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Factors of Child Growth Failure Based on the Composite Index of Anthropometric Failure in West Sulawesi Province

Faktor Gagal Tumbuh pada Anak Berdasarkan Composite Index of Anthropometric Failure *di Provinsi Sulawesi Barat*

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ABSTRACT

Background: The composite index of anthropometric failure (CIAF) provides a comprehensive measure of growth failure through various child anthropometric indicators. In regions with a high prevalence of stunting, several factors may contribute to the occurrence of growth failure in children under five years.
Objectives: This study aims to analyze the factors influencing the incidence of child growth failure based on the CIAF in a province with high stunting prevalence in Indonesia.
Methods: The cross-sectional study used the 2022 Indonesian Nutrition Status Survey (SSGI) data. The sample comprised children aged 0-23 months from West Sulawesi Province, totaling 1,573 children. The number of samples analyzed was 1,327 children, excluding incomplete data and outliers that were values outside a certain range and treated as missing values based on the World Health Organization (WHO). Multivariate analysis was conducted using logistic regression with a complex sample facility.
Results: This study found that 24.9% of children experienced growth failure based on the CIAF. Factors associated with the incidence of growth failure based on the CIAF were older age between 12-23 months (OR=4.5; CI=2.36-8.43; p=0.000), birth weight less than 2,500 g (OR=6.85; CI=3.85-12.21; p=0.000), boys (OR=1.56; CI=1.13-2.15; p=0.000), incomplete immunization status (OR=1.8; CI=1.31-2.77; p=0.001), and poor economic status in quintile 1 (OR=2.1; CI=1.08-3.99; p=0.028).
Conclusions: The risk factors for child growth failure based on the CIAF included older age, male sex, low birth weight, incomplete immunization status, and low economic status.

INTRODUCTION

The world is facing a triple burden of malnutrition that remains unresolved, particularly in low- and middle-income countries since 2020[1]. According to the 2022 Indonesian Nutrition Status Survey (SSGI), 7.7% of children experienced wasting, 3.5% were overweight, 21.6% were stunted, and 17.1% were underweight[2]. Stunting remains a serious concern, showing the highest prevalence of cases compared to other nutritional problems[3].

Stunting refers to a condition where children under five have a height that is inappropriate for their age and suffer from irreversible cognitive impairment caused by growth failure[3,4]. Growth failure experienced by toddlers can have negative impacts in the future. The short-term impact includes lower academic achievement during school years due to impaired cognitive development[5,6]. Meanwhile, the long-term impact of growth failure includes reduced quality of life in adulthood in terms of education, employment opportunities, and income[5]. The United Nations International Children's Emergency Fund (UNICEF) 2020 conceptual framework identified various factors contributing to growth failure, categorized as direct factors, indirect factors, and enabling factors[7]. Direct factors include inadequate food intake, both in quality and quantity, and a history of infectious diseases[8,9]. Indirect factors include child food[7], care[5], health services[10], and environmental sanitation[8,11]. In addition, enabling factors include governance, resources, and norms in the community[7].

The period under five years old is crucial for human growth and development[12], with the initial two years being particularly significant for rapid growth and development, while also being highly susceptible to nutritional problems[8,13]. This period presents golden opportunities for social and cognitive development and the formation of body tissues such as the brain. Rapid growth and development makes children vulnerable to both malnutrition and overnutrition with lasting effects[12,14].

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One of the regions with a high prevalence of stunting in Indonesia is West Sulawesi. From 2021 to 2022, this province had the second-highest stunting prevalence in Indonesia, with rates increasing from 33.8% in 2021 to 35% in 2022[2,15]. This rate is significantly higher than the national average of 21.6%, indicating a potential risk if not addressed.

So far, early detection of growth failure is typically assessed using the Weight-for-Age Z-score (WAZ)[16]. Another index that can be used is the composite index of anthropometric failure (CIAF)[17]. Compared to conventional indices, CIAF offers a more comprehensive overview of anthropometric failure[18].

A study conducted using data from the 2013 Basic Health Research (Riskesdas) showed that 2.5% of children in Indonesia were underweight, stunted, and wasted[19]. Children with growth failure have a higher risk of mortality compared to normal children[20]. A study in the Lakhimpur region of Assam, India, reported a 48.6% prevalence of growth failure based on the CIAF[21], while another study in Depok reported a 31% prevalence of growth failure based on the CIAF. The number of children classified as normal according to the CIAF is lower than those classified as normal by conventional indices such as WAZ, Height-for-Age Z-score (HAZ) or Weight-for-Height Z-score (WHZ)[22]. This indicates that the CIAF more comprehensively reflects the overall prevalence of nutritional problems in children.

Many studies have investigated similar topics, but few studies have been conducted in Indonesia using the CIAF to assess growth failure. In addition, this study used the latest secondary data, namely the 2022 SSGI, which has not yet been analyzed in relation to the causes of growth failure according to the CIAF. The results of this secondary data analysis are expected to identify the factors associated with growth failure on a broader scale and serve as a reference for determining appropriate interventions. Based on the aforementioned explanation, this study aims to analyze the factors associated with the incidence of child growth failure based on the CIAF in West Sulawesi Province, which has a high prevalence of stunting in Indonesia.

METHODS

This study used secondary data from the 2022 SSGI, conducted by the Health Research and Development Agency of the Indonesian Ministry of Health (MOH). The Ethics Commission of Health Research of the Faculty of Public Health, Universitas Diponegoro, approved this study with a certificate number 118/EA/KEPK-FKM/2024. The research design adhered to the cross-sectional nature of the 2022 SSGI. The research population comprised all households with children under two years in seven regencies/cities in West Sulawesi Province. The sample was selected based on inclusion and exclusion criteria. The inclusion criteria were: (1) children aged 0-23 months, and (2) children residing in West Sulawesi Province. The exclusion criteria were: (1) incomplete data, and (2) outlier data, defined as values outside a certain range and treated as missing values. The final sample included 1,573 households with children under two years. However, after data cleaning, the sample was reduced to 1,327 households with complete data.

The dependent variable of this study was the incidence of child growth failure based on the CIAF. The independent variables included child factors (age, sex, birth weight, and food diversity), maternal factors (education level, employment status, antenatal care (ANC), gestational age, and parity), household factors (food security and care practices such as early initiation of breastfeeding, exclusive breastfeeding, and complementary feeding), environmental sanitation (source of drinking water and sanitation facilities), household economic status, health services (immunization status, weight measurement, length/height measurement, Mid-Upper Arm Circumference (MUAC) measurement, development monitoring, counseling/consultation, vitamin A administration, and deworming), and history of child infectious diseases.

Descriptive statistics were used to analyzed the data, and hypothesis testing was conducted through multivariate analysis. Before multivariate analysis, a bivariate test was conducted to determine the correlation between several factors (independent variables) and the incidence of child growth failure based on the CIAF (dependent variable). The dependent variables associated with the dependent variable with a p-value of less than 0.25 in the bivariate test were included in the multivariate test. Out of the 29 variables analyzed, 18 variables were eligible for inclusion in the multivariate analysis using logistic regression with complex samples. Data analysis was performed using IBM SPSS Statistics 24, with significance levels at α of 0.05, and p of less than 0.05.

RESULTS AND DISCUSSIONS

A comprehensive overview of the characteristics of the respondents is provided in Table 1. A greater proportion of children under two years were between 12 and 23 months (49.0%) and were girls (51.0%). The prevalence of low birth weight (LBW) was 6.5%. Additionally, 47.0% of children's food intake was not diverse. A significant proportion of mothers had a low level of education (52.5%) and were not employed (69.6%). Furthermore, the majority of mothers had fewer than three children or were not at risk in terms of parity (58.1%). Half of the mothers had more than six antenatal care (ANC) visits, and 26.8% of the mothers had a history of preterm birth. The proportion of households with low food security was 69.1%. The care of children under two years was found to be satisfactory, with the majority being exclusively breastfed (57.4%), receiving age-appropriate complementary foods (57.4%), and receiving early initiation of breastfeeding (61.0%). The environmental sanitation of households was relatively satisfactory, with sources of drinking water meeting the required standards (53.0%) and sanitation being categorized as appropriate (81.9%). Regarding economic status, the highest proportion was found in the poorest or first quintile (30.4%). The majority of children under two years had an incomplete immunization status. however, the majority of children under two years had access to weight and length/height measurement,

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vitamin A administration, counseling, and deworming services according to standards, although access to mid-upper arm circumference (MUAC) measurement and developmental monitoring fell below government standards. The majority of children had no history of diarrhea (85.3%), acute respiratory infections (68.9%), pneumonia (97.1%), or pulmonary tuberculosis (99.2%). Finally, most children (78.8%) resided in rural areas.

Table 1. Frequency distribution of respondent characteristics in West Sulawesi Province, Indonesia

Variable	n (%)
Child Factors:	
Age	
12-23 Months	650 (49.0)
6-11 Months	348 (26.3)
0-5 Months	329 (24.8)
Sex	
Boy	651 (49.0)
Girl	676 (51.0)
Birth Weight (g)	
LBW	87 (6.5)
Normal	1240 (93.5)
Food Diversity	
No	623 (47.0)
Yes	704 (53.0)
Maternal Factors:	
Gestational Age	
Premature	355 (26.8)
Not Premature	972 (73.2)
Education Level	
Low	697 (52.5)
High	630 (47.5)
Employment Status	
Unemployed	923 (69.6)
Employed	404 (30.4)
Antenatal Care	
<6 Times	659 (49.6)
≥6 Times	668 (50.4)
Parity	
Risk	533 (40.1)
No Risk	794 (59.9)
Household Factors:	
Food Security	
Not Good	917 (69.1)
Good	410 (30.9)
Early Initiation of Breastfeeding	
No	517 (39.0)
Yes	810 (61.0)
Exclusive Breastfeeding	
No	566 (42.6)
Yes	761 (57.4)
Complementary Feeding	
Not Age Appropriate	566 (42.6)
Age Appropriate	761 (57.4)
Source of Drinking Water	
Not Good	623 (47.0)
Good	704 (53.0)
Sanitation	
Not Good	241 (18.1)
Good	1086 (81.9)
Economic Status	
Quintile 1	403 (30.4)
Quintile 2	323 (24.3)
Quintile 3	258 (19.5)
Quintile 4	206 (15.5)
Quintile 5	137 (10.3)
Health Services:	

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Variable	n (%)
Immunization Status	
Incomplete	993 (74.8)
Complete	334 (25.2)
Weight Measurement	
Not According to Standards	591 (44.5)
According to Standards	736 (55.5)
Length/Height Measurement	
Not According to Standards	174 (13.1)
According to Standards	1153 (86.9)
MUAC Measurement	
Not According to Standards	1219 (91.9)
According to Standards	108 (8.1)
Development Monitoring	
Not According to Standards	866 (65.3)
According to Standards	461 (34.7)
Counseling/Consultation	
Not According to Standards	1182 (89.1)
According to Standards	145 (10.9)
Vitamin A Administration	
Not According to Standards	487 (36.7)
According to Standards	840 (63.3)
Deworming	
Not According to Standards	475 (35.8)
According to Standards	852 (64.2)
History of Child Infectious Diseases:	
Diarrhea	
Yes	196 (14.7)
No	1131 (85.3)
Acute Respiratory Infection	
Yes	413 (31.1)
No	914 (68.9)
Pneumonia	
Yes	39 (3.0)
No	1288 (97.0)
Pulmonary Tuberculosis	
Yes	10 (0.8)
No	1317 (99.2)
Residence:	
Rural	1046 (78.8)
Urban	281 (21.2)

LBW (Low Birth Weight); MUAC (Mid-Upper Arm Circumference)

The results of anthropometric classification based on the CIAF provided a detailed picture of growth failure among children under two years, as shown in Table 2. This study found that the prevalence of growth failure among underweight children based on the CIAF in West Sulawesi was 24.9%, which is lower than the prevalence of stunting in the region in 2022 (35%). A quarter of children under two years experienced single or multiple malnutrition problems (stunting, underweight, or wasting). This prevalence is lower compared to other regions, such as in Semarang City (34.2%)[17], Bogor (42.1%)[23], as well as Lima Puluh Kota, South Solok, Solok City, and Padang (30.3%)[20]. Internationally, the prevalence is 21.7% in China[24], 36.1% in West Bengal[25], 38.2% in Tanzania[26], 48.6% in Assam, India[21], and 52% in Bangladesh[27]. These differences may be attributed to research duration, feeding practices, information gaps, and socioeconomic factors[28].

Table 2. Percentage of child growth failure based on the CIAF

Category	CIAF n (%)
A: No Anthropometric Failure	997 (75.1)
B: Wasting Only	35 (2.6)
C: Wasting and Underweight	42 (3.2)
D: Wasting, Underweight, and Stunted	21 (1.6)
E: Stunting and Underweight	85 (6.4)
F: Stunting Only	127 (9.6)
Y: Underweight Only	20 (1.5)

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Category	CIAF n (%)
Anthropometric Failure	330 (24.9)

Anthropometric Failure = B + C + D + E + F + Y

Data analysis began with bivariate analysis followed by multivariate analysis. The bivariate analysis identified 18 independent variables suitable for inclusion in the multivariate analysis, namely child age, child sex, birth weight, gestational age, maternal education level, parity, household food security, home sanitation, economic status, immunization status, MUAC measurement, counseling/consultation, vitamin A administration, deworming, history of infectious diseases (diarrhea, acute respiratory infections, and pneumonia), and residence. Table 3 shows the factors associated with the incidence of growth failure according to the CIAF in West Sulawesi Province.

