Profile of Early Childhood Education Services and Students' Nutritional Status: Designing an Integrated Stunting Intervention Model

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Abstract: *Background*: Stunting management in Semarang City remains sectoral and has yet to involve early childhood education centres. This study investigates early childhood education services, nutritional status, and the impact of services on stunting prevalence and designs a stunting intervention model.

Methods: A cross-sectional survey was conducted to collect data from 314 integrated early childhood education centres in Semarang City, with 20 selected for anthropometric data collection. Nutritional status was classified as wasting, stunting, and underweight. Dummy variable regression analysis was used to determine the impact of services on stunting prevalence.

Results: The integrated early childhood education (IECE) was considered good in 55.97% of cases, while 44.03% were rated as less satisfactory. The prevalence of stunted students (29%) was the highest, followed by underweight and wasting. The prevalence of stunting was higher among male students than female students, and the rate of stunting in boys increased with age. Although the influence of early childhood education services on stunting reduction was found to be very weak, it remains a positive factor in lowering stunting prevalence. Enhancing the quality of IECE through an integrated intervention model, especially targeting nutrition and health among young children, represents a significant opportunity to implement effective non-medical interventions to reduce stunting, as evidenced by service-delivery rates.

Conclusion: IECE service was found to be effective in reducing the prevalence of student stunting. These findings imply an urgent need for coordinated, targeted actions that leverage existing policy frameworks to improve service quality and focus interventions on the most vulnerable groups.

Keywords: Design, integrated, integrated early childhood education, intervention model, early childhood education services model, stunting intervention.

INTRODUCTION

Stunting stems from malnutrition that begins as early as the womb, often leaving affected children unable to achieve their full height or cognitive potential [1]. Stunting, defined as impaired growth and development due to chronic malnutrition and recurrent infections, is characterised by length or height below established standards [2]. It remains a significant issue in developing countries [3, 4]. The impact of stunting includes reduced academic achievement and developmental outcomes that fail to meet the standards for progress, abilities, potential, and cognition [5].

This study focuses on the persistently high national prevalence of stunting. In 2021, the prevalence was 9.5%, which decreased to 8.4% in 2022 and further dropped to 7.1% in 2023. However, in Central Java Province, the trend has fluctuated: 9% in 2021, rising to 9.4% in 2022, and then declining to 9.1% in 2023. Meanwhile, in Semarang City, the prevalence of stunting has decreased steadily: from 3.1% in 2021 to 3.1% in 2022, and then to 1.7% in 2023 [6]. These figures indicate that Semarang City, as the capital of Central Java Province, has better facilities than other cities, including healthcare infrastructure, health professionals, universities, and a higher regional budget, making it reasonable for Semarang City to hold the best position in terms of stunting prevalence reduction. Nevertheless, the data also highlight that Semarang City is leading efforts to reduce stunting prevalence.

This study investigates how integrated early childhood education (IECE, *Pos PAUD*) institutions, particularly those within similar units serving children from birth to four years old, can accelerate stunting mitigation programs through existing services. These

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services include early detection of growth and development (EDGD), learning activities, communal meals, and parent classes [7, 8].

Interventions targeting both stunted and non-stunted children are crucial through these services as an alternative solution to address stunting issues. To the best of the researchers' knowledge, early childhood education (ECE) institutions have not yet been involved in accelerating stunting mitigation efforts, despite serving an age group highly vulnerable to stunting. Previous studies have primarily examined the incidence of stunting among students aged 5 years and older in educational institutions [9-11]. This research not only observes the phenomenon but also offers concrete solutions to address malnutrition, with particular focus on students aged 24-59 months in early childhood education institutions, an area not previously explored to the best of the researchers' knowledge. Earlier studies have mostly emphasized integrating nutritional intervention programs into educational institutions, which may disrupt institutional activities [12-16]. In contrast, the intervention in this study builds on existing services within early childhood education settings, such as learning activities, shared meals, and parent classes, without burdening or disrupting academic activities. As shown in previous studies, school meal programs often consume a significant portion of educational time and are considered a notable drawback of such interventions [17].

Health promotion activities conducted through classroom learning, improvements to dietary intake via communal meals, and strengthened health education through parent classes (parenting), when carried out collectively and continuously in early childhood education institutions, are likely to be more effective in addressing nutritional issues such as stunting. Health education programs involving parents at schools, extended nutrition programs, and health promotion can yield better impacts on children's health, cognition, physical activity, and eating behaviour [18, 19]. Adequate nutrition from conception is a key determinant of healthy physical growth and is a primary factor in neurobehavioral development. Therefore, equitable nutritional improvement for children emphasises planning tailored to strategies, policies, and socio-economic contexts [20, 21].

