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Correlation between Exclusive Breastfeeding, Complementary Feeding, Infectious Disease with Wasting among Toddlers: a Cross-Sectional Study

Hubungan ASI Eksklusif, Makanan Pendamping ASI, Penyakit Infeksi dengan Kejadian Wasting *pada Balita:* Cross-Sectional Study

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ABSTRACT

Background: Wasting, an acute nutritional deficiency, is assessed using weight-for-height with a z-score of <-2SD from growth standards. The prevalence of wasting in Puskesmas Kendit is 14.31%, with Kukusan Village at 29%.
Objectives: This study examined the correlation between exclusive breastfeeding, Complementary Feeding (CF), infectious diseases, and wasting in young children.
Methods: Conducted with a cross-sectional design, the study sampled 51 toddlers through simple random sampling and analyzed the data using Spearman's correlation.
Results: Findings revealed no significant correlation between exclusive breastfeeding and wasting (p-value=0.105). However, there was a significant correlation between CF and wasting (p-value=0.026). Nutrient intake, including energy (p-value<0.001), protein (p-value<0.001), fat (p-value=0.002), and carbohydrates (p-value=0.025), was significantly correlated with wasting, as was the presence of infectious diseases (p-value=0.001).
Conclusions: While exclusive breastfeeding tends to reduce wasting, appropriate CF and adequate intake of energy, protein, fat, and carbohydrates are associated with a lower prevalence of wasting. Recommended actions include improving exclusive breastfeeding practices, enhancing the quality of CF, and increasing preventive measures for infectious diseases.

INTRODUCTION

Malnutrition is a major global issue impacting children in developing countries[1]. Nutritional status reflects the balance between nutrient intake and expenditure, as nutrients are essential for physical growth, development, activity, productivity, and overall health.[2]. Poor quality or insufficient quantity of food can lead to wasting. Infants undergo a critical period from conception to age two, known as the "golden window," where a lack of essential macro and micronutrients can cause irreversible brain function impairments, even if nutritional supplementation is provided later[3,4].

Wasting is a health issue classified under the three burdens of malnutrition: undernutrition, overnutrition, and micronutrient deficiencies[5]. It represents an acute form of malnutrition, defined by a weight-for-height measurement below -2SD on a child growth chart[6,7]. Wasting is further categorized into two levels: wasted, with a z-score between -3SD and -2SD, and severely wasted, with a z-score below -3SD.[8].

The Infant and Young Child Feeding (IYCF) strategy is a global initiative promoting optimal feeding practices for infants and young children. It recommends key practices such as early initiation of breastfeeding, exclusive breastfeeding from birth to six months, introducing CF at six months, and continuing breastfeeding until at least two years of age[9,10]. United Nations Children's Fund (UNICEF) identifies major contributors to wasting in children, including inadequate food intake, infectious diseases, or a combination of both[9-11]. Additional contributing factors include urban-rural disparities, low parental education, poor feeding practices, and economic status. Malnutrition, a significant global health threat, is the leading cause of 3.1 million child deaths worldwide. It results in growth and developmental issues due to nutritional deficiencies, increases the risk of acute and chronic diseases, disrupts

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cognitive function and academic performance, and lowers productivity in adulthood[1].

According to the World Health Organization (WHO), 45.4 million children under five years old (6.7%) globally were affected by wasting in 2020, with 70% of cases occurring in Asia[12]. In Indonesia, 10.2% of children under five were reported as experiencing wasting according to the 2018 Basic Health Research data[13]. Indonesia's Nutrition Status Surveillance reports the prevalence of wasting at 7.4% (2019), 7.1% (2021), and 7.7% (2022), with East Java Province showing a prevalence of 7.2%.

Several studies on wasting highlight this critical nutritional issue, particularly in developing countries. The Sustainable Development Goals include waste specific targets to reduce wasting, aiming to lower the proportion of wasted children to less than 5% by 2025 and below3% by 2030[14-16]. Situbondo Regency ranks 10th out of 38 cities in Indonesia, with a wasting prevalence of 8.6%[17]. February 2023 data from the Electronic Community-Based Nutrition Recording and Reporting system shows a 7.83% prevalence in Situbondo Regency, with the highest rate recorded at Puskesmas Kendit at 14.31%, well above the regional average.

Given this context, the researchers aim to explore the correlation between exclusive breastfeeding, CF, and infectious diseases with wasting in under five children in Kukusan Village, within the Puskesmas Kendit area of Situbondo Regency. These findings are especially relevant to the local health landscape, where malnutrition and infectious diseases are common among young children. By examining these factors, the researchers seek to provide valuable insights that could inform local health policies and improve child health outcomes in the community.

METHODS

Design, Time, and Place

This study employs an analytical design with a cross-sectional approach, collecting data at a single point in time. Preparation, data collection, and analysis were conducted from September 2023 to March 2024. The study received ethical approval from the Research Ethics Commission under reference number EA/2209.3/KEPK-Poltekkes_Sby/IV/2024.

Sampling

The study population consists of all toddlers aged 6-59 months residing in Kukusan Village, totaling 104 individuals. A sample of 51 toddlers was selected using simple random sampling, a method that gives each member of the population an equal probability of being chosen. This unbiased selection process avoids favoring or selecting based on specific characteristics, ensuring the sample represents the entire population of toddlers aged 6-59 months in Kukusan Village. Consequently, the findings are broadly applicable and statistically meaningful to the larger population.

Data Collection Method

Several systematic steps were used in data collection to ensure accuracy and relevance to the research objectives. First, primary respondents, identified as mothers of toddlers aged 6-59 months in Kukusan Village, were selected. Mothers were chosen as respondents due to their knowledge of their toddlers' characteristics, breastfeeding and CF practices, and history of infectious diseases. Inclusion criteria required mothers to be willing to participate, serve as their children's primary caregivers, and communicate effectively. Exclusion criteria included mothers of toddlers with chronic illnesses or disabilities that could affect nutritional status. Second, direct interviews were conducted with these mothers to gather information on toddler and maternal characteristics, breastfeeding and CF practices, and the history of infectious diseases (e.g., diarrhea, acute respiratory infection) over the past month. Third, a 2 × 24-hour food recall was conducted in which mothers recalled all food consumed by their toddlers over two separate 24-hour periods, providing insight into their dietary patterns. Fourth, anthropometric measurements were taken to assess toddlers' nutritional status using calibrated weighing scales, baby scales, and stadiometers for accurate height measurements for infants under 2 years old was measured lying down, and those over 2 years old, it was measured in a standing position.

Data Analysis

The data analysis in this study consists of several stages to explore relationships among the collected variables. Univariate analysis is used to describe respondent data, including toddler and maternal characteristics, breastfeeding practices, type and frequency of CF, history of infectious diseases, and nutritional status (weight and length/height). The frequency or percentage distribution of each variable is recorded and analyzed to provide an overall view of the sample characteristics. Bivariate analysis is then applied to determine relationships between pairs of studied variables. Spearman's correlation test is used to examine these relationships.

This approach aims to investigate the relationships between exclusive breastfeeding, CF practices, infectious diseases, and wasting among toddlers in Kukusan Village, Puskesmas Kendit, Situbondo Regency. By analyzing these factors, the researcher hopes to gain insights that can inform potential public health actions. The ultimate goal is to implement optimized interventions to improve nutrition and health management among children in this population.

RESULTS AND DISCUSSIONS

In this study conducted in Kukusan Village, Puskesmas Kendit, Situbondo Regency, researchers will examine various characteristics of both toddlers and their mothers. Key factors for toddlers include age, gender, immunization status, and birth weight. For mothers, characteristics such as age, education level, and occupation, all of which may influence child health outcomes.

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Table 1. Characteristics of Toddlers and Mothers in Kukusan Village, Puskesmas Kendit, Situbondo Regency

Characteristics of Toddlers and Mothers	Frequency (n)	Percentage (%)
Toddlers Age		
6-24 Months	19	37.3
25-59 Months	32	62.7
Toddlers Gender		
Female	25	49
Male	26	51
Immunization Status		
Incomplete	8	15.7
Complete	43	84.3
Birth Weight		
Low Birth Weight	4	7.8
Normal	47	92.2
Mother's Age		
<20 Years	2	3.9
20-35 Years	44	86.2
>35 Years	5	9.8
Mother's Education		
Elementary School	11	21.6
Junior High School	13	25.5
Senior High School	19	37.3
Diploma, Degree	8	15.6
Mother's Occupation		
Housewife	44	86.2
Private Employee	1	2
Others (Farmers, Drivers, Housekeeper Helpers)	6	11.8

*immunization status incomplete if any vaccine recommended for their age is not received and complete if all vaccines received according to age

Table 1 presents the demographic characteristics of toddlers and mothers of toddlers in the study on wasting incidence in Kukusan Village, Puskesmas Kendit, Situbondo Regency. The majority of toddlers are aged 25-59 months (62.7%), a vulnerable age group for wasting. The gender distribution is nearly equal, with 51% male and 49% female toddlers. Regarding immunization status, most toddlers have received complete immunization (84.3%), while 15.7% have incomplete immunization. Most toddlers were born with normal birth weight (92.2%), while a small proportion were born with low birth weight (7.8%). The majority of mothers are within the 20-35-year age range (86.2%), generally considered an ideal age for pregnancy and child care. In terms of education, most mothers have completed high school (37.3%), with some attaining a diploma or bachelor's degree (15.6%), reflecting a level of education that supports understanding of child health and nutrition. Additionally, most mothers are homemakers (86.2%), a factor that can influence access to health information and family spending on child nutrition.

Table 2. Cross-Tabulation and Spearman Correlation Test Result for Exclusive Breastfeeding, CF, Infectious Disease and Wasting Incidence in Toddlers in Kukusan Village, Puskesmas Kendit, Situbondo Regency

Variables	Nutritional Status				Total (N)	r	p-value
	Wasting		Non Wasting				
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)			
Exclusive Breastfeeding							
Not Exclusive	9	52.9	8	47.1	17	0.229	0.105
Exclusive	10	29.4	24	70.6	34		
Complementary Feeding							
Inappropriate	12	54.5	10	45.5	22	0.311	0.026
Appropriate	7	24.1	22	75.9	29		
Infectious Disease							
Sick	11	68.7	5	31.3	16	0.440	0.001
Not Sick	8	22.9	27	77.1	35		

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Relationship between Exclusive Breastfeeding and Wasting Incidence in Toddlers

Table 2 shows that toddlers who received exclusive breastfeeding had a lower percentage of wasting (29.4%) compared to those who did not receive exclusive breastfeeding (52.9%), suggesting that exclusive breastfeeding may be associated with a reduced risk of wasting in toddlers. However, despite the proportional differences, the Spearman correlation indicated that there is no statistically significant relationship between exclusive breastfeeding and wasting (r=0.229; p-value=0.105).

This finding may be influenced by the age distribution of toddlers in the study, with 62.7% in the 25-59-month range. At this stage, children's physical activity increases, resulting in higher nutritional needs compared to infants under six months. By 25-59 months, breastfeeding has typically ceased, and their nutrition relies solely on complementary foods and beverages.

This study aligns with findings by Muliyati et al. (2021), which also showed no correlation between exclusive breastfeeding and wasting (p-value=0.958) months of age, toddlers require CF, and continued breastfeeding until age two is recommended. Addition indicate no significant correlation between continued breastfeeding and weight-for-height or weight-for-length ratios, as factors like nutrient intake and infectious diseases also impact nutritional status[21].

Research by Youwe et al. (2020) found that there was no significant correlation between exclusive breastfeeding and nutritional status in toddlers (p-value=0.658). This suggests that while exclusive breastfeeding plays an important role, CF practices and infectious disease prevention are also critical factors influencing child nutrition[22].

Relationship between CF and Wasting Incidence in Toddlers

Table 3 shows that toddlers who received appropriate CF had a lower percentage of wasting (24.1%) compared to those with inappropriate complementary feeding (54.5%). The Spearman correlation indicates a significant relationship between the quality of CF and wasting incidence (r=0.514; p-value<0.001). These results indicated that appropriate CF may be associated with a lower prevalence of wasting in toddlers compared to inappropriate CF. The next table examines on the relationship between macronutrient intake and nutritional status (wasting and non wasting):

Table 3. Cross-Tabulation and Spearman Correlation Test Results between Macronutrient Intake and Wasting Incidence in Toddlers in Kukusan Village, Puskesmas Kendit, Situbondo Regency

Nutrient Intake	Nutritional Status				Total (N)	Median ± Min-Maks	r	p-value
	Wasting		Non *Wasting*					
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)				
Energy						1029.65 kcal ± 500.45 kcal-1667.55 kcal	0.475	<0.001
Deficiency	14	63.6	8	36.4	22			
Adequate	5	17.2	24	82.8	29			
Protein						30.3 g ± 13.7 g-68.35 g	0.617	<0.001
Deficiency	12	85.7	2	14.3	14			
Adequate	7	18.9	30	81.1	37			
Fat						40.8 g ± 15.3 g-60.05 g	0.427	0.002
Deficiency	13	61.9	8	38.1	21			
Adequate	6	20	24	80	30			
Carbohydrates						136.35 g ± 53.1 g-219.65 g	0.314	0.025
Deficiency	16	48.5	17	51.5	33			
Adequate	3	16.7	15	83.3	18			

Table 3 shows that toddlers with energy deficits have a higher incidence of wasting (63.6%) compared to those with adequate energy intake (17.2%). The correlation between energy intake and wasting incidence is significant (r=0.475; p-value<0.001), indicating that sufficient energy intake is associated with a lower incidence of wasting. The average energy intake among wasting toddlers (1029.65 kcal) is lower than among wasting toddlers, highlighting the importance of adequate energy intake for preventing wasting.

Protein intake analysis reveals that toddlers with protein deficiencies exhibit a much higher percentage of wasting (85.7%) compared to those with adequate protein intake (18.9%). The significant correlation (r=0.617; p-value<0.001) underscores the importance of sufficient protein intake for optimal growth and development, as wasting toddlers consume an average of 30.3 g, lower than wasting toddlers.

Fat intake shows that toddlers with fat deficiencies also have higher rates of wasting (61.9%) compared to those with adequate fat intake (20.0%). A significant correlation exists between fat intake and wasting incidence (r=0.427; p-value=0.002), emphasizing the role of adequate fat intake in toddler health.

Carbohydrate intake analysis indicates a slightly higher wasting incidence in toddlers with carbohydrate deficiencies (48.5%) compared to those with adequate intake (16.7%), with a significant correlation (r=0.314; p-value=0.025). Although the relationship is less pronounced than with energy, protein, and fat intake,

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adequate carbohydrate intake remains beneficial for reducing wasting incidence.

Introducing CF before six months significantly impacts wasting incidence (ARR 2.9, 95% CI 1.3-6.3). Toddlers with fewer meal frequencies are at higher risk (ARR 1.9, 95% CI 1.5-2.5), while a varied diet is associated with wasting status (ARR 1.3, 95% CI 1.01-1.6)[23]. This study emphasizes the importance of both the timing and quality of CF in preventing toddler wasting.

Research by Torizellia et al. (2023) identified significant correlations between toddler nutritional status and carbohydrate intake (p-value=0.001), protein intake (p-value=0.016), and fat intake (p-value=0.014) related to wasting[24]. Additionally, Azrimaidaliza et al. (2020) found that protein intake is the dominant factor correlated with nutritional status based on weight-for-height (p-value=0.007). Insufficient carbohydrate intake is strongly associated with wasting nutritional status, as the study indicated that toddlers with carbohydrate deficiencies have a higher likelihood of experiencing wasting (p-value=0.015)[25].

Macronutrient intake in children with nutritional problems such as wasting is significantly lower than the Recommended Nutrient Intake established by the Indonesian Ministry of Health in 2019[26]. Energy supports growth processes, nutrient metabolism in the body, and physical activities. Energy from food is derived from macronutrients[26,27]. Protein intake influences bone matrix proteins, growth factors, and the roles of calcium and phosphorus in bone formation[27]. Fats are macronutrients that contribute to a higher calorie content; deficient fat intake can lead to insufficient calorie intake for bodily activities and metabolic processes. Carbohydrates are the primary energy providers, and a deficit in carbohydrate intake forces the body to use other macronutrients to produce energy, disrupting the balance of other nutrients and inhibiting growth[28].

Relationship between Infections and Wasting Incidence in Toddlers

From Table 2, toddlers who suffered from infections had a higher percentage of wasting (68.7%) compared to those without infections (22.9%). The Spearman correlation showed a significant relationship between infections and wasting incidence (r=0.440; p-value=0.001). This indicates that preventing infections is crucial for lowering the prevalence of wasting, as infections are strongly correlated with an increased prevalence of wasting in toddlers.

The results of the analysis between infections and wasting revealed a p-value of 0.001 and a correlation coefficient (r) of 0.440, suggesting a significant relationship between infectious diseases and wasting in toddlers in Kukusan Village, Kendit Health Center, Situbondo Regency. This relationship is moderate and positively valued, where improvements in health status correspond to enhancements in nutritional status. Toddlers who are not ill tend to exhibit a lower frequency of appetite loss, which may contribute to their body weight remaining stable or increasing. Conversely, sick toddlers often experience decreased appetite, ultimately adversely affecting their nutritional status.

Research by Dwi et al. (2022) indicated a correlation between infectious diseases, such as pneumonia, and the nutritional status of toddlers (p-value=0.003). Repeated infectious diseases in toddlers over a long period can lead to metabolic disturbances that ultimately affect nutritional status[29]. Purba et al. (2020) also demonstrated a significant correlation between a history of illness and infection and nutritional status (p=0.032)[30].

Khairunnas et al. (2022) found statistically significant results indicating that a history of infectious diseases in the last three months affects wasting in toddlers (95% CI: 1.5-8.5)[31]. Similarly, research by Azrimaidaliza et al. (2022) indicated a history of infectious diseases in malnourished toddlers (POR=5.650, CI=1.212-26.153)[32]. Infectious diseases in toddlers often arise due to a low immune system. These diseases also impair a child's ability to optimally absorb nutrients. The relationship between infectious diseases and wasting is closely intertwined, meaning that infectious diseases can exacerbate nutritional status, while children with wasting are more susceptible to infections due to their weakened immune systems[33].

Inadequate nutrient intake and infectious diseases often occur simultaneously. Insufficient nutrient intake can increase the risk of infectious diseases, while infections can lead to malnutrition. The occurrence of infections is one of the causes that impact reduced food intake and changes in nutritional function, which should support growth but instead are used to maintain the body's immune system to combat infection[34].

CONCLUSIONS

This study provides an overview of the variables related to nutritional status (wasting and wasting) in toddlers, specifically focusing on breastfeeding practices, CF, infectious diseases, and nutrient intake (energy, protein, fats, carbohydrates). Although exclusive breastfeeding was not found to be statistically significant, toddlers who receive exclusive breastfeeding tend to have a lower prevalence of wasting compared to those who do not. Nevertheless, exclusive breastfeeding practices remain a potential factor in preventing wasting.

The study highlights a significant association between appropriate CF and a lower prevalence of wasting in toddlers. Toddlers who receive appropriate CF have a lower prevalence of wasting compared to those who receive poor-quality CF. Moreover, energy, protein, fat, and carbohydrate intake show significant associations with toddlers' nutritional status. Deficiencies in energy, protein, fat, and carbohydrates are significantly correlated with a higher prevalence of wasting. Therefore, adequate nutrient intake is crucial for preventing wasting in toddlers. Additionally, infectious diseases are a significant factor associated with wasting, as toddlers suffering from infections tend to have a higher prevalence of wasting compared to their healthy counterparts.

To reduce the incidence of wasting in toddlers, several strategic steps are recommended. First, increasing exclusive breastfeeding should continue to be encouraged through support for breastfeeding mothers. Second, improving the quality of CF is essential, with a

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focus on providing nutritious food options. Third, monitoring and early intervention regarding energy, protein, fat, and carbohydrate intake in toddlers are crucial. Fourth, enhanced preventive efforts are necessary to reduce the incidence of infectious diseases in toddlers through improved sanitation, hygiene, and access to health services. Collaboration between the government, healthcare workers, and the community is vital to ensure that all toddlers receive adequate nutrition and a healthy environment to support their optimal growth and development. Further research is needed to evaluate the long-term effectiveness of these interventions.

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AUTHOR CONTRIBUTIONS

AI: methodology, writing-original draft; RYP: conceptualization, investigation, methodology, supervision, writing-review and editing writing-original draft, writing-review and editing; ISE, TR: methodology; formal analysis, writing-original draft; IS, NM, DS: formal analysis, resources.

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Design of *Stunting* Prevention Education Media Package Based on Technology and Local Wisdom

Rancangan Paket Media Edukasi Pencegahan Stunting Berbasis Teknologi dan Kearifan Lokal

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ABSTRACT

Background: *Stunting* leads to increased morbidity and mortality among children. To accelerate *stunting* reduction, family assistance teams support at-risk families, requiring engaging and accessible educational resources. However, existing educational media materials are fragmented and lack a comprehensive approach, resulting in gaps during family assistance sessions. To improve accessibility and efficacy, a comprehensive, technology-based educational tool is necessary.
Objectives: To develop a *Stunting* Prevention Education Media Package (PaSti PenTing) based on technology and local wisdom.
Methods: This study used a Research and Development approach conducted in Cirebon City. The stages included the formulation of basic concepts, and in-depth interviews with experts, namely the Chairman of the Central Board of the Indonesian Midwives Association, the Head of the Cirebon City Health Office, the Head of the Cirebon City Women's Empowerment, Child Protection, Population Control and Family Planning Office and lecturers with S3 backgrounds. These interviews provided input related to the materials used for designing the PaSti PenTing. The research instrument uses in-depth interview guidance and data analysis was carried out using content analysis.
Results: Based on expert input, the PaSti PenTing design was developed. The main menu consists of an introduction and a menu for target groups (teenagers, brides-to-be, pregnant women, postpartum mothers, and toddlers). Each menu contains educational materials.
Conclusions: PasTi PenTing is a comprehensive media that can be used by the assistance team and families at risk of *stunting* to improve knowledge, attitudes, and behaviors in *stunting* prevention.

INTRODUCTION

Stunting contributes to an increase in child morbidity and mortality[1], forming part of the double burden of malnutrition and significantly impacting both health and economic productivity[2]. According to the Presidential Regulation of the Republic of Indonesia number 72 of 2021, the target *stunting* prevalence in Indonesia is set at 14% by 2024[3]. However, as of 2022, the *stunting* prevalence stands at 21.6%. All districts and cities within West Java Province, including Cirebon City, have been designated as priority areas for *stunting* reduction in 2022[5]. The acceleration of *stunting* reduction is carried out through specific interventions, addressing direct causes and sensitive intervention, overcoming indirect causes which must be implemented in a convergent, holistic, integrative, and quality manner through multi-sector cooperation by intensifying assistance to families at risk of *stunting*.

At the village level, the *Stunting* Reduction Acceleration Team includes the Family Assistance Team, composed of midwives, empowerment and family welfare cadres, and family planning cadres who provide support through counseling to key groups such as prospective brides, pregnant women, breastfeeding mothers, and children aged 0-59 months. Midwives play a central role as professional partners of the government and an extension of the state in implementing *stunting* prevention[2]. The collaboration of midwives and cadres can be a catalyst for accelerating *stunting* reduction. Interprofessional Collaboration with other health workers, especially nutritionists, is very necessary. To assist, appropriate, interesting, and easy-to-understand educational media are needed. Various studies prove the effectiveness of the application of video media in improving knowledge, attitudes, and behaviors related to sensitive and specific interventions. The Edu Anemia

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application can increase the knowledge and compliance of adolescents in taking Fe tablets[6]. Education using videos increases the knowledge of pregnant women about the consumption of Fe tablets[7]. M-Health Android-based Smartphone Media (Mama ASIX) application is more effective in increasing the knowledge and attitude of pregnant women about exclusive breastfeeding[8]. In addition, Cirebon's local shrimp powder-a high-protein, calcium-rich food source at an affordable price-can be used to prepare supplementary foods for toddlers[9,10]. Education using videos can improve the practice of complementary feeding based on local wisdom[11]. Android-based KIE is effective against parents' knowledge of basic immunizations[12]. Educational methods can improve the knowledge and skills of cadres in monitoring the growth and development of toddlers[13]. Decision-making tools for family planning applications have been proven to make it easier for midwives to conduct family planning counseling[14] as well as improve client knowledge and contraceptive use[15].

Despite various studies on educational media, existing resources remain fragmented and lack integration into a single, comprehensive tool for specific and sensitive interventions. Based on a preliminary study on the family assistance team in Cirebon, in assisting, some materials have not been delivered to each target group, thereby comprehensive and technology-based educational media is needed for more attractive and easy use. Therefore, this study aims to develop a *Stunting* Prevention Education Media Package (PaSti PenTing) based on technology and local wisdom which is a comprehensive educational media for families at risk of *stunting*. The urgency of this study is high, as PaSti PenTing will support accelerated *stunting* reduction, create a multiplier effect on maternal and child health improvement, and contribute to achieving sustainable development goals by reducing maternal and infant mortality rates.

METHODS

This study used a Research and Development approach to develop PaSti PenTing (android application and web base) containing educational videos and explanations for at-risk families. This study was carried out in Cirebon City from April to September 2024 because the prevalence of *stunting* is still high. The informants were four experts from practitioners, professional organizations, and academics related to the *stunting* reduction acceleration program, namely the Head of the Cirebon City Health Office, the Head of the Cirebon City Women's Empowerment, Child Protection, Population Control and Family Planning Office, the Chairman of the Central Board of the Indonesian Midwives Association, and a lecturer with a S3 background in the Reproductive Health. In-depth interviews were conducted to explore the informants' opinions about the importance of developing educational media and to explore the substance of the material that will be included in the PasTI PenTing educational media at each information workplace for about two hours. The instrument uses in-depth interview guidance with input question topics for the material in each menu in the application. Data analysis was carried out using content analysis. Research Permit Issued by the National and Political Unity Agency with number 176/2024.

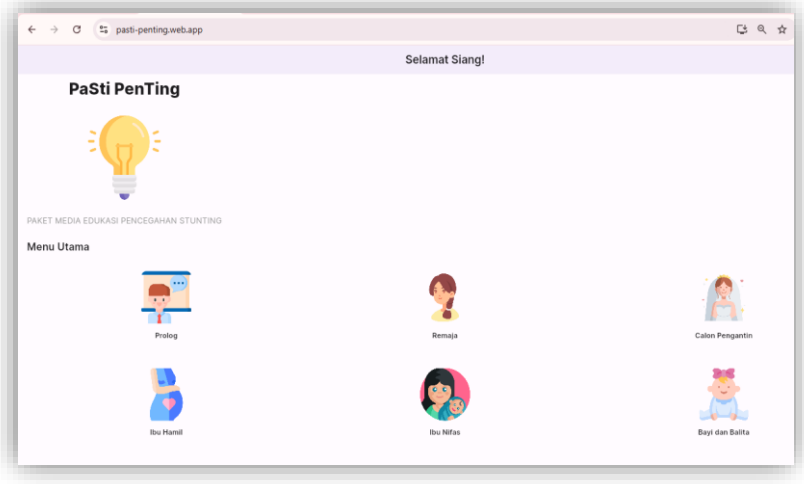

Figure 1. PasTi PenTing in web base

Figure 2. PasTi PenTing in Android Application

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RESULTS AND DISCUSSIONS

The main menu in PasTi PenTIng was formulated according to the details obtained in line with the study objectives, using target groups arranged based on categories of families at risk of *stunting*. The main menu at PasTi Penting consists of an introduction to the definition, causes, and impacts of *stunting*, and then there is a menu for target groups (adolescents, cats, pregnant women, postpartum mothers, clowns, and toddlers), thereby users can choose the menu they need. In each menu, there are educational materials for each target. Adolescent material includes the importance of Fe tablet consumption, reproductive health, and postponing the age of marriage. Educational materials for brides-to-be include the importance of checking weight, height, upper arm circumference, and blood hemoglobin levels in the 3 months before the wedding, reproductive health, and good and balanced nutritional needs. Educational materials for pregnant women include the importance of Antenatal Care (ANC) services, the importance of consuming Fe tablets, pregnancy care, postpartum birth control education, nutritional needs, and how to make additional food for chronic lack of energy pregnant women based on local wisdom. Materials for postpartum mothers are postpartum birth control education, Early Breastfeeding Initiation, postpartum care, and exclusive breastfeeding. The material for clown mothers and toddlers is the importance of complete basic immunization, making complementary feeding and supplementary foods based on local wisdom, monitoring growth and development, and prevention of infectious diseases. Based on input from the Chairman of the Central The Board of the Indonesian Midwives Association recommends using the Family Assistance Guidebook for Accelerating *Stunting* Reduction at the Village Level as a key reference for developing the application. In addition, KIA books and pocketbooks on the Kescatin application can also be used as a reference. There was input regarding the addition of material on Early Breastfeeding Initiation (IMD) to the baby menu and marriage eligibility screening three months before marriage for brides-to-be, anemia screening in adolescents, and adolescent psychology. Education for adolescents should begin at age 10. For the menu targeted at pregnant women, content on antenatal care (ANC) services should be integrated with strategies for preventing and managing infectious and non-communicable diseases, including anemia and chronic energy deficiency (CED). Additionally, information on supplemental foods made from local ingredients for pregnant women with CED should be provided, along with guidance on triple elimination of disease transmission (HIV, syphilis, and hepatitis) and support for psychological well-being and mental health during pregnancy. This requires collaboration across various professional fields. In the postpartum mother's menu, nutrition is added during the postpartum period. This opinion can be seen from the following statement:

"Well, maybe because this is a family assistance team program, this team is also a population control service, women's empowerment, child protection program" family assistance guide to accelerate stunting at the Village/Village level compiled by the Ministry of Home Affairs Team, Ministry of Health."