Table 3. Results of multivariate analysis of determinants of child growth failure based on the CIAF in West Sulawesi Province

Variable	CIAF, R^2 = 0.137[a]			
	S.E.	OR	95% CI	p-value
Child Age				
12-23 Months	0.323	4.46	2.36-8.43	0.000*
6-11 Months	0.290	2.24	1.27-3.97	0.006*
0-5 Months	reff			
Child Sex				
Boy	0.165	1.56	1.13-2.15	0.007*
Girl	reff			
Birth Weight				
LBW	0.294	6.85	3.85-12.21	0.000*
Normal	reff			
Gestational Age				
Premature	0.167	1.31	0.94-1.82	0.106
Not Premature	reff			
Mother's Educational Level				
Low	0.183	0.93	0.65-1.33	0.677
High	reff			
Parity				
Risk	0.166	1.20	0.86-1.66	0.284
No Risk	reff			
Food Security				
Not Good	0.192	1.20	0.82-1.75	0.353
Good	reff			
Sanitation				
Not Good	0.219	1.32	0.86-2.03	0.203
Good	reff			
Economic Status				
Quintile 1	0.332	2.08	1.08-3.99	0.028*
Quintile 2	0.356	1.72	0.85-3.47	0.128
Quintile 3	0.365	1.13	0.55-2.23	0.731
Quintile 4	0.342	1.09	0.56-2.14	0.796
Quintile 5	reff			
Immunization Status				
Incomplete	0.191	1.90	1.31-2.77	0.001*
Complete	reff			
MUAC Measurement				
Not According to Standards	0.347	0.89	0.45-1.77	0.743
According to Standards	reff			
Counseling/Consultation				
Not According to Standards	0.264	1.10	0.65-1.85	0.718
According to Standards	reff			
Vitamin A Administration				
Not According to Standards	0.194	0.87	0.60-1.28	0.490
According to Standards	reff			
Deworming				
Not According to Standards	0.238	0.98	0.61-1.56	0.927
According to Standards	reff			
History of Diarrhea				

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Variable	CIAF, R^2 = 0.137[a]			
	S.E.	OR	95% CI	p-value
Yes	0.246	1.16	0.72-1.89	0.542
No	reff			
History of ARI				
Yes	0.163	1.26	0.92-1.74	0.152
No	reff			
History of Pneumonia				
Yes	0.469	0.82	0.33-2.06	0.674
No	reff			
Residence				
Rural	0.217	0.72	0.47-1.10	0.127
Urban	reff			

LBW (Low Birth Weight); MUAC (Mid-Upper Arm Circumference); [a]Logistic regression; *p<0.05

A risk factor for child growth failure based on the CIAF included older child age (12-23 months) (OR=4.4; CI=2.36-8.43; p=0.000). The results of the study are consistent with a study in Tanzania, which showed that children aged 0-6 months have a lower prevalence of growth failure based on the CIAF compared to children aged over six months[26]. Similarly, a study in Ethiopia also showed that children aged 12-23 months have a 2.6 times higher risk of experiencing growth failure based on the CIAF compared to children under six months [29]. Another study found that children aged 12-23 months have a greater risk of growth failure based on the CIAF compared to children aged 0-11 months. This is attributed to the adequacy of nutrients from breast milk during the first six months. Inadequate complementary feeding and premature weaning (before six months) contribute to stunted growth[26].

Moreover, sex was associated with an increased risk of growth failure according to the CIAF. Boys appear to have a higher risk of growth failure compared to girls, with an OR of 1.56**.** (95% CI=1.13-2.15). Several studies have indicated that boys are more likely to be undernourished than girls. A narrative review by Thurstans et al. found that, despite being larger at birth and during growth, boys experienced more undernutrition under conditions of dietary deprivation. The difference is more pronounced in severe malnutrition and socioeconomically deprived contexts. Infectious diseases tend to affect boys more significantly than girls. The differences in the immune and endocrine systems also contribute to this difference[30].

Children with a history of low birth weight had a higher risk of growth failure based on the CIAF than those born with normal birth weight with an OR of 6.85 (95% CI=3.85-12.21). This finding is consistent with a study from Nagpur, India, which found that children with low birth weight had a 3.69-fold higher risk of growth failure based on the CIAF[31]. Another study in Visakhapatnam, India showed that children weighing less than 2,500 g had a 2.6-fold higher risk of growth failure based on the CIAF[32]. Children with low-birth-weight experienced growth failure based on the CIAF[33]. LBW is a predictor of infant growth, with strong correlations with maternal and child factors. Maternal factors are associated with nutrient deficiencies in the fetus. Most pregnancy disorders are related to inadequate maternal food intake, systemic diseases such as diabetes, or abnormal placental function, especially during the third trimester[17].

Low economic status was another risk factor for growth failure based on the CIAF, with an OR of 2.5 (95% CI=1.15-5.57). Economic status was assessed using a quintile index (1-5), where 1 represents the lowest economic status. This assessment was based on the ownership of valuable goods. Each valuable possession was assigned a different value. The statistical technique used to measure economic status was principal component analysis. Households with economic status in quintile 1 (lowest) had a 2.5 times higher risk of having children with growth failure based on the CIAF. The results of a study conducted in Tanzania yielded similar findings, indicating that children from poor households were at a greater risk of growth failure based on the CIAF compared to those from rich households[26]. A study in India also showed similar results, where children from poor households had double the risk of growth failure based on the CIAF compared to those from wealthier families[34]. Poor economic status often leads to food insecurity, resulting in inadequate provision of nutritious food. Poor household sanitation is another contributing factor. Households with food insecurity and poor sanitation tend to have a higher risk of infection, ultimately leading to child malnutrition. Furthermore, households with poor economic status have limited access to health services[26,35].

The incidence of growth failure in children was associated with their immunization status. Children who had received incomplete immunization were at an increased risk of growth failure, as determined by the CIAF, in comparison to those who had received complete immunization, with an OR of 1.90 (95% CI=1.31-2.77). One potential explanation for this correlation is that immunized children are better protected against infectious diseases and less susceptible to illnesses that can lead to malnutrition and growth failure[36]. In addition, vaccination programs often provide nutrition education and health services to mothers and children, which can improve maternal and child health outcomes, including child growth. Thus, immunization can substantially improve child growth and development[37]. A study in Indonesia using data from the Indonesian Family Life Study (IFLS) strengthens the evidence correlating immunization and the occurrence of chronic growth disorders (stunting) in children under five[35].

However, this study has certain limitations, especially in terms of the selection of research variables. This study only focused on postnatal factors, such as child

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factors, maternal factors, household factors, health services, and history of infectious diseases, without considering prenatal factors. Additionally, this study encountered issues with incomplete or missing data from the 2022 SSGI, which may affect the representativeness of the data.

CONCLUSIONS

The prevalence of child growth failure based on the CIAF in areas with high rates of stunting among children under two years reached a quarter of the total number of children (24.9%). Identified risk factors for growth failure based on the CIAF included age (12-23 months), sex (male), low birth weight, incomplete immunization status, and poor economic status. It is recommended that the prevention of growth failure in children should commence as early as possible, ideally during pregnancy, through the provision of comprehensive antenatal care services aimed at reducing the incidence of low birth weight (LBW) infants. Postnatally, the quality and quantity of food and fluid intake should be improved to support optimal physical and cognitive development throughout childhood. Furthermore, it is of paramount importance to ensure that all children are fully immunized, with children from poor households being a particular focus for nutrition interventions.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

HIL: conceptualization, methodology, formal analysis, writing-original draft; SS: conceptualization, supervision, writing-review & editing; AFA: supervision, writing-review & editing.

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RESEARCH STUDY
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Tiered Training Model to Improve the Skills of Posyandu Cadres in Measuring Child Anthropometry in Demak Regency, Indonesia

Model Pelatihan Berjenjang untuk Meningkatkan Kemampuan Kader Posyandu dalam Mengukur Antropometri Anak di Kabupaten Demak, Indonesia

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ABSTRACT

Background: Posyandu cadres still lack the skills to measure anthropometry. Not all cadres received regular training.
Objectives: This study aims to develop a training model to improve the skills of Posyandu cadres in conducting anthropometric measurements.
Methods: This study used a research and development approach with two main stages. The first stage was the development of the training model. The second stage was field testing of the new training model, using a pretest-posttest control group design. The training model in the form of Training of trainers (ToT) was tested to 49 cadres in the treatment and control groups with expert resource persons, followed by grassroots training with 142 cadres in the treatment group and 146 cadres in the control group with resource persons from the ToT participants. The intervention lasted three months. The effect of applying the training model on changes in the ability of cadres in anthropometric measurements was analyzed using the General Linear Model with a significant p-value <0.05.
Results: The developed anthropometry training model is tiered training, including ToT followed by grassroots training. Through the implementation of this training model, the number of trained cadre participants increased threefold. The results of the tiered anthropometry training model trial proved to improve knowledge, attitude, practice, self-efficacy, as well as the precision and accuracy of measuring the length, height, and weight of children by Posyandu cadres (p<0.05).
Conclusions: The implementation of a tiered anthropometry training model can increase cadre participants and improve the capacity of cadres in measuring child anthropometry.

INTRODUCTION

The development of public health is currently faced with the triple burden of malnutrition, namely the problem of malnutrition in children under five, excess nutrition (overweight and obesity), and deficiency of micronutrients which are quite high in Indonesia[1]. If the issue of undernutrition in children is not promptly addressed, it can have a detrimental impact on their physical growth, increasing the risk of stunted growth or a deficit in body size[2]. Furthermore, it can lead to an increased prevalence of child morbidity and mortality. In the long term, this can have a significant impact on the nutritional status of adolescents, adults, and the elderly. It can cause reduced cognitive abilities and reduced work capacity, which can increase poverty and economic losses. Furthermore, it can affect the quality of human resources, which is the basic capital of nation-building[3].

Considering the impact of malnutrition on the future of the nation, the government has carried out a program to accelerate the reduction of malnutrition in children under five through Growth Monitoring and Promotion (GMP), which is a specific intervention intensively promoted to improve nutrition and health[4,5]. Growth onitoring and promotion (GMP) at integrated health posts (Posyandu) requires good anthropometric measurement accuracy because inaccurate measurement results will lead to misclassification of nutritional status, resulting in inaccurate early detection and interventions. In addition, the government policy requires that all anthropometric measurement results for toddlers at Posyandu must be uploaded to the Electronic application-Community Based Nutrition Recording and Reporting (e-PPGBM) application so that individual target data for children can be displayed. Individual nutritional status can be known quickly and accurately, and malnourished toddlers can be quickly identified for appropriate referral or intervention[6].

Efforts to improve the accuracy of anthropometric measurements at Posyandu can be

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carried out by providing measuring tools (anthropometric kits) and increasing the capacity of cadres by improving the training, supervision/mentoring, and motivation activities[7]. Many cadres are still lacking in terms of knowledge, performance, and expertise[8]. To enhance the cadres' capacity to measure, the community health centers/Puskesmas have conducted regular training/refreshing of cadres. However, with the large number of cadres and frequent changes, not all cadres have been exposed to training, because in general, the participants are usually representatives of cadres. Furthermore, some cadre trainings are designated as trainers through Training of Trainers (ToT), and after the training, structured follow-up activities are required to ensure that cadres who have been trained can transfer their skills to other cadres who did not attend the training. The achievement of these objectives can be facilitated by the mobilization of community participation[8,9].

The government has limited resources in dealing with increasingly complex health problems in society. On the other hand, the community has considerable potential to help solve problems in their area[9]. Most Posyandus have cadres with potential. With intensive and systematic training, these cadres can enhance their skills to become vital trainers, supporting others at the village or Posyandu level.

Based on this background, the researcher developed a cadre training model by utilizing the existing potential of the community to increase the precision and accuracy of toddler anthropometric measurements at Posyandu. The research was conducted at Demak Regency, a district in Central Java which is one of the districts/cities designated as the locus of stunting management. In this district, Posyandu service quality remains low due to poor human resource quality, high cadre dropout rates, inadequate facilities, lack of incentives for cadres, and suboptimal community health activities at the village level[10]. Around 15% of children under five in this district are facing growth issues that require constant monitoring. Cadre skills are still lacking, leading to significant disparities between stunting data collected by cadres and validated measurements by trained teams.

The model development activities are expected to increase the ability of cadres to measure anthropometry and produce cadres who can train other cadres (training cadres) so that all Posyandu cadres in the village have better accuracy and precision in anthropometric measurements. The general objective of this research is to develop and examine the anthropometric training model to increase the precision and accuracy of anthropometric measurements of children by cadres at Posyandu in Demak Regency. The specific objectives of the research are to develop a tiered anthropometric training model that could increase the precision and accuracy of the results of anthropometric measurements of children at the Posyandu, and examine the effect of applying a new training model to changes in the precision (intra-observer variability) and accuracy (inter-observer variability) of toddler length, height, and weight measurements by cadres at Posyandu which were analyzed jointly with other variables (confounding).

