge had a higher risk of poor nutrition and developmental delays. Conversely, children of parents with moderate nutritional knowledge tended to have better nutritional status, with 77.7% classified as having usual nutritional status. These findings reinforce that parental nutrition literacy significantly influences children's nutritional outcomes and developmental progress. However, the study has limitations, including a small sample size, reliance on self reported data, and a cross sectional design that restricts causal interpretation. Future research should adopt longitudinal or mixed methods approaches to capture changes more accurately. The study recommends strengthening community based nutrition education, integrating routine growth and development screening, and enhancing cross sector collaboration to improve access to nutritious foods for families.

Introduction

Child malnutrition remains a global health crisis demanding urgent attention. Recent data from 2024 reveal that 150.2 million children under five experience stunting, 42.8 million suffer from wasting, and 35.5 million are overweight worldwide (WHO, 2020). These figures represent not merely statistics but a profound threat to the quality of future generations, affecting cognitive development, economic productivity, and social well-being. Nutritional deficiencies combined with limited early learning opportunities contribute to developmental loss and long-term health and economic disparities among over 200 million children under five (Hurley et al., 2016). Alarmingly, nearly half of under-five deaths are associated with malnutrition, making nutritional interventions a non-negotiable global health priority (UNICEF, 2024).

Indonesia faces a double burden of malnutrition that exacerbates the problem of child nutrition. Although there has been progress in reducing stunting, 30.8% of children under five remain affected—higher than the Asian regional average of 21.8%. Additionally, 10.2% experience wasting, while 8% are overweight, reflecting inequitable access to nutritious food and suboptimal feeding practices at the household level (Global Nutrition Report, 2021). The long-term consequences of malnutrition on Indonesia's human capital are substantial. Children

with undernutrition exhibit various cognitive abnormalities, while nutritional interventions significantly improve cognitive outcomes in malnourished preschoolers (Zarnowiecki et al., 2012). Failure to address malnutrition threatens Indonesia's demographic dividend and the goal of achieving a Golden Generation by 2045. Maternal nutrition knowledge is crucial for enabling mothers to select nutritious foods and manage household resources effectively. However, nutrition education programs in Indonesia remain suboptimal at translating this knowledge into appropriate feeding practices (Prasetyo et al., 2023).

Bengkalis Regency in Riau Province presents a specific challenge in reducing stunting. Bathin Solapan Subdistrict, consisting of 13 villages with diverse geographical and socio-economic conditions, illustrates disparities in access to healthcare and nutrition information. Parental nutrition knowledge independently predicts children's nutrition understanding beyond socioeconomic status and education level. However, in areas with limited access to information, such as Bathin Solapan, the transmission of nutrition knowledge from parents to children faces multiple structural barriers. The urgency of this study stems from the lack of empirical data on the relationship between parental nutrition knowledge and child development in this region. Although nutrition education interventions have proven effective in improving children's growth parameters and cognitive development, the absence of accurate baseline data limits the design of effective community-based programs. Furthermore, the variation in stunting prevalence between urban and rural Indonesia underscores the need for locally grounded, culturally adaptive interventions that reflect Bengkalis's socio-economic realities.

Nutrition plays a vital role in supporting children's physical growth, development, and bodily function. Adequate food intake is essential to meet energy and nutrient needs, enabling healthy development across physical, cognitive, and psychosocial domains (Gannika, 2023). However, childhood undernutrition remains a pressing global concern. Its impacts include delayed growth and stunting—defined as deficits in height-for-age. In Malaysia, 21.9% of children under five are stunted (JME, 2023). Globally, the prevalence of stunting in 2022 was 22.3%, affecting 148.1 million children, over half from Asia (76.6 million) and 42% from Africa (63.1 million).