"Population control service, women's empowerment, child protection *program, is it true that from it can also be a reference, then this eum is from the Health Office? Forum Maternal and Neonatal Nutrition."*

"For exclusive Breastfeeding that's what is the inclusion in newborns, and babies, right? IMD."

"Now try pregnant women, now ANC antenatal is sometimes ANC is not only six times during pregnancy, but integrated ANC. Yes, it is an integrated ANC, how when we collaborate with all professions."

"But how the examination is no longer done, oh if there is a new problem to be examined, not so anymore now, but the antenatal care which is called ANC integrated into the, if I always say that, midwives must collaborate, well, heum the recipe for additional food for chronic lack of energy pregnant women is correct."

Based on input from the Head of the Cirebon City Health Office, in the youth menu, the importance of Fe tablets needs to be emphasized in its implementation, as well as information about diseases that cause infections, if the largest case in Cirebon City is a case of tuberculosis. The menu for pregnant women includes additional information on triple elimination (HIV, syphilis, and hepatitis), management of tuberculosis (TB) during pregnancy, as well as guidance on ketosis and diabetes mellitus in pregnancy and the postpartum period. The toddler menu includes additional content on infectious diseases and Clean and Healthy Living Behaviors (PHBS). For supplementary feeding, it is recommended to use local foods such as fresh reborn and catfish. The menu for toddlers also includes guidelines on measuring anthropometry, particularly for cadres, and explains how to properly introduce complementary feeding to infants and toddlers. This approach is supported by the following statement:

"*The importance of Fe tablets may need to be emphasized in management because our teenagers already know the theory, they have often been given tablets, but in fact, the Fe tablets are stored and not taken."*

"He added triple elimination, pregnant women usually have three HIV tests, then the sexual transmission infection, syphilis one is HBSAg, hepatitis."

"Yes, pregnancy poisoning, later there will be hypertension then added about BB TB please, gestational diabetes is necessary because it returns to the definition that stunting is malnutrition which is a growth and development disorder due to chronic malnutrition and excessive infection."

"Several infectious diseases will affect one with growth and development."

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"Alhamdulillah, for the competence of Cirebon, everything in every posyandu already exists, but sometimes children are crying about how to weigh it."

"Feeding indeed is complementary food has become all kinds of creations, but how to give it, yes, so that the complementary feeding enters the baby."

Based on the results of an in-depth interview with the Head of the Cirebon City Population Control Service, women's empowerment, and child protection *program*, a conclusion was reached. The menu contained in the PasTi Penting design was complete, the reference that will be used for the bride-to-be's menu was added to the material in the elsimil. The toddler baby menu can be added from the Mobile Child Flower Card Application developed by BKKBN, as well as the great parent program contained in the https://www.orangtuahebat.id/ website. The results of in-depth interviews with lecturers on women's health and family planning courses complement previous opinions, the menu contained in the PasTi Penting design is complete, the references used can be from mother and child health book, and the addition of a flow for the bride-to-be if they are going to get married.

Various studies have proven the effectiveness of the application of video media in increasing knowledge, attitudes, and behaviors related to specific and sensitive interventions. The Edu Anemia application can increase adolescents' knowledge and compliance in consuming Fe tablets[6] There is an influence of video media on knowledge and compliance with Fe Tablet consumption in adolescent girls at SMPN 65 North Jakarta[16] Pesantren Darussalam Bergas[17] Pilolodaa Gorontalo Health Center area[18] and teenagers in Bengkulu City[19]. There is an educational effect on Fe tablet consumption and Hb levels in pregnant women[20] education using videos which can increase pregnant women's knowledge about the consumption of Fe tablets[7,21]. Education in the chronic lack of energy, mama nutrition intake standby program has been proven to increase the knowledge of pregnant women and cadres about the importance of nutrient intake in preventing the occurrence of chronic lack of energy in pregnant women[22]. The provision of additional food and improved nutrition in pregnant women with chronic energy deficiency[23]. E-booklet media affects the knowledge and attitude of pregnant women about Exclusive Breastfeeding and MP Breastfeeding in *stunting* prevention programs[24]. The Mama ASIX application is more effective in increasing the knowledge and attitude of pregnant women in the third trimester about Exclusive Breastfeeding compared to leaflets[8]. Other investigations prove that there is an influence of educational videos on the knowledge and attitude of mothers in exclusive breastfeeding[25]. Other similar research was conducted in Bogor[26]. Education using videos can improve the practice of MP-ASI based on local wisdom[11]. Video media is most effective in increasing knowledge about complementary feeding compared to leaflets and pocketbooks[27]. Another study proves that the use of educational videos can increase the knowledge of mothers under five about breastfeeding in Kenya[28]. Similar research was conducted in Ranah Kampar Village, Sidosari Village, Bandar Lampung, and Sitaro Islands[29,30,31].

The difference between previous investigations[6,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30] is that PaSti PenTing which will be produced is a comprehensive educational package including education on specific and sensitive interventions to improve the knowledge, attitudes, and behaviors of families at risk of *stunting* based on technology (a form of applications combined with videos). Additionally, based on Cirebon local wisdom education on the use of shrimp powder and food other localities for the manufacture of complementary food and the provision of additional food to pregnant women with chronic energy deficiency and undernourished toddlers. That difference is the novelty of this study. Universities have a very important role in accelerating *stunting* reduction by innovating and providing scientific evidence to program implementers[32].

CONCLUSIONS

In conclusion, an expert informant in this study has confirmed that the menu and content within the *Stunting* Prevention Education Media Package (PaSti PenTing) have been thoroughly completed. This comprehensive application serves as a valuable tool for both the assistance team and families at risk of *stunting*. It incorporates both specific and sensitive intervention education aimed at improving the knowledge, attitudes, and behaviors of families. The application combines technological elements (in the form of an app and videos) with local wisdom to effectively prevent *stunting*.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The author has no conflict of interest relevant to this article. This research is the result of research from basic research on higher education schemes.

AUTHOR CONTRIBUTIONS

LN: conceptualization, methodology, and writing-original draft; contributed to the design of the study and the development of the educational interventions; DW: supervision, formal analysis, and writing-review & editing; ensured the integrity of the research process and contributed to the critical revisions of the manuscript; WE: resources and project administration, managed project logistics and provided necessary resources for conducting the research; ATI: data curation, investigation, and methodology, assisted in data collection and analysis, as well as the implementation of the Emo Demo method in the study and develop application; YF: writing-original draft and data collection; participated in drafting the manuscript and gathering data from the study participant; FH: writing-review & editing and visualization, contributed to the analysis of

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results and helped refine the presentation of data within the manuscript.

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RESEARCH STUDY
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The Onset Lactation, Early Initiation Breastfeeding, and Frequency of Antenatal Care as Determinants of Successful Exclusive Breastfeeding in Primipara Mothers

Onset *Laktasi, Inisiasi Menyusui Dini, dan Frekuensi* Antenatal Care *sebagai Penentu Keberhasilan Pemberian ASI Eksklusif pada Ibu Primipara*

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ABSTRACT

Background: Since 2016 the City of Surabaya has provided assistance and mentoring for pregnant mothers and infants during the first 1000 days of life. This initiative aims have been to alleviate stunting on children and increase exclusive breastfeeding coverage on breastfeeding mothers. However, the target for exclusive breastfeeding coverage has yet been achieved, and the level of coverage remains low despite these efforts.
Objectives: The aim of this study was to determine the effect of the onset of lactation, early initiation breastfeeding frequency of antenatal care on exclusive breastfeeding in primipara mothers.
Methods: The research design was cross-sectional; the samples were 130 of 378 primipara mothers and lactating pregnant women who were selected by cluster random sampling. The data were analyzed using both Chi-Square and Logistic Regression analysis α=0.05. data was collected in April 2021.
Results: The results showed that there was a significant relationship between ANC, EIB, and onset of lactation with EB (x^2=3.145; p-value=0.008, x^2=18.745; p-value<0.001, and x^2=47.147; p-value<0.001).
Conclusions: ANC, EIB, and onset of lactation are determining the success of EB.

INTRODUCTION

Maternal and child health is a determinant of human resources quality[1]. The period of initial one thousand days, from conception to two years old, is an important period of infants growth and development[2]. The first 1000 days of life is deemed the "golden window of opportunity"[3]. To ensure an optimal growth and development in infants aged 0-6 months, exclusive breastfeeding is highly recommended[4]. Exclusive breastfeeding plays a crucial role in improving infant health outcomes, particularly by reducing the risk of infections. A comprehensive review revealed that exclusive breastfeeding significantly minimizes the risk of gastrointestinal infections and acute respiratory infections in infants. Research shows that if optimal breastfeeding is practiced, it could save approximately 800,000 children's lives annually, particularly in low-income settings where infection rates are high. Despite this, only about 37% of infants globally are exclusively breastfed for the first six months[5,6].

Moreover, exclusive breastfeeding has been linked to better cognitive and social-emotional development in children. A study conducted by the American Academy of Pediatrics' found that exclusive breastfeeding for at least six months was associated with improved cognitive development, better physical growth,

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and reduced rates of stunting by age three. The research suggests that the maternal-infant bonding facilitated through breastfeeding, alongside the nutritional benefits, play a pivotal role in these developmental outcomes[7].

In addition to cognitive benefits, the protective role of exclusive breastfeeding against childhood morbidity is well-documented. Another study reviewed over 70 research articles and confirmed the consistent link between breastfeeding and reduced incidences of infections such as diarrhea and respiratory illnesses. It emphasizes the need for clearer definitions and better monitoring of breastfeeding practices globally to ensure consistent data collection and support for Exclusive Breastfeeding initiatives[6].

In practice and supported by the research, it is evident that several factors impact the implementation of Early Initiation Breastfeeding (EIB). These include maternal age, parity, education, occupation, knowledge, attitude, place of delivery, type of birth attendant, as well as support from healthcare providers, family, and the husband. The research carried out by Ulfa demonstrated that younger mothers, particularly those aged 17-25 (52.94%), had less knowledge compared to those mothers in the pregnancy ideal age range (26-35). Despite the healthcare visits from prenatal care to delivery, the older respondents were hardly capable of comprehending any conveyed information or acting upon it during these visits[8].

The World Health Organization targets 50% of newly-born babies to receive exclusive breastfeeding. According to the Basic Health Research 2018, East Java, only 38% of newly-born babies received exclusive breastfeeding[9]. In the report on assistance in the West Surabaya and North Surabaya areas in 2021, only 40% of babies were exclusively breastfed. Exclusive breastfeeding coverage has yet met the expectations. Another study in Europe found that many mothers discontinued exclusive breastfeeding earlier than planned due to concerns about insufficient milk production and inadequate infant weight gain. Up to 40% of mothers also reported issues such as nipple pain and mastitis, contributing to early cessation. These physical and emotional challenges illustrate the need for better postnatal support[10]. In addition to the factors already discussed, global studies consistently highlight various contributors to the low rates of exclusive breastfeeding. In India, for instance, 57% of mothers experienced delayed initiation of breastfeeding due to numerous key factors including caesarean sections, lower maternal education, and non-institutional births. Furthermore, non-exclusive breastfeeding rates were significantly higher among mothers in urban settings and those who experienced premature delivery[11,12]. The failures of exclusive breastfeeding are commonly caused by the delay in onset of lactation or the delay in the release of breast milk for the first time[13,14]. The timing of lactation onset determines the success of breastfeeding. In Indonesia, there are 42% of mothers experiencing delayed onset of lactation, while in Malaysia , 34.7% of mothers are reported to experience similar issues[15], and 47.1% of mothers perform exclusive breastfeed.

Early initiation breastfeeding is essential to maintain the baby's life, early initiation of breastfeeding has proven to successfully alleviate the incidence of hypothermia[16,17]. A systematic review reported that initiation of breastfeeding within 24 hours of birth was significantly associated with a reduction in “all-cause neonatal mortality”[18]. A meta-analysis across countries such as China and the U.S. revealed that delayed onset of lactation affected 30-34% of mothers. Socioeconomic factors, maternal age, and access to antenatal care were identified as major contributors to this issue. Addressing these challenges could significantly improve global breastfeeding outcomes[11]. Early initiation of breastfeeding is associated with exclusive breastfeeding[19,20].

Delayed onset of lactation is a key factor which triggers failures of Exclusive Breastfeeding (EB). In addition, timely initiation breastfeeding is crucial for neonatal health, as delayed onset can contribute to neonatal mortality and morbidity. In a study across 58 low- and middle-income countries, over half of the mothers (53.8%) experienced delayed initiation of breastfeeding, which was particularly prevalent after caesarean section births. Caesarean sections were linked to delayed lactation due to physiological and recovery factors, leading to an increased risk of neonatal mortality[21,22]. Another study highlighted that delayed initiation breastfeeding more frequently occur in low-resource settings, especially when birth takes place at home. Women giving birth at health facilities are generally less likely to delay breastfeeding than those who experience labor at home. This emphasizes the role of healthcare supports during childbirth in improving breastfeeding practices[22]. Breastfeeding within the first hour of life is associated with a significantly lower risk of neonatal mortality. Infants who started breastfeeding longer than 24 hours after birth were 2.19 times expected to experience neonatal death compared to those who initiated breastfeeding within the first hour[21]. Thus, both timely onset of lactation and early initiation breastfeeding critical for reducing mortality and improving neonatal health outcomes globally.

The World Health Organization (WHO) recommends at least eight ANC visits during pregnancy[23]. Similarly, the Government of the Republic of Indonesia advises at least six ANC visits[24]. Timely and appropriate evidence-based ANC practices have been exhibited to produce a substantial impact on maternal and infant health outcomes. ANC provides crucial opportunities for healthcare providers to educate mothers for breastfeeding practices, including the benefits of early initiation and EB. Studies have shown that frequent ANC visits are associated with higher rates of exclusive breastfeeding, as mothers presumably receive guidance, support, and resources for breastfeeding during these visits. However, despite the recommendations, only 74.1% of pregnant women in Indonesia attended at least four ANC visits, as reported in the 2018 Basic Health Research Report[25]. The objective of this study was to explore the influence of ANC frequency, onset of lactation, and early initiation of breastfeeding on exclusive breastfeeding rates. The objective of this study was to determine the effect of the onset of lactation, early initiation breastfeeding, frequency of Antenatal Care on exclusive breastfeeding.

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Antenatal care plays a key role in preventing delayed onset of lactation by providing mothers with the knowledge and support needed for successful breastfeeding. The WHO recommends at least eight ANC visits during pregnancy[23]. The Government of the Republic of Indonesia recommends at least six ANC visits during pregnancy[24]. It has been established that by implementing timely and appropriate evidence-based practices, ANC can save lives[23]. Based on the 2018 Basic Health Research Report, only 74.1% of pregnant women in Indonesia performed ANC up to 4 times[25].

In light of the high of prevalence of delayed lactation and suboptimal breastfeeding practices. The objective of this study was to determine the effect of the onset of lactation, early initiation breastfeeding, frequency of Antenatal Care on exclusive breastfeeding outcomes. Understanding the relationship is critical for developing strategies to enhance maternal care and breastfeeding support.

METHODS

The research design employed was a cross-sectional study, with observations conducted at a single point in time. Observations regarding mentoring conditions took place in April 2021. The study population consisted of all pregnant women and breastfeeding mothers participating in the mentoring program for the first 1,000 days of life in Surabaya. A total of 105 pregnant and 273 lactating mothers were distributed across various the Community Health Centers. The sampling method used was cluster random sampling, which began by selecting clusters based on the geographic area of responsibility: North Surabaya, South Surabaya, West Surabaya, East Surabaya, and Central Surabaya. The chosen clusters for this study were West Surabaya and North Surabaya. From these areas, breastfeeding mothers whose babies were at least 7 months old were randomly selected. The inclusion criteria samples were 1) Their participants must be a minimum age of 19 years old. 2) They were residents in 3) Resident of the administrative area of Surabaya. 4) They had undergone prenatal check-ups and planned births in the city area of Surabaya. The exclusion criteria samples were included 1) Suffering from infectious diseases (Hepatitis, Tuberculosis Hepatitis, Tuberculosis, HIV/AIDS). 2) Obesity. 3) Having a nonmarital pregnancy (pregnancy that occurs outside of a wedlock). The sample size consisted of 130 breastfeeding mothers, selected through random sampling from those whose babies were at least 7 months old.

Independent variables in the study included: early initiation of breastfeeding, this refers to breastfeeding the baby in the first hour after birth. The indicator is the time the baby first starts breastfeeding after birth, measured in minutes/hours, family income, a family's monthly income is measured within a specific range, based on the regional minimum wage or other applicable standards. Maternity job is the mother's employment status after giving birth including whether the mothers are full-time or part-time workers or unemployed, onset lactation, the time indicator when a mother starts producing breast milk after giving birth. It is measured based on maternal reports and is rated as "on time" if it occurs less than the first 72 hours after birth, and "delayed" if it is more than 72 hours. frequency of antenatal care, the number of visits made by pregnant women to health facilities for pregnancy check-ups, measured based on the number of visits in accordance with health service standards Dependent variable: exclusive breastfeeding. Exclusive Breastfeeding to babies without additional food or other drinks during the first six months of life, in accordance with WHO recommendations. The indicator is whether the baby receives breast milk merely for the first six months. Bivariate analysis was carried out using the Chi-Square test (α=0.05) to determine the effect of early initiation of breastfeeding on exclusive breastfeeding, the effect of onset of lactation on exclusive breastfeeding and the effect of frequency of antenatal care visits on exclusive breastfeeding. Multivariate analysis with logistic regression (α=0.05) to determine the effect of the independent variables together on the dependent variable. The statistical analyses were conducted using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY).

Informed consent was obtained from all individual participants included in the study. Participants were provided with detailed information about the study's purpose, procedures, potential risk, and benefits. All data collected were kept confidential and used solely for the purposes of this research. This study was granted by ethical clearance number 372/HRECC.FODM/VII/2021 from research ethical clearance Universitas Airlangga.

RESULTS AND DISCUSSIONS

The result in Table 1 shows that most breastfeeding mothers are employed at 73.1% respectively. Also, most families earning an income less than or equal to IDR 4,000,000 and greater than IDR 4,000,000 were at the same percentage. Similarly, mothers who started breastfeeding early, released breast milk three days after delivery and had more than six ANC visits were of 64.9 %, 77.9 %, and 79.4 %, respectively. Lastly, the respondent's ages ranged from 21 to 34 years old, with the majority of them were married at 30 years old.

Table 1. Characteristics of Breastfeeding Mothers in the Mentoring Program for the first 1000 days of life in Surabaya, Indonesia in 2021

Variable	n (%)
Family Income	
≤IDR 4,000,000	65 (50.0)
>IDR 4,000,000	65 (50.0)
Mother's Job	
Employee	35 (73.1)

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Variable	n (%)
Housewives	95 (26.9)
Early Initiation Breastfeeding	
Yes	72 (55.4)
No	58 (44.6)
Exclusive Breastfeeding	
Yes	54 (41.5)
No	76 (58.5)
Onset of Lactation	
On-time (≤3 days)	80 (61.5)
Delay (>3 days)	50 (38.5)
ANC Frequency	
≤6x	92 (29.2)
>6x	38 (70.8)

%=Percentage of Respondents

Several factors influence the success of EB in Indonesia, including maternal education, socioeconomic status, and the support provided during ANC. Research shows that higher maternal education is associated with a greater likelihood of exclusive breastfeeding, as mothers with higher education levels tend to have better knowledge about breastfeeding benefits and techniques[26]. Furthermore, women who made more than six ANC visits reported higher rates of EB, as frequent consultations provide mothers with essential information and guidance on breastfeeding[27].

Employment also plays a significant role in EB success. Employed mothers often face challenges in balancing work and breastfeeding; consequently, they contribute to lower EB rates compared to unemployed mothers. In a study conducted in Ethiopia, a significant number of employed mothers ($p<0.0001$) were unable to exclusively breastfeed, with time constraints and lack of workplace support cited as major factors[28] with time constraints and lack of workplace support cited as major factors[29]. Workplace policies that provide adequate maternity leave and breastfeeding-friendly environments can significantly impact the success of EB.

At last, family income also affects EB. A study conducted in Qatar identified that only 29.9% of high-income mothers were unable to exclusively breastfeed before 12 months[30]. Families with higher incomes tend to have a better access to healthcare and breastfeeding resources; thus, they ensure successful EB practices. However, in low-income settings, mothers may face economic pressures that disrupt breastfeeding, such as the need to return to work early[26]. Economic support programs and community health education are crucial in bridging these gaps and promoting EB across socioeconomic strata.

The income of the respondents ranged from IDR 1.5 million to IDR 13.0 million, with an average of IDR 5.4 million. In the City of Surabaya, the minimum wage in 2020 was of IDR 4.2 million per month, as established and declared by the Governor of East Java in 2019. Family income is closely linked to food supplies, which in turn affects the nutritional status of breastfeeding mothers[31]. The Indonesian government recommends that antenatal care (ANC) inspections occur at least six times during pregnancy: twice in the first trimester, once in the second trimester, and three times in the third trimester[24]. As a result, most pregnant women participating in Surabaya's mentoring program for the first 1,000 days of life had more than six ANC inspections throughout their pregnancy[32,33].

The importance of exclusive breastfeeding for infants aged 0-6 months is well-documented in numerous studies. A survey based on the 2017 Indonesia Demographic Health Survey stated that mothers who had received four or more antenatal care visits were most likely to initiate early breastfeeding and exclusively breastfeed their babies. The study also found that factors like skin-to-skin contact after delivery increased the likelihood of successful early initiation of breastfeeding, which is a critical component for EB success[34,35].

In addition, a study conducted in Indonesia identified that one of the main reasons why mothers decide to quit breastfeeding early is the mother's Perception of Insufficient Milk supply (PIM). This perspective is often illogical. Yet, it brings up considerable influences over the decision to introduce supplemental feeding. The study found that mothers who did not receive proper breastfeeding counselling during ANC were 19.7 times more likely to experience PIM. This emphasizes the role of healthcare workers in providing lactation education during ANC visits to improve EB rates[34].

Lastly, research published in the Journal of Public Health and Preventive Medicine revealed socioeconomic factors influencing EB practices in Indonesia. Mothers from wealthier families and higher educational levels were more likely to exclusively breastfeed. The study highlighted that rural and urban settings were alike, access to quality maternal health services, including ANC, was critical for promoting EB. The availability of healthcare facilities and trained professionals was a major determinant of whether mothers adhered to EB recommendations[35].

To support the findings regarding ANC, a study explained that pregnant women who received six or more ANC visits had a significantly lower risk of pregnancy complications and adverse birth outcomes, such as preterm birth or low birth weight[36]. The study found that 78.6% of women who attended regular ANC visits delivered full-term babies with normal birth weights. This

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demonstrates the critical role of regular ANC visits in monitoring maternal and fetal health, allowing for early detection of potential issues, and providing timely interventions to ensure a safe delivery and healthy infant.

In relation to family income and its impact on maternal nutrition, a study highlighted that families with a monthly income above IDR 4 million could possibly afford a nutritious diet for breastfeeding mothers, compared to lower-income households. The study reported that 65% of breastfeeding mothers in high-income families had access to a balanced diet rich in essential nutrients like protein, vitamins, and minerals which are crucial for maintaining milk production and overall health. In contrast, only 42% of mothers from lower-income families reported similar access to nutritious food, leading to potential nutrient deficiencies and lower milk quality. This underscores the direct relationship between family income, food security, and maternal health outcomes[37].

Furthermore, a study examined the economic challenges faced by breastfeeding mothers in urban areas like Surabaya. The study found that 74.3% of mothers with incomes below the minimum wage experienced difficulties in maintaining an adequate diet due to high living costs, especially for food and healthcare[38]. These mothers would most possibly rely on cheaper, less nutritious food options which negatively affected their nutritional status and breastfeeding outcomes. This highlights the need for targeted nutritional support programs for low-income families, especially for breastfeeding mothers, to ensure both maternal and infant health are safeguarded despite financial constraints.

In 2014, the Indonesian government set a goal for 50% of babies born in 2019 to be breastfed early and exclusively[39]. In Surabaya, the implementation of mentoring programs for the first 1,000 days of life has surpassed the targets established by the Indonesian Ministry of Health, achieving early breastfeeding rates of 64.9% and exclusive breastfeeding rates of 54%. These figures are significantly higher than the national rates for exclusive breastfeeding in Indonesia and East Java, which stand at 37.3% and 38%[25], respectively. Consequently, early initiation of breastfeeding (EIB) has a notable positive impact on the success of exclusive breastfeeding (EB)[40].Exclusive breastfeeding (EB) in Indonesia has shown an improvement in recent years, yet challenges remain. According to a study based on the 2017 Indonesian Demographic Health Survey, 51.6% of mothers practiced EB, with the highest rates in the Nusa Tenggara region (72.3%) and the lowest in Kalimantan (37.5%). These disparities are attributed to regional socioeconomic differences and access to healthcare services, which play a vital role in breastfeeding success[41]. The initiation of breastfeeding within the first hour, known as EIB, has also been recognized as a key factor in EB success. A 2022 study pinpointed that EIB helps establish lactation and increases the likelihood of mothers exclusive breastfeeding for the recommended six months[42]. However, the rate of EIB in Indonesia varies significantly across regions, correlating with healthcare access and maternal education. Research also indicates that family and community supports are vital in promoting and sustaining exclusive breastfeeding. A 2023 study found that family involvement, particularly managed by husbands, substantially contributes to higher EB rates. Mothers who received consistent family supports probably continue breastfeeding despite external pressures to introduce formula[43]. Another study found that workplace policies also influenced breastfeeding practices. In areas where workplace support for breastfeeding mothers is lacking, EB rates are lower[44]. The government has fostered breastfeeding-friendly environments although further improvements are required to meet the national targets. The public health education remains crucial in promoting EB. Studies suggest that once healthcare providers offer continuous breastfeeding education and supports during antenatal care to pregnant women; consequently, they tend to be successful in practicing exclusive breastfeeding[45].

The bivariate analysis results in Table 2, performed using Chi-Square (α=0.05), depict significant effort on exclusive breastfeeding success for several variables. Maternal job status has a p-value of 0.010, family income is highly significant with p=0.000, and the frequency of antenatal care visits is significant at p=0.008. Additionally, early initiation of breastfeeding and onset of lactation both exhibit high significant results, each with p-value<0.001.