Based on the preceding elaboration, this study aims to analyse IECE services, assess their impact on stunting prevalence, and design an integrated stunting intervention model through IECE services.

METHODS

Participants

314 IECE in Semarang City participated in this study. IECE service is the independent variable, comprising early detection of child growth and development, learning activities, communal meals, and parent classes. The dependent variable is students' nutritional status, categorised as wasting, stunting, and underweight.

Data Source

This study employed a cross-sectional survey approach to collect data on integrated childhood education (IECE) services and students' anthropometric measurements in Semarang City. Data collection was carried out at the beginning of October 2024, following the official end of the COVID-19 pandemic in Indonesia on June 21, 2023 [22]. The initial stage of data collection used a saturated (census) sampling method to assess all IECE services across Semarang City, in which one questionnaire was distributed to each institution and completed by a teacher at each institution. Planning and implementation of early detection of growth and development (EDGD), instructional activities, communal meals, and parent class services were used as indicators of service quality.

Validity and Reliability Testing

Before the study, the teacher questionnaire underwent validity and reliability tests, conducted by distributing the instrument to IECE institutions outside the research area (outside Semarang City). Of the 40 pilot institutions, 36 responded. The data were analyzed using SPSS version 30.00, with a 5% significance level and Cronbach's alpha exceeding 0.7.

Anthropometric Measurement Sample

The second stage of data collection (anthropometric data) involved purposive selection of institutions. Survey results and service analysis from the first stage informed the selection of 20 sample institutions across five districts of Semarang (East, North, Central, South, and West Semarang). The selected institutions in each district had to meet the following criteria:

1. Institutions classified as providing good service
2. Offering EDGD services

3. Having complete anthropometric data for the previous two months

4. Including student cohorts aged 24-35 months, 36-47 months, and 48-59 months

After selecting 20 institutions, researchers visited each to collect anthropometric data.

Statistical Analysis

Service quality was analyzed with SPSS version 30.0.0, using the mean to categorize each service as either 'less satisfactory' or 'good'. The WHO Anthro software was used to analyze students' nutritional status. Wasting was classified as 'thin' and 'normal', stunting as 'short' and 'normal', and underweight as 'well-nourished' and 'malnourished', according to WHO standards [23, 24].

Dummy regression was used for further analysis to determine the effect of ECE service quality (independent variable) on student stunting (dependent variable) [25]. This analysis allowed assessment of the impact of both 'less satisfactory' and 'good' service categories on stunting. The average difference in effects between 'less satisfactory' and 'good' service could be estimated using a dummy regression, which is not observable in other regression analyses that only present the effects of service types and stunting [25]. In the dummy regression, qualitative (categorical) independent and dependent variables were first converted to quantitative data. Stunting status (short and regular) was coded 0 and 1, respectively; service quality (less satisfactory and good for EDGD, learning, communal meals, and parent classes) was also coded as 0 and 1, respectively.

Ethical Approval

Ethics approval No. 438/KEPK/FK/KLE/2024 was obtained from the Faculty of Medicine, Universitas Negeri Semarang, Indonesia. Consent for voluntary participation was obtained from the involved IECE teachers. We signed the commitment to maintain the confidentiality and safety of research participants.

RESULT

Analysis of IECE Services

We created tables, categorised them, and analysed data based on questionnaire responses from 314 participating institutions. We used the results to classify IECE services as good or suboptimal, using the median from the descriptive analysis as a reference for categorisation. The results of descriptive statistical analysis are presented in Table **1**.

Table **1** shows that the descriptive statistics for the sample of 314 institutions indicate that the EDGD service ranged from 4 to 26, with an average of 20.16 and a standard deviation of 3.656. The learning service had a minimum value of 21, a maximum of 42, an average of 31.66, and a standard deviation of 3.625. The communal meal had a minimum value of 1, a maximum value of 20, an average of 13.4, and a standard deviation of 2.293. The parent class had a minimum value of 0, a maximum value of 18, an average of 12.28, and a standard deviation of 3.365.

We therefore categorised existing services into criteria for good services and suboptimal services, as presented in Table **2** below.

In general, Table **2** concludes that 55.975% of institutions provided good services, while 44.025% provided suboptimal services. A detailed explanation is elaborated below.