Within ASEAN, countries such as Cambodia, the Philippines, Vietnam, and Myanmar have reduced stunting, while Malaysia, Thailand, and Indonesia show increases. Indonesia's stunting rate rose slightly from 27.5% in 2016 to 27.7% in 2020, whereas Malaysia's increased from 17.7% to 21.8% (JME, 2023). Nationally, 3.9% of Indonesian children suffer from severe malnutrition, 13.8% from moderate malnutrition, and 3.1% from overnutrition (Riskesdas, 2020). Similarly, PSG (2018) and Riau Province data indicate that 4.2% of children experience severe malnutrition, 14% moderate malnutrition, and 1.2% overnutrition (Hartini, 2023). These data highlight persistent inequities in nutritional outcomes across Indonesia.

Stunting's effects extend beyond physical growth, impairing brain development, learning ability, and adult productivity (Oka & Annisa, 2019). The 2023 Indonesian Quality Survey (SKI) reports that one in five children is stunted, with provincial disparities ranging from 7.2% to 37.9% (Kemenkes RI, 2023). This underscores the weak implementation of healthy dietary practices at both household and early childhood education levels. Nutritional status serves as a crucial indicator of health, reflecting dietary patterns and metabolism. Well-nourished children achieve appropriate growth and developmental milestones, while malnourished children experience stunted physical and mental development (Nurmaliza, 2019).

Meeting children's nutritional needs involves not only quantity but also quality. Family environment and parenting style strongly influence healthy feeding behaviors. Emotional interaction between parent and child affects feeding success, while mothers' nutritional knowledge determines the quality of children's diets in terms of food selection, portioning, and preparation (Ummah, 2019; Dwi Ertiana & Shafira Berliana Zain, 2023). The preschool period (ages 5–6) is critical, as 90% of brain development occurs before age six (UNICEF, 2020). Consequently, the "Healthy and Nutritious Eating Habit," the fourth habit in the *Gerakan 7*

Kebiasaan Baik Anak Indonesia Hebat, is pivotal in preventing stunting and wasting, including in Bathin Solapan.

The Indonesian government promotes this fourth habit—eating healthy and balanced food—as part of its national education movement for children. This practice entails selecting appropriate food types, balanced portions, and regular meal schedules. Healthy and nutritious diets serve as a long-term investment to enhance quality of life, prevent disease, and promote well-being (Novitasari, 2021). For young learners, nutritious eating supports optimal growth, concentration, and daily functioning, while reducing long-term health costs.

Despite various interventions, Indonesia continues to face the double burden of malnutrition, with 24.4% stunted, 8% wasted, and 8.6% overweight (BPS, 2022; Kemenkes RI, 2023). This emphasizes the need for holistic and interactive approaches to strengthen nutrition education as a family culture. Developmental theories highlight the family's central role in optimal growth. According to Sumantri (2018), understanding cognitive, ecological, and physical development theories helps parents guide children more effectively. Studies by Hayati & Siregar (2019) and Evionita & Tama (2022) confirm that parental education significantly influences stimulation patterns and nutritional fulfillment in early childhood, reinforcing the importance of family-based interventions.

The current child development crisis, rooted in nutrition, poses an invisible yet critical threat to Indonesia's future human resources. Globally, in 2022, 149 million children under five were stunted, 45 million wasted, and 37 million overweight (World Health Organization, 2024). The 2024 update similarly reports 150.2 million stunted, 42.8 million wasted, and 35.5 million overweight, with nearly half of all under-five deaths linked to malnutrition (UNICEF, 2024). Bengkalis Regency, with an economy driven by plantations, faces this dual challenge—economic prosperity coexisting with nutritional deficits. Its 2021 stunting rate of 21.9% falls below the Riau average but remains concerning (Prado & Dewey, 2022).