Table 2. Results of Chi-Square bivariate analysis

Variable	Exclusive Breastfeeding		x^2	p-value
	Yes	No		
	n	n		
Maternal Job				
Employee	33	62	6.772	0.010
Housewives	21	14		
Family Income				
≤4,000,000	16	49	15.331	<0.001
>4,000,000	38	27		
Frequency ANC				
≤6x	45	47	3.145	0.008
>6x	9	29		
Early Initiation of Breastfeeding				
Yes	42	30	18.745	<0.001

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Variable	Exclusive Breastfeeding		x^2	p-value
	Yes	No		
	n	n		
No	12	46		
Onset of Lactation				
On-time (≤3 days)	52	28	47.147	<0.001
Delay (>3 days)	2	48		

n=Total of Respondents, x^2=The Difference between Observed and Expected Frequencies of Outcomes, p-value=Probability Value

Plenty ANC visits are undesirable since they hardly affect EB. In practice, pregnant women can turn to healthcare workers for seeking advice about mothers' self-care and baby care. Therefore, healthcare workers are vital in ensuring that EB messages are delivered intensively during ANC by the midwives or doctors who treat them. They will produce an outstanding impact on the success of EB. Moreover, midwives are usually more successful than other healthcare workers in educating pregnant women for the success of EB[46].

Researches illustrate that ANC visits play a crucial role in improving EB rates. A study found that mothers who got a counseling concentrated on breastfeeding during ANC had higher chances of initiating EB within the first hour after delivery. Healthcare workers, especially midwives, were considered pivotal in providing this education[47]. Midwives are often more effective in educating mothers on breastfeeding techniques than other healthcare workers due to their regular interaction and specialized training in maternal care.

Moreover, a study highlights that the quality of antenatal education directly influences maternal breastfeeding confidence. Pregnant women who received personalized breastfeeding education from healthcare workers showed considerably improved EB practices, underscoring the importance of skilled healthcare interventions[48]. Moreover, a study highlights that the quality of antenatal education directly influences maternal breastfeeding confidence. Pregnant women who received personalized breastfeeding education from health workers showed significantly improved EB practices, underscoring the importance of skilled healthcare interventions[48]. Community health workers (CHWs) have also been proven to be instrumental in enhancing EB outcomes, particularly in low-income settings. CHWs offer continuous support during ANC and postnatal care, increasing breastfeeding initiation and duration rates, according to a systematic review from the Maternal and Child Health Journal[47].

Early breastfeeding initiation has a significant effect on the implementation of EB. Similarly, implementing early breastfeeding initiation in the first hour after delivery give the mother confidence and provide comfort to the baby. This will stimulate the hormones prolactin and oxytocin to produce breast milk and to stimulate the letdown reflex, respectively, allowing breast milk to be given. Therefore, the success of EB is determined by the mother's self-confidence and family support[49,50].

Researches demonstrate that healthcare workers play a critical role in promoting EB, particularly during ANC visits. A study found that pregnant women who received frequent and intensive counseling from midwives were 2.5 times more likely to successfully implement EB compared to those who did not receive such guidance[51]. Midwives are often the primary source of information on breastfeeding, and their ability to provide hands-on education, answers for their worries, and emotional supports has proven to increase the likelihood of EB initiation. In short, consistent breastfeeding education delivered by midwives during ANC visits can significantly enhance a mother's confidence and ability to breastfeed exclusively[52].

Additionally, Early Initiation Breastfeeding (EIB) has indicated a profound effect on the continuation of EB. A study revealed that mothers who initiated breastfeeding within the first hour of delivery were 3.1 times more likely to continue breastfeeding exclusively for six months, thanks to EIB which facilitates early bonding between mother and child, which triggers hormonal responses necessary for milk production and the letdown reflex[42]. This study is in line with the result (Table 2.) that showed a significant between EIB and EB (*p<0.001*). The study also emphasized that mothers who experience a successful early breastfeeding gain more confidence in producing enough milk, reducing anxiety and increasing the likelihood of adhering to EB recommendations.

Family support, particularly contributed by the pregnant women's spouses, also plays a significant role in the success of EB. A study demonstrated that 78% of mothers who received considerable supports from their husbands and immediate family members successfully practiced EB for six months. Emotional encouragement, practical help, and a supportive environment should grow a mother's confidence and reduce her stress, which can directly establish the breastfeeding success[53]. The study highlights that family members who understand the importance of breastfeeding and offer continuous support can greatly enhance a mother's ability to continue breastfeeding exclusively despite unexpected challenges.

The onset of lactation is the first release of milk shortly after the baby's birth. However, when it occurs after 72 hours, it is referred to as delayed onset of lactation[14,54]. The onset of lactation gives the mother confidence to breastfeed her child; thus, it ensures the success of EB. Conversely, delayed release of breast milk after delivery can cause maternal anxiety and uncertainty about the quality of her milk[55,56]. According to the research of Anna Ismiyana conducted in Indonesia, 42% of mothers experience delayed onset of lactation[57]. Whereas in China, 30.3% of mothers experience delayed onset of lactation[54]. According to Kathryn G. Dewey research in 2003, 22% of those who faced delayed onset of lactation were prim parous mothers[58]. Furthermore,

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the delay onset of lactation will be longer in the case of a Caesarean Section delivery, which begins four days later following the delivery[14].

Exclusive Breastfeeding (EB) relies heavily on the onset of lactation. A study by Brown and Jordan found that delayed onset of lactation often leads to the introduction of formula supplementation as mothers perceive their milk supply as insufficient. This early supplementation negatively affects EB rates, reducing baby chances to get the recommended exclusive breastfeeding that should be maintained for six months[59]. Further research conducted by Christian emphasized that early skin-to-skin contact and breastfeeding initiation applied immediately in postpartum stage can improve EB success, even in cases of delayed lactation. These practices increase the likelihood of exclusive breastfeeding during the early days of postpartum recovery[60]. Additionally, a review published in the *Journal of Perinatology* suggested that infants who were breastfed within the first hour after birth had significantly higher rates of EB. Early initiation breastfeeding is linked to lower risks of neonatal morbidity and mortality, further emphasizing the critical window for establishing EB and minimizing formula use[61,61].

The table presents the results of a logistic regression analysis conducted to assess the impact of independent variables on the dependent variable, which is exclusive breastfeeding (EB) success. Table 3 indicates that family income significantly influences EB success, with p-values of 0.006 and 0.05. Additionally, early initiation of breastfeeding also demonstrates a notable impact on EB success, with p-values of 0.002 and 0.05. The onset of lactation shows a strong effect on EB success as well, with p-value<0.001 and 0.05. Furthermore, the frequency of antenatal care (ANC) visits is another variable that significantly affects EB success, with p-values of 0.010 and 0.05. In contrast, the other variables analyzed do not show a remarkable effect on EB. Based on these results, the following regression equation is proposed:

$$\text{Probability} = \frac{\exp(1.848+1.072\ Onset\ of\ Lactation+0.966\ EIB)}{1+\exp(1.848+1.072\ Onset\ of\ Lactation+0.966\ EIB)}$$

Considering the value of Exp(B), it can be concluded that deliveries with early initiation of breastfeeding (EIB) have a 2.628 to 3 times greater chance of successful exclusive breastfeeding (EB) compared to deliveries without EIB. Additionally, when comparing timely onset of lactation to delayed onset, timely initiation offers a 2.921 to 3 times greater likelihood of achieving successful EB.

Table 3. Logistic regression analysis with α=0.05

Variable	p-value	OR	95% CI	
			Lower Scale	Upper Scale
Maternal Job	0.316	0.435	0.085	2.214
Family Income	0.006	0.126	0.029	0.552
Early Initiation of Breastfeeding	0.002	0.189	0.065	0.551
Onset of Lactation	<0.001	69.823	12.289	396.702
ANC Frequency	0.010	3.085	1.316	7.235

p-value=Probability Value, OR=Odd Ratio, 95% CI=95% Confident Interval

CONCLUSIONS

The study indicates that antenatal care, the onset of lactation and EIB are critical factors that significantly impact the success of EB. Regular ANC is important for monitoring maternal and fetal health, studies reveal that the frequency of ANC visits unlikely has a direct impact on EB success. Mothers who receive frequent and high-quality ANC, particularly focusing on breastfeeding education and support, are easier to initiate and sustain EB. Furthermore, mothers, upon practicing EIB within the first hour of birth, are three times more successful in carrying out exclusive breastfeeding compared to those who postpone early initiation breastfeeding. Similarly, mothers who experience timely onset of lactation, typically within 72 hours post-delivery, tend to be three times more successful in sustaining EB compared to those who encounter delayed lactation. This highlights the importance of immediate breastfeeding support after delivery to enhance maternal confidence and ensure lactation success.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare no potential conflict of interests with any part.

AUTHOR CONTRIBUTIONS

DS: principal investigator, conceptualized and designed the study, prepared the draft of the manuscript, and reviewed the manuscript; SS: advised on the data analysis and interpretation and reviewed the manuscript; AS: reviewed the manuscript review; BS: reviewed the manuscript; RAR: editing and reviewed the manuscript.

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Health Concerns as the Fundamental Dietary Choices for Potential Stunting Preventions: a Qualitative Study

Kesehatan sebagai Dasar Pemilihan Pangan Berpotensi Mencegah Stunting*: Studi Kualitatif*

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ABSTRACT

Background: Pasongsongan Village lies in the Regency of Sumenep on the Island of Madura. It is a village bordered on the north by the Java Sea which is abundant of fish majorly consumed by adults. Whereas, children under two years old are scarcely served with fish in their diets.
Objectives: The study aims to observe any factors relevant to mothers' choices in serving meals for children under two years of age.
Methods: This study used a qualitative approach with an ethnographic design. The informants were eleven mothers and grandmothers whose children were under two years old. Data was collected by way of interviews and observations. Subsequent to the data collection, the triangulation was carried out. Data were analyzed using thematic analysis.
Results: The results showed that children under two years of age were provided with complementary foods prior to the age of 6 months old. Four children were barely fed with fish due to numerous myths regarding worm infestation in toddlers of below two years old if they consume fish or any types of animal food. Moreover, six children were served with fish and animal food due to health issues.
Conclusions: In conclusion, the mothers' choices for children's meals under two years of age in this village were highly influenced by cultural and health concerns. The implication of this study was that selecting food for toddlers under two years old should bring up a positive impact on their growth.

INTRODUCTION

Food, whether it is deemed edible or non-edible might be determined by socio-cultural aspects. For example, hamburgers are widely accepted as food in American society, while in India where the majority of Hindus live, beef is prohibited since cows are regarded as sacred animals in Hinduism. Food also carries cultural significance that shapes individuals' perspectives and influences their food choices. Food, when primarily perceived as something to satisfy hunger will impact how individuals select their meals. Food selection is the process of choosing food to be consumed. The selection of food is the result of the strengthening process. Factors that influence people for choosing food include health, taste, cost and social status[3], sensory, food appearance, aroma, and texture, mood, comfort, content in food[4], experience, and belief. These underlying reasons guide people to buy and consume food. The choice of food in a family is generally determined by the parents. Health, nutrition, and taste are the main motivators for parents in food selection[5].

Regarding Pasongsongan Village which is a coastal area and situated at the northern part of Sumenep Regency, it gains benefits from the Java Sea which is abundant in fish and other seafood, such as squid, shrimp, crab, and seaweed. Fisheries play a central role in the community's livelihood and fish is a common main dish in their daily meal. However, according to Soesanti's research, children under one year old, or before they start walking, are not given fish in their daily diets. This dietary restriction is likely influenced by the food choices made by their mothers. Mothers often hold specific reasons or motivations for selecting the foods served to their children. The aim of this study was to explore the factors that influence mothers' food choices for children under two years of age.

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METHODS

Kurt Lewin stated that interviews in respect to food choice can hardly reveal the reasons for selecting food: in choosing food there are values that can unlikely be displayed explicitly or verbally[3]. Therefore, it is necessary to use participant observation techniques that can be seen from important information about foods that are selected eminently[1]. Based on this, this study uses a qualitative approach with an ethnographic research design.

The informants were mothers and grandmothers whose children or grandchildren were under two years of age. The number of informants was 10, who were selected purposively. During the research, the researchers stayed in Pasongsongan Village until the entire information concerning mothers' and grandmothers' food choices provided for their children or grandchildren was gathered. The researchers employed interviews, participant observations, and documentation as data collection techniques to gain in-depth insights into the underlying reasons behind the informants' food choices. The instrument used in this study was an interview guide comprising questions about the types of food provided to children under two years old and the reasons for selecting those foods. The observation process covered the entire sequence, starting from the food purchase by the informants at markets or from food vendors, followed by the food preparation, and ended with the food service to the children. Triangulation was conducted during data collection to ensure the validity and reliability of the findings. This study used methodological triangulation, combining interviews, observations, and document analysis to gain a comprehensive understanding of the topic and minimize bias. Triangulation also involved cross-referencing data from multiple informants to confirm the accuracy of the information obtained.

The next stage involved thematic analysis. At this point, the data were coded, and all codes were reviewed to ensure consistency and whether codes within each group conveyed the same meaning. The process of identifying shared meanings led to the development of themes. Once the themes were identified, they provided deeper insights into the data. This study is part of a larger study from which data collection was conducted from 2018 to 2019, and data analysis was managed. In case of the lack of data, the researcher would return to the field for the data completion.

This research has undergone ethical review and approval by the Health Research Ethics Committee of the Faculty of Public Health, Airlangga University. The certificate of passing the ethical review includes the Description of passing the ethical review number 06-KEPK.

RESULTS AND DISCUSSIONS

The study revealed three themes: a. Give early complementary foods in addition to breast milk before 6 months of age. b. The provision of complementary foods for ages 9-11 months due to the fear of worm infestation in fish and dietary restrictions. c. Health considerations are the reasons for offering complementary foods with animal foods.

Giving early complementary feeding before 6 months of age.

Based on the data obtained, the informants fed their children before the age of 6 months as it was confirmed by informant H below:
"*I feed my 4-month-old child. His grandmother asked him to eat. Given the baby brown rice porridge, just buy it and then add hot water to it. He said, it would be a pity if you didn't feed him immediately. It is time for 4 months old baby to be fed*."

Informant A, a grandmother, also fed her grandchild before reaching the age of 6 months. This is stated below:
"When my grandson was 5 months, I asked my son to feed him since it was time to feed the baby with brown rice porridge mixed with hot water. The banana flavor is also bad."

T informants also confirmed about the same thing yet, in different ways, as shown below:
"*My child was fed at 6 months old. The midwife said, it was time for 6 months to be fed. My child was given breast milk in bottles. When my child was 2 months old my child cried when he was hungry so they gave him milk mixed with porridge through a bottle*."

Table 1. Complementary feeding before 6 months of age

Name	Age (Months)	Food Type	Reason
H	4	Porridge	Culture/Tradition
A	5	Porridge	Hunger and Feeding Schedule
F	1,5	Egg + Coconut	No Significant Weight Gain
IM	1	Banana	Culture/Tradition
T	2	Porridge	Continuous Crying due to Insufficient Breastfeeding
R	5	Porridge	Culture/Tradition and Advice from Mother
AM	5	Porridge	Culture/Tradition and Advice from Mother

The provision of complementary foods for 9-11 months of age due to the fear of worm infestations in fish and food restrictions.

The data showed that complementary foods were served when babies were 9-11 months. The informants gave steamed rice cake and soup. This was told by informant Y below:
"*My child was given steamed rice cake and gravy. Don't consume fish. You can't walk, you can't give fish. Y said that the people here were infested with worms.*"

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Information provided by informant IM whose husband is a fisherman and always carries fish.
"*My husband is a fisherman. He always brings fish home. There are lots of fish in the house. My child, before the age of one year, was not given fish due to the fear of worms. The food served was lontong (steamed rice cake) and broth. Eggs were not given; their intestines could hardly accept it."*

AM informant also did the same thing, not giving fish and other side dishes. The informant told the following:
"*I didn't give my child fish. Eggs, chicken were also not given. His small intestines could not accept solid food. My child was given tajin (cooked rice water) in the morning and in the afternoon. In the evening he was fed with lontong (steamed rice cake) and soup*."

Informant H fed her son with *lontong* (steamed rice cake) and moringa leaves soup, and meatballs. She explained below:
"*My son was served with porridge and immature chicken eggs at the age of 4 months. As a result, he suffered from an abdominal pain that made him hospitalized. After being discharged from the hospital, I fed him with porridge. At the age of 8 months, I served him steamed rice cake and gravy since I was worried that his intestines could hardly digest solid food*."

Table 2. The provision of complementary foods for 9-11 months of age based on myth and food prohibitation

Name	Food Type	Reason
H	Tajin Steamed Rice Cake + Meatball Stock + Soup	Cultural/Tradition
A	Tajin (rice water) Porridge Rice Cake + Soup/Moringa Leaves Soup	Hunger and Time for the Child to be Fed
R	Tajin (rice water) Steamed Rice Cake + Soup/Beef Stock	Culture/Tradition and Order from Her Mother
AM	Tajin (rice water) Porridge Steamed Rice Cake + Soup/Moringa Leaves Soup or Meatball Stock	Cultural/Tradition and Order from Her Mother

Health concerns are the underlying reasons for providing complementary foods with animal foods

R, the informant, fed quail eggs to her child.
"*When my son was 6 months old, he was fed with only boiled quail eggs. My mother said that her grandson should eat quail eggs to be healthy. And I also made fishball.*"

Informant T also supplied fish to her child when the child was 6 months old.
"*My son was given fish to eat at 6 months old. Lontong (steamed rice cake) was given with fish and Moringa sauce. T said "Fish is good for children. I know it from TV and the internet. My father is a fisherman, he has lots of fish at home. The child likes it. I am not afraid that my child has worms. If the children have worms, just give them worm medicine*."

H informant provided different foods to her children, as described below:
"*At 6 months my son was given fish. The child liked it. He disliked porridge. H said," Fish is good for children and I continue to love them. Sometimes he was given eggs but the child liked fish. I often cooked tuna wrapped in scrambled eggs. The child liked it. Mother said, it would be good if your child wanted fish. The child had no worms. He was big and fat*."

F informants provided different food from the previous informants.
"*I feed my one and a half months old child. I give immature eggs and rokkorok (young coconut meat). My brother said his son would grow up fast if he was given that. The child grew big and fat quickly. When he was 9 months old he didn't want to eat that, then he asked for fish every day."*

The informant M gave the same food as the F informant. He explained below:
"*My child was given immature eggs and rokkorok (young coconut meat) at 6 months of age in the afternoon and evening. When I asked embuk (Mother) about the food choice. She said that she was ordered by my brothers. They said, "To be healthy and the baby grows big fast". In the morning the baby was given brown rice porridge. Sometimes it tasted like mung beans*."

AM had different story was told by the following informants:
"*I gave my son lontong (steamed rice cake) and a half-boiled chicken egg and moringa leaves soup. Embuk (my mother) and Embah (my grandmother) said that their grandchildren are given half-boiled chicken eggs and moringa vegetable soup to stay healthy. At home there is plenty of fish, but the fish is not served to my child. Embuk and Embah prohibited their grandson from being fed with fish due to the fear of worm infestations in fish. Children infested with worms commonly have big bellies. People never serve fish to their children due to the fear that fish are infested with worms; thus, their children will be infested with worms as well."*

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Table 3. Health consideration is the reason for providing complementary foods with animal foods

Name	Food Type	Reason
IM	Egg + Steamed Rice Cake + Moringa Soup	She wants her child to be healthy. She knows from her mother and her school.
A	Quail Eggs + Steamed Rice Cake	She wants her child to be healthy.
F	Pigeon Egg + Coconut (from Her Family)	Her child has no considerable weight gain. She wants her child to gain weight quickly and get fat and grow up quickly.
M	Pigeon Egg + Coconuts (from Her Mother and Family)	She wants her child to be healthy and get fat.
R	Fish and Egg + Steamed Rice Cake + Moringa Soup	Fish and eggs are good. She wants her child to be healthy (school and TV).
T	Fish + Steamed Rice Cake + Moringa Soup	Fish is a good food for her child and she wants her child to be healthy (school, TV, google).
H	Rice + Fish	She wants her child to be healthy (her mother).

The data above shows that only one informant provided complementary feeding at the age of 6 months. Four informants supplied no fish in the child's diets due to the fear of worm infestation, yet they also served the children with no other types of side dishes such as eggs, chicken and beef since these types of foods are not easily digested by toddlers' intestines, Consequently, they only provided steamed rice cake and soup. Six informants gave fish, pigeon eggs, quail eggs, half-boiled chicken eggs with steamed rice cake or rice and moringa leaves soup. The pigeon eggs, quail eggs, chicken eggs and fish were opted for the children's diets because they were considered beneficial for the children's health in order to boost the children's growth.

These results are matched with existing nutritional status data showing that four informants who provided no animal food, nutritional status are <-2SD or stunting. Informants who supplied animal foods such as fish, chicken eggs, pigeon eggs and quail eggs, indicated that their nutritional status was >-2SD or not stunting. The results of observations on food preparation indicated that each informant prepared everything on their own: from determining the menu, purchasing materials at the market, cooking food, serving it at the table and feeding their children. Informants buy virgin eggs for their child's food. Even though the palm bird eggs are expensive but two informants still buy on the grounds for their children to be healthy and quickly grow.

The informants supplied complementary feedings for the infant before the age of 6 months. It is customary in the village that complementary feedings are supplied before infants reach 6 months of age. Early complementary feedings in addition to breastfeeding may result in intestinal problems such as abdominal pain, and diarrhea because the baby's digestive system is still developing and can hardly accept solid foods[7]. Before the age of 6 months the baby's intestines can only receive food in the form of liquids such as breast milk[8,9].

The informants did not give the children fish because of the fear of worm infestations in fish. Such fear has turned to a myth, namely the worm myth, which has been passed on from generation to generation. Consequently, it raised concerns and fear in the society. Since the myth has existed in the society's subconsciousness, undoubtedly, they keep a strong belief and resistance not to give fish to their babies. The prohibition for eating fish for children is contrary to environmental conditions[10,11]. The environment supports the availability of food containing protein, but dietary restrictions cause nutrient intake far from being fulfilled. So far, no single research has yet found that fish consumption can grow intestinal worms. More research results state that fish contains various nutrients such as protein, fat, calcium, magnesium, phosphorus. The nutritional content of fish is excellent for children aged 6 months to 24 months of age because of its high protein content which is good for growth. Fish also contains amino acid which are also advantageous for the growth of children under two years of age.

The informants who hardly provided fish, also served no other animal food side dishes such as eggs, chicken, and beef assuming that they were less easily digested foods. The child's intestine is considered unable to accept solid foods. Based on this, the informants merely fed their children with steamed rice cake and stock. *Lontong* (steamed rice cake) and broth contain more carbohydrates and water. The lack of nutrients in the food given to informants' children should bring up a negative impact on children's growth[12,13].

The worms and abstinence from animal foods results in restrictions on nutrients needed by children's bodies in the first two years of life since this period is critical in infants' growth[14,15]. Children who are not given animal foods do not get animal protein. Animal foods contain protein and amino acids, and both of these nutrients are needed during the growth period, especially in the first two years of life. Children whose consumption of animal foods is low can have a hindrance to their growth[16].

Thus, mothers choose food for their children based on myths and dietary restrictions. so that it can inhibit the growth of children. Pigeon eggs, quail eggs and chicken eggs are foods that contain various nutrients. Nutrients contained in eggs such as amino acids, protein, vitamin A[24,25]. Children who do not eat fish and other animal foods based on available nutritional status data are included in stunted children. Low consumptions of animal foods can cause stunting[17] and lead to low amino acid intake which can result in stunting[18]. Therefore, such food consumption the children get hardly supports their growth and can result in stunting. Children under two years old who are stunted must be treated before the age of two[15,26].

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Unlike the informants who provided animal foods to their children They were motivated to choose animal foods so that their children stay healthy, grow up fast and gain weight quickly because the food is beneficial for their children. This shows that the selection of the informants' diet was based on health concerns should enable the growth and support the child's nutritional status. Consumption of animal foods increases IGF1[20,21] and improves health[22,23].

Complementary foods in addition to breast milk for infants should contain rich protein and amino acids to help improve the condition of malnourished children and improve growth. A variety of foods is a good complementary food for inadequate breastfeeding[27]. Health-based food choices can affect children's growth and health[28]. Protein and amino acids have an effect on both. Both of these nutrients are excellent for children's growth. Hence, consuming them ensures stunting prevention. In other words, the correct choice of complementary foods should contain animal protein[24] and amino acids . It should be recommended to boost infants' growth and prevent stunting.

CONCLUSIONS

Complementary feeding for infants in addition to breastfeeding were served before the age of 6 months. In the village of Pasongsongan, the provision of complementary foods for toddlers of 9-11 months of age is influenced by the myth of worm infestations and food restrictions. The choice of complementary foods based on cultural factors may lead to a negative impact on the infants' growth because they lack nutrients. While complementary foods chosen based on health concerns should affect children's growth due to its nutrient contents that can boost children's growth and prevent stunting.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

There is no conflict of interest.

AUTHOR CONTRIBUTIONS

IS: conceptualization, data curation, formal analysis; TT: funding acquisition, investigation; AI: methodology, project administration, resources; SH: writing-review and editing interview respondent.

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The Correlation between Macronutrient Intake and Physical Activity with Overnutrition among Fifth-Grade Students at Banjarbendo State Elementary

Hubungan Asupan Makronutrien dan Aktivitas Fisik terhadap Kelebihan Gizi pada Siswa Kelas 5 di Sekolah Dasar Negeri Banjarbendo

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ABSTRACT

Background: Overweight status, which falls under the category of overweight and obesity, has become a serious and growing global health problem, especially among school-aged children. Unbalanced nutrition and low physical activity are the main factors contributing to the increasing prevalence of malnutrition among children in Indonesia.
Objectives: This study aims to analyze the correlation between macronutrient intake and physical activity with nutritional status (overweight and obesity) in fifth-grade students at Banjarbendo State Elementary School, Sidoarjo.
Methods: This study employed an observational analytical method with a cross-sectional design. The sample consisted of 64 fifth-grade students who were randomly selected through simple random sampling. Data were collected through anthropometric measurements to determine nutritional status based on body mass index-for-age (BMI-for-age) as well as interviews to assess food intake using a 2x24 hour food recall and physical activity using a 2x24 hour physical activity recall. Data analysis was carried out using Spearman's correlation test with a 95% confidence level (α=0.05).
Results: The results indicated a significant correlation between macronutrient intake, physical activity, and nutritional status. Most students with excessive macronutrient intake and low physical activity were found to be overweight or obese
Conclusions: A significant correlation between macronutrient intake, physical activity level, and nutritional status was observed. It is important to raise awareness of balanced nutrition and encourage physical activity in children to prevent overnutrition and its associated health problems in the future.

INTRODUCTION

Nutritional status is a condition resulting from the balance between nutrient intake from food and the body's nutritional needs for metabolic processes. Nutritional needs vary among individuals, depending on factors such as age, weight, gender, and physical activity[1,2]. Currently, overnutrition is a global health problem that requires urgent attention[3–10]. Overnutrition can affect individuals at any age and is commonly categorized into overweight and obesity.

To support growth and development, especially in school-aged children, a balanced diet with adequate nutrients is essential[11]. Nutrition plays a critical role during childhood[12–16], directly impacting optimal growth and development[17]. Children's nutritional adequacy can be assessed by examining their nutritional status, as insufficient intake can lead to various health problems[18,19]. According to the World Health Organization (WHO), the prevalence of overweight and obesity in children and adolescents aged 5-19 years was 340 million, with 19% males and 18% females[20]. Nutritional problems in school-aged children are health problems that affect the future and intelligence of children, thereby requiring urgent attention[21]. Obesity is one of the nutritional problems that occurs in children and becomes a public health problem[22,23].

According to the 2018 Basic Health Research, the prevalence of overweight in children increased to 21.8%, with 10.8% overweight and 9.2% obese[24]. Environmental factors are the main contributors to overweight and obesity in children[25,26], including imbalanced diets, eating habits, and physical inactivity[27]. Physical activity has been found to correlate significantly with obesity in children[28–35].