Early Detection of Growth and Development (EDGD) Services

58% of institutions provided good service, while 42% provided suboptimal service. These results indicate that EDGD services have not been optimally

Table 1: Descriptive Statistics

IECE Services	N	Minimum	Maximum	Mean	Std. Deviation
EDGD	314	4	26	20.16	3.656
Learning	314	21	42	31.66	3.625
Communal Meal	314	1	20	13.40	2.293
Parent Class	314	0	18	12.28	3.365
Valid N (listwise)	314				

Notes: IECE: integrated, early childhood education, EDGD: early detection of growth and development.

Table 2: Category of IECE Service Frequency

IECE Services	Category		Frequency
	Good	Suboptimal	
EDGD	58	42	314
Learning	54.1	45.9	314
Communal Meal	54.5	45.5	314
Parent Class	57.3	42.7	314
Total	55,975	44,025	314

Notes: IECE: integrated, early childhood education; EDGD: early detection of growth and development.

implemented. Most respondents cited limited funding and personnel as primary factors hindering service quality. Administrative management remains inadequate in most institutions, leading to underutilised activity outcomes for supporting learning, communal meals, or parent classes. Activities also lacked collaboration with external institutions. Additionally, teachers reported no participation in EDGD-related training, workshops, or courses.

Learning Services

54.1% of institutions provided good service, while 45.9% provided suboptimal service. Analysis reveals suboptimal implementation of learning activities. Most teachers did not prepare lesson plans before classes and rarely delivered content on health-promoting behaviour pocketbooks. Opportunities for students to engage in scientific thinking (observing, questioning, gathering information, reasoning, and communicating) during learning activities were minimal.

Communal Meal Services

55.5% of institutions fell into the good category, while 45.5% were suboptimal. Communal meal services were not optimally executed. Most institutions lacked meal planning, did not provide standardised food menus for children to bring from home, and failed to involve nutrition experts. Some institutions allow students to bring snacks to school, with a few even scheduling snack-based meals for communal activities.

Parent Class Services

57.3% of institutions provided good services, while 42.7% provided suboptimal services. While most institutions conducted parent classes, activity frequency remained low (once annually). External stakeholders were rarely involved, and parent participation was minimal (attendance below 25% of total parents). Health-related topics received the least attention, with child education and general issues dominating class discussions.

Analysis of Students' Nutritional Status

Nutritional status was analyzed for 303 students enrolled in 20 ECE institutions following an elimination process. Overall, stunting was the most prevalent dietary abnormality (29%), followed by underweight (12.2%), and the lowest was wasting (5.9%). Analysis

Table 3: Students' Nutritional Status

Nutritional Status		Total	Percentage	Male		Female	
				Total	Percentage	Total	Percentage
Wasting	Thin	18	5,9	6	4	12	7,5
	Normal	285	94,1	143	96	142	92,5
Total		303	100	149	100	154	100
Stunting	Short	88	29	46	30,9	42	27,3
	Normal	215	71	103	69,1	112	72,7
Total		303	100	149	100	154	100
Underweight	Undernutrition	37	12,2	19	12,8	18	11.7
	Good Nutrition	266	87,8	130	87,2	136	88.3
Total		303	100	149	100	154	100

Table 4: Analysis of the Impact of IECE Services on Stunting Prevalence

IECE Services	Short with Stunting		
	Sig	R	Expected B
EDGD	0,002	0,175	0,487
Learning	< 0,001	0,194	0,414
Communal Meal	0,002	0,177	0,449
Parent Class	0,003	0,169	0,455

by gender indicated a higher prevalence of stunting among boys (30.9%) compared to girls (27.3%). Conversely, the percentage of students with normal height was higher among girls (72.7%) than among boys (69.1%) (Table **3**).

Impact of IECE Services on Stunting Prevalence

The impact of IECE services on stunting prevalence was analysed using dummy variable regression. This technique was used because the number of IECE service variables (independent) did not match the number of students with stunting (dependent). The analysis results are presented in Table **4**.

Table **4** shows that IECE services (EDGD, learning activities, communal meals, parent classes) significantly influence the incidence of stunting among students, as indicated by p-values < 0.05. All R-values for ECE service variables were positive, ranging from 0.169 to 0.194 (<0.29), indicating a positive but very weak association between ECE services and stunting incidence. Positive R-values suggest that improvements in ECE service quality are associated with greater effectiveness in preventing or reducing stunting among students.