METHODS

This research comprised two related stages: developing the initial model (stage 1) and field trials of the model (stage 2). Various approaches were used for developing training models, including Research and Development (R&D).[11]. Borg and Gall outline ten stages for development research: preliminary study, planning, hypothetical model development, hypothetical model review, revision, limited trials, revised trial results, wider trials, final model revisions, and dissemination. Sugiyono summarizes these into two main stages: product development and field trial[11].

The product development phase began with a Training Needs Assessment (TNA) comprising quantitative and qualitative studies. Quantitative research examined the behavior and measurement skills of Posyandu cadres through interviews and observations of their anthropometric measurements. A comparison was made between measurements by cadres and supervisors to assess accuracy and precision.

The quantitative study involved 452 purposefully chosen Posyandu cadres from 20 villages in Demak District. Ten villages with high stunting prevalence and ten with low prevalence were selected. Research sites included Kembangan and Betahwalang in Bonang, Donorojo in Demak, Kedongori in Dempet, Sidomulyo in Wonosalam, Boyolali, Gedangalas, and Sambiroto in Gajah, Guntur in Guntur, and Bumirejo in Karangawen sub-district for high prevalence. Low prevalence sites were Sumberejo and Jatirogo in Bonang, Kalikondang in Demak, Jerukgulung in Dempet, Pilangrejo in Wonosalam, Banjarsasi, Kedongdong, and Surodadi in Gajah, Bakalrejo in Guntur, and Pundenarum in Karangawen sub-district. The qualitative study included a literature review and Focus Group Discussions (FGD) involving 12 health workers from the district health office and community health centers experienced in training cadres. FGD sessions aimed to address Posyandu management issues, training implementation, and cadre mentorship comprehensively.

Based on the results of the Training Needs Assessment (TNA), the researchers carried out product planning and design, preliminary product development, and early-stage trials. The preliminary product design was a model and a tiered anthropometric training module was developed. Then, an internal product trial was conducted. Required elements for the internal product trial include (1) expert validation (expert review) involving 3 people with different types of expertise purposively selected as subjects, namely public health nutrition experts, health promotion experts, and empowerment experts. The experts held Indonesian National Competency Qualification Level 9 or a Ph.D.; (2) user validation involved three selected subjects, including cadres, village health workers, and public health nutritionists at Puskesmas Mranggen, Demak Regency; and (3) Limited subject testing featured 30 selected Posyandu cadres in Mranggen sub-district, Demak Regency. Adjustments were made to

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the model based on the limited subject trial results before continuing to the field trial.

In the second stage of the study, field trials were conducted to assess the efficacy of the model in comparison to the conventional training model. Conventional training is defined as the training model that is routinely or commonly conducted by officers at the district health office, community health centers, and auxiliary health centers. The second stage involved the field testing of the training model design, employing a pretest-posttest control group design. Field trials of the model were conducted at two levels: level 1 was a ToT training to train cadres of trainers at the district level with expert resource persons and grassroots training at the village level with ToT trainee resource persons.

The subjects or participants in the level 1 training were 47 key cadres representing Posyandu from 10 stunting locus villages as the intervention group, and 47 key cadres representing Posyandu from 10 non-stunting locus villages as the control group. However, the cadres who fully participated until the end of the level 1 training (after taking the pre and post-test) were 39 cadres in the treatment group and 39 cadres in the control group. Level 2 trainees were new cadres or regular cadres who had never attended anthropometry training. Subjects or participants of level 2 training consisted of 184 cadres from 10 stunting villages as the treatment group and 174 cadres from 10 non-stunting villages as the control group. However, cadres who fully participated until the end of the level 2 training (following the pre and post-test) were 142 cadres in the intervention group and 146 cadres in the control group.

The model intervention was conducted over three months. In the initial month, preparation activities and level 1 training (ToT) were organized at the district level. Then, in the second month, level 2 training was conducted at the village or Posyandu level, and field mentoring was conducted for two months. The trainers and facilitators of the level 2 training are cadres who have attended the level 1 training (ToT) at the district level. In the third month, in addition to mentoring activities, monitoring and evaluation of intervention results were also conducted. The evaluation of the results of the model implementation was carried out by comparing changes in the ability of the cadre group that participated in the level 2 training and the control group (who received conventional training).

The research variables observed and quantified in the subjects or cadres were as follows: the independent variable was the implementation of a novel model of Posyandu cadre training. Intermediate variables include attitudes, knowledge, self-efficacy, and cadre measurement practices. Confounding variables include cadre-specific factors such as gender, employment status, age, cadre experience, the number of incentives, and education of cadres. The dependent variable was the change in cadres' ability to measure the anthropometry of children under five, as measured by changes in intra-observer variability (precision), and changes in inter-observer variability (accuracy). The effectiveness of the new training model was evaluated by comparing the change in measuring ability between the intervention group (cadres who received level 2 training) and the control group (cadres who received conventional training). To ascertain the impact of the intervention, a different test was conducted on the changes observed in both groups, and the results were also analyzed using a multivariate General Linear Model (GLM).

This multi-year study has obtained an ethical approval from the Health Research Ethics Committee, Faculty of Public Health, University of Diponegoro, Number: 558/EA/KEPK-FKM/2019. All participants gave their consent before taking part in the study. The children were involved in the study with their mothers' consent.

RESULTS AND DISCUSSIONS

The model development phase began with a Training Needs Assessment (TNA) through a quantitative study that highlighted differences in the accuracy of anthropometric measurements made by cadres at Posyandu. The results of the observation revealed that the anthropometric measurement practices carried out by cadres did not follow the established standards. The findings of this assessment are presented in Table 1. The consequences of not adhering to measurement procedures can be seen in the results of anthropometric measurements that were imprecise and inaccurate. The observations of the 452 cadres in the study sites revealed that only 35.8%, 29.6%, and 92% of cadres measured child height, body length, and child weight, respectively, with good precision. Furthermore, the proportion of cadres who performed measurements of children's height, length, and weight with an acceptable level of accuracy was low, at 17.3%, 13.1%, and 20.1% respectively. The accuracy and precision of cadres in measuring child length was the lowest compared to measuring child height and weight.

Table 1. Inventory of anthropometric measurement errors of toddlers at Posyandu

No	Type of Measurement	Description Non-conformance with standard operating procedures (SOPs)
1	Body weight (Dacin or Steelyard)	- Balancing pendulum is not always checked before weighing to ensure the needle is in a straight position. - Bulky clothing is not removed or minimized (jackets, diapers, hats, baby shoes, etc). - Weighing results are rounded, not written to 0.1 kg scale. - Parallax reading position. - One-off measurement without repetition.

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No	Type of Measurement	Description Non-conformance with standard operating procedures (SOPs)
2	Body length (infantometer)	- Socks, pendants, pigtails, headgear, or hats are sometimes not removed. - Measurement is done alone without the help of other cadres/assistant measurers. - The position of the head is not ensured to look up straight, and the top of the head is attached to the measuring board. - At the time of reading the position of both feet is not tight, straight, and against the measuring board. - Measurement is only done once without repetition.
3	Height (microtoise)	- Socks, pendants, pigtails, headgear or hats are sometimes not removed. - The child's head position is sometimes still lowered when reading the results. - The position of the measuring eye when reading the results is sometimes not straight reading window. - Measurement is only done once without repetition.

Referring to the general guidelines for Posyandu revitalization issued by the Ministry of Home Affairs to increase the precision and accuracy of the anthropometric measurements of children, there are at least six models that can be developed and implemented, namely the policy and regulatory model; the model of increasing community participation and partnerships; the cadre training model; the model of coaching and technical assistance; the model for providing standard measurement infrastructure at Posyandu; and the model for improving service governance[12].

Given the limited resources and time, to increase the precision and accuracy of anthropometric measurements at Posyandu, the development of a cadre training model was chosen. The model was chosen because it can have a direct effect on increasing the knowledge and skills of measuring cadres, and many studies have proven this[13–15]. Referring to the Posyandu training guidelines developed by the Ministry of Health, the tiered training or training of trainer (ToT) model has often been used as a training model for cadre facilitators. Training for Human Development Workers (HDWs) in villages also uses the ToT model[16]. It should be noted that the aforementioned study incorporated a specific curriculum pertaining to anthropometric assessments of children at Posyandu.

There were four sub-themes obtained related to the Posyandu cadre training method, namely (1) special anthropometric training for cadres, (2) there were simulation sessions and measuring practices, (3) training media as needed, in addition to PowerPoint (PPT), equipped with multimedia (videos and modules), (4) ToT training model for posyandu key cadres with structured post-training activities. Overall, the results of the Focus Group Discussion (FGD) produced themes and sub-themes that became feedback for the development of anthropometric training models for Posyandu cadres (Table 2).

Table 2. Topics and sub-topics in Posyandu implementation based on the results of the FGD

Topic	Sub-topics
Monitoring the growth of children	- The concept of growth and the importance of monitoring child growth, - How to determine the exact age, - How to determine the direction of N/T growth (plotting to KMS)
Anthropometric measurement tools at Posyandu	- The importance of standard measuring instruments - How to maintain the tools - Provision of standard measuring instruments - Knowledge of standard measuring instruments
Anthropometric measurement practice at Posyandu	- Factors affecting the quality of measurement - Correct measuring procedure - Examples of right and wrong measurement practices
Posyandu cadres	- Roles and duties of cadres - Mastery of effective communication - Motivating staff performance
Desk activity at Posyandu	- A good description of 5 table service activities - Setting up cadres at the counseling table
Cadres training	- There are simulation sessions and practice measurements - Anthropometric special training for cadres - Training media as needed, apart from PPT, equipped with multimedia (videos and modules), - ToT training model with structured post-training activities

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The training needs assessment (TNA) revealed the need to develop a model for enhancing the accuracy and precision of anthropometric measurements of toddlers in Posyandu. The aforementioned model, which is a tiered anthropometric training model for Posyandu cadres, is supported by components presented in Figure 1. The formulation of the tiered anthropometric training model for Posyandu (Figure 1) represented the initial stage of the product development process. The design of the modules or training media was planned according to the new training model once it had been defined. The results of the training needs assessment (TNA) indicated that multimedia products, specifically videos, were the most suitable training media for subjects. The training videos were created based on the results of a review of the Ministry of Health's toddler growth assessment videos (see https://youtu.be/id68KWUPRHM). The new training videos contained more comprehensive topics and subtopics based on the findings of the observations and focus group discussions (see https://youtu.be/rV_AUgvV_eU).

Following the initial development of the cadre training model, the model was subjected to validation and approval by experts and users. A limited trial was conducted. The pilot test results demonstrated that the training model was effective in enhancing knowledge, attitude, and practice measurement scores. Furthermore, validity and reliability tests resulted in 25 valid and reliable knowledge instrument items and 20 valid and reliable attitude instrument items. After the module was revised, it was tested in the field.

In phase 2, field testing of the new model was conducted with the intervention group, which employed a multilevel training approach. The first level comprised Training of Trainers (ToT) for prospective cadre trainers. Level 2 training involved all cadres, including new appointees, in a village or grassroot setting, effectively training three times more cadres than the conventional model.

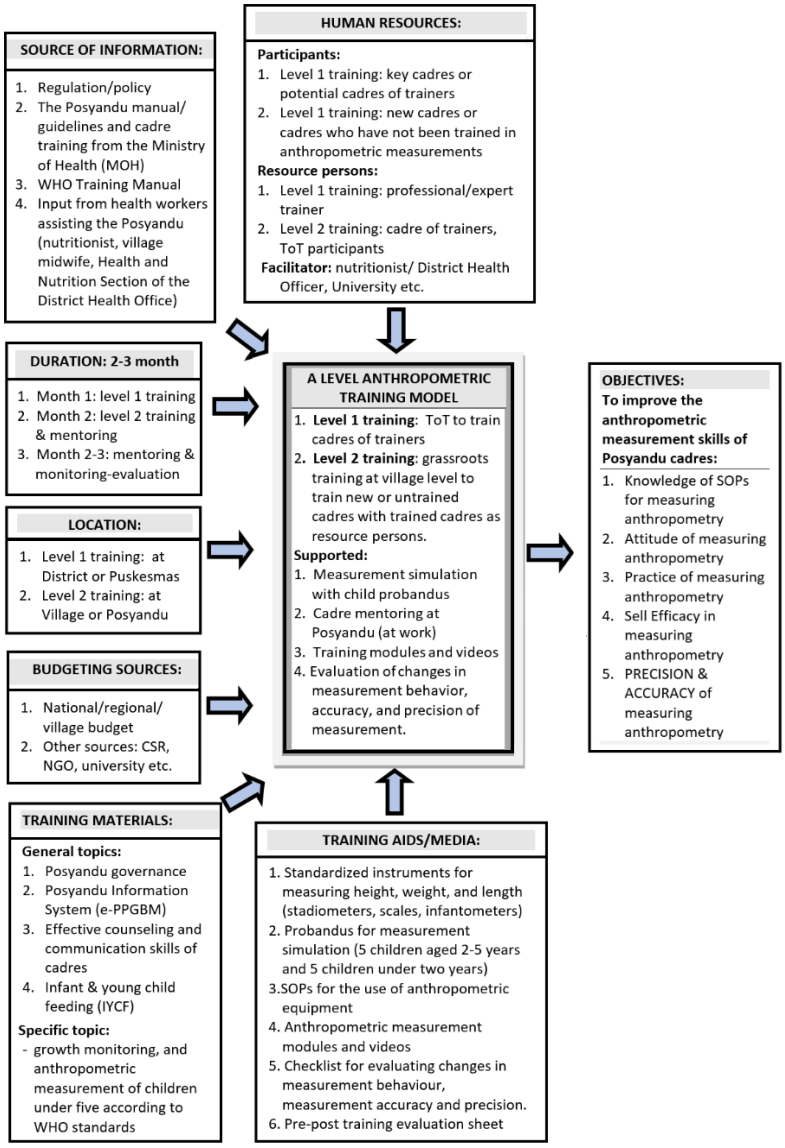

Figure 1. The formulation of a level anthropometric training model for Posyandu cadres to increase the precision and accuracy of measurements

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The results of the analysis indicated a notable enhancement in knowledge, attitudes, practices, and self-efficacy following the implementation of the training model. This was particularly evident among training participants at the village level (Table 3). The lack of previous training experience among those participating in the village training was a significant factor in the more pronounced increase in knowledge, attitudes, and practices compared to those who received Training of Trainers (ToT) at the district level. The cadres who participated in the ToT training at the district level were predominantly those who had consistently represented their respective Posyandu at every training and meeting at the district level. As a result, they had accumulated a wealth of knowledge from various sources.