Eating habits have also been found to correlate significantly with obesity in children[36–39]. Obesity results from excessive fat accumulation due to imbalance between energy intake and energy expenditure for a long

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time[40,41]. Individuals with obesity are at risk for diseases such as diabetes mellitus, hypertension, cancer, asthma, coronary heart disease, stroke, gout, and sleep apnea[42]. The prevalence of overweight and obesity among school-aged children (6-12 years) is 9.2%. The prevalence of overweight and obesity among school-aged children (6-12 years) in eleven provinces in Indonesia exceeds the national average, namely 11.6% in Nanggroe Aceh Darussalam, 10.5% in North Sumatra, 11.4% in South Sumatra, 10.9% in Riau, 11.6% in Lampung, 9.7% in Riau Islands, 12.8% in the Special Capital Region of Jakarta, 10.9% in Central Java, 12.4% in East Java, 14.7% in Southeast Sulawesi, 14.4% in and West Papua[43]. The 2018 Basic Health Research revealed the prevalence of non-communicable diseases among children aged 5-14 years, including asthma (1.9%), cancer (0.031%), diabetes mellitus (0.004%), and heart disease (0.7%). Among those aged 15 years and above, the prevalence of central obesity increased from 18.8% in 2007 to 26.6% in 2013 and 31% in 2018[44].

The prevalence of adult obesity reached 16.09% by 2020 and 19.61% in 2021. In response, the Health Office of East Java Province has launched initiatives such as the Healthy Living Community Movement (GERMAS) and the Nusantara Movement to Reduce Obesity Rates (GENTAS) to address these trends. During the COVID-19 pandemic, the Health Office of East Java Province faced challenges in meeting obesity handling targets, with only 65% of active integrated service posts (*posyandu*). Factors contributing to overweight include genetic factors, environmental factors (e.g., access to fast food and lack of physical activity*),* and hormonal factors (e.g., consumption of appetite-stimulating drugs). The short-term effects of being overweight include reduced immunity, growth disorders, and respiratory problems, while the long-term impact of excess weight include the risk of developing non-communicable diseases such as coronary heart disease, diabetes mellitus, cancer, and pregnancy complications[45–48]. According to data from the Central Bureau of Statistics (BPS), the East Java Province ranks the third lowest levels of physical activity, a situation that is quite alarming.

The aforementioned background led to the implementation of this study. This study aims to determine the correlation between macronutrient intake, physical activity, and overweight status among fifth-grade students (10-12 years) at Banjarbendo State Elementary School, Sidoarjo. The nutritional status of the students were assessed using body mass index-for-age.

METHODS

This study employed an analytical observational method with a cross-sectional design. This method allows the exploration of the how and why behind health phenomena. It is followed by the examination of the dynamics of the correlation between phenomena or between risk factors and effect factors by collecting data at a single point in time. In this study, both risk and effect variables for the study population were measured simultaneously[49].

Participants

The study population consisted 75 students with the following criteria: active fifth-grade students, students in good health, and students who consented to participate. The sample size was determined using Slovin's formula (1960) as follows:

$$n = \frac{N}{1 + N\,(e)^2}$$

$$n = \frac{75}{1 + 75(0.05)^2}$$

$n = 63{,}16$ (rounded up to 64 respondents)

Variables:
n = Total Sample Required
N = Population Size
(e) = Error Rate (5% of Population Size)

Sampling was performed through simple random sampling, in which each member of the population was assigned a number and selected randomly. This resulted in a total sample size of 64 respondents.

Data Collection

Data collection was carried out over six months, from September 2023 to March 2024. Initially, consent forms were distributed to the respondents or their guardians to obtain their agreement to participate in this study. Upon obtaining consent, anthropometric measurements were taken. Height was measured using a stadiometer accurate to 0.1 cm, while weight was measured using a digital scale accurate to 0.1 kg. These measurements were essential for calculating the body mass index-for-age (BMI-for-age), which was then used to determine the nutritional status of the students. The classification of overnutrition status was based on the WHO 2007 standards. Students with a BMI-for-age between >1SD and 2SD were classified as overweight, while those with BMI greater >2SD were classified as obese.

Following the anthropometric measurements, interviews were conducted with the respondents to assess their dietary intake through a 2x24-hour food recall, which included one weekday and one weekend day. Additionally, a 2x24-hour physical activity recall was conducted to capture their activity levels during both weekdays and weekends. Food intake data were categorized into three groups based on the Recommended Dietary Allowance (RDA): deficit (<90% RDA), normal (90-119% RDA), and excessive (≥120% RDA). Meanwhile, physical activity data were grouped into three categories based on Metabolic Equivalent of Tasks (MET) values: low (1.40-1.69), moderate (1.70-1.99), and high (2.00-2.40).

Data Analysis

Data analysis was performed in two stages. First, a univariate analysis was conducted to describe the frequency distribution of each variable, including macronutrient intake, physical activity, and overnutrition status. The data were presented as frequency

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distributions, cross-tabulations, and percentages to provide a clear overview of the findings. Following this, a bivariate analysis was carried out to determine the correlation between the independent and dependent variables using Spearman's correlation test. This statistical method was chosen due to the ordinal nature and non-normal distribution of the variables. The correlation test was conducted at a 95% confidence level (α=0.05).

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee of the Surabaya Health Polytechnic, Ministry of Health of the Republic of Indonesia, with an approval number EA/2931/KEPK-Poltekkes Sby/V/2024. This study adhered to ethical guidelines as outlined by the 2011 WHO standards and the 2016 CIOMS guidelines, ensuring respect for the rights and welfare of the participants. Therefore, this study is expected to provide valuable insights into the correlation between macronutrient intake, physical activity, and overnutrition status in children.

RESULTS AND DISCUSSIONS

This section details the correlation between variables based on the results, which are presented in the following tables. The results of previous research compared to this study are also explained in this section. Table 1 summarizes the characteristics of fifth-grade students at Banjarbendo State Elementary School, Sidoarjo who participated in this study.

Table 1. Frequency Distribution of the Characteristics of Fifth-Grade Students at Banjarbendo State Elementary School, Sidoarjo

Characteristics	n	%
Gender		
Male	37	57.81
Female	27	42.19
Age (Years)		
10	25	39.06
11	37	57.82
12	2	3.12
Energy Intake		
Severe Deficit	4	6.25
Moderate Deficit	3	4.69
Mild Deficit	7	10.94
Normal	37	57.81
Excessive	13	20.31
Protein Intake		
Severe Deficit	2	3.13
Moderate Deficit	4	6.25
Mild Deficit	6	9.37
Normal	23	35.94
Excessive	29	45.31
Fat Intake		
Severe Deficit	3	4.69
Moderate Deficit	4	6.25
Mild Deficit	8	12.5
Normal	26	40.62
Excessive	23	35.94
Carbohydrate Intake		
Severe Deficit	9	14.06
Moderate Deficit	12	18.75
Mild Deficit	11	17.19
Normal	29	45.31
Excessive	3	4.69
Physical Activity		
Light	31	48.44
Moderate	25	39.06
High-Intensity	8	12.5
Nutritional Status		
Very Skinny	1	1.56
Skinny	3	4.69
Normal	38	59.37
Overweight	8	12.5
Obese	14	21.88

Classification according to the Indonesian Ministry of Health of 1996 and 2010

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The analysis revealed the age and gender distribution among the 64 respondents. In terms of age, the majority of respondents were 11 years old, accounting for 57.82% of the sample, followed by 10-year-olds at 39.06%, and 12-year-olds at 3.12%. This distribution suggests that the sample primarily included younger students, potentially reflecting specific enrollment patterns at the primary school. In terms of gender, 57.81% of the respondents were male, while 42.19% were female, indicating a notable predominance of male students. This gender imbalance may influence the study's outcomes, especially if the variables are affected by gender differences.

Overall, the majority of students were 11 years old and predominantly male. This demographic skew has implications for the study's results and highlights the importance of considering age and gender in further analyses. Future research should aim to stratify samples by age and gender to enhance representativeness and generalizability, as well as to investigate the underlying causes of this demographic distribution, such as school admission policies or socioeconomic factors.

In terms of nutritional status, the analysis revealed that most respondents fell within the normal category, while a smaller but significant proportion fell within the overweight category. These results suggest that overnutrition is a health problem at the primary school. The existing nutritional problems are also reflected in physical activity data, where most respondents fell into the light category. At the time of data collection, the researchers found that overnourished students tended to spend more time buying food and drinks or sitting and socializing with friends.

Further analysis of nutritional status revealed that the majority of respondents fell within the normal category, followed by the obese category with a total of 21.88%. Obesity remains a serious health problem that occurs in elementary school students. Overall, these findings highlight the need for targeted nutritional interventions and educational programs to improve dietary habits and physical activity among school-aged children, aiming to reduce the risk of overweight and obesity.

The analysis of dietary intake and nutritional status of the 64 students revealed important insights. For energy intake, 57.82% of respondents met recommended levels, while 21.88% had a deficit and 20.3% exceeded recommendations. This indicates that while most students meet their energy needs, a notable portion is at risk of undernutrition. For protein intake, 45.32% exceeded recommended amounts, 35.93% were within the normal range, and 18.75% had a deficit, suggesting potential dietary imbalances. For fat intake, 39.07% of students met recommended levels, 37.49% exceeded recommended amounts, and 23.44% had a deficit, highlighting concerns about overall dietary balance. Carbohydrate intake is particularly alarming, with 50% of respondents having a deficit, which is critical for meeting energy needs, especially in growing children. Physical activity levels showed that 48.45% of students engaged in light activities, 39.06% in moderate activities, and only 12.49% in high-intensity activities, indicating a need for increased physical engagement. Lastly, the nutritional status of the respondents showed that 59.37% were classified as normal, while 21.88% were obese and 12.5% were overweight, raising concerns about long-term health implications. Overall, these findings highlight the need for targeted nutritional interventions and educational programs to improve dietary habits and physical activity among school-aged children, aiming to reduce the risk of overweight and obesity.

Correlation between Energy Intake and Overnutrition

The findings indicated that the majority of students had normal energy intake, with a total of 37 students (57.82%). Among respondents with normal nutritional status, 27 students (42.19%) normal energy intake. Conversely, among overnourished respondents, five students (7.81%) with overweight nutritional status and eight students (12.5%) with obesity had excessive energy intake. The 2x24-hour food recall interviews revealed unhealthy eating patterns among most overweight children, such as consuming excessive calories, eating fast food and foods containing saturated fats, as well as foods and drinks high in sugar. Additionally, overnourished children were less active than their friends. During breaks, they typically sat and ate until the bell rang, while children with normal nutritional status engaged in active play, such as ball games, with their friends. The pattern of excessive consumption and low physical activity leads to ongoing fat accumulation in the body and limited calorie expenditure, resulting in unwanted weight gain. This finding is consistent with a study which found that the average energy consumption of students with obesity was 1917.64 kcal, while that of students with normal nutritional status was 1600.13 kcal. Statistical analysis showed that energy intake had a significant correlation with the nutritional status of primary school children (ρ=0.000). Excessive macronutrient intake can increase the body's capacity to accumulate energy. However, this may result in weight gain and an increased risk of obesity[50]. A similar study at Dukuhsari Elementary School in Sidoarjo Regency also reported a correlation between energy adequacy and children's nutritional status[51].

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Table 2. Correlation Between Macronutrient Intake and Physical Activity with Overnutrition Among Fifth-Grade Students at Banjarbendo Elementary School, Sidoarjo

Variables	Nutritional Status										p-value
	Very Skinny		Skinny		Normal		Overweight		Obese		
	n	%	n	%	n	%	n	%	n	%	
Energy Intake											
Severe Deficit	0	0	0	0	4	6.25	0	0	0	0	
Moderate Deficit	0	0	0	0	3	4.69	0	0	0	0	
Mild Deficit	0	0	1	1.56	4	6.25	0	0	2	3.13	<0.001
Normal	1	1.56	2	3.13	27	42.19	3	4.69	4	6.25	
Excessive	0	0	0	0	0	0	5	7.81	8	12.5	
Protein Intake											
Severe Deficit	0	0	0	0	2	3.13	0	0	0	0	
Moderate Deficit	0	0	1	1.56	3	4.69	0	0	0	0	
Mild Deficit	0	0	0	0	5	7.81	0	0	1	1.56	<0.001
Normal	1	1.56	1	1.56	18	28.12	0	0	3	4.69	
Excessive	0	0	1	1.56	10	15.63	8	12.5	10	15.63	
Fat Intake											
Severe Deficit	0	0	0	0	2	3.13	1	1.56	0	0	
Moderate Deficit	0	0	0	0	4	6.25	0	0	0	0	
Mild Deficit	1	1.56	1	1.56	6	9.38	0	0	0	0	<0.001
Normal	0	0	2	3.13	18	28.13	0	0	5	7.81	
Excessive	0	0	0	0	7	10.93	7	10.93	10	15.63	
Carbohydrate Intake											
Severe Deficit	1	1.56	0	0	7	10.93	0	0	1	1.56	
Moderate Deficit	0	0	2	3.13	8	12.5	0	0	2	3.13	
Mild Deficit	0	0	0	0	7	10.93	2	3.13	2	3.13	0.005
Normal	0	0	1	1.56	16	25	6	9.38	6	9.38	
Excessive	0	0	0	0	0	0	0	0	3	4.69	
Physical Activity											
Light	0	0	2	3.13	14	21.88	5	7.81	10	15.63	
Moderate	1	1.56	1	1.56	17	26.56	3	4.69	3	4.69	0.045
High-Intensity	0	0	0	0	7	10.93	0	0	1	1.56	

*) Significant at p-value<0.05 (Spearman's test)

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Correlation between Protein Intake and Overnutrition

The findings indicated that the majority of students had normal protein intake, with 23 students (35.93%) falling into this category. However, among those with overnutrition status, significant figures emerged: 10 students (15.63%) were classified as obese and eight students (12.5%) as overweight status, suggesting excessive protein intake. This pattern indicates a potential correlation between excessive protein consumption and adverse nutritional outcomes. Food recall interviews further revealed that overnourished children frequently consumed two to three servings of protein-rich side dishes and snacks, such as sausages and meatballs. This increase in protein intake often accompanied higher carbohydrate consumption, leading to the accumulation of excess protein stored as fat and contributing to unwanted weight gain.

These findings are consistent with previous research, which also established a significant relationship between protein intake and nutritional status (ρ=0.000). Excessive protein intake may lead to weight gain, as surplus protein is converted into triglycerides through deamination, a process that releases nitrogen and transforms the carbon chain into acetyl-CoA. Acetyl-CoA then facilitates lipid formation, further increasing body mass[51]. Additional research found similar correlations in overweight children, with 85% of overweight respondents having adequate protein intake, suggesting a need for dietary balance[52].

Correlation between Fat Intake and Overnutrition

Among respondents with overnutrition status, seven students (10.93%) with overweight status and 10 students (15.63%) with obesity had excessive fat intake. The Spearman's correlation test revealed a ρ-value<0.001. This value indicates a significant correlation between fat intake and overnutrition among fifth-grade students at Banjarbendo State Elementary School, Sidoarjo.

Food recall interviews revealed that children with overnutrition status mostly consumed high-fat snacks such as fried foods, while only a small proportion of students consumed fat from sources such as grains and vegetables. Diets high in fried and high-fat foods may increase the risk of overnutrition. Frying methods involve the process of cooking and drying food items using oil as a heat-conducting medium. One commonly used frying technique is deep-fat frying, where food is cooked at high temperatures and submerged in oil[53].

These findings are consistent with the research by Amalia et al., which identified a correlation between fat intake and children's nutritional status (ρ-value<0.05)[54]. Ernawati et al. also reported a significant correlation between fat intake and nutritional status based on BMI-for-age in Indonesian children aged six months to 12 years[55]. Similarly, Fadillah et al. found a correlation between fat intake and nutritional status in children aged 7-12 years in Semarang City[56].

Correlation between Carbohydrate Intake and Overnutrition

This study found that the majority of students had normal nutritional status but insufficient carbohydrate intake, with a total of 22 students (34.36%). Among respondents with overweight nutritional status, six students (9.38%) with overweight nutritional status and six students (9.38%) with obesity had normal carbohydrate intake. Meanwhile, among students with obesity, three students (4.69%) had excessive carbohydrate intake. The Spearman's correlation test revealed a ρ-value of 0.005, indicating a significant correlation between overnutrition and carbohydrate intake among fifth-grade students at Banjarbendo State Elementary School, Sidoarjo.

The 2x24-hour food recall interviews revealed that children with overnutrition status consumed more complex and simple carbohydrates than specified in the Nutritional Adequacy Score. The recommended fiber intake for children aged 7-12 years is 23-28 grams. Complex carbohydrates are high in fiber, minerals, and vitamins that are essential for the body, while simple carbohydrates provide quick energy. Low fiber intake and high simple carbohydrate intake indicate an imbalance in the consumption of carbohydrate types. Therefore, excessive consumption of sugary foods can increase the risk of unwanted weight gain in children. These findings are consistent with the North African Food and Nutrition Study and other studies that report a correlation between carbohydrate intake and overweight status[57–59].

Correlation between Physical Activity and Overnutrition

The findings indicated that the majority of students engaged in light physical activities, with a total of 31 students (48.45%). Among the respondents, five students (7.81%) with overweight nutritional status and 10 students (15.63%) with obesity engaged in light physical activity. The Spearman's correlation test revealed a p-value of 0.045, indicating a significant correlation between physical activity and overnutrition among fifth-grade students at Banjarbendo Elementary School, Sidoarjo. Lifestyle changes often lead to changes in diets rich in calories, fats, and cholesterol, which, without adequate physical activity, result in overnutrition problems. A diet high in calories, fats, and cholesterol needs to be balanced with physical activity to maintain a balanced nutritional status.

Active physical activity in children can affect their BMI and reduce the risk of overnutrition, as there is a balance between energy intake and expenditure. Physically active children tend to have good health as physical activity helps strengthen muscles and bones, prevents excessive weight gain, and reduces the risk of chronic diseases. Exercise does not only benefit the physical health, but also the mental health of children[60].

Most of the respondents only engaged in physical activities organized by the school once a week, especially during physical education classes. During breaks, the respondents tended to buy snacks available inside and outside the school, and spend time chatting with classmates. Outside of school hours, most respondents spent their time watching television, using gadgets, playing games, or studying. This finding is consistent with research noting that the increasing prevalence of obesity in school children is due to their tendency to spend their leisure time with activities that do not involve much energy, such as watching television. This condition lowers

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their physical activity level, which in turn contributes to an unbalanced diet[52].

The use of electronic devices is not only common among adults, but has also spread among young children. Prolonged use of these devices can lead to gadget addiction in children, visible through signs such as ignoring calls from parents and declines in academic performance. In addition, frequent gadget use can also interfere with children's development, especially in terms of physical, psychological, and social aspects. Physical development includes the growth of the body in terms of weight, height, and strength, which are the basis of later development. This study found that the physical development of children who frequently used gadgets were hindered compared to those who rarely used them. The effects include impaired brain development, red eyes due to exposure to high radiation, laziness affecting muscle growth, and weight gain that can lead to childhood obesity[61,62].

CONCLUSIONS

This study showed a significant correlation between macronutrient intake, specifically energy, protein, fat, and carbohydrate, and overweight status among fifth-grade students at Banjarbendo State Elementary School, Sidoarjo. The prevalence of overweight and obese students was higher among those with excessive energy (34.38%), protein (34.38%) and fat (35.93%) intake, with ρ-values of less than 0.001. Carbohydrate intake was also associated with overnutrition, as evidenced by 34.4% of students categorized as overnourished and a ρ-value of 0.005. In addition, physical activity level significantly influenced overnutrition status, with 48.45% of students doing light activity (Physical Activity Index=1.4) and a ρ-value of 0.045. These findings underscore the urgent need for regular monitoring of students' nutritional status and implementation of increased physical activity, such as morning exercises, to promote healthier dietary practices and reduce the risk of obesity.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors have no conflict of interest to declare. This study was funded by the Health Polytechnic of Surabaya.

AUTHOR CONTRIBUTIONS

MM: methodology, formal analysis, writing-original draft, writing-review, and editing; ERP: conceptualization, investigation, methodology, supervision, writing-original draft, writing-review, resources, and editing.

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The Effect of Continuity of Midwifery Care (CoMC) Based on EDUGARLIN Application and Booklet on Postpartum Fitness Quality

Pengaruh Model Pelayanan Kebidanan Berkesinambungan (CoMC) Berbasis Aplikasi "EDUGARLIN" Dan Cetak Terhadap Kualitas Nifas Bugar

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ABSTRACT

Background: The puerperium is the period between the delivery of the placenta and the return of the uterus to its pre-pregnancy condition, which lasts for 6 weeks or 42 days. During this recovery period, mothers often experience several physiological and physical changes that cause discomfort. Several studies have shown that the discomfort experienced can lead to pathological development and complications when not treated properly. To prevent complications, information technology from smartphones with Android-based applications can be used to improve the quality of postpartum well-being.
Objectives: This study aimed to analyze the effect of utilizing EDUGARLIN (postpartum fitness education) application on the knowledge, attitudes, and quality of postpartum fitness in TPMB (Independent Midwife Practice).
Methods: The study procedures were carried out using a Quasi-experimental design with a nonequivalent posttest-only control group method. The purposive sampling was then used to select a total of 84 respondents, who were divided into 2 groups, namely EDUGARLIN application (intervention) and booklet (control). The data obtained in this study were analyzed using the Mann-Whitney test.
Results: The results showed that there were significant differences in knowledge, attitudes, and postpartum fitness quality between the intervention and control groups. In the intervention group, 36 respondents (85.7%) had good knowledge, compared to 22 respondents (52.4%) in the control group (p-value<0.05). A total of 36 respondents (85.7%) also showed positive attitudes, compared to 34 (81%) in the control group (p-value<0.05). In addition, 38 respondents (90.5%) in the intervention group had good postpartum fitness quality, compared to 26 (61.9%) in the control group (p-value<0.05).
Conclusions: The android-based EDUGARLIN application was effective in improving knowledge, attitudes, and behavior of postpartum mothers in terms of the quality of postpartum fitness.

INTRODUCTION

Postpartum period is a stage that starts after the placenta is delivered and continues until the uterus returns to its pre-pregnancy condition, generally lasting about 6 weeks or 42 days. During this period, mothers often undergo several physiological changes that may cause discomfort. Several studies have shown that understanding the nature of the discomfort as part of the body's natural healing process is essential. However, there is a high risk of developing complications when the condition is not properly managed. These complications include anemia, preeclampsia/eclampsia, postpartum bleeding, postpartum depression, and postpartum infections, which affect mothers' health status[1].

Common issues during pregnancy include postnatal weight retention, musculoskeletal problems, such as pelvic pain, low back pain, abdominal diastasis, pelvic floor disorders, as well as psychological disorders, including postpartum depression. To address these issues, medical personnel have recommended exercise during postpartum period, which aids in recovery after childbirth, helps in returning to pre-pregnancy weight, reduces the risk of developing health conditions and future chronic diseases, enhances fitness parameters,

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fosters mother-baby interaction, and encourages social engagement[2].

According to previous studies, postpartum service policy typically consists of 3 sessions. The midwife conducts the first session, namely Postpartum Visit or KF1, while the mother is still at the medical facility. The second and third sessions, KF2 and KF3, comprise follow-up or home visits according to a schedule. However, these follow-up sessions have not been carried out effectively as proposed[3]. The average coverage of initial postpartum services for KF1, KF2, and KF3 was reported by Riskesdas (*Riset Kesehatan Dasar*/Basic Health Research) 2018 statistics at 93.3%, 66.9%, and 45.2%, respectively. This indicates that Indonesian postpartum services, such as KIA (*Kesehatan Ibu dan Anak*/Mother and Child Health), are still below the country's goals. The intervention and policies of KIA program have also been reported to be erratic in operation, leading to increased infant and maternal mortality rates[4].

The 2018 Family Health Directorate's routine report showed that the coverage of postpartum visits was relatively in the good category, with scores of 77% and 97% for first postpartum and neonatal visits, respectively. However, data from several surveys, such as the 2012 Balitbangkes (*Badan Penelitian dan Pengembangan Kesehatan*/Health Research and Development Organization) showed that maternal deaths during postpartum period were 61.59%. This indicated that the quality of postnatal care for mothers and infants was still low, specifically with the current problems of access and integration of postnatal care with other health service[5].

Maternity continuum of care is a model of integrated components of maternal health service from pregnancy to the post-partum period to improve maternal, neonatal, and infant health. Healthcare systems that provide midwifery service through a continuity-of-care method have shown beneficial effects on both mothers and infants. World Health Organization (WHO) supports midwife continuity of care models, where a certified midwife trained to international standards, such as those set by the International Confederation of Midwives, or a small, familiar team of midwives, offers care in pregnancy, labor, and postpartum period. Mothers who experienced these models reported more positive pregnancy labor, and postpartum experiences, as well as reduced costs for antenatal (pregnancy) and intrapartum (labor and birth) care. Continuous care in postpartum period helps mothers feel more supported, secure, and calm while adjusting to the new role[6].

Postpartum care is essential as mothers often undergo significant physical and psychological changes to regain their health and well-being after childbirth[7]. Current principles in postpartum and breastfeeding midwifery care focus on supporting methods as healthy individuals, viewing recovery as a natural process. Midwives provide mothers-centered care, which takes a holistic method by addressing the physical, emotional, psychological, spiritual, social, and cultural needs. Postnatal care services serve as a Continuation of Midwifery Care (CoMC) model, which extends support beyond pregnancy and delivery[8].

Previous studies have shown that Indonesia does not yet have optimal awareness regarding the importance of postpartum health, as it is influenced by facilities, medical personnel, inadequate infrastructure, and education, which are not evenly distributed[5]. This gap can be addressed with a technological method and the use of information. Postpartum mothers often require quality education and health services to care for infants without disturbing their lifestyle. Providing information as an educational effort can be combined with various media in health education. At present, information technology is widely promoted, changing almost all aspects of human life in which IT plays a significant role. In addition, an Android application was developed to take the role of media by providing education to increase knowledge about psychological changes, danger signs, needs, and care[9].

A study conducted by Shorey regarding the Postnatal Education Program Mobile Health Application (Home-but not Alone) showed that it was handy as a postnatal educational medium, especially for new parents. Daehn et al. also developed the SmartMoms application, which improved awareness and provided information about postpartum depression. The results showed that 62.2% of mothers who accessed self-screening for the condition had positive results and received help more quickly. The use of app interventions in postpartum period helps to establish early diagnosis, postnatal education, and identification of infections and adverse events[10,11]. Therefore, this study aims to develop a strategy for providing educational media for postpartum fitness. A media application called EDUGARLIN was created, which utilizes Android-based smartphone technology as a more practical guide for postpartum mothers to improve postpartum fitness.

METHODS

This study was an enhancement of the 2022 application, refined based on feedback from midwives providing services and clients receiving CoMC services. Following these improvements, a quantitative study proceeded to assess the impact of EDUGARLIN application on knowledge and attitudes related to fitness in the experimental (intervention) group. This study aimed to identify cause-and-effect relationships by involving both an experimental or intervention group and a control group. The intervention group received EDUGARLIN application, while the control group was provided only the printed EDUGARLIN booklet. Both groups completed a pre-test, received their respective interventions, and then completed a post-test. However, these 2 groups were not randomly selected.

EDUGARLIN application and the booklet addressed topics pertinent to all mothers and their infants, such as recognition of danger signs in labor, nutritional needs, physical adjustments during childbirth, and feeding mothers. In addition, it also covered the journey through motherhood, acclimatizing to parental lifestyle, healthful living behaviors, postpartum illness, and complications prevention, as well as maternal role acceptance for family planning and exclusive breastfeeding experiences in different socioeconomic backgrounds across regions. Videos were provided to

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improve the nurturing abilities of a mother after birth. After completing a knowledge and attitude questionnaire, new mothers had access to several videos covering postnatal yoga, the parenting transition period, baby massage, and feeding methods (i.e. breastfeeding). Developing EDUGARLIN application included a structured process that ensured the final products function efficiently, starting with defining the application's purpose. The design phase included creating wireframes and prototypes to visualize the user experience. An appropriate technology stack was selected in development, and clean code was written to implement the design. Ongoing maintenance and updates were crucial for optimal performance and user satisfaction.