The dummy-variable regression analysis also shows an expected B value for EDGD services of 0.487, indicating that good EDGD services can reduce the prevalence of stunted students by 0.487 times compared to suboptimal EDGD services. The Expected B value for learning activities is 0.414, implying that good learning activities can reduce the prevalence of stunted students by 0.414 times compared to suboptimal learning activities. The Expected B value for communal meals is 0.449, which indicates that good communal meal services can reduce the prevalence of stunted students by 0.449 times compared to suboptimal communal meal services. The Expected B value for parent classes is 0.455, indicating that good parent class services can reduce the prevalence of stunted students by 0.455 times compared to suboptimal services.

Designing an Integrated Stunting Intervention Model Through IECE Services

Based on prior data analysis, researchers designed an integrated stunting intervention model leveraging IECE services. This model aims to accelerate stunting reduction by optimising existing IECE programs without disrupting their operational frameworks. Interventions target three core services at IECE institutions: learning activities, communal meals, and parent classes. Implementation involves coordination and collaboration with IECE service users. The model design is presented in Figures **1** and **2**.

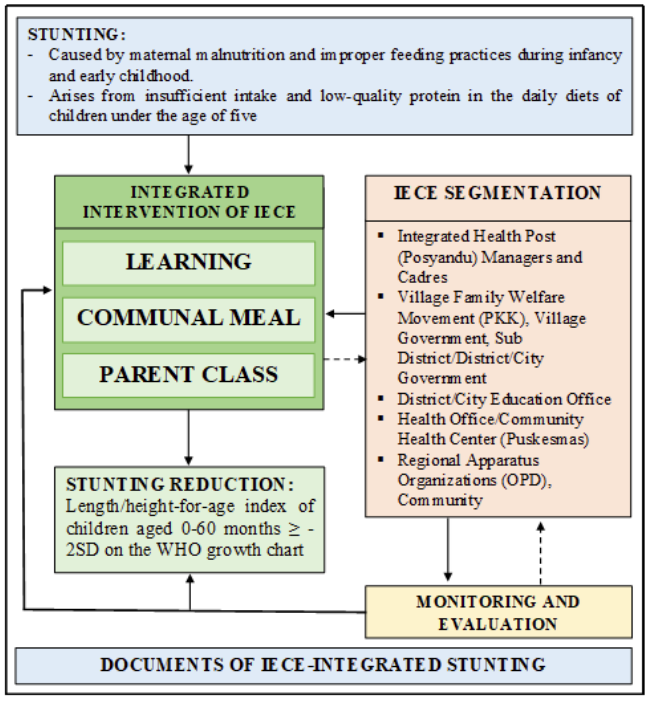

Figure 1: Conceptual Model of IECE-Integrated Stunting Intervention.

Figure **1** illustrates that the stunting intervention was implemented through three key services: learning activities, communal meals, and parent classes. The intervention was carried out in coordination with IECE service users, which can help reduce stunting prevalence.

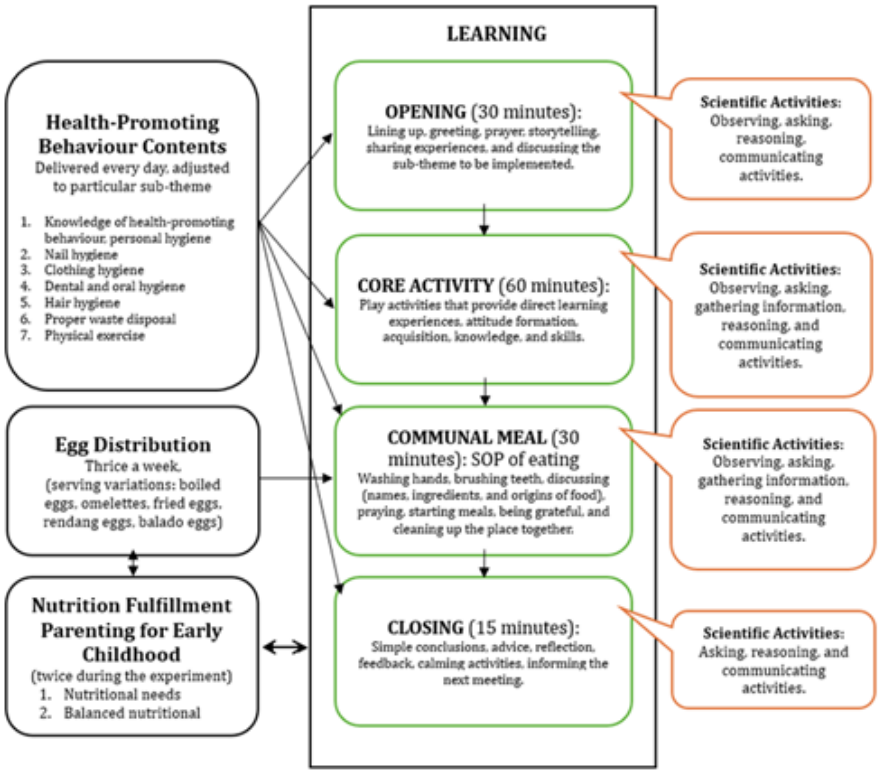

Figure 2: IECE-Integrated Stunting Intervention Flowchart.