Table 3. The effect of multilevel training on changes in self-efficacy, knowledge, attitudes, and practice of measuring anthropometry of Posyandu Cadres in Demak Regency, Indonesia

Training Level	Control			Intervention			p-value
	n	Mean	SD	n	Mean	SD	
Training Level 1 (Training of Trainers /District)							
Change in self-efficacy score	39	7.1	9.00	39	9.7	9.48	0.2252[a]
Change in knowledge score	39	-1.9	11.28	39	7.6	26.63	0.326[b]
Change in attitude score	39	7.7	30.16	39	18.6	21.82	0.057[b]
Change in practice score of measuring Body Length	39	14.7	27.80	39	26.1	20.98	0.048[b]*
Change in practice score of measuring Weight	39	25.6	14.32	39	29.3	15.80	0.285[a]
Change in practice score of measuring High	39	29.8	16.08	39	27.8	11.82	0.429[b]
Training Level 2 (Grassroot/Village)							
Change in self-efficacy score	146	6.88	11.91	142	11.63	14.22	0.002[a]*
Change in knowledge score	146	-0.09	1.08	142	10.13	19.91	0.000[b]*
Change in attitude score	146	2.83	30.75	142	11.71	28.88	0.019[b]
Change in practice score of measuring Body Length	146	14.32	25.89	142	17.16	22.22	0.419[b]
Change in practice score of measuring Weight	146	23.33	17.97	142	29.19	18.54	0.007[a]*
Change in practice score of measuring High	146	25.08	17.43	142	27.84	17.02	0.058[b]

[a]Independent t-test; [b]Mann Whitney U Test; *sig (p-value<0.05)

The change in knowledge, as indicated by the training participants in the village, was relatively more significant than the changes in attitudes, self-efficacy, and practice. Through anthropometric training, the cadres were trained in measuring children's body length, height measurement, baby scales, and stepping scales to measure children's weight according to SOPs. Several other studies that examined the impact of anthropometric training on increasing knowledge also showed a significant increase after the training[17,18]. The results of this study are in line with the findings of research conducted in Palopo City, indicating that anthropometric training is related to the improved ability of cadres to detect stunting[19]. As demonstrated in Table 3, multi-level training had a positive impact on the improvement of cadres' measurement skills. The observed decline in measurement practice scores following training indicates that the proficiency in measuring body length exhibited a lesser reduction than that observed in the practice scores for height and weight measurements. Measuring body length uses more complex tools and more parts of the procedure to control than measuring a child's height and weight. The results of the analysis demonstrated that the difficulty of anthropometric measurements of infants decreased to a greater extent than that of toddlers[15]. Measuring the body length of younger children is more difficult. Carsley et al. found that length measurements in children under 2 years old had the highest measurement error[20].

This study revealed improvements in cadres' knowledge, attitudes, and practices alongside enhanced accuracy in anthropometric measurements for toddlers. The implementation of the cadre measuring skill score model led to increased skills, impacting measurement precision. Similarly, Eti et al.'s study in Semarang demonstrated improved measuring skills among cadres, achieving mastery in required competencies[21]. Alignment with SOPs and training in correct measurement methods were crucial for precise results. In-service training and regular supervision have been identified in other studies as vital for performance enhancement[5].

The effect of multilevel training on changes in intra-observer variability (precision) and inter-observer variability (accuracy) in child anthropometric measurements made by village cadres is presented in Table 4. The results in Table 4 indicate confounding variables analyzed using the multivariate general linear model. There was a decrease in intra and inter-observer variability of measurements (especially length and height of children) in the control group which was lower than the intervention group (shown by the beta coefficient). This means that the cadre group that received the tiered training model intervention experienced a greater reduction in intra and inter-variability of measurements or increased precision and accuracy of anthropometric measurements, higher than the group that received conventional training. The findings of this study are similar to those of Gupta et al. which showed that the quality of manual anthropometric data in children under five years old improved after training. The reliability of measurement after training increased as evidenced by a decrease in

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the technical error of measurement (TEM)[22]. The training and standardization of surveyors for Ethiopia's Large Household Nutrition Survey showed that most anthropometricians (>75%) could achieve satisfactory precision in anthropometric measurements. This protocol allows the researchers to assess trainees, identify individuals who have not achieved the desired level of precision, and retrain or adjust their roles before survey implementation[23].

Table 4. The effect of multilevel training on changes in precision and accuracy anthropometry measurement in village cadres in Demak Regency Indonesia

Parameter	Intra-observer Variability (Precision)					Inter-observer Variability (Accuracy)				
	B	SE	sig	LB for B	UB for B	B	SE	sig	LB for B	UB for B
Length Measurement		R-square=0.068[b]					R-square=0.056[c]			
Intercept	0.446	0.517	0.389	-0.571	10.463	0.581	0.312	0.063	-0.032	10.195
Control group	-0.339	0.118	0.004*	-0.571	-0.106	-0.138	0.071	0.054*	-0.278	0.002
Intervention group	reff					reff				
Female	-0.550	0.381	0.150	-10.299	0.200	-0.611	0.230	0.008*	-10.063	-0.159
Male	reff					reff				
Non-working	0.106	0.084	0.208	-0.059	0.272	0.091	0.051	0.075	-0.009	0.191
Working	reff					reff				
Age, year	0.003	0.006	0.561	-0.008	0.015	0.001	0.003	0.900	-0.006	0.007
Experience as cadre, year	-0.005	0.006	0.408	-0.016	0.007	0.001	0.003	0.947	-0.007	0.007
Change of knowledge, score	-0.003	0.003	0.271	-0.009	0.002	0.001	0.002	0.897	-0.004	0.003
Change of attitude, score	0.001	0.001	0.779	-0.003	0.002	0.001	0.001	0.761	-0.002	0.001
Change of self eficacy, score	-0.002	0.003	0.522	-0.008	0.004	-0.003	0.002	0.076	-0.007	0.000
Change of practice, score	-0.002	0.002	0.318	-0.005	0.002	0.001	0.001	0.891	-0.002	0.002
Cadre incentive, sum	0.033	0.069	0.635	-0.104	0.170	0.039	0.042	0.355	-0.044	0.121
Cadre education, year	-0.002	0.015	0.887	-0.031	0.026	0.007	0.009	0.395	-0.010	0.025
Height Measurement		R-square=0.114[a]					R-square=0.024[b]			
Intercept	0.497	0.470	0.291	-0.429	10.423	0.248	0.339	0.465	-0.419	0.916
Control group	-0.382	0.104	0.001*	-0.586	-0.179	-0.067	0.075	0.372	-0.214	0.080
Intervention group	reff					reff				
Female	0.005	0.346	0.988	-0.677	0.687	-0.232	0.250	0.353	-0.724	0.259
Male	reff					reff				
Non-working	-0.040	0.077	0.600	-0.192	0.111	-0.026	0.056	0.647	-0.135	0.084
Working	reff					reff				
Age, year	-0.003	0.005	0.623	-0.013	0.008	0.004	0.004	0.262	-0.003	0.012
Experience as cadre, year	0.003	0.005	0.600	-0.008	0.013	-0.002	0.004	0.613	-0.009	0.006
Change of knowledge, score	0.002	0.003	0.442	-0.003	0.007	-0.002	0.002	0.341	-0.005	0.002
Change of attitude, score	-0.00003	0.001	0.980	-0.002	0.002	0.001	0.001	0.783	-0.001	0.002
Change of self eficacy, score	0.003	0.003	0.305	-0.002	0.008	0.00005	0.002	0.981	-0.004	0.004
Change of practice, score	-0.005	0.002	0.013*	-0.009	-0.001	-0.001	0.001	0.348	-0.004	0.002
Cadre incentive, sum	0.035	0.059	0.559	-0.082	0.151	-0.014	0.043	0.743	-0.098	0.070
Cadre education, year	-0.003	0.013	0.815	-0.029	0.023	0.004	0.010	0.642	-0.014	0.023
Weight Measurement		R-square=0.045[a]					R-square=0.098[b]			
Intercept	-0.040	0.543	0.941	-1.108	1.028	1.018	0.487	0.037	0.060	1.976
Control group	-0.016	0.121	0.896	-0.254	0.222	0.149	0.108	0.170	-0.064	0.362
Intervention group	reff					reff				
Female	0.393	0.394	0.320	-0.383	1.170	-0.403	0.354	0.256	-1.099	0.294
Male	reff					reff				
Non-working	-0.024	0.088	0.788	-0.196	0.149	0.061	0.078	0.438	-0.094	0.215
Working	reff					reff				
Age, year	-0.005	0.006	0.431	-0.017	0.007	0.004	0.005	0.483	-0.007	0.014
Experience as cadre, year	0.007	0.006	0.244	-0.005	0.019	0.003	0.005	0.579	-0.008	0.014

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Parameter	Intra-observer Variability (Precision)					Inter-observer Variability (Accuracy)				
	B	SE	sig	LB for B	UB for B	B	SE	sig	LB for B	UB for B
Change of knowledge, score	-0.003	0.003	0.321	-0.009	0.003	0.004	0.003	0.091	-0.001	0.010
Change of attitude, score	-0.001	0.001	0.330	-0.004	0.001	0.0005	0.001	0.687	-0.002	0.003
Change of self eficacy, score	0.008	0.005	0.075	-0.001	0.017	0.001	0.004	0.826	-0.007	0.009
Change of practice, score	0.004	0.002	0.068	0.000	0.008	-0.002	0.002	0.381	-0.006	0.002
Cadre incentive, sum	-0.070	0.068	0.305	-0.203	0.064	-0.238	0.061	0.001*	-0.358	-0.118
Cadre education, year	0.002	0.015	0.905	-0.028	0.032	0.017	0.014	0.212	-0.010	0.044

B (Beta Coefficient); SE (Standar Error); Sig (Significancy or p-value); LB (Lower Bound); UB (Upper Bound); [a]General Linear Medel; *sig (p-value<0.05); [b]Dependent Variable: Intra-observer variability change; [c]Dependent Variable: Inter-observer variability change

The anthropometry training intervention was implemented over three months, including two months of mentoring. The results were measurable, with improved measuring skills of the cadres. Improvements in cadre practices and performance cannot be achieved in a short period, and do not require training or mentoring. As the cadre empowerment study conducted in Semarang found, change from mentoring requires at least two months of mentoring[7].

Based on the results of this research, it is recommended that cadre training at the community health center/district level be strengthened and reformatted with a special focus on anthropometric measurements carried out in stages. For expert resources, local governments can collaborate with universities as was done in this study. To ensure program sustainability, coordination and synchronization of activities and funding between regional and village governments is needed. For example, the training budget (ToT) at the district/community health center level must be obtained from the Health Operational Assistance Fund (BOK) for each community health center, while the training budget at the grassroots or village can be sourced from village funds. The use of village funds for cadre empowerment is possible based on government regulation[24].

The limitation of this study was the potential for interaction and communication between cadres in the intervention group and those in the control group. This was because they were in the same sub-district and there was a communication forum between cadres in one sub-district. However, during the trial of the model, it was established that in the control group, no training activities were conducted at the village level, or such on-the-job assistance was provided, whether carried out independently by cadres or by the community health center/health office. The involvement of cadres during the pre-evaluation activities and the progress of the digitalization may result in the acceptance of additional information by cadres during the implementation of the intervention, thereby allowing for changes in the ability of cadres due to non-intervention factors. The application of the pretest-posttest control group design was expected to eliminate the effect of the non-intervention. The measurement process requires children to be calm while being measured by trained cadres and enumerators (gold standard). On occasion, it was found that the children could not be measured properly because the children were fussy, crying, or bored. This situation could affect the measurement results. If the child could calm down, then the measurement would continue. In the event of an uncooperative child, a replacement child would be used as a backup object to be measured.