Ansuya et al. (2023) demonstrated, through a cross-sectional study of 191 parent–child pairs in Australia, that parental nutrition knowledge significantly predicts children's nutritional understanding (r = 0.30, p < 0.001), independent of socioeconomic and educational factors. However, their study did not explore actual feeding practices or physical growth outcomes—the central focus of this study in Bengkalis. Prado & Dewey (2014) analyzed 43 studies on nutrition and cognitive development during the first 1,000 days, finding that micronutrient deficiencies (iron, zinc, iodine) and protein-energy malnutrition significantly impair brain structure and function (effect sizes −0.3 to −1.2 SD). Lassi et al. (2013), in a meta-analysis of 23 RCTs, found that maternal nutrition education interventions improved children's weight-for-age (0.25 SD) and height-for-age (0.41 SD), although results varied by context. Danaei et al. (2016) identified maternal factors—low education, BMI, and anemia—as the most significant contributors to stunting globally, highlighting the indirect yet consequential role of maternal knowledge.

Building upon these global insights, this study introduces several research gaps. First, most prior research focused narrowly on single indicators (e.g., stunting) without examining holistic growth; second, few integrated physical and cognitive measures. Third, studies rarely examined how parental knowledge translates into daily feeding practices, especially in plantation-based contexts such as Bengkalis. Fourth, comprehensive theoretical integration across multiple frameworks remains scarce. Fifth, there is no local empirical data from Bathin Solapan, limiting the evidence base for interventions.

Therefore, this study aims to analyze the relationship between parental nutrition knowledge and the growth and development of children aged 5–6 years in Bathin Solapan, Bengkalis Regency, Riau Province. Specifically, it (1) measures parental nutrition knowledge, (2) assesses child growth using four indicators—weight-for-age, height-for-age, weight-for-height, and developmental status (KPSP), and (3) examines their correlations. This research adopts an integrative theoretical lens combining Physical Growth Theory, Piaget's Cognitive Development Theory, Bronfenbrenner's Ecological Theory, Maslow's Hierarchy of Needs, and Notoatmodjo's

Knowledge Theory to explain how parental knowledge affects multiple developmental outcomes.

The study offers three significant contributions. Scientifically, it enriches the literature by integrating five core theories to elucidate the multidimensional relationship between parental nutrition knowledge and child development. Practically, it provides accurate data for local governments and health centers to design effective nutrition programs and supports Indonesia's national *7 Good Habits for Children* movement, particularly the fourth habit on healthy eating. Methodologically, the use of four simultaneous growth indicators yields a more comprehensive developmental profile than prior studies. Collectively, this research contributes to science and policy by informing Indonesia's long-term mission to cultivate a healthy, intelligent, and productive generation toward 2045.

Methods

Study Design and Setting

This study employed a cross-sectional design and a quantitative associative approach to analyze the relationship between parents' nutritional knowledge and children's growth and development at 5–6 years of age. This design was selected because it allows simultaneous measurement of the independent variable (parents' nutritional knowledge) and the dependent variable (children's growth and development) at a single point in time.

The research was conducted in Bathin Solapan District, Bengkalis Regency, Riau Province, Indonesia. The site was chosen based on the following considerations: (1) diverse geographical and socioeconomic characteristics, representing plantation areas in Indonesia; (2) significant prevalence of nutritional problems with limited previous research; and (3) variation in healthcare accessibility among central, peripheral, and remote villages. From 13 villages in the district, three were purposively selected to represent this diversity: one central village (good access), one peripheral village (moderate access), and one remote village (limited access). Data collection was conducted over two months in 2024.

Population, Sample, and Sampling Technique

The population consisted of all parents with children aged 5–6 years living in Bathin Solapan District. According to the Central Bureau of Statistics (BPS, 2022), the district population was 115,542. The 5–6-year age range was chosen as it represents a critical period for brain development and transition to formal education.

The sample size was determined using the Slovin formula, with a 5% margin of error and a 95% confidence level, yielding a total of 100 respondents. Samples were proportionally allocated among the three selected villages according to the number of children aged 5–6 years. Sampling was conducted using a simple random sampling technique through the following steps: (1) coordination with *posyandu* cadres to obtain the sampling frame; (2) randomization using a random number table; and (3) confirmation of participation willingness through *posyandu* cadres.