Figure **2** explains how the intervention model was implemented without altering the institutions' existing services. a) Learning Services: In this service, teachers act as motivators and facilitators, playing a crucial role in classroom teaching and learning activities while delivering both theoretical and practical intervention materials aligned with themes and child development stages. Teachers do not need to modify the Learning Implementation Plan (LIP) they have prepared; instead, they need to adjust and align intervention materials with the existing LIP. The intervention involves providing pocketbooks on health-promoting behaviour. It is expected to impact students' knowledge, skills, and habits regarding clean and healthy living from an early age. b) Communal Meal Services: This service is conducted daily at IECE institutions according to the teaching schedule and meal SOPs in each unit. The intervention does not change menus, methods, or meal schedules already in place at the institution. The intervention involves adding food during communal meals, such as egg supplementation, aimed at reducing stunting prevalence. Eggs, rich in animal protein, are expected to accelerate students' growth in height. Eggs are provided for students to consume daily at the institution, adjusted to communal meal services. Various cooking methods and egg presentations need to be implemented to prevent students from becoming bored with eating eggs. Egg provision can be done at least three times a week. c) Parent Class Services: This class aims to align teachers' and parents' perceptions of child education. In line with the principle of parent involvement, parents are required to attend parent classes regularly at agreed-upon times. The intervention does not alter existing activity schedules but modifies the activity materials to align with the model's objectives. If health-related materials were previously the third choice after educational and general topics, in this model, health becomes the primary focus of these services. For example, parenting on early childhood nutrition fulfillment becomes the primary material presented at least four times per semester. Parenting around nutrition fulfillment is expected to affect parents' methods, behaviours, and habits in providing their children with more effective nutrition.

DISCUSSION

Analysis of IECE Services

The study reveals that services across 314 IECE tend to be suboptimal, with 55.97% providing good services and 44.03% categorised as suboptimal. Optimising these services requires concerted efforts from all stakeholders to achieve institutional goals.

IECE centers aim to support children's holistic growth and development, preparing them for subsequent educational stages [26].

EDGD Service

Funding constraints, limited personnel, and a lack of teacher training in growth monitoring programs hinder service quality. Addressing these issues is critical to enhancing educators' early-detection skills. Training healthcare workers in early childhood development is essential to strengthen community-based early detection and intervention programs [27]. Comparisons of growth across peer groups are vital for assessing child development [28]. Nourhan *et al*. [2024] emphasise the need for innovative approaches to the detection and management of pediatric dental health to improve preventive and treatment strategies [29].

Learning Service

Learning activities are suboptimally implemented, with most teachers lacking lesson plans and rarely incorporating scientific thinking (observing, questioning, gathering information, reasoning, and communicating) or health education, such as a health-promoting behaviour pocketbook. School-based health education programs can foster lifelong healthy habits by promoting physical activity [19]. Teacher preparedness through workshops, training, and professional development is key to improving service quality and educational outcomes [30].

Communal Meal Service

Communal meals are inadequately planned, with no standardised menus or involvement of nutrition experts. Snacks remain prevalent in schools, undermining nutritional goals. School food standards and policies banning sugar-sweetened beverages and energy-dense, nutrient-poor foods are effective in promoting healthy eating [31]. Repeated exposure to nutritious foods in early education settings, paired with positive peer interactions, enhances children’s willingness to try new foods [32].

Parent Class Service

Parent classes are infrequently held (once annually), lack external collaboration, and prioritise general topics over child health. Family-based nutrition programs providing simplified dietary guidance can substantially reduce unhealthy fat intake and increase fruit and vegetable consumption [33]. Family nutritional practices significantly influence household feeding behaviours and general caregiving [34].