CONCLUSIONS

The tiered anthropometry training model has the potential to expand the coverage of trainees with greater involvement (three times) compared to conventional training. In addition, the application of the tiered anthropometric training model has increase the cadres' knowledge, attitudes, self-efficacy, and ability to take anthropometric measurements of children, better than the conventional training model The tiered anthropometry training model can significantly reduce the variability of measurement results or increase the precision and accuracy of anthropometric measurements, especially measurements of child height and length conducted by Posyandu cadres at the village level.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare that they have no competing interests. The research was funded by the Faculty of Public Health, Universitas Diponegoro.

AUTHOR CONTRIBUTIONS

S: conceptualization, investigation, methodology, supervision, writing–review and editing; MIK: methodology, writing–original draft; HSS: methodology; formal analysis; SF: writing–review and editing; SAN: formal analysis, resources.

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RESEARCH STUDY
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Effect of Booklet Education and Cadre Assistance on Iron Tablets Consumption among Anemic Pregnant Women in East Jakarta

Efek Pemberian Edukasi Buklet dan Pendampingan Kader terhadap Konsumsi Tablet Tambah Darah pada Ibu Hamil Anemia di Jakarta Timur

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ABSTRACT

Background: Anemia during pregnancy significantly increases maternal risk and poor pregnancy outcomes by 1.71-fold. Enhancing pregnant women's knowledge and adherence to health guidelines requires a comprehensive approach.
Objectives: This study analyzed the effects of booklet education and cadre assistance on adherence to iron tablet consumption among anemic pregnant women in East Jakarta.
Methods: This quasi-experimental study was conducted in 2019 on anemic pregnant women in Makasar Public Health Center, Jakarta. This study comprised three groups: iron-folic acid supplementation only (IF), iron-folic acid supplementation with booklet education (IFB), and iron-folic acid supplementation with booklet education and cadre assistance (IFBA), serving as control, intervention I, and intervention II, respectively. The interventions lasted for three months. Adherence to iron supplementation and knowledge, attitude, and behavior (KAB) regarding anemia were measured. The data were analyzed using ANOVA/Kruskall-Wallis test, Wilcoxon test, and Mc-Nemar test with a significance level of 0.05.
Results: There was no difference in the increase of knowledge and behavior regarding anemia among the three groups ($p < 0.05$) although the behavior score in the IFBA group was significantly higher than in the other two groups. In addition, there was no difference in the percentage of adherence to iron tablet consumption before and after the intervention in the IF, IFB, and IFBA groups ($p > 0.05$). However, the IFBA group showed an increase of about 41% in adherence.
Conclusions: There was no difference in the increase of knowledge and attitude regarding anemia among the three groups, except for behavior. However, the IFBA group showed a significant increase in knowledge, attitude, and behavior after the intervention.

INTRODUCTION

Anemia affects 24.8% of pregnant women worldwide, with a higher prevalence in developing countries[1]. According to the 2018 National Health Survey, 48.9% of pregnant women in Indonesia were anemic[2]. The number significantly increased from 37.1% in 2013 and 24.5% in 2007[3,4]. Anemia in pregnant women is associated with the risks of bleeding, labor complications, prematurity, low birth weight, and even mortality[5]. The risk of having an anemic child is 1.71-fold higher in women with pre-pregnancy anemia than in those without pre-pregnancy anemia[6].

The primary cause of anemia during pregnancy is iron deficiency, affecting between 20% and 80% of cases[7]. This condition arises from a combination of factors, including low socioeconomic status, inadequate iron supplementation, chronic energy deficiency, low dietary diversity, high parity, poor nutritional knowledge, and worm infection[8]. Furthermore, there is a lack of knowledge about proper dietary habits and food choices among women[9].

The Program for the Prevention and Control of Anemia in Pregnant Women has identified low number of antenatal care (ANC) visits, poor nutritional knowledge, and low adherence to iron-folic acid consumption (IFA) as persistent issues[10,11]. Despite efforts, the adherence rate to iron tablet consumption remains low, with only 34.69% compliance in Jakarta, far below the program's target of 80%. The lowest compliance rates are found in East Jakarta, particularly in Makasar Subdistrict, where many anemic pregnant women reside[12].

Barriers to adherence to IFA consumption include fear of side effects, inadequate counselling, and insufficient information on the importance of compliance[13]. Prenatal education and counselling have been shown to positively impact nutritional knowledge

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and diet quality[14], leading to improved hemoglobin levels, dietary intake, and nutritional knowledge about anemia and iron-rich foods[15]. Educational interventions, such as lectures, audiovisual materials, booklets, and discussions, have been effective in increasing knowledge and improving nutrition and health behaviors. In particular, the lecturing method has shown significant improvements in knowledge, attitudes, and practices among Maternal and Child Health Services cadres after module-based interventions[16].

Behavioral changes have also been observed through peer-group education and focus group discussions[17]. Research by Mithra et al. shows that cadre assistance and social support play an important role in enhancing in maternal adherence to iron tablet consumption[13]. Behavioral changes require support from the surrounding environment, such as family and educational institutions, highlighting the need for cadre assistance[18]. This study demonstrates that both booklet education and cadre assistance not only enhance understanding of anemia and the importance of iron supplements, but also substantially increase compliance. This showcases the benefits of integrating educational and supportive strategies. By combining booklet education with cadre assistance, this aims to develop a new nutritional education method that can be applied in future health education programs.

METHODS

This quasi-experimental study was conducted from May to October 2019 at the Makasar Public Health Center, East Jakarta, Indonesia. The study participants were selected using a stratified random sampling technique from four areas: Kebon Pala, Cipinang Melayu, Makasar, and Pinang Ranti. The sample size was calculated based on previous research by Sulastijah et al. (2015), with a confidence level of 95%, a beta of 5%, an expected difference of six points, and an expected 10% loss to follow-up[19]. The minimum sample size required for each group was eight pregnant women. This study received approval from the Ethics Committee of the Jakarta Health Polytechnic II with a certificate number LB.02.01/I/KE/277/2019. All participants were informed about the objectives of this study and provided written consent for voluntary participation.

A screening was conducted in Makasar Subdistrict, East Jakarta, involving 181 healthy pregnant women aged between 16-40 years. The inclusion criteria were pregnant women who were willing to participate in this study by signing an informed consent, with a gestational age of 12-24 weeks, a hemoglobin level of less than 11 g/dL (based on medical records), a single pregnancy, and good and cooperative awareness. Meanwhile, the exclusion criteria were pregnant women with chronic diseases (heart disease, diabetes, liver disease, or tuberculosis) and those with a history of bleeding (hemorrhoids, anemia, thalassemia, and leukemia).

Out of 181 subjects from the four areas, 38 anemic women were screened and randomly categorized into three groups with at least 12 subjects in each group. However, five subjects were dropped out due to reasons such as untraceable addresses, abortion during the intervention, or inability to attend the seminar because of illness or family matters. Therefore, only 33 subjects remained at the end of the intervention.

Measurement Tools

The baseline data were collected through interviews using semi-structured questionnaires. The collected data include age, mother's occupation and education, family income, trimester of pregnancy, gravidity, previous miscarriage, malnutrition, adherence to iron supplementation, knowledge, attitude, and behavior (KAB) regarding anemia, and nutrition during pregnancy. In addition, mid-upper arm circumference (MUAC) was measured using a non-elastic measuring tape to assess malnutrition.

Knowledge was assessed using true/false questions, including twelve questions related to healthy food intake during pregnancy, anemia, and IFA consumption. Knowledge was categorized as good (≥ 60%) and low (< 60%)[20]. The attitude questionnaire consisted of 10 Likert scale questions with the following response options: strongly disagree, disagree, agree, and strongly disagree. Attitude was categorized as negative (less than median) and positive (median or more)[21]. Behavior was also assessed using Likert scale questions with the following response options: always, often, rarely, and never[22]. The KAB questionnaire was validated with similar characteristics from a rural setting and had a Cronbach's α of 0.705.

Adherence to iron-folic supplementation was measured through self-reports, such as the number of tablets taken per week. All reports were collected monthly during ANC visits or maternal classes, and the subjects were considered adherent if they took at least five IFA tablets per week[23]. Otherwise, they were classified as non-adherent to iron-folic supplementation. Dietary intake was measured using 2x24-hour food recalls before the intervention, while nutrient intake was estimated using NutriSurvey version 2007 with database the Indonesian Food Composition Table (IFCT) database. The IFCT data were obtained from Indonesian Food Composition Table (IFCT), updated from panganku.org, and supplemented with additional information on certain nutrients such as vitamin C and iron. Dietary intake was compared to the Estimated Adequacy Requirement (EAR) from Indonesia's Recommended Dietary Allowance (RDA) for pregnant women[24].

Intervention

This study comprised three treatment groups: iron-folic acid supplementation only (IF), iron-folic acid supplementation with booklet education (IFB), and iron-folic acid supplementation with booklet education and cadre assistance (IFBA), serving as control, intervention I, and intervention II, respectively. All groups received iron and folic acid supplementation as per the government's policy regarding iron supplementation for pregnant women. The supplements were distributed through public health centers, with each tablet containing 60 mg of iron and 400 mcg of folic acid.

Initial data collection was conducted by trained enumerators and included socio-demographic data, nutritional status in early pregnancy (using MUAC as a

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malnutrition indicator), food intake, knowledge, attitude, behavior, hemoglobin levels, and adherence to iron supplementation. For both intervention groups, booklets were provided during baseline data collection. These booklets contained information on the definition of anemia, its etiology in pregnant women, and types of food that can enhance iron absorption. The booklets also included a monitoring section with blank boxes for placing stickers to track iron tablet consumption.

Cadre assistance was provided three times over a 12-week period for approximately 30 minutes each. This assistance was provided by trained local cadres using education materials through the booklet and focus group discussion methods to maintain adherence to iron supplementation. Furthermore, to ensure consistency, each cadre received the same materials and a question checklist for each session. Each cadre worked with two-three subjects, with a total of four cadres participating in this study. Before this study, the cadres received training on nutrition, anemia, iron supplementation, and counseling techniques specific to the IFBA group of pregnant women. Endline data collection was conducted after 12 weeks of intervention.

Data Analysis

The collected data were analyzed using a statistical software program. Frequencies and percentages were computed to describe characteristics and estimate the prevalence of categorical variables. The mean and standard deviation were computed to describe numerical variables. Chi-square test was used to analyze categorical data and assess the independence or association between variables. ANOVA or the Kruskal-Wallis test was used to analyze differences between independent groups, while paired t-test or the Wilcoxon test was used to analyze differences before and after the intervention. Dichotomous data before and after intervention were analyzed using the McNemar test.

RESULTS AND DISCUSSIONS

Table 1 shows the characteristics of the subjects in all three groups. Most subjects had received secondary education and worked as factory workers or traders, with family incomes ranging from low to middle (263.7-512.7 USD or 3,600,000-7,000,000 IDR). Statistically, there was no significant difference between the three groups, except for family income. Meanwhile, there was a significant relationship between family income and the intervention group, with the IFBA group tending to have a lower income than the other groups.

There was no significant difference in gestational age at the beginning of ANC as 30.3% of subjects started their ANC in the second and or third trimester. In general, acceptance of iron supplementation was neutral (54.5%), and only 30,3% dislike the characteristic of Fe tablets. Almost all the subjects were supported by their family, either husband or mother (78,8%). Two-thirds of the subjects had poor knowledge of anemia before the intervention, including knowledge about the frequency of ANC visits until delivery and nutrition-related anemia, although most were unaware of the definition of anemia. Based on the questionnaire regarding the subjects' knowledge and attitude, it was found that they had insufficient knowledge (81.8%) and negative attitude (75.8%).