Variables and Measurement Instruments

The independent variable was parents' nutritional knowledge, defined as understanding of balanced nutrition principles, children's nutritional needs, nutritious food types, and feeding practices. The dependent variable was children's growth and development, measured through four indicators: (1) weight-for-age (W/A); (2) height-for-age (H/A); (3) weight-for-height (W/H); and (4) developmental status.

The Nutrition Knowledge Questionnaire used a validated instrument adapted from Akbar (2013), consisting of 17 multiple-choice items covering macronutrients (4 items), micronutrients (4 items), balanced nutrition (3 items), feeding practices (3 items), and nutritional problems (3 items). Each correct answer received a score of 1, and each incorrect answer received a score of 0. Total scores were converted into percentages and categorized as good (76–100%), moderate

(56–75%), or poor (<56%). Validity was confirmed using Pearson Product-Moment correlation (r > 0.3, p < 0.05), and reliability was established using Cronbach's Alpha (α = 0.601).

Anthropometric measurements were taken using a digital scale (accuracy 0.1 kg) for weight and a stadiometer (accuracy 0.1 cm) for height. Results were converted into z-scores using WHO Anthro Plus and categorized as follows: (a) W/A: severely undernourished (<−3 SD), undernourished (−3 to <−2 SD), standard (≥−2 SD); (b) H/A: severely stunted (<−3 SD), stunted (−3 to <−2 SD), standard (≥−2 SD); (c) W/H: severely undernourished (<−3 SD), undernourished (−3 to <−2 SD), standard (−2 to 2 SD), overweight (>2 SD).

The Developmental Pre-Screening Questionnaire (KPSP) was the standard instrument of the Indonesian Ministry of Health for children aged 5–6 years, consisting of 10 questions assessing gross motor, fine motor, language and speech, and personal-social domains. Interpretation categories were: normal development (9–10 "Yes" answers), doubtful (7–8 "Yes" answers), and delayed (≤6 "Yes" answers). Assessments were conducted through parent interviews and direct child observation. The KPSP instrument's reliability was assessed using Cronbach's Alpha (α = 0.755).

Data Collection, Analysis, and Ethical Considerations

This cross-sectional observational study involved no intervention. Preparation included coordination with *posyandu* cadres. Data collection procedures were as follows: (1) respondents were contacted by *posyandu* cadres for confirmation and scheduling; (2) home or *posyandu* visits were conducted according to respondent preference; (3) detailed explanation of the study and informed consent process; (4) interviews for socio-demographic characteristics (5–10 minutes); (5) administration of the nutritional knowledge questionnaire (20–30 minutes); (6) anthropometric measurements conducted twice and averaged (10 minutes); and (7) developmental screening using KPSP through interviews and direct observation (15–20 minutes).

Data were analyzed using SPSS version 25.0 through the following steps: (1) data cleaning to detect missing data, outliers (z-scores outside −5 to +5 SD), and inconsistencies; (2) univariate analysis for categorical variables (frequency and percentage) and numerical variables (mean, median, standard deviation); and (3) bivariate analysis using cross-tabulation to describe independent–dependent variable relationships. Hypothesis testing employed the Chi-Square test at a 95% confidence level (α = 0.05). A p-value < 0.05 indicated a significant relationship between variables, while a p-value> 0.05 indicated no significant relationship. Assumption tests included normality (Kolmogorov–Smirnov, p > 0.05) and homogeneity (Levene's Test, p > 0.05).

The ethical principle of respect for persons was implemented through a rigorous informed consent process. Participants received complete explanations in accessible language covering the study objectives, procedures, estimated time, potential benefits, minimal risks, their rights to voluntary participation, and confidentiality assurances. Respondents with limited literacy were given more detailed oral explanations before providing consent.