Analysis of Students' Nutritional Status

This analysis utilised anthropometric data from IECE units. The nutritional status of students aged 24-59 months was analysed to assess the prevalence of wasting, stunting, and underweight. The overall prevalence of wasting, as shown in Table **3**, is 5.9%, with details in Table **5**: male students aged 24-35 months had a prevalence of 0%, 36-47 months 3.3%, and 48-59 months 5.9%. Meanwhile, female students aged 24-35 months had a prevalence of 10.7%, 36-47 months 6.7%, and 48-59 months 7.8%. Wasting among students may be caused by poor dietary patterns, economic factors that limit access to adequate food, and infectious diseases. The prevalence of wasting increases with the severity of food insecurity, from mild to moderate to severe levels [35]. The duration of illness and delays in accessing healthcare services double the likelihood of experiencing wasting compared with those who receive early healthcare services [36].

The overall prevalence of stunting among students aged 24-59 months, as shown in Table **5**, is 29%, with details that male students aged 24-35 months have a prevalence of 30%, 36-47 months 27.9%, and 48-59 months 33.8%. Female students aged 24-35 months have a prevalence of 21.4%, 36-47 months 26.7%, and 48-59 months 31.4%. Various factors, including poor dietary patterns, maternal education, infectious diseases, and poor sanitation, cause stunting prevalence. Statistically, stunting is significantly associated with maternal education, decision-making speed, handwashing practices during critical periods, agroecological settings, antenatal care services, membership in food network programs, exclusive breastfeeding practices, minimum dietary diversity, child illnesses, gender, and age [37].

Furthermore, the overall prevalence of underweight students aged 24-59 months, as shown in Table **3**, is 12.2%. Detailed data in Table **5** indicate that male students aged 24-35 months have a prevalence of 15%, 36-47 months 8.2%, and 48-59 months 16.2%. Female students aged 24-35 months have a prevalence of 7.1%, 36-47 months 5.3%, and 48-59 months 23.5%. A lack of physical activity, poor dietary patterns, and the absence of exclusive breastfeeding may contribute to underweight among students. A cohort study on children aged two to six years found that breastfeeding was inversely associated with the

Table 5: Students' Nutritional Status Based on Age

Status	Umur/Bulan	Status	Male		Female	
			Jumlah	Percent	Jumlah	Percent
Wasting	24 – 35	Kurus			3	10,7
		Normal	20	100	25	89,3
		Total	20	100	28	100
	36 – 47	Kurus	2	3,3	5	6,7
		Normal	59	96,7	70	93,3
		Total	61	100	75	100
	48 – 59	Kurus	4	5,9	4	7,8
		Normal	64	94,1	47	92,2
		Total	70	100	51	100
Total			149		154	303
Stunting	24 – 35	Pendek	6	30	6	21,4
		Normal	14	70	22	78,6
		Total	20	100	28	100
	36 – 47	Pendek	17	27,9	20	26,7
		Normal	44	72,1	55	73,3
		Total	61	100	75	100
	48 – 59	Pendek	23	33,8	16	31,4
		Normal	45	66,2	35	68,6
		Total	68	100	51	100
Total			149		154	303
Underweight	24 – 35	Gizi Kurang	3	15	2	7,1
		Gizi Baik	17	85	26	92,9
		Total	20	100	28	100
	36 – 47	Gizi Kurang	5	8,2	4	5,3
		Gizi Baik	56	91,8	71	94,7
		Total	61	100	75	100
	48 – 59	Gizi Kurang	11	16,2	12	23,5
		Gizi Baik	57	83,8	39	76,5
		Total	68	100	51	100
Total			149		154	303

risk of obesity in children; exclusive formula feeding in infants may be a risk factor for underweight conditions in preschool-aged children [38].

We observed in this study that the prevalence of stunting was higher among male students than female students (Table **3**). This result is consistent with previous studies [10, 39, 40]. We did not conduct extensive investigations regarding demographics, parenting patterns, students' daily activities, or eating habits at home. However, our age- and sex-group analysis (Table **5**) revealed that stunting prevalence increased with age in male students, whereas it decreased with age in female students. This finding aligns with previous research indicating that stunting scores in boys tend to become more negative as they age [41].

Impact of IECE Services on Stunting Prevalence

Analysis of the effect of service provision on stunting prevalence among students showed that ECE services, including EDGD, learning activities, communal meals, and parent classes, significantly

influenced stunting prevalence ($p < 0.05$). However, the strength of these effects, as indicated by R-values for all services, was positive but very weak (<0.29). This suggests that better ECE services for students and parents are associated with more effective efforts to prevent and reduce stunting. Integrating health-related material into the curriculum will improve instruction and enhance students' understanding, conceptual knowledge, and attitudes toward clean and healthy living. Enhancing the communal meal service by more strictly implementing healthy meal menus will improve students' dietary intake. Improvements in parent class (parenting) services, particularly those focused on child health and nutrition, will enhance parents' understanding and skills in providing quality care and nutrition at home. This corresponds with research findings indicating that nutrition education for mothers and children results in significant improvements in both growth and nutritional knowledge [16]. Existing dietary guidelines need to be reviewed, promoted, and monitored to ensure that school meal programs provide protection and effectively improve students' nutritional status [42].