Table 1. Distribution of socio-demographic characteristics of the anemia pregnant women in East Jakarta

Variables	Total	IF			IFB			IFBA			p value
	n (%)	mg/dL	n	%	mg/dL	n	%	mg/dL	n	%	
Hemoglobin level		10.03±0.34			9.96±0.62			10.24±0.68			-
Age											
At risk	5 (15.2)		1	12.5		2	15.4		2	16.7	-
Normal	28 (84.8)		7	87.5		11	84.6		10	83.3	
Education level											
Low	9 (27.3)		2	25.0		3	23.1		4	33.3	-
Moderate	21 (63.6)		5	62.5		9	69.2		7	58.3	
High	3 (9.1)		1	12.5		1	7.7		1	8.3	
Occupation											
Unemployed	8 (24.2)		2	25.0		2	15.4		4	66.7	-
Employed	25 (75.8)		6	75.0		11	84.6		8	33.3	
Family Income											
Low (< 263.7 USD)	18 (54.5)		2	25.0		7	53.8		9	75.0	<0.05[a*]
Moderate (263.7-512.7 USD)	12 (36.4)		3	37.5		6	46.2		3	25.0	
High (> 512.7 USD)	3 (9.1)		3	37.5		0	0.0		0	0.0	
Gravidity											
< 2	24 (72.7)		8	72.7		8	61.5		9	75.0	-
≥ 2	9 (27.3)		3	27.3		5	38.5		3	25.0	
Malnutrition											
Yes	8 (24.2)		2	25.0		4	30.8		2	16.7	-
No	25 (75.8)		6	75.0		9	69.2		10	83.3	

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Variables	Total	IF			IFB			IFBA			p value
	n (%)	mg/dL	n	%	mg/dL	n	%	mg/dL	n	%	
Gestational age at the beginning of ANC											
First trimester	23 (69.7)		6	75.0		8	61.5		9	75.0	-
Second and third trimester	10 (30.3)		2	25.0		5	38.5		3	25.0	
Knowledge											
Low	27 (81.8)		5	62.5		13	100.0		9	75.0	
Good	6 (18.2)		3	37.5		0	0.0		3	25.0	-
Attitude											
Negative	25 (75.8)		4	50.0		11	84.6		10	83.3	
Positive	8 (24.2)		4	50.0		2	15.4		2	16.7	-
Acceptance of iron supplementation											
Like	5 (15.2)		1	12.5		2	15.4		2	16.7	
Neutral	18 (54.5)		5	62.5		4	30.8		9	50.0	-
Dislike	10 (30.3)		2	25.0		7	53.8		1	8.3	
Family support for iron supplementation											
Yes	26 (78.8)		7	87.5		10	76.9		9	75.0	-
No	7 (21.2)		1	12.5		3	3.33		3	25.0	

ANC (Antenatal Care); Iron and folic acid supplementation (IF), iron, folic acid supplementation and booklet education (IFB), and iron, folic acid supplementation, booklet education, and cadre assistance (IFBA); [a]Ordinal Spearman Correlation; *p<0.05

Table 2 shows the dietary intake of pregnant women at the start of this study compared to the EAR, which is 77% of Indonesia's RDA. Most subjects did not meet the dietary recommendations. Although their protein and energy intakes were close to the EAR, they were still lower than the required amounts.

Table 2. Mean and percentage of adequacy intake anemic pregnant women in East Jakarta

Intake variables	Mean	%EAR
Energy (kkal)	1415.15±1044.50	83.64[a]
Protein (g)	47.02±22.31	91.12[a]
Iron (mg)	4.70±3.63	21.66[a]
Calcium (mg)	334.68±321.96	42.27[a]
Folic acid (mcg)	113.28±80.05	35.40[b]
Vitamin C (mg)	30.90±59.81	43.64[a]
Vitamin A	500.67±667.94	77.88 [a]
Iron bioavailability		
Heme iron intake (mg)	1.84±1.47	-
Non-heme iron intake (mg)	2.76±2.20	-
Heme iron absorption (mg)	0.42±0.34	-
Non-heme iron absorption (mg)	0.11±0.12	-
Total iron absorption (mg)	0.54±0.45	61.52[c]

[a]Estimated Average Requirement (EAR) were estimated from 77% Recommended Dietary Allowance (RDA) (Gibson, 2005)[25]; [b]FAO 2004[26]; [c] WHO 1989[27] (77% from 1.14 mg iron absorption)

In general, the iron intake of the subjects was low. A systematic review by Hartriyanti et al. (2012) indicated that the average iron intake of pregnant women in Indonesia is still below the EAR (90% of EAR)[28]. It is crucial for pregnant women to meet their nutrient requirements, including protein and iron. Despite consuming a variety of foods, the protein and iron intakes of the subjects were still below the EAR[29]. Insufficient intake can lead to a lack of energy and impaired metabolic function.

The subjects mostly consumed plant-based foods rather than animal-derived foods. Fitri (2015) noted that 70% of pregnant women in Bogor consumed less than three servings of animal-based food per day[30]. Furthermore, vegetable sources or legumes such as tempeh, tofu, or *oncom* have lower iron absorption compared to heme-containing foods. The amount of iron-based food consumed does not directly determine the amount absorbed as iron absorption is extremely sensitive to changes in body iron status. Both heme and

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non-heme iron absorption show an inverse relationship to iron stores, absorption will increase if iron stores decrease[31]. Several methods can be used to calculate iron bioavailability, including the Monsen et al. (1978) method, which is based on heme factors and vitamin C consumption[32]. This study suggested that the iron absorption of the subjects was low, fulfilling only about 61.52% of the EAR for iron absorption.

Table 3. Differences in knowledge, attitudes, behavior, and intake of groups of pregnant women after intervention in East Jakarta

Variables	IF	IFB	IFBA	*p value*
Knowledge				
Baseline	140.0 ± 23.9	136.2 ± 39.5	135.8 ± 30.6	
Endline	160.0 ± 7.6	156.2 ± 21.0	163.3 ± 13.0	
Δ	20.0 ± 23.3	20.0 ±39.4	27.5 ± 30.8	0.646[c]
p value	0.046[b*]	0.092[b]	0.008[a*]	
Attitude				
Baseline	35.38 ± 6.11	31.69 ± 6.58	33.58 ± 5.07	
Endline	37.25 ± 4.97	35.07 ± 6.38	39.33 ± 5.86	
Δ	1.87 ± 3.97[b]	3.38 ± 7.9 [b]	5.75 ± 7.5 [b*]	0.550[c]
p value	0.224[b]	0.142[a]	0.022[b]	
Behaviour				
Baseline	38.50 ± 9.94	36.00 ± 10.19	37.25 ± 5.03	
Endline	42.63 ± 12.68	42.77 ± 6.02	52.67 ± 9.55	
Δ	4.13 ± 13.2 [b]	6.77 ± 9.0 [b*]	15.42 ± 8.6 [b*]	0.020[c*]
p value	0.407[b]	0.020[b]	0.000[b]	

Iron and folic acid supplementation only (IF), iron-folic acid supplementation with booklet education (IFB), and iron-folic acid supplementation with booklet education and cadre assistance (IFBA); [a]Wilcoxon test; [b]Paired sample t-test; [c]Kruskall-Wallis test; *p < 0.05; Δ (difference)

Table 3 shows a significant increase in behavior regarding anemia among the three groups, with the highest increase observed in the IFBA group. However, there was no difference in the increase in knowledge and attitude regarding anemia across the three groups. The intervention in this study included booklet education and cadre assistance, with cadres providing health examination and education during pregnant women's classes. The number of active cadres in the area was relatively high compared to areas outside Jakarta, with cadres often conducting more than two activities per week. Supporting activities took place smoothly at each post, except when one or two pregnant women did not attend the class. In such cases, the cadre or researcher provided assistance at their homes.

The IFBA group showed the highest increase in behavior. However, no difference was found in the increase in knowledge and attitude regarding anemia across the three groups. Significant increases were also found in understanding IFA consumption for health, avoiding inhibitor foods after meals, maintaining minimal ANC frequency until delivery, and eating healthy meals. Education and counselling for pregnant women effectively imparted correct information and knowledge about anemia, enabling them to assess their own perceptions, beliefs, and behaviors to make necessary decisions[33] .

Research conducted in Aykel, Ethiopia, found that knowledge about anemia and IFAS did not significantly affect adherence levels. Despite being knowledgeable, some pregnant women did not adhere to IFAS recommendations consistently[34]. Another study in Kenya also indicated that educational interventions alone did not significantly improve adherence rates among pregnant women. Even with adequate knowledge about the benefits and importance of IFAS, many women still failed to comply with the supplementation guidelines[23]. Adherence to IFAS regimen was associated with knowledgeability on IFAS, primigravidity, and IFAS counselling, especially on the management of its side effects[23].

Changes in knowledge, attitude, and behavior require time to become significant, as evidenced by the notable increases found exclusively in the IFBA group. The Health Belief Model showed that behavioral change consists of several stages: perceived susceptibility (trust), perceived severity (recognition of the seriousness of a problem), perceived benefits (belief that change will reduce consequences), perceived barriers (recognition of obstacles to changes), and self-efficacy[35,36].

The Transtheoretical Method also outlines the stages of change: pre-contemplation, contemplation, preparation, action, and maintenance. In the pre-contemplation and contemplation stages, individuals recognize the need for change. In the preparation stage, they decide to change, and in the action stage, they begin to implement real changes. Finally, in the maintenance stage, individuals achieve the goal of making the new behavior a habit[37,38].

Based on these two theories, in this study, behavior change preceded changes in knowledge and attitude. This suggests that even without sufficient knowledge and attitude, behavior can change if individuals have passed the preparation and action stages or if they perceive the benefits and severity of the problem according to the Health Belief Model. Immediate action may also be driven by external pressure from health workers and family members, who encourage

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pregnant women to consume iron tablets regularly and maintain their health. However, if the behavior does not change, it can be influenced by low self-efficacy[39].

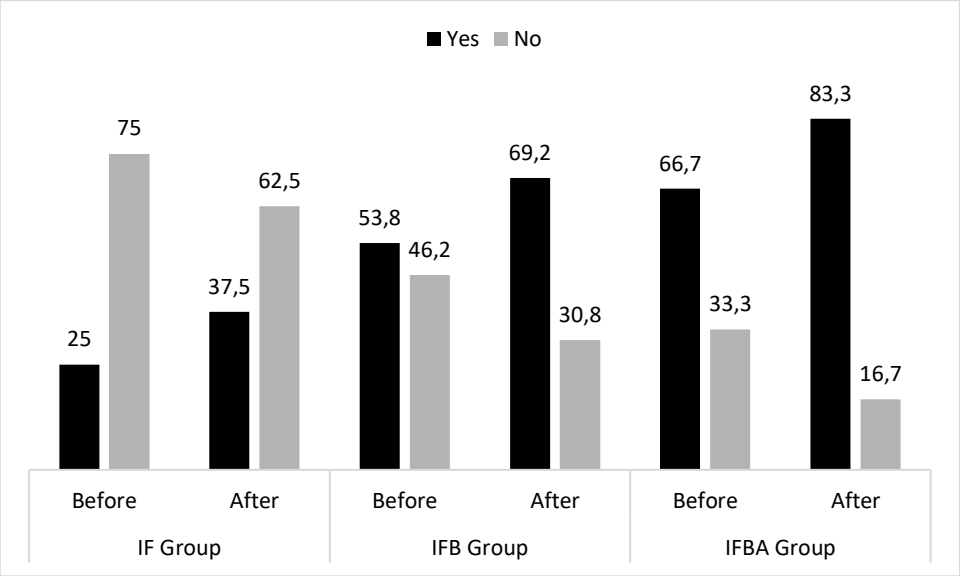

Figure 1. Prevalence of adherence to iron tablets before and after the intervention in the Iron and folic acid supplementation (IF), iron-folic acid supplementation with booklet education (IFB), and and iron-folic acid supplementation with booklet education and cadre assistance (IFBA) groups (McNemar test, no significance difference ($p > 0.05$)

Figure 1 shows no significant change in adherence to iron consumption among the three groups before and even after the intervention ($p > 0.05$). However, there was a slight tendency for an increase in adherence to iron supplementation in the IFB and IFBA groups. One contributing factor to low adherence is the poor acceptance of iron tablet characteristics[40]. Despite health services' efforts to improve maternal adherence through promotional activities, the non-adherence rate remains high[41]. Among the subjects, 30.3% expressed a dislike for iron supplementation, while 54.5% had a neutral attitude. Some subjects reported experiencing nausea, vomiting, dizziness, drowsiness, and urinating. Other factors include fear associated with the side effects of IFA tablets due to perceived or experienced effects, and forgetfulness[13,40].

Perceived barriers can be addressed by overcoming hesitation to consume iron tablets because of its side effects. A person who can control their behavior is more likely to develop the intention to engage in healthy behavior. This intention strengthens with the level of control exhibited[41]. Perceived benefits and barriers, as well as family support, are significantly correlated with pregnant women's adherence to iron supplementation. Further in-depth behavioral studies should be conducted since family support did not increase motivation among some subjects.

This study has several limitations. One of the obstacles in achieving adherence to IFA supplementation is the inconsistency in timing and quantity of tablet delivery across different subdistricts. Therefore, it is difficult to address their adherence, especially in the IF and IFB groups. In addition, this study faced low participation levels because of the high mobility in the urban population. For instance, pregnant women often moved to their hometowns to give birth in the third trimester, which made it difficult to follow up. Nevertheless, this study highlights different methods to monitor pregnant women's adherence to iron supplementation and potential nutritional counseling strategies through peer-group collaboration. These methods can be implemented in other populations, such as rural areas, which might yield different results.

CONCLUSIONS

There was no difference in the increase of knowledge and attitude regarding anemia among the three groups, except in behavior. However, there was a significant increase in knowledge, attitude, and behavior in the IFBA group after the intervention. Although there was no difference in adherence, cadre assistance for preventing anemia in pregnant women is required. This assistance addresses various inhibiting factors or barriers such as forgetfulness, side effects, and organoleptic properties of IFA tablets, which should be carefully managed for future improvement. Furthermore, creating a supportive environment is crucial to ensure program sustainability by increasing demand and support for anemia prevention. Family support cadres can help mitigate the problems experienced by pregnant women, such as forgetfulness, and contribute to better adherence.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

AF: conceptualization, data curation, formal analysis, funding acquisition; validation, visualization, roles/writing-original draft, writing-review & editing II: investigation, methodology, project administration, resources, writing-review and editing; SF: data curation, investigation, methodology, project administration, resources.