A quasi-experimental method was used in this study, specifically applying a Nonequivalent Control Group Design. In this design, neither the experimental group nor the control group was selected randomly. Both groups were subjected to an initial pre-test. In this method, the experimental and control groups are compared, although the samples were selected and assigned without randomization. Both groups received a pre-test, then an intervention, followed by a post-test. The groups received different treatments, with the experimental group using EDUGARLIN application and the control group using a printed version in booklet form, and concluded with a final test for each group. This study's population included all postpartum mothers who had postpartum visits at the 2 midwife practices namely TPMB (Independent Midwife Practice), a key healthcare provider in the Jakarta and South Tangerang areas. Participants were determined based on inclusion and exclusion criteria, and selected under specific conditions to ensure study relevance and accuracy. Eligibility criteria included the absence of postpartum complications, ownership of an Android phone capable of installing EDUGARLIN application, and willingness to partake in the study. These criteria were meticulously designed to ensure that only those who could genuinely benefit from and contribute to the study were included. The selective method guaranteed that the results were valid and pertinent to the targeted population, the sample size included in the study criteria was calculated using the Raosoft formula application http://www.raosoft.com/samplesize.html. A margin of error of 5% was considered and a confidence level of 95% from a total population of 120 postpartum mothers. The sampling method used purposive sampling with a total sample of 42 participants using EDUGARLIN application and 42 participants using the booklet. The treatment and a control group comprised 42 participants each. The leading inpatient clinic in Jakarta was selected as the treatment group because all participants in this group owned Android phones. Meanwhile, TPMB in South Tangerang was selected as the control group. A nonprobability sampling was used with a purposive sampling method. This method enabled the study teams to select a sample that best represented the characteristics of the population.

Primary data were used to collect information on postpartum fitness, with a questionnaire as the data collection instrument. This questionnaire, administered during the pre-test and post-test phases, comprised 20 items on knowledge and 20 items on attitudes toward postpartum fitness. In addition, it covered topics such as recognition of postpartum danger signs, adherence to nutritional guidelines, physical adaptation of postpartum and breastfeeding mothers, the maternal role attainment process, adaptation to parenting, health promotion for healthy behavior, prevention of postpartum disease and complications, family planning, and the success of exclusive breastfeeding. A validity test was performed on the instruments to ensure accuracy and reliability, confirming that both questionnaires, namely 1 for knowledge and 1 for attitudes were valid, with correlation values exceeding the table thresholds. The study aimed for precise measurement of these variables, with significant correlations indicated by asterisks (1 for 95% and 2 for 99% significance levels). Reliability was measured using Cronbach's Alpha, yielding a score of 0.80, which confirmed high reliability. After securing study permissions, conducting a preliminary study, and completing sampling, the study teams informed participants of the study's objectives, procedures, benefits, and potential risks, obtaining informed consent before proceeding with the pre-test.

Data collection commenced by explaining the study procedures to participants, and those willing to participate signed a consent form. In addition, a pre-test questionnaire was administered to both groups. For the treatment group, study teams provided an intervention using EDUGARLIN application, which included information on postpartum care. Participants were encouraged to download and use the application, which focused on postpartum fitness. For 2 weeks, participants in the treatment group were asked to engage with the application for a minimum of 15 to 30 minutes every day during rest periods, exploring educational content and videos on improving postpartum fitness.

The control group received a printed fitness booklet and was asked to read it during their free time, with no time constraints. After 2 weeks, both groups completed a post-test questionnaire. As a follow-up, the control group was also provided access to EDUGARLIN application after the post-test.

The study teams performed editing, coding, scoring, and statistical analysis to examine the data. Subsequently, the data was processed and analyzed using SPSS version 26.0 to assess changes in knowledge and attitudes between the control and treatment groups. The Wilcoxon Signed-Rank Test was used to evaluate the comparative correlation between the 2 samples for each dependent variable in ordinal data, with a significance threshold set at p-value=0.05. To compare 2 independent samples from different populations, the Mann-Whitney U Test was applied. When the results yielded a p-value <0.05, the null hypothesis (Ho) was rejected, and the alternative hypothesis (H1) was accepted, indicating a significant difference in knowledge and attitudes between the control and treatment groups.

Ethical approval was granted by the Study Ethics Commission of University Respati Indonesia, with the number 532/SK.KEPK/UNR/VIII/2024 issued on 2 April 2024. All participants provided their informed consent before their involvement in the study. In addition, their rights, including the ability to withdraw from the learning

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without facing any repercussions were properly stated. The study process upheld confidentiality and anonymity, safeguarding participants' identities and personal information.

RESULTS AND DISCUSSIONS

Univariate analysis was used to obtain an overview of the distribution of participants according to several characteristics, according to the independent variable and the dependent variable. In this study, univariate analysis was used to determine the frequency distribution of knowledge, attitudes, and behavior of fit postpartum quality after providing interventions using EDUGARLIN application and booklets.

Table 1. Frequency distribution of post-test knowledge, attitudes, and behavior of the quality of postpartum fitness at TPMB

Variable	Group	
	Intervention (n=42)	Control (n=42)
Knowledge		
Good	36 (85.7%)	22 (52.4 %)
Fair	6 (14.3%)	15 (35.7%)
Less	0 (0 %)	5 (11.9%)
Attitude		
Positive	36 (85.7%)	34 (81%)
Negative	6 (14.3%)	8 (19%)
Postpartum Quality Fit		
Fit	38 (90.5%)	26 (61.9%)
Not Fit	4 (9.5%)	16 (38.1%)

Based on Table 1, it was found that after receiving treatment, participants with good knowledge were more common in the intervention group (85.7%) compared to the control group (52.4%). In addition, those with a positive attitude were more common in the intervention group (85.7%) than in the control group (81%). Regarding actions, those in the intervention group were more adherent (90.5%) than those in the control group (61.9%).

Table 2. The influence of EDUGARLIN application on knowledge of the quality of postpartum fitness

Participants	Knowledge			p-value
	Good	Fair	Less	
Intervention Group (EDUGARLIN Application)	36 (62.1%)	6 (28.6%)	0 (0%)	0.000*
Control Group (Booklet)	22 (37.9%)	15 (71.4%)	5 (100%)	
Total	58 (100%)	21 (100%)	5 (100%)	

*Mann –Whitney Test, significant if p-value <0.05

Based on Table 2, the results of knowledge about postpartum mother care revealed that among 58 participants with good knowledge, the majority (62.1%) were in the intervention group, while 37.9% were in the control group. Among 21 participants with sufficient knowledge, the majority (71.4%) were in the control group, compared to 28.6% in the intervention group. All 5 participants with less knowledge were in the control group. The statistical test results showed a p-value of less than 0.05, indicating a significant difference in knowledge of postpartum health quality between the intervention and control groups. This analysis suggested that EDUGARLIN application had a positive effect on increasing knowledge about the quality of postpartum care in TPMB.

Table 3. The influence of EDUGARLIN application on attitudes of the quality of postpartum fitness

Respondent	Attitudes		p-value
	Positive	Negative	
Intervention Group (EDUGARLIN Application)	36 (51.4%)	6 (42.9%)	0.000*
Control Group (Booklet)	34 (48.6%)	8 (57.1%)	
Total	70 (100%)	14 (100%)	

*Mann –Whitney Test, significant if p-value <0.05

The results of attitudes regarding the puerperium quality in postpartum mothers, based on Table 3, show that of the 70 participants with positive attitudes, the majority were in the intervention group (51.4%), compared to the control group (48.6%). Among the 14 participants with negative attitudes, the majority were in the control group (57.1%) compared to the intervention group (42.9%). The statistical test results revealed a p-value <0.05, indicating a significant difference in attitudes toward the quality of postpartum health between the intervention and control groups. This demonstrates that the application positively impacts attitudes to enhance the quality of postpartum health.

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Table 4. The influence of EDUGARLIN application on the behavior of the quality of postpartum fitness

Group	Postpartum Fitness		p-value
	Fit	Not Fit	
Intervention Group (EDUGARLIN Application)	38 (59.4%)	4 (20.0%)	0.002*
Control Group (Booklet)	26 (40.6%)	16 (80.0%)	
Total	58 (100%)	21 (100%)	

*Mann –Whitney Test, significant when p-value <0.05

The results of postpartum fitness quality behavior in postpartum mothers, as shown in Table 4, revealed that 59.4% of the 64 participants who exhibited postpartum fitness were in the intervention group, compared to 40.6% in the control group. Meanwhile, among the 20 participants categorized as unfit, the majority were in the control group (80.0%) while only 20.0% belonged to the intervention group. The statistical test results showed a p-value <0.05, indicating a significant difference in behavior that indicated the quality of a fit postpartum between the intervention group and the control group. This revealed that EDUGARLIN application had an impact on improving the care of postpartum mothers at TPMB.

This study was conducted at TPMB in the Jakarta and South Tangerang areas for 7 months. In addition, it started with validity and reliability tests on 28 March 2024. After that, the study teams divided 84 postpartum mothers into 2 groups and gave each group a questionnaire on knowledge, attitudes, and behavior regarding the quality of postpartum health. A total of 42 mothers participated in the intervention group, which used EDUGARLIN application, while 42 mothers, as controls, received the booklet. Compared with the control group, the intervention group had more mothers with excellent knowledge, according to the study results in Table 1. Knowledge was the result of perception or sensation, which occurred after gaining understanding.

Age, education, environment, information, experience, society, culture, and economy were all variables that influenced knowledge[12]. This study's findings were consistent with theories that explained these elements in detail. In this study, participants received information through EDUGARLIN application and booklet media, significantly enhancing their understanding. Using digital applications and printed materials as educational tools successfully integrated traditional and modern methods to improve health literacy. Most participants showed good knowledge, indicating that these methods effectively conveyed essential health information. In addition, combining multiple sources of information ensured that the educational content was accessible and comprehensible to a broader audience, thereby fostering an informed and educated community[13].

Each individual had a different ability to perceive and understand information through their senses because the more often the senses were engaged, the easier it was to understand. According to Janah and Timiyatun, health education depended on the level of an individual's sensory grasp, the more frequently it was used, the better the understanding. Consequently, the benefits of using audio-visual media were very effective and influential in receiving information from leaflet media regarding health education[14].

Since it appealed to all senses, disseminating knowledge through the media made acceptance, which was previously challenging, much more accessible. Smartphones were one of the types of electronic media that could be used for marketing[15], proving to be convenient to transport, useful everywhere, resistant to damage, and had numerous uses. These benefits, along with their appealing animations, made cell phones popular. According to Putri's study, "The Effect of the 'Mommy Postpartum' Application on Increased Mother's Knowledge and Skills", after completing the Mommy Postpartum application, the treatment group gained significantly more knowledge about postpartum care. Similar studies had shown that the Nifasku application improved maternal knowledge of postnatal care for newborns[16].

Previous studies on using the "Bidanku" application also found similar results. Of the 22 participants, the majority (73.3%) experienced high academic scores. There were considerable differences in improvement between the control and intervention groups, with a p-value less than 0.05 and an RR of 2.2. This proved that using "Bidanku" significantly increased knowledge, up to 2.2 times compared to the control group[17].

The results from Table 3 indicated that of the 70 participants with positive attitudes, the majority (51.4%) were in the intervention group compared to 48.6% in the control group. Meanwhile, among the 14 participants with negative attitudes, the majority (57.1%) were in the control group, compared to 42.9% in the intervention group. Statistical tests revealed a significant difference in attitudes towards the quality of postpartum fit between the intervention and control groups, with a p-value <0.05. This analysis indicated that EDUGARLIN application positively impacted improving attitudes toward the quality of postpartum fit at TPMB.

Attitudes were influenced by previously acquired knowledge and based on an individual's tendency to act toward objects or stimuli. In addition, attitudes were reflected in their reactions or behaviors toward an object. For example, a person could practice breast care more diligently after learning their importance and methods. This transformation in behavior depicted how gaining information positively impacted one's attitudes and actions. The dynamic between knowledge and attitude was crucial, as it could lead to better health outcomes and proactive health behaviors. By educating individuals effectively, it was possible to foster positive attitudes and

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encourage beneficial practices, thereby enhancing overall well-being[12,18].

According to Bem's Self-Perception Theory, an individual's positive or negative attitude toward an object was formed by observing their behavior[19]. This theory suggested that people developed their attitudes by reflecting on their actions and the context in which it occurred. During postpartum period, mothers with positive attitudes were particularly motivated to engage in self-care practices[20]. In addition, these practices included regular exercise, balanced nutrition, and seeking support when needed. In addition, their positive attitudes were reinforced these health-promoting behaviors were consistently performed. This, in turn, could significantly improve their postpartum fitness and overall well-being[21]. The self-perception mechanism emphasized the importance of fostering positive behaviors and attitudes, because of their interconnectivity, which could lead to sustained health benefits[22,23].

Action was a critical aspect of practice, specifically in midwifery. In this study, midwives' knowledge and positive attitudes were fundamental to their ability to provide high-quality care. According to the Health Belief Model theory, knowledge heavily influenced a person's practice. This model suggested that individuals' actions toward health were determined by their understanding of health issues and the perceived benefits of taking action. For midwives, possessing comprehensive knowledge and maintaining a positive outlook made it easy to execute their effective care strategies, educate patients, and promote healthy behaviors. By being well-informed and fostering a supportive environment, midwives could significantly enhance the health outcomes for mothers and newborns[24].

The period following childbirth was crucial for both mother and infant. Postpartum hemorrhage was responsible for approximately 60% of maternal deaths, with 50% occurring in 24 hours after birth[2]. In Bogor, maternal mortality had shifted from complications during pregnancy and childbirth to an increase in postnatal deaths. This study exhibited some limitations, in addition to the requirement to assess fitness history starting from pregnancy to track participants' fitness from that period through postpartum phase. The fitness assessment in this study relied on self-reported questionnaires, whereas direct observation could provide a more accurate measurement of postpartum fitness. However, the study's strengths was in EDUGARLIN application, which evaluated maternal fitness during the puerperium and provided valuable educational resources for participants. Some limitations of this study included that not all postpartum mothers had adequate access to devices or internet connections, which could limit participation and reduce optimal use of the application. In addition, differences in technological mastery were an obstacle, specifically for mothers who were less familiar with applications or digital devices, which could affect their understanding of the content provided. Some mothers faced difficulties in following guidelines or instructions provided through the app without direct support. Applications could not detect physical or emotional changes that required quick intervention. As the app relied on inputs from the user, the data obtained did not reflect the true condition when the user did not report their progress consistently or was not completely honest. The app also lacked personal interaction compared to face-to-face services, which could make mothers feel less emotionally or psychologically supported, which was a very important aspect of postpartum care. Each mother had different health needs during postpartum period, therefore, the application struggled to tailor its content to individual needs, which could affect its effectiveness with each mother. In addition, the application included education on mental health for postpartum mothers, enhancing their overall well-being.

CONCLUSIONS

EDUGARLIN application enhanced maternal knowledge, improved their attitudes, and positively influenced their behavior, ultimately boosting the quality of postpartum fitness. Health workers, specifically midwives, could use EDUGARLIN application as an additional educational tool to improve knowledge, attitudes, and postpartum fitness. Future study teams must assess maternal fitness from pregnancy through postpartum, with direct observation recommended for more accurate fitness assessments. The application was hoped to evolve to enable seamless online communication between midwives and postpartum mothers.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

SS: Conceptualization, methodology and writing—original draft; Study design and educational interventions. DW: Formal analysis – supervised and writing—review & editing (ensured the integrity of research process; contributed to critical revisions of manuscript) LN: Data curation, investigation and methodology; helped with data collection and analysis, implementation of Emo Demo method. JJ: Writing—original draft, and data collection (research interview) —contributed to writing the original paper AK: Oversaw project logistics, organized what is needed to do the research, and facilitated collaboration. Writing—original draft, writing—review & editing, visualization; helped

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analyze results and refine data presentation within the manuscript.

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Enhancing Maternal Knowledge and Practices in Complementary Feeding through Emotional Demonstration Methods

Meningkatkan Pengetahuan dan Praktik Ibu dalam Pemberian Makanan Pendamping ASI melalui Metode Demonstrasi Emosional

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ABSTRACT

Background: Complementary feeding is crucial for children's growth and development, especially between the ages of 6 to 24 months. Adequate nutritional intake during this period can prevent long-term health issues, such as stunting and obesity. However, many mothers struggle with providing appropriate complementary feeding due to a lack of knowledge and inappropriate feeding practices.
Objectives: This study aimed to assess the effectiveness of the Emotional Demonstration (Emo Demo) method in improving maternal knowledge, attitudes, and behaviors related to complementary feeding.
Methods: Using a pretest-posttest control group design, 100 mothers with children aged 6 to 24 months were assigned to one of three groups: control (lecture), demonstration, and Emo Demo. Data were collected via questionnaires and observational assessments at multiple intervals to measure the sustainability of behavior changes. Statistical analyses, including ANOVA and Least Significant Difference (LSD) tests, revealed that the Emo Demo method significantly enhanced knowledge, attitudes, and feeding practices compared to traditional methods.
Results: The study found no significant demographic differences between groups. ANOVA showed significant improvements in knowledge, attitudes, and behavior (p-value<0.05). LSD analysis revealed significant changes in the Emo Demo group (p-value=0.010 for knowledge and behavior, p-value=0.028 for attitude), indicating its effectiveness in improving complementary feeding practices.
Conclusions: Innovative and emotionally engaging methods like Emo Demo can effectively address the challenges of complementary feeding, ultimately contributing to public health efforts to reduce stunting in Indonesia. Further research is recommended to refine educational strategies for improving maternal nutrition practices in diverse communities.

INTRODUCTION

Complementary feeding is a critical phase in a child's growth and development, particularly between the ages of 6 to 24 months. During this stage, children require adequate nutritional intake to support both their physical and cognitive development. According to the World Health Organization (WHO), appropriate complementary feeding helps prevent various long-term health issues, including stunting and obesity[1]. However, many mothers face difficulties in providing adequate complementary feeding, often due to a lack of knowledge, unsupportive attitudes, and inadequate feeding practices[2]. Several studies have shown a significant relationship between maternal feeding practices and the incidence of stunting[3–6]. Influencing factors include maternal knowledge and motivation regarding complementary feeding practices[7–11], education[12–16], maternal working status[17–19], social status[19–23], economic level[24], and cultural beliefs[25,26].

Nutrition education for mothers with children aged 6–23 months is essential to address the issue of stunting by enhancing maternal knowledge and attitudes[27,28]. Nutrition education must be prioritized to improve mothers' understanding of infant and young child feeding guidelines, helping them navigate challenges in providing proper nutrition and promoting effective complementary feeding practices for malnourished children[29]. One promising educational intervention is the Emotional Demonstration (Emo Demo) approach. The Emo Demo method is an innovative educational strategy that employs creative and

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provocative techniques based on the Behavior Centered Design (BCD) theory[30–33]. This theory posits that behavior change can occur when individuals are exposed to new, challenging, surprising, or stimulating experiences[34,35]. The aim of the Emo Demo method is to drive behavioral change in public health through engaging and stimulating techniques, which is expected to increase knowledge of stunting and complementary feeding among mothers.

Various educational interventions have been implemented to improve maternal knowledge and skills in complementary feeding. However, traditional methods such as lectures or standard demonstrations often fall short in effectively changing maternal attitudes and behaviors[36]. These methods rely heavily on passive knowledge transfer, which does not foster active engagement. Additionally, these approaches may not adequately address the emotional and psychological barriers that mothers face, such as anxiety, fear of inadequacy, or cultural norms that influence feeding practices.

Previous research has demonstrated that interventions involving emotional and interactive engagement can significantly improve understanding and application of complementary feeding practices among mothers[37]. Consequently, the Emo Demo method, as a behavioral communication strategy, is expected to enhance the emotional engagement of mothers with the information provided, fostering better behavior changes in complementary feeding practices.

This study also aimed to compare the Emo Demo method with the traditional lecture and demonstration approaches to assess which was more effective in changing maternal behavior. The findings of this study are expected to contribute significantly to the development of health education programs for mothers, especially in promoting appropriate complementary feeding practices and supporting government efforts to reduce stunting rates in Indonesia. This research is crucial in providing new insights into health education and behavioral interventions and in encouraging better complementary feeding practices among mothers in Indonesia. This study aims to evaluate the effectiveness of the Emotional Demonstration (Emo Demo) method in improving maternal knowledge, attitudes, and behaviors related to complementary feeding.

METHODS

Research Design

This study used a Pretest-Posttest Control Group Design to examine the effectiveness of the Emo Demo method in changing mothers' behavior regarding complementary feeding. The design involved four groups, namely: Control Group 1 (X1) – did not receive any education intervention (pure control group), Control Group 2 (X2) – received education through the lecture method, Treatment Group 1 (X3) – received education through the demonstration method, and Treatment Group 2 (X4) – received education through the Emotional Demonstration (Emo Demo) method. The pretest-posttest design allowed the researchers to measure knowledge, attitudes, and behaviors before and after the intervention and compare the effects of each method across groups. The use of control and treatment groups ensured that changes could be attributed to the specific intervention, controlling for external factors that might influence the outcomes.

Sample Selection

This research was conducted in several *Puskesmas* (community health centers) in Surabaya, Indonesia, from January to October 2019. The target population consisted of mothers with toddlers aged 6 to 24 months attending the *Puskesmas*. A purposive sampling technique was used to recruit participants, selecting mothers willing to participate and providing informed consent. A simple randomization technique was used to allocate participants into four groups: control, lecture, Demonstration, and Emotional Demonstration, with 25 mothers assigned to each group. This randomization ensured that each participant had an equal chance of being in any group. The sample size was determined using power analysis, with $\alpha = 0.05$ and a power level of 80%. An effect size of 0.5 was assumed based on previous research, suggesting moderate effects of behavioral interventions. Calculations indicated a minimum of 25 participants per group was sufficient for detecting significant differences through one-way ANOVA. The sample size was also supported by Cohen (1988), who states that for behavioral research, such a sample size is often adequate for detecting moderate effects. The purposive sampling method ensured the sample reflected the characteristics of the target population, focusing on mothers actively seeking health services at the *Puskesmas* and willing to provide informed consent.

Intervention

Three educational interventions were designed to improve maternal knowledge, attitudes, and practices related to complementary feeding: Lecture Method (X1): In this group, Mothers received education through traditional lectures on complementary feeding, nutritional guidelines, and meal strategies for toddlers. Each session lasted 90 minutes and was delivered four times. This method aimed to improve maternal knowledge through verbal communication and information delivery. Demonstration Method (X2): Mothers in this group participated in practical demonstrations on how to properly prepare and serve complementary feeding. Each demonstration lasted 60 minutes and was conducted three times. The purpose of this method was to enhance mothers' skills in preparing nutritious meals, understanding portion sizes, and ensuring that they could replicate the practices at home. This method engaged mothers through hands-on learning, which is crucial for reinforcing new behaviors. Emo Demo Method (X3): This group received an emotionally engaging intervention incorporating elements of storytelling, role-playing, and visual aids. Each session lasted 120 minutes and was conducted twice. The Behavior Centered Design (BCD) theory was applied, which posits that behavior changes occur in response to emotionally engaging, innovative stimuli. The Emo Demo method was designed to foster a deeper connection between mothers and the information they

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received, creating an emotional and cognitive shift that could lead to lasting behavior change. By involving emotional narratives and interactive activities, the Emo Demo method aimed to resonate with the mothers' personal experiences, encouraging them to adopt healthier feeding practices.

Data Collection

Data were collected using a combination of quantitative and qualitative methods. A structured questionnaire was the primary instrument for evaluating maternal knowledge, attitudes, and practices related to complementary feeding. The questionnaire underwent pre-testing for validity and reliability to ensure it effectively measured the intended variables. It consisted of four sections: demographic information, maternal knowledge of complementary feeding, attitudes toward complementary feeding, and self-reported feeding practices. In addition to the questionnaire, observational assessments were carried out before and after the interventions to assess changes in feeding practices. Data were collected at four time points: O1 (pre-intervention), O2 (post-intervention), O3 (three months post-intervention), and O4 (six months post-intervention) to track the sustainability of behavior changes over time. This longitudinal approach allowed for the tracking of behavior changes over time and provided insights into the sustainability of these changes. The study's use of mixed methods enabled not only the measurement of changes in knowledge, attitudes, and behaviors, but also a deeper understanding of the reasons behind these changes and the challenges mothers faced in implementing new practices.

Data Analysis

Data processing and analysis were carried out using appropriate statistical software. Descriptive statistics were employed to summarize participants' demographic characteristics and baseline measurements. Frequency distributions were generated for categorical variables, while means and standard deviations were calculated for continuous variables. This initial step helped establish the comparability of groups before the intervention for the quantitative data. Inferential statistics were used to assess the intervention's impact. Independent t-tests with a 95% confidence level (α=0.05) were applied to compare differences between the treatment and control groups. Prior to performing these tests, normality tests were conducted to ensure the data met the assumptions required for parametric testing. To compare the three treatment groups (Lecture, Demonstration, and Emo Demo) on knowledge, attitudes, and practices, an Analysis of Variance (ANOVA) was conducted. In cases of significant differences, post-hoc analyses using the Mann-Whitney test were performed to identify specific group differences. This combination of statistical techniques ensured that both broad trends and detailed differences between the groups were captured.

In addition to the quantitative analysis, qualitative data were collected through participant interviews and focus group discussions. The qualitative data were analyzed using thematic analysis. Transcripts were coded to identify common themes and patterns related to maternal knowledge and practices in complementary feeding. This dual approach allowed for a comprehensive understanding of the intervention's impact, combining numerical trends with participants' insights and experiences.

Validity and Reliability

The validity of the questionnaire was confirmed to ensure it accurately measured the intended constructs: knowledge,
attitudes, and practices. Reliability was assessed using Cronbach's Alpha to ensure internal consistency in the questionnaire responses. A Cronbach's Alpha score above 0.7 was considered acceptable, indicating that the instrument was reliable for measuring the variables of interest. These steps were essential for ensuring the accuracy and trustworthiness of the research findings.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Commission of the Ministry of Health Polytechnic Surabaya No.EA/0366.1/KEPK-Poltekkes_Sby/V/2020, and all participants provided informed consent before taking part in the study. The participants were informed of their rights, including the right to withdraw from the study at any time without any consequences. Confidentiality and anonymity were maintained throughout the research process, ensuring that the participants' identities and personal information were protected.

RESULTS AND DISCUSSIONS

The analysis of Table 1 shows that the homogeneity test for each variable (age, education, and occupation) shows p-values greater than 0.05, indicating no significant differences between the intervention groups. This suggests that the distribution of age, education, and occupation is relatively balanced across the three intervention methods (Lecture, Demonstration, and Emo Demo). Regarding age, most respondents fall within the 20-29 age range (46.7%), followed by those aged 30-39 (42.6%), with only a small percentage under 20 years old (4%) and above 40 years old (6.7%). In terms of education, the majority of respondents have higher education degrees (44%), particularly in the Demonstration group (60%). Respondents with elementary and middle school education are fewer in number. For occupation, most respondents are housewives (56%), with each intervention group having 60% housewives. Civil servants, entrepreneurs, and private employees make up a smaller proportion of respondents. These findings suggest that the groups are well-distributed and homogeneous, ensuring a valid comparison of the intervention results without demographic bias.