Dummy variable regression analysis also showed an expected B value of 0.487 for EDGD services at 0.487, indicating that good EDGD services can reduce stunting prevalence by 0.487 times compared to suboptimal EDGD services. The Expected B value for learning activities was 0.414, indicating that good learning services can reduce stunting prevalence by 0.414 times compared to suboptimal learning services. The Expected B value for communal meals was 0.449, indicating that good communal meal services can reduce stunting prevalence by 0.449 times compared to suboptimal services. The Expected B value for parent classes was 0.455, which indicates that good parent class services can reduce stunting prevalence by 0.455 times compared to suboptimal parent class services.

This analysis concludes that, although IECE institutions have never been formally involved in government-led stunting reduction efforts and their services were not originally designed to target stunting reduction, the results demonstrate a significant contribution of IECE services to reducing stunting prevalence among students. Researchers argue that IECEs are highly suitable institutions to integrate into efforts to reduce stunting prevalence because they serve children aged 0-6 years and operate as community-based organisations, structured from the central to regional levels. This structure would facilitate program implementation and evaluation. Integration and collaboration efforts can be enhanced by involving all stakeholders to ensure targeted outcomes. This finding aligns with research by Botero *et al*. [2020], which explains that Colombia's ISA program, despite its design involving the government, health agencies, and the private sector, failed to reduce stunting due to insufficient sectoral integration [43]. Another study highlights that policy development to support school-based implementation strategies can be achieved by strengthening school-community partnerships to improve child nutrition [44].

Comparison of School Feeding Programs in Ethiopia, Bangladesh, and the Philippines

Ethiopia

The School Feeding Program (SFP) in Ethiopia [17], implemented in 2016, targeted primary school children aged 10-14 years and provided local foods (mainly legumes and pulses). The SFP yielded a significant positive impact on dietary diversity, nutritional status, school attendance, and reduced short-term hunger among schoolchildren. However, the program faced challenges related to financial constraints, delayed food deliveries, low community participation, and the substantial academic time it consumed, a key drawback. It was recommended that the program be expanded to other food-insecure regions as an essential measure to improve schoolchildren's nutritional status.

Bangladesh

Bangladesh’s School Feeding Program (SFP) [45], initiated in 2002, targeted preschool and primary-aged children by providing micronutrient-fortified biscuits. The program successfully increased school enrollment and reduced dropout rates. Notably, it improved children’s body mass index, academic achievement (especially in mathematics), concentration during learning, overall health, and happiness. The main weakness was the insufficient targeting of appropriate program regions. Recommendations include more precise targeting to ensure school feeding becomes an effective tool for jointly achieving educational and nutritional objectives in developing countries such as Bangladesh.

Philippines

The school lunch feeding and nutrition education program in the Philippines [16], conducted in 2017, targeted primary school children aged 7-9 and their mothers or caregivers. The program involved daily

implementation of the "Pinggang Pinoy®" school lunch model from the FNRI, complemented by nutrition education sessions for both students and their mothers or caregivers. This approach effectively improved knowledge, attitudes, and behaviors (KAB), and the nutritional status of schoolchildren. Protein intake was more readily achieved than energy intake for both children and households. Nutrition education for mothers or caregivers was considered essential, as behavioral change among mothers proved more difficult than among children. Recommendations include developing program modules for teacher education in schools to support nutrition, food, and health instruction; adopting Pinggang Pinoy® as a standard for school feeding programs; and increasing advocacy to institutionalize comprehensive interventions at the primary education level.

Implications of Presidential Regulation No. 72/2021 in Indonesia

Presidential Regulation No. 72 of 2021 on the Acceleration of Stunting Reduction [2] provides a robust and comprehensive legal framework for addressing stunting as a national movement.

Policy and Coordination Implications

The regulation mandates multisectoral collaboration at all administrative levels (including the Ministries of Health, Education, Public Works and Housing, Social Affairs, and the National Population and Family Planning Board). The establishment of Stunting Reduction Acceleration Teams (TP2S) at each level of government creates a clear institutional structure for coordinating, synergizing, and evaluating related programs. The scope of interventions has been broadened to include prevention efforts targeting adolescents, prospective brides, pregnant women, and breastfeeding mothers.