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Determinants for Low Birth Weight in Mothers Giving Birth during the Covid-19 Pandemic

Determinan Kejadian Berat Badan Lahir Rendah pada Ibu Melahirkan Selama Pandemi Covid-19

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ABSTRACT

Background: Low birth weight (LBW) remains a significant global health issue, leading to higher rates of infant and child morbidity and mortality. In 2022, Indonesia had a 12.58% rate, while in Kutai Kartanegara Regency, East Kalimantan, the rate was higher at 16.30%. The Covid-19 pandemic, which severely impacted East Kalimantan also influenced LBW rates.
Objectives: Analyzed the determinants of LBW incidence during the Covid-19 pandemic in Kutai Kartanegara.
Methods: This population of 1265 mothers delivered in four public health centers with the highest cases of BBLR. This study used a case control design for 240 mothers, including 120 mothers who gave birth to babies with low birth weight and 120 mothers who gave birth to babies with LBW. Data were obtained from e-cohort data according to specific inclusion and exclusion criteria. Data collection occurred from August until October 2022 through interviews with structured questionnaires and maternal child handbooks. Data analysis was performed with logistic regression.
Results: Determinant factors LBW were maternal nutritional risk (upper arm circumference <23.5 cm) (OR=2.800, 95% CI=1.237-6.340), history of anemia (OR=3.156, 95% CI=1.716-5.804), history of Covid-19 (OR=4.357, 95% CI=2.355-8.063), living with a smoker (OR=2.505, 95% CI=1.716-2.804), and not having health insurance (OR=2.744, 95% CI=1.435-5.247).
Conclusions: Internal factors such as age, under arm circumference, anemia, Covid-19, birth spacing, and parity and external factors (such as living with smokers, not having insurance) were interconnected in contributing to the risk of LBW, the pandemic further influenced these determinant factors.

INTRODUCTION

Low birth weight (LBW) becomes still a major concern as a health program in infants. Birth weight is a sensitive indicator of fetal development in the womb. Data from the World Health Organization (WHO) and the United Nation Children Fund (UNICEF) states that around 22 million babies are born worldwide with LBW and an increase of 7%[1,2]. LBW is an important indicator of maternal health throughout the period before and during pregnancy. It has a significant impact on neonatal, infant and childhood mortality and morbidity[2–4]. LBW is the leading cause of infant mortality and is associated with high morbidity and mortality of children under 5 years of age, increased infectious disease, growth deficits, and development delays[3].

As a developing country and in the Southeast Asia region, Indonesia has the second highest LBW rate after the Philippines with a proportion of 21.2%[5] . This proportion value has also increased since the Covid-19 Pandemic situation two years ago. In 2022, the percentage of LBW in Indonesia is still high at 12.58%[6]. At the time this research was conducted, the Covid-19 pandemic was still occurring. Covid-19 has an impact on increasing the risk of fetal health complications, including LBW[7]. According to the literature review, Covid-19 infection can worsen pregnancy when compared to uninfected women in pregnancies of the same age[8]. Research indicates that the risk factors for LBW include low income, low iron intake, low vitamin D consumption, anemic mothers, maternal age <20 years and ≥35 years, Covid-19 infection, food supply during the Covid-19 pandemic, and exposure to cigarette smoke[9,10].

East Kalimantan (Kaltim) is one of the regions that also has a record of cases infected with the Covid-19 Virus, the number of cases in 2021 had reached 37,089 cases with a mortality rate of 25.3% per 1000 cases, while in Indonesia itself, and the number of cases at the same time also reached 977,474 cases with a mortality rate of 28% per 1000 cases, but so far there is no data related to the number of pregnant women infected with the Covid-

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19 virus. Data from the East Kalimantan Provincial Health Office Profile in 2020 showed that the percentage of LBW in East Kalimantan was 5.2%. In East Kalimantan Province, the highest LBW rate occurred in Kutai Kartanegara Regency (KuKar), which is 7.79%[10]. This case control study determined various risk factors for LBW during the Covid-19 pandemic, starting from the smallest sub-region and become the basis for being able to provide input as an effort to prevent LBW if emergency conditions, such as a pandemic occur again.

METHODS

This study used a case control design in the population of mothers who gave birth in 2021 to 2022 (during the Covid-19 pandemic), the population is 1265. The sample size calculation was carried out with a 95% test strength with a ratio of 1: 1 between the LBW and non-LBW groups. The results of the sample calculation obtained research subjects totaling 240 mothers from the case group and control group, each group of 120 subjects. The case group was mothers who gave birth to babies with a birth weight of <2500 grams, and the control group was mothers who had given birth to babies with a birth weight of 2500 to 4500 grams. Case subjects were obtained through data taken from the cohort book, control subjects were obtained in the same location as case subjects, and a search for the mother's address was carried out through cellular contacts, and asked for the mother's consent by filling out informed consent.

Subjects were selected purposively from the list of mothers giving birth at the public health center based on the case inclusion criteria, namely those who gave birth to babies weighing <2500 grams in 2021 to 2022 in the KuKar region, and have a Maternal Child Health (MCH book). The control group inclusion criteria were mothers who gave birth to babies >2500 grams. Exclusion criteria for cases and controls were mothers who gave birth and had died, mothers who had cancer or were in legal proceedings. The list of respondents' names was obtained from the cohort book of the community health center in the four areas with the highest LBW cases in Kutai Kartanegara, namely Loa Kulu, Loa Janan, Separi and Mangkurawang health centers.

The main variable of this study was the incidence of LBW. The independent variables consist of internal and external factors. Internal variables include everything related to the condition of the mother and her health that cannot be changed such as reproductive age of risk, namely mothers who are pregnant with (age <20 years and ≥35 years), age not at risk, namely pregnant women aged 20-35 years. Safe parity is mothers with parity 2 and 3, while unsafe parity is mothers with the first pregnancy and more than 3. History of anemia is the Haemoglobin (Hb) level of pregnant women in the final trimester less than 11 mg/dl. Height is the height of the mother (<150 cm and ≥150 cm), Upper Arm Circumference <23.5 cm and ≥23.5 cm) is the size of the upper arm circumference of the mother during Antenatal Care (ANC) examination. Birth spacing (<2 years and ≥2 years) is the birth distance between the current child and the previous child. Number of Antenatal Care (ANC) visits is the number of ANC check-ups the mother had during pregnancy (<4 times and >4 times). Weight Gain (BW) is the mother's weight gain during pregnancy in accordance with the recommendations, and the history of Covid-19 is the mother's history of Covid-19 infection during pregnancy. External variables are factors that exist in the mother in the form of things that can be changed or cannot be changed, such as the level of education is the last education graduated by the respondent. Income is the regular money earned by the family every month. Health insurance ownership is the ownership of insurance both private and BPJS (social health insurance body) owned by pregnant women. Living with a smoker is the presence of family members who have a smoking habit. Participation in pregnant women's classes is whether or not the mother has attended pregnant women's classes during pregnancy either once until completion. Access to health services is the distance to the public health centers with a distance of >5 KM or a distance of >15 minutes.

Data were collected by interview using a structured questionnaire and by looking at records in the MCH book. Data were analyzed using Chi Square test with a significance level of 0.05 and logistic regression was performed on variables with a p-value of 0.25 as a condition for entering the regression model to determine the potential risk factors of each variable with OR values and 95% CI, all statistical analysis tests using Statistic Packager for Social Science (SPSS). This study was approved by the Research Ethics Commission of the Faculty of Public Health, Diponegoro University No.281/EA/KEPK-FKM/2022.

RESULTS AND DISCUSSIONS

The total number of mothers giving birth as research subjects was 240 respondents, consisting of 120 cases and 120 controls. The babies who were born less than 50% in the case group (LBW) were 43 (89.6%), most of the mothers' occupations were not working / housewives as many as 195 mothers. Meanwhile, related to the husband's occupation, six (100%) respondents had the husbands who were unemployed after the Covid-19 pandemic occurred. Besides, the location of the respondent's residence is mostly in the centre of the district, as many as 134 respondents, living on the edge of the district, and on the riverbank as many as 106 respondents.

Tabel 1. Social demographics and characteristics of respondent's mother delivered have baby with low birth weight and normal birth weight in Kutai Kartanegara

Characteristics	LBW n (%)	Normal Birth Weight n (%)	Total n (%)	p-value
Gestational age of Birth				
Full term	77 (40.1)	115 (59.5)	192 (100)	0.001*
Preterm	43 (89.6)	5 (10.4)	48 (100)	
Living Location				1.000

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Characteristics	LBW n (%)	Normal Birth Weight n (%)	Total n (%)	p-value
City Center	67 (50)	67 (50)	134 (100)	
Regional Periphery/Riverside	53 (50)	53 (50)	106 (100)	
Mother Occupation				
Unemployed/Housewife	100 (51.3)	95 (48.7)	195 (100)	0.408
Employed	20 (71.4)	25 (55.6)	45 (100)	
Husband's Occupation				
Unemployed	6 (100)	0 (0)	6 (100)	0.029
Employed	114 (48.7)	120 (51.3)	234(100)	
Total	120	120		

*chi-square (significant if p-value <0.05), LBW (Low Birth Weight), OR (Odds Ratio)

Table 2 sheds light on internal factors that significantly influence the risk of LBW. Maternal age appears to play a role, with an odds ratio (OR) of 0.521 and a 95% confidence interval (CI) of 0.310-0.875. This suggests that mothers on either end of the age spectrum might be at higher risk. Nutritional status also emerged as a significant factor. A low maternal upper arm circumference (OR=2.390, CI=1.166-4.898) indicates that malnutrition potentially increases the likelihood of LBW deliveries. The study also found a connection between short birth intervals (OR=1.694, CI=0.942-3.036) and LBW, suggesting that mothers who conceive too soon after a previous birth may be at risk. Finally, a history of both anemia (OR=2.843, CI=1.657-4.880) and Covid-19 infection (OR=4.071, CI=2.327-7.120) were identified as significant risk factors for LBW.

Tabel 2. Internal and external risk factor for low-birth-weight incidence in Kutai Kartanegara

Variable	Case LBW n (%)	Control Normal Birth Weight n (%)	Total n (%)	OR	CI (95%)	p-value
Internal Factor						
Age						
Reproduction at Risk (<20 & ≥35 years old) (Ref)	59 (43.1)	78 (56.9)	137 (100)	0.521	0.310-0.875	0.013*
Reproductively Healthy (20-35 years old)	61 (59.2)	42 (40.8)	103 (100)			
Upper Arm Circumference						
<23,5 cm (Ref)	27 (67.5)	13 (32.5)	40 (100)	2.390	1.166-4.898	0.015*
≥23,5 cm	93 (46.5)	107 (53.5)	200 (100)			
Height						
<150 cm (Ref)	33 (55.9)	26 (44.1)	59 (100)	1.371	0.759-2.476	0.294
≥150 cm	87 (48)	94 (52)	181 (100)			
Parity						
Unsafe Parity (1 and >3) (Ref)	66 (50)	64 (49.2)	130 (100)	1.069	0.644-1.777	0.796
Safe Parity (2 and 3)	54 (49.1)	56 (50.9)	110 (100)			
Birth Interval						
Risk (<2 years) (Ref)	37 (59.7)	25 (40.3)	62 (100)	1.694	0.942-3.046	0.077*
Not Risk (≥2 years)	83 (46.6)	95 (53.4)	178 (100)			
History of Anemia						
Anemia (Ref)	61 (65.6)	32 (34.4)	93 (100)	2.843	1.657-4.880	0.001*
Not Anemia	59 (40.1)	88 (59.9)	147 (100)			
History of Covid-19 Infection						
Covid (Ref)	65 (70.7)	27 (29.3)	92 (100)	4.071	2.327 -7.120	0.001*
No Covid	55 (37.2)	93 (62.8)	148 (100)			
ANC Visit History						
<4 (four) (Ref)	10 (50)	10 (50)	220 (100)	1.000	0.400-2.498	1.001
≥4 (four)	110 (50)	110 (50)	20 (100)			
Weight Gain Compliance with Recommendation						
Not Recommended (Ref)	29 (53.7)	25 (46.3)	54 (100)	1.211	0.660-2.223	0.536
As Recommended	91 (48.9)	95 (51.1)	186 (100)			
Education Level						
Less Education (Ref)	26 (50)	26 (50)	52 (100)	1.000	0.541-1.848	1.000
Higher Education	94 (50)	94 (50)	188 (100)			

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Variable	Case LBW n (%)	Control Normal Birth Weight n (%)	Total n (%)	OR	CI (95%)	p-value
External Factor						
Income Level						
<Regional Minimum Wage (Ref)	42 (57.5)	31 (42.5)	73 (100)	1.546	0.888-2.692	0.123*
≥Regional Minimum Wage	78 (46.7)	89 (53.3)	167 (100)			
Exposure to Active Cigarette Smoke						
Yes (Ref)	104 (54.5)	87 (45.5)	191 (100)	2.466	1.272-4.777	0.006*
No	16 (32.7)	33 (67.3)	49 (100)			
Health Service Distance						
Far (Ref)	37(43)	49 (57)	86 (100)	0.646	0.380-1.099	0.106*
Near	83(53.9)	71 (46.1)	154 (100)			
Participation in Maternity Class						
Not Participating (Ref)	10 (52.6)	9 (47.4)	19 (100)	0.892	0.349-2.279	0.811
Follow	110 (49.8)	111(50.2)	221(100)			
Health Insurance Ownership						
Do not Have (Ref)	52 (70)	22 (30)	74 (100)	3.406	1.895-6.125	0.001*
Have Health Insurance	68 (41)	98 (59)	166(100)			

*Included in regression analysis if p-value <0.25, LBW (Low Birth Weight), OR (Odds Ratio), CI (Confident Interval) 95%.