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Table 1. Frequency distribution of respondent characteristics

Parameter	Lectures		Demonstration		Emo Demo		Total		Homogeneity Test
	n	%	n	%	n	%	n	%	
Age in Years									
<20	2	8	0	0	1	4	3	4	0.506
20-29	13	52	12	48	10	40	35	46.7	
30-39	8	32	10	40	14	56	32	42.6	
≥40	2	8	3	12	0	0	5	6.7	
Education									
Primary school	6	24	3	12	6	24	15	20	0.213
Junior high school	4	16	4	16	3	12	11	14.7	
High school	5	20	3	12	8	32	16	21.3	
College	10	40	15	60	8	32	33	44	
Occupation									
Housewives	15	60	12	48	15	60	42	56	0.753
Civil servants	5	20	6	24	3	12	14	18.7	
Self employed	3	12	4	16	3	12	10	13.3	
Private Employe	2	8	3	12	4	16	9	12	

To assess the effect of the treatments on changes in complementary feeding practices, ANOVA was conducted on the delta of knowledge, attitudes, and behavior (the difference between pre- and post-intervention) across the treatment and control groups. The ANOVA results revealed significant differences between all groups (p-value<0.05). To further identify which specific groups differed, a post-hoc analysis was performed using the Least Significant Difference (LSD) test.

Table 2. Results of LSD test on complementary feeding practice on the difference in before and after intervention results between the control group and the three intervention groups

Category	Control Group	Intervention	Least Significant Difference (LSD) Test Value
Knowledge	Control	Demonstration	0.193
		Emo Demo	0.010
Attitude	Control	Demonstration	0.086
		Emo Demo	0.028
Behavior	Control	Demonstration	0.0776
		Emo Demo	0.010

Based on Table 2, the Least Significant Difference (LSD) test was used to compare the means between the control group and the intervention groups (Demonstration and Emo Demo) for the variables of knowledge, attitude, and behavior. The results indicate significant differences between these groups. For the knowledge variable, the LSD test value between the control group and the Demonstration group was 0.193, while the difference between the control group and the Emo Demo group was 0.010. The lower LSD value for the Emo Demo group suggests that this method was more effective in enhancing participants' knowledge of complementary feeding compared to both the Lecture and Demonstration methods. This difference highlights the effectiveness of Emo Demo in increasing participants' understanding of complementary feeding. For the attitude variable, the Emo Demo method demonstrated a significant difference, with an LSD value of 0.028 when compared to the control group. Although the Demonstration method also showed some effects (LSD=0.086), it was less impactful than Emo Demo. Regarding behavior, the LSD value between the control group and the Demonstration group was 0.776, indicating no significant difference. In contrast, Emo Demo produced a significant result with an LSD value of 0.010, highlighting its effectiveness in influencing mothers' behavior in providing complementary feeding.

This study aimed to evaluate the effectiveness of three intervention methods—lectures, demonstrations,

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and Emo Demo—in improving maternal knowledge, attitudes, and behaviors related to complementary feeding. These methods provide valuable insights into their ability to facilitate behavioral change, particularly regarding appropriate complementary feeding practices. The study design includes a control group and uses ANOVA and the LSD follow-up test to analyze the differences between the groups.

The results, as shown in Table 1, indicate that the demographic characteristics of the respondents, such as age, education, and occupation, are evenly distributed among the intervention groups. This conclusion is supported by the homogeneity test, which revealed a p-value of 0.05, indicating no significant difference in the demographic distribution between the lecture, demonstration, and Emo Demo groups. With this homogeneous distribution, the comparison of intervention results is validated without demographic bias. The majority of respondents were aged 20-29 years (46.7%) and 30-39 years (42.6%), with fewer respondents under 20 or over 40. In terms of education, most respondents had higher education (44%), especially in the Demonstration group, where the percentage reached 60%. This suggests that the majority of mothers in the study had a sufficient level of education, which may influence their ability to absorb and apply information from the interventions. The primary occupation of the respondents was housewife (56%), with an even distribution across all intervention groups.

Analysis of Differences in Knowledge, Attitudes, and Behaviors

To assess the effectiveness of each intervention method in changing maternal knowledge, attitudes, and behaviors related to complementary feeding, a mixed-method approach was employed. The quantitative results from the ANOVA and LSD tests showed significant differences between the groups, while qualitative data collected from interviews and focus group discussions (FGDs) provided additional insights into these changes.

Knowledge

The results of the quantitative analysis using the LSD test indicate that the Emo Demo method is significantly more effective in enhancing knowledge compared to the demonstration and lecture methods. The LSD value for the Emo Demo is 0.010, showing a significant difference from the control group, whereas the demonstration group exhibits no significant difference (LSD value=0.193). This suggests that the emotional approach utilized in Emo Demo effectively improves mothers' understanding of the importance of complementary breastfeeding. The emotional engagement involved enables participants to better absorb the information, fostering improved retention and application compared to traditional methods.

Qualitative data gathered from interviews and focus group discussions further supports these findings. Many mothers reported that the emotional narratives shared during the Emo Demo sessions made the information more relatable and memorable. One participant noted, *"The stories shared during the Emo Demo really stuck with me. I could relate to the characters and their experiences, making the information easier to remember and apply"*. This emotional connection not only enhanced understanding but also motivated mothers to implement appropriate complementary feeding practices, emphasizing that the knowledge gained is not only temporary but also leads to lasting behavioral change.

Attitude

The Emo Demo method demonstrated significant improvements in maternal attitudes toward MP-breastfeeding, with an LSD value of 0.028 compared to the control group. In contrast, the demonstration method showed less impactful results (LSD=0.086). This indicates that the Emo Demo not only enhances knowledge but also effectively shifts mothers' attitudes, which is crucial for fostering long-term behavioral changes. The qualitative data further underscores this finding, revealing that the emotional connections formed during the Emo Demo sessions were instrumental in shaping positive attitudes. Many mothers reported that the interactive and relatable nature of the sessions prompted them to reflect on and reconsider their previous feeding practices. One participant noted, *"Seeing the impact on children's health in the role-play made me realize how important it is to change my approach to feeding my child".* This emotional engagement not only facilitated a shift in attitudes but also strengthened the link between positive attitudes and desired behavioral outcomes. It confirms that the Emo Demo method had a more profound influence on attitude changes compared to traditional demonstration approaches.

Behavior

In the behavioral variable, the Emo Demo method demonstrated significant effectiveness with an LSD value of 0.010, indicating a notable difference from the control group. In contrast, the demonstration method showed no significant change (LSD value=0.776), highlighting that while the demonstration method may improve knowledge and attitudes, it is the emotional engagement fostered by Emo Demo that encourages real behavior change. Quantitative results reveal that mothers who participated in Emo Demo were more successful in implementing appropriate complementary breastfeeding practices compared to those who attended lectures or demonstrations.

Qualitative data further illuminate these findings, as numerous mothers in the Emo Demo group reported adopting new feeding practices inspired by the emotional and practical lessons they encountered during the intervention. One participant shared, *"After participating in Emo Demo, I felt more motivated to follow through with what I learned because the sessions made me feel responsible for my child's health. It wasn't just about learning but about feeling the need to act"*. This strong emotional connection, which was less pronounced in the lecture and demonstration groups, significantly facilitated genuine and lasting behavior changes, effectively reinforcing the quantitative outcomes of the study.

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This study confirms that the Emo Demo method is the most effective among the three intervention methods in improving maternal knowledge, attitudes, and behaviors related to complementary feeding. Emo Demo is a communication-based behavior change strategy that combines the theories of Behavior Communication Change (BCC) and Behavior Communication Definition (BCD)[38]. BCC emphasizes interactive communication between individuals, groups, or communities, aiming to develop strategies that promote positive behavior change. On the other hand, BCD focuses on using an individual's psychological constructs—such as feelings, needs, and thoughts—to influence behavior. The effectiveness of Emo Demo is evident in its ability to engage the emotional and psychological aspects of mothers, allowing them to respond more deeply to the information provided. This not only enhances the mothers' knowledge but also significantly impacts their attitudes and behaviors. In the context of complementary feeding, behavior change is the ultimate goal of the intervention, and Emo Demo has proven to be the most successful in achieving this outcome. The emotional approach used in Emo Demo enables mothers to better understand and feel the importance of correct complementary feeding practices. For example, when mothers receive information conveyed through an emotional approach, they tend to internalize it and apply it to their daily lives. This approach incorporates emotional elements, such as a sense of responsibility for the child's health, which reinforces their motivation to change behavior[39].

While this study provides compelling evidence regarding the effectiveness of the Emo Demo method, several limitations should be considered. First, the study was conducted with a relatively small sample size and was limited to a specific region, which may limit the generalizability of the results to a broader population. Additionally, demographic characteristics such as age, education, and occupation may have influenced the intervention's outcomes, although homogeneity tests suggest that the groups were balanced in these areas. Second, the study relied on self-report measurements to assess changes in knowledge, attitudes, and behaviors, which can be subject to bias. For example, mothers may provide answers that align with socially expected responses, particularly after engaging in emotionally driven interventions. To improve the accuracy of the data, more objective methods such as direct observation or third-party assessments could be used. Furthermore, the study did not assess the sustainability of the observed behavior changes after the intervention. Changes resulting from interventions like Emo Demo may not be long-lasting without continued support. Future research should involve long-term follow-up measurements to determine whether the changes are sustained over time.

Other study limitations including a small sample size, the potential for self-report bias, and the absence of measures to assess the sustainability of behavior change. Future research should incorporate long-term follow-up and employ more objective evaluation methods to validate the findings. Despite these limitations, the results provide strong evidence supporting the Emo Demo method as an effective intervention in educational programs aimed at improving complementary feeding practices among mothers.

CONCLUSIONS

The results of this study indicate that the Emo Demo method is more effective than the Lecture and Demonstration methods in enhancing mothers' knowledge, attitudes, and behaviors regarding complementary feeding. The LSD test results show significant differences in all three variables (knowledge, attitude, and behavior) for the Emo Demo group compared to the control group (LSD value=0.010). This suggests that the emotional approach utilized in Emo Demo is more effective in driving substantial changes across these areas compared to the other interventions. In contrast, the Demonstration and Lecture groups did not show significant improvements in most of the variables. By incorporating direct communication and psychological elements such as feelings and needs, Emo Demo effectively promotes positive behavior change. Therefore, Emo Demo is recommended as a more effective intervention in educational programs for mothers on complementary feeding.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

AI: Conceptualization, methodology, and writing—original draft; contributed to the design of the study and the development of the educational interventions. ISE: Supervision, formal analysis, and writing—review & editing; ensured the integrity of the research process and contributed to the critical revisions of the manuscript. IS: Data curation, investigation, and methodology; assisted in data collection and analysis, as well as the implementation of the Emo Demo method in the study. JC: Writing—original draft and data collection; participated in drafting the manuscript and gathering data from the study participants. KS: Resources and project administration; managed project logistics and provided necessary resources for conducting the research. LW: Writing—review & editing and visualization; contributed to the analysis of results and helped refine the presentation of data within the manuscript.

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Determinants Affecting Family Commitment and Capability in Preventing Stunting in Children Under Two Years

Determinan Faktor-Faktor yang Mempengaruhi Komitmen dan Kemampuan Keluarga dalam Mencegah Stunting pada Baduta

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ABSTRACT

Background: Stunting remains a public health issue in Indonesia. Despite a decline in national prevalence, East Java recorded a stunting prevalence of 32.7%, exceeding national standards and those set by the World Health Organization (WHO).
Objectives: This study aimed to identify the factors influencing family commitment and capability in preventing stunting in children under two years old.
Methods: The study employed an observational survey design involving 150 mothers of children aged 0–2 years in the *Puskesmas* (Community Health Center) areas of Surabaya. Data were collected using questionnaires to assess personal, interpersonal, cognitive-behavioral, resource, and fundamental family value variables. Analysis was conducted using Structural Equation Modeling (SEM) with Partial Least Square (PLS) methodology.
Results: Personal, interpersonal, and cognitive-behavioral factors significantly influenced family commitment to stunting prevention. Approximately 89.89% of a family's ability to monitor child growth and development could be predicted by the study model. However, resource factors and fundamental family values were not significant.
Conclusions: Interpersonal, cognitive-behavioral factors, and family assessment can increase family commitment in preventing stunting in children under two years. Assistance from health workers is essential to further strengthen family commitment to stunting prevention.

INTRODUCTION

Stunting is a condition characterized by growth failure in children due to insufficient nutrient absorption. It is reflected in the Height-for-Age indicator, where a z-score of less than -2 standard deviations (SD) from the median child growth standard indicates stunting[1–5]. According to the 2018 Basic Health Research report, the prevalence of stunting decreased from 37.2% in 2013 to 30.8% in 2018. In East Java, although the stunting prevalence was lower at 35.8% in 2013, it only declined to 32.7% in 2018. Despite this improvement, the proportion of stunting remains higher than national and WHO averages, exceeding the 20% threshold. As a result, East Java is one of 18 provinces with stunting rates above the national average, and Surabaya has been identified as a locus for stunting[6]. There are three main factors contributing to the incidence of stunting during the first 1,000 days of life: the high incidence of anemia in pregnant women, low rates of exclusive breastfeeding, and insufficient complementary feeding[7–10].

According to the 2018 Basic Health Research report, the prevalence of anemia in pregnant women in Indonesia reached 48.9%, a significant increase compared to the 2013 data[11]. Although the government implemented a program to provide 90 iron tablets during pregnancy and coverage reached 100%, adherence remains low, contributing to the high anemia rates[7]. Furthermore, exclusive breastfeeding coverage for infants aged 0-5 months, at 37.3%, is below the 2025 Global Nutrition Target, which aims for at least 50%, and even further from the 70% target for 2030[12].

Family support and commitment are essential for ensuring that pregnant women adhere to iron tablet consumption and exclusive breastfeeding[13]. However, the implementation of home visit assistance during the COVID-19 pandemic faced challenges due to movement restrictions, and some families were unwilling to meet health workers[14].

If these challenges persist, they may negatively impact the knowledge and behavior of pregnant and

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breastfeeding women, thus hindering stunting prevention efforts for children under two years old. To address this, an online approach has been proposed to reduce direct contact while continuing stunting prevention efforts[15]. In light of these challenges, especially during the COVID-19 pandemic, the authors are interested in studying the factors influencing family commitment and capability in stunting prevention for toddlers.

METHODS

This study was conducted in the working area of public health centers in Surabaya, Indonesia. The study employed a cross-sectional observational survey design to systematically collect factual information about the subject matter. It aimed to evaluate the influence of family commitment and cognitive behaviors in preventing stunting through exclusive breastfeeding and complementary breastfeeding. The sample consisted of 150 mothers with children under two years living in the Public Health Centers area in Surabaya. A multistage random sampling method was used to ensure a representative sample. The inclusion criteria included pregnant women who were willing to participate and breastfeeding mothers with children under two years. The study examined various factors such as personal factors (e.g., mother's education level and age), resource factors (e.g., access to healthcare services), interpersonal factors (e.g., support from health workers), cognitive behavioral factors (e.g., perception of the benefits of exclusive breastfeeding), family commitment, and family capability in preventing stunting.

The operational definitions and categories: Knowledge categories based on respondents' answer scores; good: grades 80-100, respondents showed a strong understanding and were able to apply knowledge well. Moderate: grades 60 -79 if respondents have an adequate understanding, but there are some shortcomings that need to be corrected. Poor: grades 0-59 if respondents showed a lack of understanding and difficulty in explaining or applying knowledge. For the motivation variable, good (80-100): the respondents showed strong and proactive enthusiasm, moderate (60-79): adequate, but inconsistent, and poor (0-59): the respondents lacked motivation and tended to be apathetic. The cognitive-behavioral factors were categorized as follows: perceived benefit was classified into three levels: very helpful (advanced, 80-100) for strong and proactive enthusiasm, beneficial (enough, 60-79) for adequate but inconsistent engagement, and less useful (not enough, 0-59) for a lack of motivation. Barriers to action were categorized as well (advanced, 80-100) for minimal obstacles, enough (60-79) for moderate barriers, and not enough (0-59) for significant difficulties in taking action. Self-efficacy was divided into very sure (advanced, 80-100) for high confidence, pretty sure (enough, 60-79) for moderate confidence, and not sure (not enough, 0-59) for a lack of confidence. Finally, the activity-related effect was categorized as positive (advanced, 80-100) for strong positive outcomes and negative (not enough, 0-59) for adverse effects or no improvement.

Cognitive and behavioral factors were assessed using specific categories and scoring ranges. Family connectedness was classified as good (80-100) for strong support, moderate (60-79) for adequate but inconsistent support, and poor (0-59) for minimal or absent support. Community resources were categorized as good (80-100) for sufficient resources, moderate (60-79) for some resources with limitations, and poor (0-59) for insufficient or lacking community support. Competing role demand was rated as good (80-100) for well-balanced roles, moderate (60-79) for moderate balance with occasional stress, and poor (0-59) for overwhelming demands that hinder performance

Data were collected through structured interviews using a questionnaire that assessed the characteristics of respondents and the variables under study. Each variable was analyzed in terms of its impact on stunting prevention efforts. For data analysis, descriptive analysis was performed to calculate the frequency distribution, mean, and standard deviation of each variable. Additionally, Structural Equation Modeling (SEM) with the Partial Least Square (PLS) method was used to test the relationships between variables and assess their influence on family commitment and capability in stunting prevention.

Model Validity and Reliability, Convergent validity testing shows that most indicators have a loading factor value above 0.7, indicating that the indicator is valid for measuring latent variables. The discriminatory validity test using the AVE (Average Variance Extracted) value confirmed that all variables had an AVE value of >0.5, indicating good validity. Reliability was tested using Composite Reliability (CR) and Cronbach's Alpha, with all variables having a CR value >0.7, indicating high reliability. Testing the inner model, relationship between variables: Personal Factors, family commitment: There was a significant influence with a path coefficient value of 0.45 (p-value<0.05). Interpersonal Factors, family commitment: Significant influence with a path coefficient value of 0.38 (p-value<0.05). Cognitive Behavioral Factors, family commitment: The most significant influence with a path coefficient value of 0.52 (p-value<0.01). Resource Factors, family commitment: Not significant (p-value>0.05). Fundamental values family commitment: not significant (p-value>0.05). The R^2 value for the family commitment variable is 0.89, indicating that 89% of the variability of family commitment can be explained by the model.

The measurement model and convergent validity test, it can be concluded that the above indicators are stated to be valid for measuring the latent variables, except for age and education. The conclusion from the convergent validity test results that the indicators used are valid in measuring the latent variables, is also strengthened by the results of the discriminant validity test and construct validity, where the results show that all valid indicators are proven to be able to explain latent variables in the model, except for the indicators of age and education are invalid in explaining the latent variable, namely the personal factor. Furthermore, indicators of age and education were issued. After the measurement model (outer model) testing is completed and valid indicators explaining latent variables are obtained and proven reliable, the next step is to test the structural model (inner model).

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In the structural model analysis, we tested the effect of exogenous variables on endogenous variables. The results showed that most of the exogenous variables with respect to other exogenous and endogenous variables showed a t-count value above 1.96 with a positive value, which indicated that these variables had an effect and increased except for resources that had no effect on basic values and basic values had no effect on the respondent commitment to exclusive breastfeeding and complementary breastfeeding in preventing stunting in toddlers. This research obtained ethical feasibility from the Ethics Commission of the Surabaya Ministry of Health Polytechnic No.EA/2209.1/KEPK-Poltekkes_Sby/IV/2021 dated April 2, 2021.

RESULTS AND DISCUSSIONS

Respondent Characteristics

Most of the mothers are still breastfeeding (76.7%), with the majority being housewives (63.3%). Among them, 24.6% have three children, while more than half (55.4%) have two children who are under two years old. Prior to the pandemic, most of them 110 (73.3%), regularly visited the integrated health service post, a community-based health service program in Indonesia that focuses on maternal and child health. These posts provide various health services, including immunization, nutrition counseling, and health education. In this study, integrated health service post will be used to refer to these essential health service points. As shown in Table 1.

Table 1. Distribution of respondent characteristics at Public Health Centers in Surabaya for mothers with children under two years 2021

Parameter	Category	Frequency	
		n	%
Age In Years	<20	3	2.0
	20-35	114	76.0
	>35	33	22.0
Mother Status	Pregnant	35	23.3
	Breastfeeding	115	76.7
Occupation	Housewife	95	63.3
	Self-employed	21	14.0
	Factory employees	31	20.7
	civil servants	3	2.0
Number of Children	1	48	36.9
	2	50	38.5
	≥3	52	34.6
Number of Children < 2 years	0	52	34.7
	1	26	17.3
	2	72	48.0
Integrated Health Service Post	Never	2	1.3
	Rarely	10	6.7
	Occasionally	28	18.7
	Always frequently	110	73.3
Total		150	100

Table 2. Distribution of personal factors, cognitive behavior, resources. interpersonal/health workers, fundamental values and family assessment

Factor	Category	Frequency		Mean	SD
		n	%		
Personal	Education			3.34	1.02
	Higher Education	13	8.7		
	Senior High School	63	42.0		
	Junior High School	46	30.7		
	Elementary School	18	12.0		
	No Schooling	10	6.6		
	Knowledge			60.31	4.10
	Good	103	68.7		
	Moderate	41	27.3		
	Poor	6	4.0		
	Motivation			14.02	2.44
	High	38	25.3		
	Moderate	85	56.7		
	Low	27	18.0		

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Factor	Category	Frequency		Mean	SD
		n	%		
Cognitive Behavior	Perceived				
	Very Helpful	106	70.7	34.17	7.30
	Beneficial	25	16.7		
	Less Beneficial	19	12.6		
	Barriers to Action				
	Well	67	44.7	17.47	6.69
	Moderate	83	55.3		
	Self-Efficacy				
	Very Confident	94	62.7	33.65	6.0
	Confident	50	33.3		
	Not Confident	6	4.0		
	Activity-Related Effect				
	Positive	101	67.3	8.93	1.01
	Negative	49	32.7		
Resource Factors	Family Connectedness				
	Good	115	76.7	35.18	5.12
	Moderate	34	22.7		
	Poor	1	0.6		
	Community Resources				
	Good	119	79.3	29.09	3.53
	Moderate	31	20.7		
	Poor	0	0		
	Competing Role Demands				
	Good	115	76.7	18.29	2.40
	Moderate	35	23.3		
	Poor	-	-		
Interpersonal/Health Workers	Enabling				
	Good	70	46.7	8.82	3.24
	Moderate	19	12.6		
	Poor	61	40.7		
	Empowering				
	Good	111	74.0	10.97	1.77
	Moderate	31	20.7		
	Poor	8	5.3		
	Supporting				
	Good	70	46.7	9.06	2.82
	Moderate	32	21.3		
	Poor	48	32.0		
Fundamental Values	Responsibility				
	Positive	126	84.0	7.68	0.74
	Negative	24	16.0		
	Respect				
	Positive	125	83.3	7.56	1.06
	Negative	25	16.7		
	Caring				
	Positive	124	82.7	7.56	0.84
	Negative	26	17.3		
Family Appraisal	Challenge				
	Positive	108	62.3	10.63	1.70
	Negative	42	37.7		
	Stressor				
	Positive	135	90.0	4.87	2.20
	Negative	15	10.0		

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Table 3. Distribution of family commitment in stunting prevention in children under two years

Factor	Category	Frequency		Mean	SD
		n	%		
Family Commitment	Responsibility				
	High	94	62.7	17.32	2.99
	Sufficient	51	34.0		
	Insufficient	5	3.3		
	Independence				
	High	91	60.7	14.01	2.17
	Sufficient	58	38.7		
	Insufficient	1	0.6		
	Goals				
	High	108	72.0	17.72	2.75
	Sufficient	37	24.7		
	Insufficient	5	3.3		
	Self-improvement				
	High	121	80.7	18.25	2.15
	Sufficient	29	19.3		
	Insufficient	0	0		
	Desire to Succeed				
	High	117	78.0	18.06	2.46
	Sufficient	31	20.7		
	Insufficient	2	1.3		

Table 4. Distribution of frequency of family ability in stunting prevention in children under two

Factor	Category	Frequency		Mean	SD
		n	%		
Family Capability	Growth Disorders				
	Good	102	68.0	17.12	3.13
	Sufficient	39	26.0		
	Insufficient	9	6.0		
	Child Development Deviation				
	Good	33	22.0	11.27	4.51
	Sufficient	37	24.7		
	Insufficient	80	53.3		

Focus Group Discussion (FGD) was conducted after the researchers had collected and analyzed data. The targets of the FGD were seven health workers, including nutritionists, midwives, nutrition managers, the Surabaya City Health Office, and researchers who were involved in research activities to assist pregnant women and breastfeeding mothers in exclusive breastfeeding and complementary feeding for the prevention of stunting in toddlers.

Based on the results of the Focus Group Discussion (FGD) and from the strategic issues found, it is necessary to strengthen family capacity in the practice of exclusive breastfeeding and complementary breastfeeding to prevent stunting in toddlers. This effort needs to be made so that families have good abilities and overall continuity of activities in accordance with the duties and functions of families who have toddlers.

Personal factors, family commitment (0.45): Personal factors, including education, knowledge, and motivation, significantly influence family commitment. Higher education and a good level of knowledge enable mothers to better understand the importance of stunting prevention. Interpersonal Factors, Family Commitment (0.38): Interpersonal support from health workers plays an important role in enhancing family commitment. Health workers who are effective in providing assistance and education strengthen the family's ability to act. Cognitive behavioral factors, Family commitment (0.52): This factor is the main predictor in the model, suggesting that perception of benefits, self-efficacy, and barriers play a major role in driving family commitment. Interventions that increase maternal self-efficacy can be more effective in encouraging exclusive breastfeeding and complementary breastfeeding. Resource Factors, family commitment (0.05, insignificant): Community resources and family connectedness have a limited contribution to family commitment. This may be due to limited resources or a lack of utilization of existing facilities. Fundamental values, family commitment (0.03, insignificant): Fundamental values, such as responsibility and care, showed an insignificant influence in the context of this study. However, these values remain relevant for strengthening community-based programs.

This study aimed to understand the factors that affect family commitment and their ability to prevent stunting in bald children. Through the analysis of the characteristics of the respondents presented in Table 1, it could be seen that the majority of respondents were in

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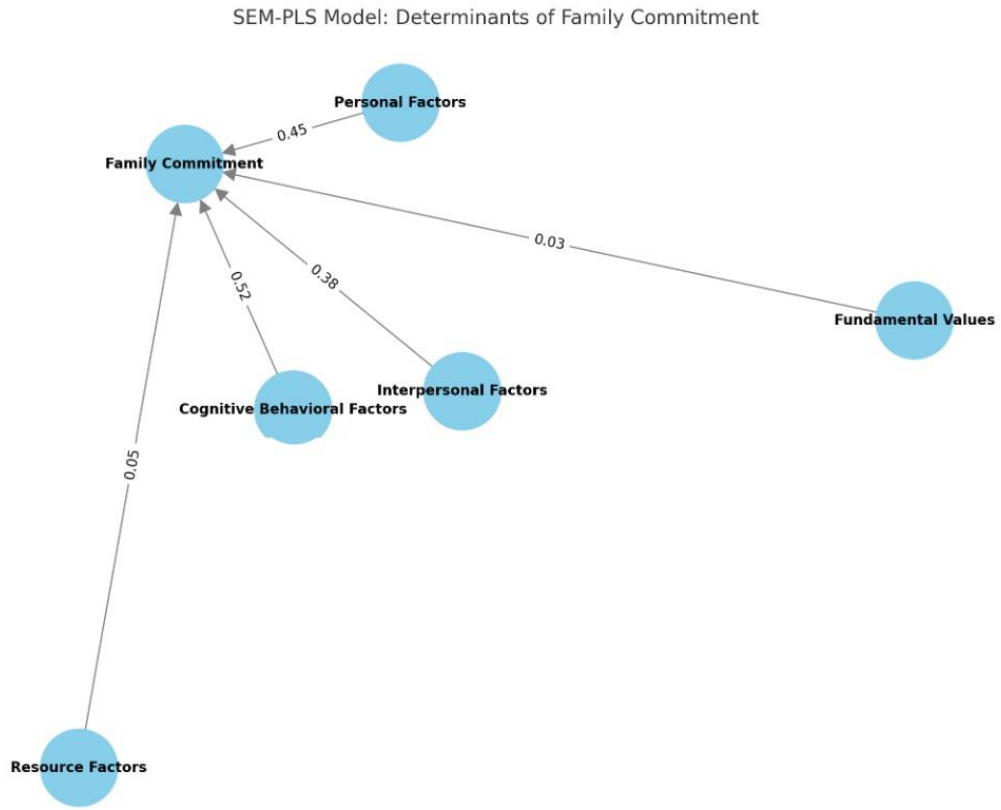
the age range of 20 to 35 years or about 76% of the total 150 people. This age was the ideal reproductive age for caring for children therefore respondents were expected to have adequate knowledge and readiness in parenting. The status of mothers was dominated by breastfeeding mothers (76.7%), indicating that the focus of this study were mothers who already had children and were breastfeeding. This was important considering that exclusive breastfeeding played a crucial role in preventing stunting. In addition, the majority of respondents were housewives (63.3%), suggesting that many of them focused on childcare allowing them to be more involved in promoting good health practices.