Result

This study involved 100 parents of children under five years old in Bathin Solapan District. The collected data were analyzed using descriptive and inferential statistical methods to determine the relationship between parents' nutrition knowledge and various indicators of children's nutritional and developmental status. The results presented below focus on the association between parents' nutrition knowledge level and weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H), and child development index.

Relationship Between Nutrition Knowledge and Weight-for-Age (W/A)

The analysis of the Weight-for-Age Index (W/A) reveals apparent differences in children's nutritional outcomes by parents' level of nutritional knowledge, as summarized in Table 1.

Table 1. Relationship Between Parents' Nutrition Knowledge Level and Weight-for-Age Index (W/A)

Parents' Nutrition Knowledge Level	Poor Nutrition	Undernutrition	Normal	Total
Low Knowledge	9	11	3	23
Moderate Knowledge	7	5	42	54
High Knowledge	6	9	8	23
Total	**22**	**25**	**53**	**100**

As shown in Table 1, more than half of the children (53%) had normal nutritional status, while 25% were undernourished and 22% were categorized as having poor nutrition. Among parents with **low** nutrition knowledge**,** nearly nine out of ten children suffered from nutritional problems—about 39% with poor nutrition and 48% with undernutrition—indicating that limited understanding of dietary balance and feeding frequency strongly correlates with poor weight outcomes.

Conversely, moderate nutrition knowledge appears to offer the most favorable nutritional balance. Over three-quarters of children (77.7%) in this group achieved normal weight, suggesting that practical, experience-based knowledge and consistent feeding routines may be more impactful than theoretical mastery alone. In the high-knowledge group**,** however, the pattern becomes less stable: 26.1% of children still experienced poor nutrition, and 39.1% were undernourished. This irregularity may reflect gaps between knowledge and practice, such as inconsistent meal planning or economic constraints that prevent the application of correct nutritional principles.

The statistical pattern suggests a non-linear relationship between nutrition knowledge and child weight outcomes: children of moderately knowledgeable parents exhibit the most balanced nutrition, while both extremes—insufficient and overly theoretical knowledge—correspond to less optimal outcomes. This implies that functional nutritional literacy, rather than mere knowledge accumulation, plays a decisive role in shaping children's weight-for-age status.

Relationship Between Nutrition Knowledge and Height-for-Age (H/A)

The analysis of the Height-for-Age Index (H/A) provides further evidence that parents' nutritional knowledge influences children's linear growth patterns. The distribution of nutritional status by parental knowledge level is presented in Table 2.

Table 2. Relationship Between Parents' Nutrition Knowledge Level and Height-for-Age Index (H/A)

Parents' Nutrition Knowledge Level	Stunted	Short	Normal	Total
Low Knowledge	12	9	2	23
Moderate Knowledge	6	9	39	54
High Knowledge	6	6	11	23
Total	**24**	**24**	**52**	**100**

The data show that 52% of all children had normal height-for-age, while 24% were classified as short and 24% as stunted. When disaggregated by parents' levels of knowledge, the differences become more pronounced.

Children whose parents had low nutrition knowledge were at the most significant risk of growth faltering: more than half (52.2%) were stunted, 39.1% were short, and only 8.7% achieved normal height. This pattern suggests that insufficient awareness of protein and micronutrient sources, and of meal diversity, likely restricts linear growth during the critical early years. In contrast, children of parents with moderate nutrition knowledge exhibited a substantially healthier pattern. About 72.2% of these children achieved normal height, whereas only 11.1% were stunted and 16.7% were short. This suggests that parents with adequate and applicable nutrition knowledge tend to adopt balanced feeding habits and monitor child growth more consistently.