Program Implementation Implications

Programs should integrate both specific and sensitive interventions, set ambitious yet measurable targets, and strengthen data systems, research, innovation, and adoption of integrated data systems. Village governments are encouraged to allocate village funds for program implementation.

Long-Term Implications

Improvements in human resource quality, with children growing up healthy, intelligent, and productive; upholding children's rights to optimal development; synchronizing budgets and programs at the local level; and maintaining political commitment to meet established targets.

Designing an Integrated Stunting Intervention Model Through IECE Services

Previous analyses reinforce the need for an integrated stunting intervention model leveraging IECE services. This model optimises available resources and involves all IECE stakeholders to reduce stunting prevalence. This aligns with the findings and recommendations of Maria Paula Marla Nahak (2024), which highlight the lack of harmonisation in stunting-reduction efforts in Malaka Regency due to poor team coordination. The study recommends further mixed-method research and collaboration with existing NGOs [46]. The model design is outlined as follows.

Learning Service Intervention

Intervention in this service is carried out by providing health-promoting behaviour pocketbook materials during teaching and learning activities, both inside and outside the classroom. The intervention does not alter the LIP prepared by teachers. Health-promoting behaviour pocketbook materials (knowledge of the book, personal hygiene, nail care, clothing, oral care, hair hygiene, waste disposal, and exercise) are delivered in alignment with the discussed themes. Strengthening teachers' knowledge and skills regarding the pocketbook is crucial before implementing the intervention, enabling them to design and implement the health-promoting behaviour pocketbook activities effectively within IECE. The intervention allows students to engage in scientific thinking (observing, questioning, gathering information, reasoning, communicating), ensuring that the materials are deeply embedded in students' understanding and equipping them with skills and knowledge about clean, healthy living habits, thereby improving their quality of life. This aligns with findings that school-based health education interventions can help children adopt healthy lifestyles as they grow by increasing physical activity [19]. Other studies show that comprehensive WASH (water, sanitation, and hygiene) interventions in schools can reduce stunting [47]. Involving students in interventions through regular deworming programs, health promotion activities, healthy food promotion, and hygiene practices is vital for improving food intake and student health status [14].

Communal Meal Intervention

Intervention is carried out by providing high-protein animal-based food supplements during school meals

three times a week, without altering existing menus, methods, or school-prepared SOPs. Teachers should also offer opportunities for students to engage in scientific thinking during meals so that students not only eat but also learn about food names, benefits, and origins. The intervention can include egg supplementation during meals. Eggs are prepared in various ways to prevent students from becoming bored with them. This intervention aligns with research findings showing that consuming dairy products and eggs is inversely associated with stunting risk, while meat, fruits, and vegetables are not significantly associated with stunting [48]. Consuming one egg daily significantly increases intake of vitamin B and choline, but has more substantial benefits when combined with efforts to improve dietary diversity [49].

Parent Class Intervention

Intervention in this service strengthens parents' knowledge, skills, and awareness of early childhood health and nutrition through parenting programs that address early childhood nutrition needs. Providing parenting materials on children's nutritional needs and balanced menus during regularly scheduled parent classes is expected to foster parents' awareness and enthusiasm for delivering the best for their children's health at home. This intervention design aligns with findings that educating mothers about good feeding practices significantly reduces the risk of malnutrition as children grow [50]. Parent education on healthy nutrition should be part of school health programs to prevent growth impairments among school-aged children [51].

CONCLUSIONS

This study explores the quality of IECE services and students' nutritional status, analyzes the impact of services on stunting prevalence among students aged 24-59 months, and designs an integrated stunting intervention model through IECE services. A field survey conducted in October 2024 revealed that EDGD services, learning activities, communal meals, and parent classes were not optimally implemented. Nutritional status analysis identified stunting as the most prevalent issue, with male students exhibiting higher rates than female students.

More dedicated consideration must be given to existing services through maximal modifications and interventions, as this study found that well-implemented IECE services significantly reduce stunting prevalence. Service modifications can be achieved through the proposed intervention model: integrating health-promoting behaviour pocketbooks into learning activities, providing egg supplementation during communal meals, and implementing nutrition-focused parenting programs in parent classes.

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Received on 03-10-2025 Accepted on 12-04-2026 Published on 15-06-2026

https://doi.org/10.6000/1929-4247.2026.15.03.6