Images 1. SEM-PLS model: determinants of family commitment

In terms of the number of children, almost one-third of respondents had two children while 34.6% of the respondents had three or more children. This highlights family dynamics that can affect commitment and ability to care for children, especially in the context of stunting prevention. Respondents who had two children under two years old also demonstrated the importance of paying more attention to stunting prevention considering that they had to manage two children in a crucial growth stage. The high rate of visits to integrated health service post (73.3%) showed the active participation of mothers in accessing health services. These regular visits can have a positive impact on mothers' understanding and practices in stunting prevention, which is expected to increase knowledge and awareness about the importance of exclusive breastfeeding and complementary breastfeeding. In terms of education, the majority of respondents were at the high school education level (42.0%) showed that although many mothers had sufficient educational backgrounds, their knowledge about children's health still needs improvement. Respondents who had good knowledge (68.7%) showed awareness about health issues but the motivation to implement this knowledge was low, with only 25.3% having high motivation. This indicates the need for interventions to increase maternal motivation in carrying out health practices considering that motivation is the main determinant in health decision-making.

The cognitive behavior of the respondents also showed interesting results. Although 70.7% of the respondents felt that the support they received was very helpful. As many as 55.3% of them also experienced obstacles in acting. This suggests that despite the existence of social support, there are still obstacles that can hinder the implementation of optimal health practices. High independence (62.7%) indicates that mothers feel confident in making decisions but further efforts are needed to improve better decision-making skills. The results of the study also show that resource factors, including family connectivity and community resources play an important role in supporting mothers in parenting with 76.7% of respondents considering family connectivity to be good and 79.3% stating that community resources are in the good category, this shows significant social support. However, challenges remain in the face of competing role demands where although 76.7% of respondents feel capable of managing roles in the family, the dual responsibilities faced by

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mothers remain a challenge that needs to be overcome. Interaction with health workers is also crucial in supporting mothers. Although 74.0% of respondents felt that health workers had successfully activated their participation, only 46.7% of the respondents felt that health workers were adequately empowering them. This shows that the quality of support from health workers needs to be improved to be more effective in empowering mothers in the health practices needed to prevent stunting.

The aspect of fundamental values is also an important part of this research. The majority of respondents showed a positive attitude towards responsibility, respect, and care. With 84.0% of respondents stating responsibility in exclusive breastfeeding and complementary breastfeeding, mothers showed a high awareness of the importance of their role in children's health. Respect (83.3%) and care (82.7%) also show that these values are crucial in shaping mothers' behaviors and attitudes.

The family's assessment of challenges and stressors showed that 62.3% of respondents perceived challenges as positive, while 90.0% rated stressors as positive. This indicates that families are able to adapt and take advantage of challenges to support exclusive breastfeeding and complementary breastfeeding, although 37.7% of the respondents perceived the challenges as negative. This reflects the complex dynamics within the family that need to be understood more deeply to develop more effective interventions. 94% of women who received extensive support, namely from various supporters including partners, maternal grandmothers, friends and health workers but only mothers who were expected to breastfeed at 2 months. Conversely, mothers with poor knowledge were less likely to start breastfeeding within an hour after birth[16]. In this study, the development of a model for assisting pregnant and breastfeeding mothers was employed in exclusive breastfeeding and complementary breastfeeding to prevent stunting in toddlers. Through this model, it is hoped that the growth and development of children will proceed normally, with an emphasis on enhancing the fundamental values (basic values) of the family, including increasing the family's ability to take responsibility, show respect, and care. This also includes promoting the use of the MCH handbook for early detection of irregularities in child growth and development[17].

The role of the family in the early detection of child growth and development still relies on the services provided through integrated health service post activities carried out by cadres and health workers, ensuring that parents' involvement in mentoring activities is optimal[18]. In principle, the assistance model for pregnant women and breastfeeding mothers in exclusive breastfeeding and complementary breastfeeding for stunting prevention in toddlers aims to increase the ability of families to participate in preventive activities, ensuring that children's growth and development improve[19]. This is supported by research conducted by Januarti et al. who state that the role of parenting culture significantly influences the prevention of stunting in toddler with the result of p-value 0.019 <α 0.05[20]. This shows that the role of parenting culture can enhance the prevention of stunting in toddlers[21]. Development in the family sector, especially for mothers who are always close to their children, is important for improving their ability to produce family values such as responsibility, attention, and care[22]. Increasing family filial bonds can increase positive family appraisals and, eventually, boost family commitment and the ability to detect early deviations in child growth and development[23]. These efforts can be expanded through secondary targets, such as parents-in-law or husbands, who can provide a positive and valued role[24].

This study demonstrates that although family commitment to stunting prevention is relatively high, there are challenges that need to be overcome, particularly in terms of motivation and reducing barriers to action. Maternal education, knowledge, support from health workers, and fundamental values play a significant role in contributing to family commitment to stunting prevention. Further efforts are required to improve family understanding and skills in addressing growth disorders and developmental deviations. A key recommendation for relevant parties, such as the health office and educational institutions, is to design intervention programs that can boost maternal motivation and knowledge, as well as reinforce existing social support in the community.

The article provides a comprehensive overview of the factors influencing family commitment in preventing stunting in children under two years old. It emphasizes the importance of maternal education, knowledge, and motivation in shaping family behavior, with many respondents having completed high school and possessing good knowledge, though motivation remained notably low. The study also underscores the role of cognitive behavior, including self-efficacy and perceived benefits, in driving commitment, with findings indicating that self-efficacy is a significant predictor. Interpersonal support from health workers is crucial, though some barriers hinder the effective implementation of optimal health practices. Family and community resources, such as family connectivity and access to healthcare, are generally positive, yet the challenge of managing dual responsibilities, particularly for mothers, persists. Furthermore, the quality of support from health workers, while generally good, requires improvement to better empower mothers. Overall, the study underscores the need for targeted interventions to enhance motivation and self-efficacy among mothers, as well as to improve health worker empowerment, in order to strengthen family commitment in stunting prevention efforts. The research highlights the importance of an integrated approach involving education, support, and resources in promoting optimal health practices for child development.

CONCLUSIONS

Personal, interpersonal, and cognitive-behavioral factors significantly influenced family commitment to stunting prevention. Approximately 89.89% of the family's ability to monitor child growth and development could be predicted by the study model. However, resource factors and fundamental family

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values were not significant. Interpersonal factors, cognitive-behavioral factors, and family appraisals can enhance family commitment to exclusive breastfeeding and complementary feeding practices. Assistance from health workers is essential to reinforce family commitment to stunting prevention.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

TR: conceptualization. investigation. methodology. supervision. writing–review and editing. NH: data curation. formal analysis. writing–original draft. writing–review and editing. AI: resources. project administration. validation. visualization.

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RESEARCH STUDY
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Development of High Dietary Fiber Cereal Bar as Emergency Food Product and The Chemical-Microbiological Properties and Nutritional Content

Pengembangan Sereal Bar Makanan Tinggi Serat sebagai Produk Makanan Darurat dan Sifat Kimia-Mikrobiologi serta Kandungan Gizi

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ABSTRACT

Background: Dietary fiber is essential for maintaining digestive health, especially during emergencies with limited food availability.
Objectives: To analyze the chemical, microbiological, and nutritional properties of high-fiber cereal bars designed as emergency food.
Methods: This study used an experimental design. The cereal bars were made from rice crisps and oats and tested based on chemical and microbiological parameters. Chemical analysis included dietary fiber, carbohydrates, protein, fat, minerals, and vitamins while the microbiological analysis covered total plate count (TPC) and detection of pathogenic bacteria such as Escherichia coli, Salmonella, and Staphylococcus aureus in accordance with food safety standards from the Indonesian Food and Drug Authority (BPOM). The testing was conducted from November 3–15, 2023, at PT Saraswanti Indo Genetech laboratory, Indonesia.
Results: The test showed that the mixed berry cereal bar contained 9.43% dietary fiber, exceeding BPOM standards. The product was free from heavy metal contamination (arsenic, cadmium, mercury, lead, and tin) and showed no trans fats. Microbiological tests confirmed that the product was safe from pathogenic microbes, with total plate count (TPC) and *Enterobacteriaceae* within safe limits. The product also did not contain *Salmonella* or *Staphylococcus aureus*.
Conclusions: This high-fiber cereal bar meets strict food safety and nutritional standards, making it suitable for development as emergency food. Its high fiber content and lack of harmful contaminants make it safe and nutritious for disaster victims. Continued testing and development with diverse flavors and formulations are recommended to improve acceptance across age groups in emergency situations.

INTRODUCTION

Dietary fiber is essential for maintaining digestive health[1,2], especially in emergencies where food variety is limited, as it helps prevent gastrointestinal issues. High-fiber foods provide a steady energy release, crucial for managing physical and emotional stress of disasters[3]. They also promote satiety and help control hunger during food scarcity. Additionally, fiber stabilizes blood sugar levels[4], reducing the risk of spikes and crashes. Adequate fiber intake lowers the risk of chronic diseases[5–7], supporting overall health and resilience during recovery. The urgency of this study stems from the increasing frequency of natural disasters, particularly in disaster-prone regions such as Indonesia, which disrupt food supply systems and lead to nutritional instability. Dietary fiber is crucial for maintaining digestive health and preventing gastrointestinal issues during emergencies. High-fiber foods provide steady energy, promote satiety, and help manage physical and emotional stress of affected populations. Developing Emergency Food Products (EFP) that meet these nutritional needs is vital for supporting disaster victims during recovery.

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The seriousness of the situation is highlighted by the heightened risk of malnutrition and chronic diseases among those affected by disasters. Insufficient dietary fiber can exacerbate health complications, making the development of high-fiber cereal bars essential. This study aims to innovate EFPs that are nutritionally adequate and culturally acceptable for diverse age groups. Using local Indonesian ingredients, the research supports local economies while promoting food security. The findings will enhance the effectiveness of food aid distribution and ensure that the nutritional needs of disaster victims are met, contributing to immediate relief and long-term recovery. Disasters cause disruption of food supply systems and put people at risk of food scarcity and nutrition instability[8]. The development of emergency food products (EFP) is important in disaster mitigation[9–11], especially in Indonesia which is vulnerable to various types of natural disasters[12–14]. The developed emergency food must not only meet the nutritional needs of disaster victims but also be well received by consumers of various age groups[15–17]. One of the products that has the potential to be developed as an emergency food is high-fiber cereal bars[18], which in addition to being practical and easy to store, also has good nutritional content. This product is expected to help meet the nutritional needs of disaster victims who experience limited access to fresh food during the recovery period.

However, to ensure that this emergency food product is feasible and widely acceptable, it is necessary to conduct an in-depth evaluation of the two variants of high-fiber cereal bars to be developed. This evaluation includes an analysis of the chemical, microbiological, and nutritional content of the product compared to the standards and regulations applicable in Indonesia[19,20]. Therefore, it is crucial to ensure that these products meet safety and nutritional standards and have a high acceptance rate among disaster victims.

By developing more preferred and diverse emergency food products, the government can increase the effectiveness of food aid distribution and ensure that the nutritional needs of disaster victims are properly met. The cereal bars analyzed are products that use local Indonesian ingredients. In order for this product to be accepted abroad, oats from abroad were added. High-fiber cereal bars can be one of the right solutions in meeting the needs of emergency food that is nutritious, safe, and accepted by all age groups in the midst of emergency situations. The purpose of this study is to analyze the chemical, microbiological, and nutritional properties of two variants of emergency food products (EFP) of high-fiber bar cereals.

METHODS

The test was carried out at Saraswanti Indo Genetech. Testing was conducted from November 3–15, 2023. The samples used in this study were cereal bars developed as emergency food products, with the main ingredients being rice crispy, oats, vegetable oil, sugar, and maltodextrin. Chemical analysis was carried out to determine the composition of chemical substances contained in cereal bar products, such as the content of dietary fiber, carbohydrates, proteins, fats, as well as the content of minerals and vitamins. Techniques that can be used in this test include a proximate test to analyze macronutrient composition (fat, protein, carbohydrates), as well as fiber measurement with special methods such as the gravimetric method for dietary fiber content[21–23].

The high-fiber cereal bars were made from the following ingredients: rice crispy, oats, plant-based fats, sugar, and maltodextrin. The production process consisted of several phases, namely mixing the ingredients in a specific proportion to form a consistent dough, shaping the dough into bars, drying the bars to reduce its moisture and enhance its shelf stability, and packaging the cereal bars under specific conditions to maintain their quality.

The exact proportions of each ingredient are proprietary, but they are designed to maximize dietary fiber content while ensuring taste and texture. A number of samples were analyzed, and two variants of high-fiber cereal bars were analyzed. Variable/parameters measured included chemical compositions, consisting of: dietary fiber, carbohydrates, proteins, fats, vitamins, and minerals, and microbiological contamination consisted of total plate count, *Enterobacteriaceae*, pathogenic bacteria (salmonella, staphylococcus aureus). Moisture content analysis was conducted to assess shelf-life stability. Chemical analysis was conducted through a proximate analysis to determine macronutrient composition (fat, protein, carbohydrates). Fiber measurement was conducted using the gravimetric method. Heavy metal testing was conducted using Inductively Coupled Plasma Mass Spectrometry (ICP MS) for arsenic, cadmium, mercury, lead, and tin.

Microbiological testing; total plate count was measured using Standar Nasional Indonesia - International Organization for Standardization (SNI ISO) 4833-1:2015, *Enterobacteriaceae* testing used SNI ISO 21528-2:2017, pathogen detection: Salmonella: ISO 6579-1:2017/Amd 1:2020, Staphylococcus aureus: ISO 6888-1:1999/Amd 2:2018, Standards used chemical analysis: SNI 01-2894-1992 for sulfite content. Methods for cholesterol and trans fatty acids were conducted through Gas Chromatography - Flame Ionization Detector (GC-FID). Microbiological Standards: SNI ISO 4833-1:2015 for total plate count, SNI ISO 21528-2:2017 for *Enterobacteriaceae* , ISO 6579-1:2017 for Salmonella. ISO 6888-1:1999 for Staphylococcus aureus.

The analysis of high-fiber cereal bars was conducted using methods established by the Association of Official Analytical Chemists (AOAC). The dietary fiber content was determined using AOAC Method 985.29, which involves enzymatic-gravimetric analysis to quantify total dietary fiber after hydrolyzing starches. Proximate analysis for macronutrients—protein, fat, and carbohydrates—was performed using AOAC Methods 979.09, 920.39, and 930.09, respectively. Microbiological safety was assessed through total plate count using AOAC Method 966.23, along with specific methods for detecting pathogens such as Escherichia coli, Salmonella, and Staphylococcus aureus.

To ensure the validity and reliability of the results, the study strictly followed these standardized AOAC methods, minimizing variations and enhancing comparability. All analytical instruments were regularly

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calibrated, and control samples were analyzed alongside test samples to verify results. Each analysis was performed in replicates to ensure reproducibility, and research personnels were trained in the specific methods to ensure proper execution. Additionally, a quality assurance program was established to monitor compliance with standards, ensuring that the results obtained were valid and reliable, thus providing a strong basis for the conclusions drawn about the high-fiber cereal bars. This process has been approved by the Health Research Ethics Commission of the Ministry of Health of Palu (Number: 0015.1/KEPK-KPK/1/2023), with an ethical exception granted by the commission for this study.

RESULTS AND DISCUSSIONS

Refugees often face significant challenges in obtaining nutritious food that meets their dietary needs. In emergency situations, where access to food sources is limited, and living conditions are unstable, it is crucial for them to receive a balanced nutritional intake. The need for food rich in fiber, proteins, and vitamins becomes essential for maintaining health and resilience, as well as helping them adapt to high-stress levels. This is where high-fiber cereal bars can serve as an effective solution. These products are specifically designed to meet the nutritional needs of refugees, with a balanced composition and significant health benefits.

High-fiber cereal bars contain a substantial amount of fiber, reaching about 9.43%, which can help prevent common digestive issues among refugees, such as constipation. Fiber also plays a role in providing longer-lasting satiety, thus reducing feelings of hunger amid food scarcity. Additionally, these products contain proteins and carbohydrates that are necessary for energy, which is vital for refugees who need to engage in daily activities under challenging conditions. Another advantage of cereal bars is their long shelf-life, allowing them to be stored without refrigeration. This makes them an ideal choice for emergency situations where food stability is essential.

Compared to other food products, such as instant meals and canned foods, high-fiber cereal bars offer a healthier alternative. Instant meals often contain high levels of salt and preservatives that can negatively impact long-term health. Meanwhile, canned foods are typically low in fiber and nutrients, which may not sufficiently meet the dietary needs of refugees. Thus, these cereal bars not only provide longer-lasting satiety but also offer better nutritional values.

The benefits of high-fiber cereal bars for the refugee population are significant. These products support digestive health, increase the energy needed for daily activities, and provide greater comfort and satisfaction over time. In crisis situations, where stress and uncertainty are high, receiving nutritious and satisfying food can have a positive impact on the mental and physical health of refugees. With practical and lightweight packaging, these cereal bars can be easily distributed to refugee camps, reaching more people in need.

From a production cost perspective, raw materials such as rice and oats are relatively affordable, and large-scale production can lower the cost per unit. By enhancing efficiency in the production and distribution processes, total costs can be minimized, making these products accessible to a larger number of refugees. Effective distribution programs, including collaborations with humanitarian aid organizations, can ensure that these cereal bars reach those who need them most.

Overall, high-fiber cereal bars represent a highly relevant and practical solution for refugees. By providing the necessary nutritional intake, while considering practical and cost aspects, these products not only help meet food needs during emergencies but also contribute to the long-term recovery of health and well-being for this vulnerable population.

Table 1. Chemical test results and nutritional content of cereal bars

No.	Parameter	Unit	Result	Limit Of Detection	Method
1	Sulfite	mg/kg	Not detected	1.6	SNI 01-2894-1992. Point 2.6.3
2	Dietary Fiber	%	9.43	-	18-8-6-2/MU/SMM-SIG
3	Cholesterol	mg/100 g	23.65	-	18-6-5/MU/SMM-SIG (GC-FID)
4	Trans Fatty Acids	%	Not detected	0.0015	18-6-1/MU/SMM-SIG (GC-FID)
5	Arsenic (As)	mg/kg	Not detected	0.0003	18-13-14/MU/SMM-SIG (ICP MS)
6	Kadmium (Cd)	mg/kg	Not detected	0.0005	18-13-14/MU/SMM-SIG (ICP MS)
7	Mercury (Hg)	mg/kg	Not detected	0.001	18-13-14/MU/SMM-SIG (ICP MS)
8	Lead (Pb)	mg/kg	Not detected	0.0004	18-13-14/MU/SMM-SIG (ICP MS)
9	Tin (Sn)	mg/kg	Not detected	0.0025	18-13-14/MU/SMM-SIG (ICP MS)
10	Carbohydrates (By Difference)	%	73.89	-	18-8-9/MU/SMM-SIG (Count)
11	Total Fat	%	12.53	-	18-8-5/MU/SMM-SIG point 3.2.2 (Weibull)
12	Protein	%	4.92	-	18-8-31/MU/SMM-SIG (Titrimetric)
13	Saturated Fat	%	9.71	-	18-6-1/MU/SMM-SIG (GC-FID)
14	Natrium (Na)	mg/100 g	61.28	-	18-13-1/MU/SMM-SIG (ICP OES)
15	Total Energy	Kcal/100g	428.01	-	Calculation

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No.	Parameter	Unit	Result	Limit Of Detection	Method
16	Energy from Fat	Kcal/100g	112.77	-	Calculation
17	Total Sugar	%	25.1	-	18-8-8/MU/SMM-SIG (Luff Schoorl)
18	Total Ash	%	0.67	-	SNI 01-2891-1992 point 6.1
19	Moisture Content	%	7.99	-	SNI 01-2891 - 1992, point 5.1

SNI = Standar Nasional Indonesia (Indonesian National Standard)
SIG = Saraswanti Indo Genetech
GC-FID = Gas Chromatography-Flame Ionization Detector
ICP MS = MS: Inductively Coupled Plasma Mass Spectrometry
ICP OES = Inductively Coupled Plasma Optical Emission Spectroscopy

Tabel 2. Microbiology test results of cereal bars

No.	Parameter	n	c	Result	m	M	Unit	Method
1	Total plate count	1	2	$1.0x10^1$	10^3	10^4	colony/g	SNI ISO 4833-1: 2015
2	Total plate count	2	2	<10	10^3	10^4	colony/g	SNI ISO 4833-1: 2015
3	Total plate count	3	2	<10	10^3	10^4	colony/g	SNI ISO 4833-1: 2015
4	Total plate count	4	2	$1.0x10^1$	10^3	10^4	colony/g	SNI ISO 4833-1: 2015
5	Total plate count	5	2	$4.0x10^1$	10^3	10^4	colony/g	SNI ISO 4833-1: 2015
6	*Enterobacteriaceae*	1	2	<10	10	10^2	colony/g	SNI ISO 21528-2:2017
7	*Enterobacteriaceae*	2	2	<10	10	10^2	colony/g	SNI ISO 21528-2:2017
8	*Enterobacteriaceae*	3	2	<10	10	10^2	colony/g	SNI ISO 21528-2:2017
9	*Enterobacteriaceae*	4	2	<10	10	10^2	colony/g	SNI ISO 21528-2:2017
10	*Enterobacteriaceae*	5	2	<10	10	10^2	colony/g	SNI ISO 21528-2:2017
11	Salmonella sp.	1	0	Negative	Negative	NA	/ 25 g	ISO 6579-1:2017/Amd 1:2020
12	Salmonella sp.	2	0	Negative	Negative	NA	/ 25 g	ISO 6579-1:2017/Amd 1:2020
13	Salmonella sp.	3	0	Negative	Negative	NA	/ 25 g	ISO 6579-1:2017/Amd 1:2020
14	Salmonella sp.	4	0	Negative	Negative	NA	/ 25 g	ISO 6579-1:2017/Amd 1:2020
15	Salmonella sp.	5	0	Negative	Negative	NA	/25 g	ISO 6579-1:2017/Amd 1:2020
16	Staphylococcus aureus	1	1	<10	10^2	$2x10^2$	colony/g	ISO 6888-1:1999/Amd 2: 2018
17	Staphylococcus aureus	2	1	<10	10^2	$2x10^2$	colony/g	ISO 6888-1:1999/Amd 2: 2018
18	Staphylococcus aureus	3	1	<10	10^2	$2x10^2$	colony/g	ISO 6888-1:1999/Amd 2: 2018
19	Staphylococcus aureus	4	1	<10	10^2	$2x10^2$	colony/g	ISO 6888-1:1999/Amd 2: 2018
20	Staphylococcus aureus	5	1	<10	10^2	$2x10^2$	colony/g	ISO 6888-1:1999/Amd 2: 2018

n = Number of Samples
c = Number of Positive Samples
m = Lower Limit of Acceptable Value
M = Upper Limit of Acceptable Value
SNI ISO = Standar Nasional Indonesia - International Organization for Standardization
NA = Not Applicable

Emergency Food Products (EFP) have an important role in disaster management, especially in Indonesia, which is prone to natural disasters. One form of innovation in the development of emergency food is high-fiber cereal bars with mixed berry flavor. This product is designed to meet the nutritional needs of

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disaster victims, while maintaining strict taste quality and food safety. In this study, cereal bars made mainly from rice and oat crisps were developed, with measurements of chemical and microbiological properties that showed promising results. Content Dietary fiber is an important component in food products, especially for emergency food, because it is able to support digestive health during the recovery period[24,25]. In this study, mixed berry flavored cereal bars had a dietary fiber content of 9.43 grams per 100 grams of product. This content is much higher than the standard set by the Indonesian Food and Drug Supervisory Agency (BPOM), which is 6 grams per 100 grams in solid form. This advantage shows that this product is not only qualified as an emergency food, but can also provide significant health benefits, especially in maintaining the intestinal health of disaster victims who may experience stress or limited access to healthy food.

The safety of emergency food products is a top priority during development, particularly in relation to the presence of harmful contaminants such as heavy metals and other chemical substances. According to laboratory test results, this mixed berry-flavored cereal bar shows no detection of sulfites, which are commonly used as preservatives but can cause side effects in sensitive individuals. Additionally, the cholesterol content in this product is 23.65 mg per 100 grams, which remains within the safe limit for daily consumption and complies with the standards for emergency food products. The product is also free from trans fatty acids, which were not detected in measurements. Since trans fatty acids are known to increase the risk of heart disease, their absence further enhances the health value of the product.

One of the important aspects in the safety evaluation of food products is the presence of heavy metal contamination, such as arsenic, cadmium, mercury, and lead[26–29]. The test results showed that the five types of heavy metals were not detected in mixed berry-flavored cereal bars. The absence of heavy metals in this product confirms that this cereal bar is safe to consume in emergency situations, where food safety is very crucial. The absence of heavy metals such as arsenic and mercury is very important because these substances are known to be harmful even in small amounts. This finding ensures that the product can be widely distributed to disaster victims without the risk of significant health hazards. This is in accordance with the food safety regulations set by BPOM Indonesia, which sets strict thresholds for these contaminants in food.

This cereal bar product uses rice crisps and oats as the main ingredients. These two ingredients were chosen because they have a high fiber content and a texture that is easy to consume in various conditions, including emergency situations. Oats are known to be rich in soluble fiber, which can help lower cholesterol levels[30–32] and control blood sugar levels[33–35]. Rice crisps, on the other hand, provide a crunchy texture that is preferred by a wide range of ages, including children and adults. The use of these healthy and easy-to-obtain ingredients increases the potential of cereal bar products to be an effective emergency food choice. In addition, since this product does not require special preparations, such as heating or further processing, it can be directly consumed in emergency situations, making it practical and efficient.

Carbohydrates are a very important main source of energy, especially in emergency situations when energy needs increase. This mixed berry cereal bars with carbohydrate content of 73.89% is sufficient to support the energy needs of disaster victims. This high carbohydrate content helps maintain the body's stamina and energy in emergency situations where access to food may be limited. In addition, the use of ingredients such as rice crisps and oats also provides complex carbohydrates, which are more slowly digested by the body, thus providing long-lasting energy. Regarding fat and saturated fat levels, the total fat content in this cereal bar was recorded at 12.53%, with saturated fat reaching 9.71%. Although the saturated fat content is quite high, this product is still within safe limits for emergency consumption. Fats are necessary to provide high energy, especially in conditions where calorie requirements are increased. In addition, fat also plays a role in the absorption of fat-soluble vitamins such as vitamins A, D, E, and K, which are important for the health of the body. The imbalance between saturated and unsaturated fats is usually a concern, but in the context of emergency foods, the presence of saturated fats is acceptable as these foods are designed to be used for a limited period of time. The importance of fat in providing longer energy and its role in maintaining body temperature, especially in extreme disaster situations, cannot be ignored.

The protein content in this cereal bar reached 4.92%. Although not as high as other animal or vegetable protein sources, this content is adequate to support protein intake needs in emergency conditions. Protein plays an important role in repairing and building damaged body tissues, especially for disaster victims who may experience physical stress or malnutrition. In addition, protein also helps in maintaining the body's immune function, which is very important in emergency situations.