For parents with high nutrition knowledge**,** growth outcomes improved compared to the low-knowledge group, but were not as optimal as in the moderate group. In this category, 26.1%

of children were stunted, 26.1% were short, and 47.8% had normal height. This mixed result implies that knowledge alone may not suffice without adequate economic resources, meal availability, or health service utilization. The statistical pattern underscores that height-for-age outcomes depend not only on the level of knowledge but also on how that knowledge is practiced**.** Moderate, experience-based understanding of nutrition appears most conducive to sustained child growth, suggesting that balanced and consistent parental engagement is a key determinant in preventing stunting.

Relationship Between Nutrition Knowledge and Weight-for-Height (W/H)

The Weight-for-Height Index (W/H) reflects the balance between a child's body weight and height and serves as an indicator of both acute malnutrition and overweight. The analysis results across different levels of parents' nutrition knowledge are displayed in Table 3.

Table 3. Relationship Between Parents' Nutrition Knowledge Level and Weight-for-Height Index (W/H)

Parents' Nutrition Knowledge Level	Overweight	Normal	Total
Low Knowledge	10	13	23
Moderate Knowledge	10	44	54
High Knowledge	2	21	23
Total	**22**	**78**	**100**

As shown in Table 3, 78% of children were within the normal weight-for-height range, while 22% were overweight. The distribution indicates a clear association between parents' nutritional literacy and the likelihood that children maintain a proportional body weight relative to height.

Among parents with low nutrition knowledge**,** 43.5% of children were overweight, suggesting possible overfeeding, frequent consumption of calorie-dense foods, or lack of portion control. Although undernutrition was not the issue in this group, the data suggest that an insufficient understanding of balanced nutrition can lead to overnutrition and unhealthy weight gain. Children of parents with moderate nutrition knowledge demonstrated the healthiest pattern: 81.5% of them maintained a normal weight, and only 18.5% were overweight. This outcome implies that moderate-level knowledge tends to translate into appropriate dietary regulation, balanced meal composition, and responsive feeding practices that prevent both under- and overnutrition.

Meanwhile, the group with high nutrition knowledge had the lowest overweight incidence (8.7%) and the highest normal weight percentage (91.3%). This trend indicates that a comprehensive understanding of nutrient balance and energy intake enables parents to manage feeding more effectively, avoiding excessive calorie intake while ensuring adequate nutrient intake. The pattern suggests a progressive improvement in weight balance as parental nutrition knowledge increases**.** Both moderate and high knowledge levels appear protective against overweight risk, though moderate knowledge may represent the most realistic and consistently applied understanding in everyday feeding behavior. These findings emphasize that parental nutrition literacy is crucial not only for preventing malnutrition but also for reducing the emerging risk of childhood overnutrition.

Relationship Between Nutrition Knowledge and Child Development Index

The analysis of the Child Development Index (CDI) provides a comprehensive view of how parents' nutrition knowledge correlates not only with physical growth but also with broader developmental outcomes, including cognitive, social, and motor domains. The cross-tabulation results are shown in Table 4.

Table 4. Relationship Between Parents' Nutrition Knowledge Level and Child Development Index

Parents' Nutrition Knowledge Level	Deviated Development	Questionable	Normal	Total
Low Knowledge	12	4	7	23

Parents' Nutrition Knowledge Level	Deviated Development	Questionable	Normal	Total
Moderate Knowledge	42	10	2	54
High Knowledge	0	10	13	23
Total	**54**	**24**	**22**	**100**

As seen in Table 4, more than half of the children (54%) experienced developmental deviations, 24% fell into the questionable category, and only 22% demonstrated normal development. However, this distribution varied markedly across the three levels of parental nutrition knowledge.

Children whose parents had low nutrition knowledge showed the most concerning outcomes: 52.2% had deviated development, 17.4% were questionable, and only 30.4% achieved normal development. This suggests that inadequate nutritional awareness likely leads to suboptimal feeding practices and limited stimulation, both of which are critical factors in early childhood development. In contrast, the group of moderate knowledge parents exhibited an unexpected trend. Despite higher awareness, 77.8% of their children were categorized as having deviated development, while only 3.7% were categorized as having normal development. This anomaly may indicate that although parents possess general nutrition knowledge, its application may be inconsistent or hindered by environmental constraints, such as time, income, or access to health services.