The sodium in this cereal bar is measured at 61.28 mg per 100 grams. This relatively low sodium content ensures the product is safe for consumption by a wide range of groups, including those who may have salt sensitivities or high blood pressure. In the context of emergency food, moderate sodium levels are also important to prevent dehydration, which is often a problem in disaster situations. In terms of energy total, one of the important components in the development of emergency food is the total energy that can be supplied by the product. This cereal bar provides a total energy of 428.01 kcal per 100 grams, which is quite high and meets the calorie needs of disaster victims. This amount provides enough energy intake to help disaster victims survive in critical conditions. The sugar content in this cereal bar was recorded at 25.1%. This fairly high sugar content provides a sweet taste that can increase product acceptance by consumers, especially children. In addition, sugar also serves as a source of fast energy needed in emergency situations. On the other hand, the low ash content of 0.67% indicates that the product has good purity, with a small amount of non-organic minerals that the body does not need.

The moisture content in this product reaches

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7.99%, which is relatively low. Low moisture content is essential for emergency food products, as it helps to extend the shelf life of the product and prevent the growth of microorganisms that can cause food spoilage. In emergency situations, food with a low moisture content is safer and can be stored for a long period without the need for refrigeration.

Microbiological safety is one of the most important aspects in the development of food products, especially those intended for consumption in emergency situations. In this study, the total number of plates, *Enterobacteriaceae*, *Salmonella spp.,* and *Staphylococcus aureus* was measured. The results showed that the average total plate count was below standard, indicating that the product was safe from microbial contamination. The low measurement of the total plate count indicates that this product is manufactured with high hygiene standards, and a good manufacturing process so that there is no growth of pathogenic microorganisms harmful to health.

The presence of *Enterobacteriaceae* was also measured and the results showed less than 10 colonies per gram. *Enterobacteriaceae* is a group of bacteria that is often used as an indicator of the microbiological quality of a food product. The presence of these bacteria in low quantities indicates that the product is produced in clean and maintained conditions, thereby reducing the risk of infection or disease caused by microorganisms. Maintaining the quality of microbiology is important, considering that emergency food products are often consumed by vulnerable groups such as children, the elderly, and pregnant women.

Salmonella spp. and *Staphylococcus aureus* are two major pathogens that are often of concern in food safety analysis. In this test, the results showed that *Salmonella spp.* was not detected in this cereal bar product, which indicates that this product is safe from salmonellosis infection. In addition, *Staphylococcus aureus* measurement indicates fewer than 10 colonies per gram, which indicates that this product does not have a significant risk of contamination. The presence of these bacteria can cause food poisoning, so the result indicating the absence or very low number of these bacteria are encouraging.

All products of cereal bars with mixed berry-flavors are not detected to contain heavy metals. The number of microbes in cereal bar products meets the standards and regulations in Indonesia. The nutritional content of this product is in accordance with the regulations of the Indonesian Minister of Health regarding supplementary foods for toddlers and pregnant women by Minister of Health of the Republic of Indonesia 2021.

Future research should adopt a longitudinal approach to evaluate the long-term effects of high-fiber cereal bars on disaster victims' health, while also exploring consumer preferences for various flavors and formulations to enhance acceptance across different age groups. Expanding the nutritional analysis to include other essential nutrients and conducting field studies in disaster-prone areas would provide practical insights into usability and effectiveness. The study's strengths lie in its rigorous methodology and focus on dietary fiber, addressing critical nutritional needs during emergencies. However, limitations such as a small sample size and the short-term nature of the analysis highlight the need for broader investigations that include multiple product variants and long-term outcomes, ultimately improving the development of emergency food products.

CONCLUSIONS

Cereal bars show chemical and microbiological test results that meet food safety standards. This product contains 9.43% dietary fiber, 23.65 mg/100g cholesterol, is free from trans fatty acids and does not contain heavy metals such as arsenic, cadmium, mercury, lead, and tin. Microbiological tests showed that the total plate count (ALT) and *Enterobacteriaceae* were within safe limits, as well as free of pathogenic bacteria such as *Salmonella* and *Staphylococcus aureus*. In terms of nutritional content, this cereal bar is rich in carbohydrates (73.89%) with a total energy of 428.01 Kcal/100g, making it an ideal source of energy in emergency conditions. This mixberry bar cereal is safe and has the appropriate nutritional content to be developed as a safe, nutritious, and suitable emergency food for various age groups.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

AR: conceptualization, methodology, writing–review and editing; SS: methodology, supervision; EK: methodology; formal analysis, writing–original draft, LN: investigation, DN: formal analysis, resources; SB: writing–original draft, writing–review and editing, FH: methodology; formal analysis, writing, TM: methodology, supervision.

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RESEARCH STUDY
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Low Birth Weight, Child Gender, Number of Children, and Maternal Education as Risk Factors for Stunting in Palu City - Indonesia

Berat Lahir Rendah, Jenis Kelamin Anak, Jumlah Anak dan Pendidikan Ibu Sebagai Faktor Risiko Stunting di Kota Palu - Indonesia

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ABSTRACT

Background: The worldwide issue of stunting, which is prevalent up to 20.5%, can have an impact on future productivity and health
Objectives: to determine the risk factors and prevalence of stunting in children aged 0-23 months in Palu City, Indonesia.
Methods: This study used a cross-sectional analytical design in eight sub-districts of Palu City (January-June 2024), involving 516 pairs of mothers and children aged 0-23 months. Data were collected by 20 enumerators under the supervision of the Health Office, through interviews related to breastfeeding, complementary feeding, infection history, and other variables as well as anthropometric measurements using length Board Measuring calibrated tools. The data were analyzed using univariate analysis, chi-square test bivariate, and logistic regression. Data collection is carried out through the Cobocollect platform.
Results: Logistic regression analysis shows several important findings. Children of mothers with low education (OR=1.9), male children (OR=2.2), low birth weight (OR=3.1), and families with more than 3 children (OR=2.1) have a higher risk of stunting. Of the 516 children, 20.5% experienced stunting. These findings highlight the importance of maternal education, gender, birth weight, and number of children as risk factors for stunting, as well as their implications for health policies.
Conclusions: Factors such as low birth weight, male sex, the number of children over three, and mothers' education of less than 9 years significantly increased the risk of stunting in children. Targeted nutrition interventions for mothers with low education and families with many children are essential to reduce the prevalence of stunting in Palu City.

INTRODUCTION

Stunting is a global community problem[1–8]. The prevalence of stunting varies between countries and between regions is 7.9% to 57.4%[2]. Stunting prevalence is 21.6% in Indonesia[3], East Java Province - Indonesia 19.2%[8] and stunting prevalence is 12% in Malang - Indonesia[7]. Previous studies showed that the prevalence of clowns in Palu City, Central Sulawesi was 33.0%[9]. Previous studies have shown that the danger of stunting is low productivity when entering adulthood and increasing the risk of heart disease, diabetes, and hypertension[10]. Several studies show that the risk factors for stunting in children are low birth weight[11–13], sex[14–16], number of children in the family[16-17], and maternal education[9,19–23]. According to a prior study by Hafid et al. (2023)[24], in Palu City, stunting was linked to a history of childhood diseases (AOR = 4.1, 95% CI = 1.3–12.9), cesarean sections (AOR = 2.3, 95% CI = 1.3–4.2), maternal education (AOR = 2.3, 95% CI = 1.1–4.8), and maternal employment (AOR = 1.9, 95% CI = 1.1–3.4). Some factors that prevent stunting include the provision of early breastfeeding initiation[3], exclusive breastfeeding[25], higher paternal education[3], nutrition education, micronutrient intake, balanced consumption, multi-mineral micro supplementation, school children's supplementary food, calcium milk[3], maintaining personal hygiene and water availability[26], and the habits of nutritious food consumption such as fish[27].

To answer the need for efforts to reduce stunting in the city of Palu, a role of the Indonesian Ministry of Health Polytechnic educational institution is to provide recommendations in stunting prevention in Palu City and Central Sulawesi Province, support the implementation of health transformation of the Indonesian Ministry of

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Health, as well as the implementation of research and publication cooperation with Management and Science University of Malaysia is the background for the implementation of this research. The purpose of this study is to determine the prevalence and risk factors for stunting in children 0-23 months in Palu City – Indonesia.

METHODS

Design, Place, Time, and Sampling Method

The design of this study is an analysis with a cross-sectional approach, carried out in eight sub-districts in Palu City, Central Sulawesi, between January and June 2024. The study involved 516 pairs of mothers and children aged 0-23 months, with data collection carried out by 20 enumerators educated in Bachelor Diploma of Nutrition supervised by the Palu City Health Office. This process has been approved by the Health Research Ethics Commission of the Ministry of Health of Palu on February 14, 2023 Number: 0015/KEPK-KPK/1/2023, ensuring appropriate research ethics. In addition, training for enumerators will ensure the quality and consistency of the data collected, as well as the use of measurement tools that have been calibrated for the accuracy of anthropometric data.

Data Collection

Several systematic steps in the collection of research data are designed to ensure that the data obtained is accurate and in accordance with the research objectives. The first step is the identification of respondents, which is focused on the mother of a child aged 0-23 months in Palu City. The mothers were chosen as respondents because they had important information related to their characteristics and their toddlers, breastfeeding and complementary feeding patterns, and a history of infectious diseases in their toddlers. The second step is collecting data through direct interviews with mothers of toddlers. This interview aims to obtain information about the characteristics of toddlers and mothers, breastfeeding and complementary feeding practices, as well as a history of infectious illnesses that toddlers have had in the previous month, like diarrhea and ARI. The third step is anthropometric measurements using a calibrated Length Board Measuring tool to ensure accurate measurement results. Measurements were taken at least twice to ensure accuracy and reduce potential errors due to movement or positioning of the child. To ensure precise results, the position of both the subject and the enumerator was arranged as follows. Subject Position: The child was laid flat on the length board, with the head firmly positioned against the headboard and legs fully extended. Ensuring the legs are straight and the feet are flat against the footboard is essential for accurate results. Enumerator Position: The enumerator ensured a direct view of the measurements to avoid parallax errors. Their task was to keep the child steady, prevent movement, and ensure the measuring device was properly aligned. The length measurements were then compared to the WHO 2005 standards for height-for-age. These WHO 2005 standards provide internationally recognized growth curves used to assess a child's growth status based on age and length or height. Data is collected using the Kobocollect platform.

Data Analysis

The data analysis of this study included several stages to understand and explore the relationship between variables that have been collected from the respondents. Univariate analysis was used to describe the variables collected from the data, such as the characteristics of toddlers and mothers, breastfeeding patterns, type and frequency of complementary feeding, history of infectious diseases and nutritional status, and body length. All of these data were analyzed separately. The frequency distribution or distribution percentage of each variable was recorded and analyzed to see the overall characteristics of the sample. The association between the two variables in the study was ascertained through bivariate analysis. The logistic regression and chi square test are the statistical tests used in this investigation.

RESULTS AND DISCUSSIONS

Out of the total 516 children studied, 20.5% experienced stunting, while 79.5% had normal nutritional status. Children from North Palu have the highest stunting percentage (43.6%) compared to other sub-districts. This shows that North Palu faces greater child health problems than other regions. In contrast, children from Mantikulore (10.3%) and Ulujadi (13.3%) showed a lower percentage of stunting. Stunting is more common in children of mothers with less than nine years of education (31.7%) than in children of mothers with more than nine years of education (17.2%). This emphasizes the importance of maternal education in managing child nutrition. Boys experience stunting more often (26.5%) than girls (14.5%). These differences may indicate the presence of social or biological factors that affect nutritional status by gender. Compared to children of normal birth weight (17.6%), children of low birth weight had a significantly high frequency of stunting (39.7%). This demonstrates that one of the main risk factors for stunting is low birth weight.

The frequency of stunting was higher in children who did not receive early breastfeeding initiation (16.4%) than in those who did (21.7%). This shows that early initiation of breastfeeding can play an important role in stunting prevention. Children who received exclusive breastfeeding had a lower prevalence of stunting (19.7%) compared to children who did not receive exclusive breastfeeding (22.4%). This supports the importance of exclusive breastfeeding in supporting children's nutritional status. Almost all families have latrines (98.4%). However, latrine ownership did not show a direct significant relationship with the nutritional status of the children in this analysis, perhaps because most of the sample already had access to adequate latrines. Children who consumed unhealthy snacks showed a higher prevalence of stunting (25.0%) compared to children who did not consume unhealthy snacks (20.2%). This highlights the influence of an unhealthy diet on children's nutritional status. The prevalence of stunting was lower in children who received stimulation (19.7%) than in those who did not (22.8%). This demonstrates

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that stimulation also contributes to children's growth and development.

Table 1. Distribution of child nutrition status based on sub-district and health risk factors in Palu City

Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (410)	% (79.5)	n (106)	% (20.5)	
Sub-District					
Mantikulore	78	89.7	9	10.3	<0.001*
West Palu	34	75.6	11	24.4	
South Palu	55	87.3	8	12.7	
East Palu	65	86.7	10	13.3	
North Palu	22	56.4	17	43.6	
Tatanga	39	72.2	15	27.8	
Tawaeli	45	64.3	25	35.7	
Ulujadi	72	86.7	11	13.3	
Mother's Age					
<20 years	20	69.0	9	31.0	0.150
≥20 years	390	80.1	97	19.9	
Mother's Education					
<9 years	82	68.3	38	31.7	0.001*
≥9 years	328	82.8	68	17.2	
Child's Gender					
Male	191	73.5	69	26.5	0.001*
Female	219	85.5	37	14.5	
Type of Delivery					
Normal	291	80.8	69	19.2	0.240
Cesarean Section	119	76.3	37	23.7	
Child's Age					
0-6 Months	93	81.6	21	18.4	0.015*
7-11 Months	135	86.0	22	14.0	
12-23 Months	182	74.3	63	25.7	
Source of Drinking Water					
Not Improved	0	0.0	1	100.0	0.049*
Improved	410	79.6	105	20.4	
Family Latrine Ownership					
No	8	100.0	0	0.0	0.147
Yes	402	79.1	106	20.9	
Early Breastfeeding Initiation					
No	143	83.6	28	16.4	0.158
Yes	264	78.3	73	21.7	
Birth Length					
<48 cm	109	71.7	43	28.3	0.005*
≥48 cm	301	82.7	63	17.3	
Low Birth Weight					
No	369	82.4	79	17.6	<0.001*
Yes	41	60.3	27	39.7	
Exclusive Breastfeeding					
Not exclusive	118	77.6	34	22.4	0.344
Exclusive	289	80.3	71	19.7	

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Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (410)	% (79.5)	n (106)	% (20.5)	
Number of Children					
>3 Children	41	65.1	22	34.9	0.003*
≤3 Children	369	81.5	84	18.5	
Birth Interval					
≤3 years	282	81.3	65	18.7	0.250
>3 years	128	75.7	41	24.3	
Healthcare Facility Utilization					
No	30	93.8	2	6.3	0.031*
Yes	380	78.5	104	21.5	
Supplementary Feeding (PMT)					
No	402	80.2	99	19.8	0.011*
Yes	8	53.3	7	46.7	
Stimulation Provision					
No	105	77.2	31	22.8	0.449
Yes	305	80.3	75	19.7	
Family Smoking					
No	126	81.3	29	18.7	0.499
Yes	284	78.7	77	21.3	
History of Pneumonia					
No	404	79.4	105	20.6	0.680
Yes	6	85.7	1	14.3	
History of Respiratory Infections (ISPA)					
No	387	79.8	98	20.2	0.454
Yes	23	74.2	8	25.8	
History of Diarrhea					
No	382	79.7	97	20.3	0.555
Yes	28	75.7	9	24.3	
History of Measles					
No	397	79.9	100	20.1	0.225
Yes	13	68.4	6	31.6	
History of Parasitic Infections					
No	409	79.4	106	20.6	0.611
Yes	1	100.0	0	0.0	
Consumption of Unhealthy Snacks					
No	380	79.8	96	20.2	0.468
Yes	30	75.0	10	25.0	

*chi-square test, significant if p-value<0.05

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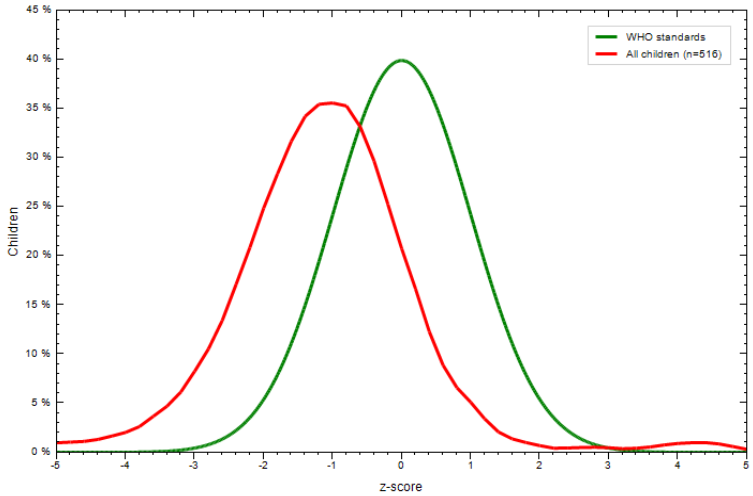

Images 1. Nutritional status curve of height for age children under two in Palu City compared to the standard curve of WHO Antro 2005

Based on bivariate analysis of the distribution of nutritional status by sub-district, children in North Palu showed the highest prevalence of stunting (43.6%) compared to other sub-districts. This indicates the presence of significant health problems in these areas that may require special intervention. Meanwhile in Mantikulore and Ulujadi, these two sub-districts show a lower prevalence of stunting, 10.3% and 13.3%, respectively. These differences may reflect local factors or the effectiveness of different health programs in the region. Children of mothers with less than 9 years of education have a higher prevalence of stunting (31.7%) compared to children of mothers with more than 9 years of education (17.2%). This suggests that maternal education plays an important role in preventing stunting, which is consistent with previous research that suggests that maternal education is closely related to children's health. Boys have a higher prevalence of stunting (26.5%) than girls (14.5%). This may indicate differences in biological or social factors that affect the health of boys compared to girls.

Stunting was significantly more common in low-birth-weight children (39.7%) than in normal-birth-weight children (17.6%). This demonstrates the significance of birth weight monitoring as a measure of a child's health and shows that low birth weight is a significant risk factor for stunting. Stunting was less common in children ages 0–6 months (18.4%) than in those ages 12–23 months (25.7%). This may indicate that the risk of stunting increases as the child ages, possibly as a result of a decrease in the quality or quantity of nutritional intake over time. Children who live at home with an unrepaired drinking water source show a very high prevalence of stunting (100%). However, only one child was identified in this category. these results may not be representative enough and require further confirmation.

All families without latrines showed normal nutritional status for all their children while among families with latrines the prevalence of stunting was 20.9%. This suggests that latrine ownership may not be a major factor in determining nutritional status, considering that almost all families have latrines. There was no significant difference in the prevalence of stunting between children who received early breastfeeding initiation and those who did not (16.4% vs. 21.7%. p-value=0.158). This may indicate that other factors, such as the duration or quality of breastfeeding, are more important than the timing of breastfeeding initiation. Children who received supplementary food (PMT) showed a much higher prevalence of stunting (46.7%) compared to those who did not receive (19.8%). These results may indicate that PMT administration may be inadequate or not implemented in a way that supports the child's growth effectively. Children who consumed unhealthy snacks had a slightly higher prevalence of stunting (25.0%) compared to those who did not consume unhealthy snacks (20.2%). Although these differences are not statistically significant. Unhealthy diets can still contribute to stunting risk.

Table 2. Risk factors affecting child stunting: results of logistics regression analysis in Palu City

Variables	p-value	AOR	95% CI	
			Lower	Upper
Low Birth Weight				
Yes	<0.001*	3.1	1.7	5.4
No		1.0		
Child's Gender				
Male	0.001*	2.2	1.4	3.5
Female		1.0		

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Variables	p-value	AOR	95% CI	
			Lower	Upper
Number of Children				
>3 Children	0.013*	2.1	1.2	3.9
≤3 Children		1.0		
Mother's Education				
<9 years	0.012*	1.9	1.1	3.1
≥9 years		1.0		

AOR: Adjusted Odds Ratio
*Regression logistic test, significant if p-value<0.05

Here are some intriguing conclusions and interpretations that can be made from the data based on the outcomes of logistic regression analysis. The first conclusion is concerned with educational background of mothers that impacts children's nutritional status. Children of mothers with less than 9 years of education have an odds ratio (OR) of 1.9 (95% CI = 1.1–3.1) on the risk of stunting. This indicates that children of mothers with lower levels of education are nearly twice as likely to suffer from stunting as children of mothers with higher levels of education. These findings highlight how crucial maternal education is in affecting the nutritional condition of children. Higher education is typically linked to improved access to health resources and a better understanding of diet and health. Second, the gender of the child may also impact the nutritional status. In terms of the risk of stunting, boys have an odds ratio of 2.2 (95% CI = 1.4–3.5). This indicates that boys are more likely than girls to experience stunting. These results are in line with a number of studies that demonstrate that the risk of stunting varies across the sexes either as a result of biological differences, variations in dietary habits, or sex-specific health treatment. Third, the nutritional status may also be affected by birth weight. Children with low birth weight had an Odds Ratio of 3.1 (95% CI = 1.7–5.4) to experience stunting compared to children born with normal weight. This confirms that low birth weight is a significant risk factor for stunting. Low birth weight often serves as an indicator of nutritional or health problems during pregnancy, which can affect the child's future growth.

The impact of family size on nutritional status, compared to children from households with three or fewer children, children from families with more than three children have an odds ratio of 2.1 (95% CI = 1.2–3.9) for stunting risk. This implies that a child's risk of stunting may rise with the number of family members. This element could have to do with how children share resources like food, care, and medical care, which can affect a child's nutritional state. This study sheds important light on the variables influencing stunting in particular and children's nutritional health in general. 79.5% of the 516 children in the study showed normal nutritional status, whereas 20.5% experienced stunting. These results have significant ramifications for nutrition treatments and public health strategies across various geographies.

The study highlights several significant benefits. ranging from an in-depth understanding of stunting risk factors to practical policy implications. One of the main benefits is the identification of strong risk factors, such as low birth weight, child gender, family size, and maternal education.

The study's findings also highlighted how crucial birth weight is a major risk factor. Compared to children born with normal weight, children with low birth weight have a 3.1 odds ratio for stunting. Low birth weight was linked to a >2-fold greater risk of stunting in children. according to a study by Vats et al. (2024) (combined OR = 2.32; 95% CI = 2.05–2.62)[12]. The study by Nasrul et al. (2024) showed that one of the significant determinants that contributed to the incidence of stunting in Sigi Regency was the low birth weight (AOR = 2.2. 95% CI = 1.1-4.5)[28]. The study in Asia showed a relatively higher risk than the study in Africa in a stratified analysis[12]. Children with low birth weight had a significantly higher risk of stunting than children with normal birth weight (44.3% vs. 33.8%). According to a study by Halli et al. (2022), the startling result was that BBLR infants had a 19% higher likelihood of producing a child with stunted growth (AOR = 1.19; 95% CI = 1.14. 1.24; p-value<0.001) than babies with a normal birth weight, even after controlling for other significant disrupting factors including BMI and ANC[29].

Three key stages necessitate the mother's best performance in order to avoid stunted child growth during the golden phase. Preconception, pregnancy, and the baby-toddler stage are some of these stages. Mothers play a number of roles, such as providing for the nutritional needs of mothers, fetuses, infants, and children, breastfeeding exclusively, and offering suitable supplemental foods, maximizing the environment for children's growth and development, maximizing family support, and avoiding various psychosocial factors that can impede children's development[30]. Indonesia has developed the Elsimil Application, which is an effort to prevent stunting by conducting health screening followed up with marriage and pregnancy readiness assistance for 31-year-old brides[31]. According to the Maulina et al. (2024) study, there are several maternal complications that may increase the risk of stunting. They are hepatitis B, preeclampsia, heart disease, human immunodeficiency virus/acquired immunodeficiency syndrome, the coronavirus disease 2019 (COVID-19) with pneumonia, and sexually transmitted infections[32]. According to the Sari et al. (2024) study, mothers of children with stunted growth had considerably lower serum lipase levels than mothers of children with normal

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growth. These low serum lipase levels could mean that a mother is not getting enough calcium for her unborn kid while she is pregnant, which would raise the infant's risk of growth problems[33].

Stunting risk, for instance, has been demonstrated to be significantly influenced by maternal education. The frequency of stunting is higher in children of mothers with less than nine years of education (31.7%) than in children of mothers with higher education backgrounds (17.2%). This highlights how important maternal education is for controlling the nutrition of children and highlights the necessity to work toward expanding mothers' access to education[34–37]. Relevant to the Nasrul et al Study (2024), which showed that a significant determinant contributing to the incidence of stunting in Sigi Regency was the education of mothers <9 years old (AOR = 2.3. 95% CI = 1.4-3.9)[28]. In terms of similarities, this study is consistent with previous studies that show that maternal education plays an important role in stunting prevention[38–41].

Previous research has also linked low birth weight to a high risk of stunting, which is in line with the findings of Nasrul et al. (2024) who found that a significant determinant contributing to the incidence of stunting in Sigi Regency was low birth weight (AOR = 2.2. 95% CI = 1.1-4.5)[28].

In addition, the difference in stunting prevalence between the sexes of children is also consistent with several studies that show differences in risk based on gender[42]. A study by Thurstan et al (2022) showed boys had a higher prevalence of malnutrition than girls[43]. The prevalence ratio of males to females, according to Garenne et al. (2021), was 1.18 on average for stunting (Z-height score to age < −2.0), 1.01 for wasting (Z-weight to height score < −2.0), 1.05 for underweight (Z-weight score to age < −2.0), and 1.29 for both stunting and wasting concurrently (Z-weight to height score and height to age < −2.0)[44]. The study of Thurstan et al (2023) showed that in the food intervention group the average daily weight gain was consistently lower in boys compared to girls[16].

However, the study found differences in the effectiveness of nutrition interventions. For example, supplemental feeding (PMT) showed a higher prevalence of stunting, different from studies showing the benefits of PMT. This may indicate a problem in the implementation or quality of the PMT provided. In addition, although early breastfeeding initiation is usually considered important, the results of this study did not show a significant difference in stunting prevalence between children who received early breastfeeding initiation and those who did not. This suggests that other factors, such as the duration or quality of breastfeeding, may play a greater role. This research opens up several opportunities for further development. One of them is longitudinal studies can be conducted to monitor changes in children's nutritional status over time and evaluate the impact of nutritional interventions. This will offer a more thorough understanding of the long-term effects of risk factors on stunting and the efficacy of therapies.

In addition, qualitative analyses that identify social and cultural factors that influence diet and health practices can provide deeper insights into the causes of stunting. This development can involve interviews and case studies in communities with high stunting prevalence. Evaluation of intervention programs is also very important to determine the most effective strategies and ensure adequate implementation.

The study has several strengths, including a wide range of variables and the use of clear data on stunting prevalence. Broad coverage allows for the identification of various risk factors and provides a comprehensive picture of the nutritional status of children in different sub-districts. On the other hand, this study also has some weaknesses. Determining cause and effect and tracking changes in nutritional status over time are limited by cross-sectional designs. Furthermore, some characteristics, such children with unimproved drinking water sources, may not be sufficiently represented by small sample numbers.

CONCLUSIONS

This study revealed several significant risk factors of stunting prevalence in Palu City, including low birth weight, child gender, number of children in the family, and maternal education. Children born to mothers with poor education (less than 9 years of compulsory education) have almost twice the risk of stunting compared to children from more educated mothers. Children with low birth weight also have a triple risk of stunting. These findings show the importance of more targeted nutrition interventions, especially in improving maternal education to reduce stunting rates in Palu City.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

FH: conceptualization, supervision, methodology, investigation, resources, writing–review and editing writing–original draft, writing–review and editing; NN: methodology, supervision; AA: methodology, supervision; KR: methodology and formal analysis; TR: methodology, supervision; SS: methodology, formal analysis, writing–original draft.

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