Meanwhile, children of parents with high nutrition knowledge demonstrated the most favorable developmental outcomes. None of the children in this group experienced developmental deviations; more than half (56.5%) achieved normal development, and the remainder (43.5%) were classified as questionable. This finding underscores that deep and accurate understanding of nutrition—combined with effective caregiving practices—has a significant positive influence on children's developmental trajectories. These results illustrate a gradient relationship between nutrition knowledge and developmental outcomes. While limited knowledge increases developmental risks, the transition to high and applied knowledge significantly enhances developmental normality. The data suggest that parental nutritional literacy is a decisive factor in ensuring children's holistic growth, encompassing both physical health and functional development.

Discussion

The study found that the majority of parents (54%) had moderate nutrition knowledge, while 23% had low knowledge and 23% had high knowledge. This finding is consistent with Runtu et al. (2021) in Gorontalo, who reported that 65.7% of mothers had moderate knowledge. However, it differs from Krisnanto et al. (2022), who found a higher proportion in the good category (24%). The predominance of the "moderate" category indicates that parents possess a basic understanding of nutrition, although they have not optimally applied this knowledge in daily feeding practices.

The limited nutrition knowledge among parents in Bathin Solapan can be explained by Bronfenbrenner's ecological theory, which posits that access to health information varies between central and peripheral villages. A global study by Zarnowiecki et al. (2012) in Australia showed that education level and information access are strong predictors of parents' nutrition knowledge (r = 0.30, p < 0.001). In the Indonesian context, Rahmawati and Masykuroh (2022) confirmed that mothers with higher education have a better understanding of children's nutritional needs. These findings emphasize the need for nutrition education programs adapted to local contexts and information accessibility in plantation-based areas such as Bengkalis.

The practical implication of this finding is the urgent need for *posyandu*-based interventions involving trained health cadres to deliver balanced nutrition education. Educational programs should not be conducted as one-time activities but require continuous mentoring, as demonstrated by Fitria and Sudiarti (2021), who found that structured counseling significantly improved mothers' nutrition knowledge. Participatory approaches involving

community leaders and promoting local nutrient-rich foods can enhance the relevance and sustainability of community nutrition education programs.

The findings revealed an alarming situation: 47% of children experienced nutritional problems (poor or undernutrition) based on W/A and H/A indices, while 78% showed deviations or questionable development. This prevalence is far higher than Indonesia's national average of 24.4% for stunting (Kemenkes RI, 2023) and aligns with Engle and Black (2008), who reported malnutrition prevalence in middle-income countries between 20–30%. The high proportion of developmental issues (78%) is consistent with Prado and Dewey (2014), who found that nutritional deficiencies significantly affect brain structure and function, with effect sizes ranging from -0.3 to -1.2 SD in cognitive development scores.

A paradoxical pattern emerged in the W/H indicator: 78% of children were classified as usual, while 22% were overweight, indicating a *double burden of malnutrition*, as explained in the *Lancet* series by Engle and Black (2008). This reflects a nutritional transition in which chronic undernutrition (stunting) coexists with overweight conditions caused by high-calorie, low-nutrient processed foods. The situation is exacerbated by limited access to affordable, nutritious food in remote areas, where parents often provide instant foods that are convenient but lack micronutrients.

The practical implication of these findings is the need to integrate Early Detection of Growth and Development (DDTK) programs into routine *posyandu* activities, alongside training cadres in multidisciplinary assessment (anthropometry, developmental checklists, behavioral observation) in accordance with WHO standards. Ansuya et al. (2023) in India demonstrated that a combination of nutritional supplementation and parental education increased IQ scores by 7.2 points ($p < 0.001$) among malnourished children. This supports a holistic approach addressing both nutritional improvement and cognitive, motor, and socio-emotional stimulation in children.

The Chi-Square test confirmed a significant relationship between parents' nutrition knowledge and all growth and development indicators ($p = 0.000$ for W/A, H/A, and development; $p = 0.011$ for W/H). This finding is consistent with the meta-analysis of Lassi et al. (2013), which found that nutritional education interventions increased weight-for-age Z-scores by 0.25 SD and height-for-age Z-scores by 0.41 SD. However, the present study revealed an intriguing non-linear pattern: the "moderate knowledge" group showed better outcomes (77.7% of children with normal nutrition in W/A) than the "high knowledge" group (34.8%). Maslow's and Bronfenbrenner's theories can explain this phenomenon: parents with high knowledge often live in remote areas with limited access to food, preventing that knowledge from being translated into optimal practices.

Further analysis indicates that nutrition knowledge is a *necessary but not sufficient* condition for optimal child growth. A comparative study by Danaei et al. (2016) identified that maternal factors (education, nutrition knowledge) account for 29.4% of the global stunting burden, while 70.6% is influenced by other factors such as infection, sanitation, and food access. These findings underscore the importance of a multi-level ecological approach integrating nutrition education (microsystem), *posyandu* strengthening (mesosystem), local food security policies (exosystem), and social norm change regarding healthy eating habits (macrosystem).

Theoretically, this study enriches the literature by demonstrating that the knowledge–outcome relationship is moderated by socio-ecological context. Practically, it recommends multi-component interventions: (1) *posyandu*-based nutrition education focusing on local nutrient-rich food diversification; (2) cross-sector collaboration with agricultural and small-enterprise departments to improve family access to affordable nutritious foods; and (3) food assistance programs for low-income families in remote villages. These recommendations align with the *Lancet* series, which emphasizes that nutrition interventions are most effective when integrated into primary health systems and tailored to local contexts.

Conclusion

Based on the field findings, the study concludes the following: (1) There is a significant relationship between parents' nutritional knowledge and the growth and development of children aged 5–6 years in Bathin Solapan District, Bengkalis Regency, Riau Province. Parents with moderate to high levels of nutritional knowledge tend to have children with normal nutritional status (53% W/A, 52% H/A) and age-appropriate developmental stages (56.5% in the high-knowledge category). (2) The findings also reveal that 47% of children still experience nutritional problems (poor/underweight), and 78% show developmental deviations or uncertainties, indicating the presence of complex factors beyond knowledge, such as limited access to nutritious food, economic constraints, and parenting practices. (3) The Chi-Square test results (p = 0.000 for W/A, H/A, and developmental indicators) reinforce Notoatmodjo's theory that knowledge is a prerequisite for healthy behavior. However, it does not guarantee optimal outcomes without environmental support.

These findings lead to several recommendations for future research and policy development: (1) For community health programs and local nutrition policies, it is necessary to implement *posyandu*-based interventions aimed at improving parents' nutritional literacy, particularly concerning local food diversification and appropriate complementary feeding practices, in line with the recommendations of the Indonesian Ministry of Health. (2) The integration of early childhood growth and development screening (*Deteksi Dini Tumbuh Kembang* or DDTK) into routine *posyandu* activities can facilitate early identification of children at risk of stunting or developmental delays. (3) Cross-sectoral collaboration with the agricultural and MSME agencies should be optimized to enhance family access to affordable, nutritious food, considering that 22% of children whose parents possess good nutritional knowledge still experience overweight due to excessive consumption of high-calorie processed foods.

Declarations

Author Contribution Statement

All authors contributed equally and approved the final manuscript.

Data Availability Statement

Data are available from the corresponding author upon reasonable request.

Declaration of Interests Statement

The author declares no conflict of interest.

Additional Information

No additional information is available.

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