Table 2 explores not only internal factors but also external influences on LBW risk. It highlights several external factors with significant associations. Low income, specifically below the minimum wage, appears to be a contributing factor. Furthermore, limited access to healthcare facilities, potentially due to geographical distance, is another concern. Exposure to cigarette smoke by family members within the household environment also emerged as a risk factor. Finally, lacking health insurance may limit access to proper prenatal care, potentially increasing the risk of LBW.

Tabel 3. Final regression of risk factor for low-birth-weight incidence in Kutai Kartanegara

Variable	OR	CI	p-value
Upper Arm Circumference <23.5 cm	2.800	1.237-6.340	0.014*
History of Anemia	3.156	1.716-5.804	0.001*
History of Covid-19 Infection	4.357	2.355-8.063	0.001*
Exposure to Cigarette Smoke	2.505	1.716-2.804	0.001*
No Health Insurance	2.744	1.435-5.247	0.002*
Constant	0.602		

OR (Odds ratio), CI (Confident Interval), *chi-square (significant if p-value <0.05)

A multivariate logistic regression analysis, detailed in Table 3, identified several key risk factors associated with low birth weight (LBW) in mothers delivering at public health facilities in Kutai Kartanegara, Indonesia. Mothers with low upper arm circumference, indicating malnutrition (OR=2.800, 95% CI=1.237-6.340), and those with a history of anemia (OR=3.156, 95% CI=1.716-5.804) were found to be at significantly higher risk. The study also revealed a concerning association between a past Covid-19 infection and LBW, with mothers having had the disease exhibiting a fourfold increase in risk (OR=4.357, 95% CI=2.355-8.063). Furthermore, exposure to cigarette smoke at home (OR=2.505, 95% CI=1.716-2.804) and lacking health insurance (BPJS) (OR=2.744, 95% CI=1.435-5.247) were identified as additional significant risk factors for LBW deliveries.

Tabel 4. Internal and external risk factors for LBW in covid-19 patients in Kutai Kartanegara

Variabel	Case LBW n (%)	Control Normal Birth Weight n (%)	Total n (%)	OR	CI (95%)	p-value
Internal Factor						
Age				0.156	0.055-0.443	0.001*
Reproduction at Risk	23 (52.3)	21 (47.7)	44 (100)			

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Variabel	Case LBW n (%)	Control Normal Birth Weight n (%)	Total n (%)	OR	CI (95%)	p-value
(<20 & ≥35 years old) (Ref)						
Reproductively Healthy (20-35 years old)	42 (87.5)	6 (12.5)	48 (100)			
Upper Arm Circumference				1.563	1.319-1.852	0.002*
<23,5 cm (Ref)	17 (100)	0 (0)	17 (100)			
≥23,5 cm	48 (64)	27 (36)	75 (100)			
Height						
<150 cm (Ref)	21 (67.7)	10 (32.3)	31 (100)	0.811	0.317-2.073	0.662
≥150 cm	44 (72.1)	17 (72.1)	61 (100)			
Parity				1.393	0.564-3.438	0.471
Unsafe Parity (1 and >3) (Ref)	39 (73.6)	14 (26.4)	53 (100)			
Safe Parity (2 and 3)	26 (66.7)	13 (33.3)	39 (100)			
Birth Interval				3.818	1.032-14.122	0.035
Risk (<2 years) (Ref)	21 (87.5)	3 (12.5)	24 (100)			
Not Risk (≥2 years)	44 (64.7)	24 (35.3)	68 (100)			
History of Anemia				2.605	0.969-7.002	0.054
Anemia	31 (81.6)	7 (18.4)	38 (100)			
Not Anemia	34 (63)	20 (37)	54 (100)			
ANC Visit History				1.429	1.248-1.635	0.357
<4 (four)	2 (100)	0(0)	2 (100)			
≥4 (four)	63 (70)	27 (30)	90 (100)			
Weight Gain Compliance with Recommendation				1.212	0.492-2.986	0.676
Not Recommended (Ref)	13 (65)	7 (35)	20 (100)			
As Recommended	52 (68.8)	20 (31.2)	72 (100)			
External Factor						
Education Level				0.407	0.145-1.141	0.082
Less Education (Ref)	11 (55)	9 (45)	20 (100)			
Higher Education	54 (75)	18 (25)	72 (100)			
Income Level				1.134	0.427- 3.008	0.801
<Regional Minimum Wage (Ref)	21 (72.4)	8 (27.6)	29 (100)			
≥Regional Minimum Wage	44 (69.8)	19 (30.2)	63 (100)			
Exposure to Active Cigarette Smoke				5.784	1.837-18.212	0.001*
Yes (Ref)	59 (77.6)	17 (22.4)	76 (100)			
No	6 (37.5)	10 (62.5)	16 (100)			
Health Service Distance				0.343	0.131-0.898	0.026*
Far (Ref)	14 (53.8)	12 (46.2)	26 (100)			
Near	51 (77.3)	15 (22.7)	66(100)			
Participation in Maternity Class				0.319	0.037-2.274	0.273
Not Participating (Ref)	58(69)	26 (31)	84 (100)			
Follow	7 (87.5)	1 (12.5)	8 (100)			
Health Insurance Ownership				4.351	1.351-14.017	0.010*
Do not Have (Ref)	28 (87.5)	4 (12.5)	32 (100)			
Have Health Insurance	37 (61.7)	23 (38.3)	60 (100)			

LBW (Low Birth Weight), OR (Odds Ratio), * chi-square (significant if p-value <0.05), CI (Confident Interval) 95%.

Table 4 delves deeper by analyzing risk factors for LBW within two separate groups: mothers with and without a history of Covid-19. Interestingly, the factors influencing LBW risk differed between the groups. For mothers who had previously contracted Covid-19, factors like maternal age, upper arm circumference (indicating nutritional status), short birth intervals (less than 2 years between pregnancies), educational level, and exposure to cigarette smoke emerged as significant contributors to LBW risk. In contrast, Table 5 highlights the risk factors for LBW in mothers who did not have Covid-19. Here, a history of anemia and lacking health insurance were identified as the key factors associated with an increased risk of delivering a low-birth-weight baby.

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Tabel 5. Internal and external risk factors for LBW in non-Covid-19 patients

Variabel	Case LBW n (%)	Control BBLN n (%)	Total n (%)	OR	CI (95%)	p-value
Internal Factor						
Age						
Reproduction at Risk (<20 & ≥35 years) (Ref)	36 (38.7)	57 (61.3)	93 (100)	1.197	0.597-2.398	0.612
Reproductively Healthy (20-35 years)	19 (34.5)	36 (65.5)	55 (100)			
Upper Arm Circumference						
<23,5 cm (Ref)	10 (43.5)	13 (56.5)	23 (100)	1.368	0.555-3.369	0.495
≥23,5 cm	45 (36)	80 (64)	125 (100)			
Height						
<150 cm (Ref)	12 (42.9)	16 (57.1)	28 (100)	1.343	0.582-3.100	0.489
≥150 cm	43 (35.8)	77 (64.2)	120 (100)			
Parity						
Unsafe Parity (1 and >3) (Ref)	27 (35.1)	50 (64.9)	77 (100)	0.829	0.425-1.617	0.582
Safe Parity (2 and 3)	28 (39.4)	43 (60.6)	71 (100)			
Birth Interval						
Risk (<2 years) (Ref)	16 (42.1)	22 (57.9)	38 (100)	1.324	0.623-2.812	0.465
Not Risk (>2 years)	39 (35.5)	71 (64.5)	110 (100)			
History of Anemia						
Anemia (Ref)	30 (54.5)	25 (45.5)	55 (100)	3.264	1.619-6.582	0.001*
Not anemia	25 (26.9)	68 (73.1)	93 (100)			
ANC Visit History						
<4 (four) (Ref)	8 (44.4)	10 (55.6)	18 (100)	1.413	0.522-3.826	0.495
≥4 (four)	47 (36.2)	83 (63.8)	130 (100)			
Weight Gain Compliance with Recommendation						
Not Recommended (Ref)	29 (42.6)	39 (57.4)	68 (100)	1.544	0.790-3.020	0.203
As Recommended	26 (32.5)	54 (67.5)	80 (100)			
External Factor						
Education Level						
Less Education (Ref)	15 (46.9)	17 (53.1)	32 (100)	1.676	0.759-3.705	0.199
Higher Education	40 (34.5)	76 (65.5)	116 (100)			
Income Level						
<Regional Minimum Wage (Ref)	21 (47.7)	23 (52.3)	44 (100)	1.880	0.915-3.860	0.084
≥Regional Minimum Wage	34 (32.7)	70 (67.3)	104 (100)			
Exposure to Active Cigarette Smoke						
Yes (Ref)	45 (39.1)	70 (60.9)	115 (100)	1.479	0.644-3.396	0.355
No	10 (30.3)	23 (69.7)	33 (100)			
Health Service Distance						
Far (Ref)	23 (38.3)	37 (61.7)	60 (100)	1.088	0.552-2.143	0.808
Near	32 (36.4)	56 (63.6)	88 (100)			
Participation in Maternity Class						
Not Participating	52 (38)	85 (62)	137 (100)	1.631	1.414-6.427	0.481
Follow	3 (27.3)	8(72.7)	11 (100)			
Health Insurance Ownership						
Do not Have (Ref)	22 (56.4)	17 (43.6)	39 (100)	2.433	1.170-5.059	0.016*
Have Health Insurance	33 (30.3)	76 (69.7)	109 (100)			

LBW (Low Birth Weight), OR (Odds Ratio), *chi-square (significant if p-value <0.05), CI (Confident Interval) 95%.

The causes of LBW during the Covid-19 pandemic in Kutai Kartanegara in this study were found to be several factors, Upper arm circumference size <23.5 cm, history of anemia, history of Covid-19 infection, exposure to cigarette smoke and not having health insurance. The purpose of this study can be the basis for efforts to prevent LBW. This study was conducted when the respondents experienced pregnancy during the Covid-19 pandemic, so that the correlation between Covid-19 virus infection and the incidence of LBW was obtained. The Covid-19 pandemic situation as an emergency situation that has an influence on many things, in addition to the sharp increase in cases, it also has a lot of influence on the birth of premature babies, which increases the birth rate of babies with LBW. This is in accordance with research in Wuhan and Nanjing, China, which obtained the results of the birth of babies with lower weight more than the pre-pandemic period in full-term births. Mothers infected with Covid-19 increase the risk of caesarean delivery due to premature rupture of

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membranes, and fetal distress, thus increasing premature birth[7,11,12]. Pregnant women infected with Covid-19 experience limitations in the fulfillment of oxygen supply, the caesarean section rate of 46% has increased 1.5 times compared to before the pandemic[13]. The Covid-19 virus attacks the mother's respiratory tract so that the supply of food intake is also hampered due to respiratory problems experienced by the mother[11,14] . Research in Pakistan states that another thing that increases the risk of mothers experiencing low birth weight is the stressful conditions experienced by mothers during the Covid-19 pandemic[15].

The Covid-19 condition in this study increases LBW births because it occurs with other factors that also increase the risk of LBW, such as exposure to cigarette smoke. In this study, more than 80% of pregnant women lived with smokers, who smoked in the house so that during the pandemic the exposure of pregnant women to cigarette smoke increased even more. In this study, mothers have a risk of 2.505 times giving birth to LBW babies when there are family members as smokers, and in mothers infected with Covid-19 the risk of giving birth to LBW is even greater to 5.784 times, in mothers who are not affected by Covid-19 and are at home with smokers, have a risk of giving birth to LBW babies 1.479 times. The impact of exposure to cigarette smoke was greater on mothers affected by Covid-19, in Schiliro research mentioned that exposure to cigarettes for one hour has an adverse effect on lung membranes and increases symptoms of respiratory infections. This is also the case for pregnant women who are continuously exposed to cigarette smoke during pregnancy, increasing the risk of respiratory infections during pregnancy[16].

These results further strengthen Covid-19 infection during pregnancy, increasing the risk of LBW birth which is influenced by external maternal variables[17]. This study is similar to research on pregnant women in Surabaya which shows that mothers exposed to cigarette smoke are at risk of 3.04 times giving birth to LBW babies. Another study from Turkey mentioned that mothers who are exposed to secondhand smoke during pregnancy have the possibility of giving birth to LBW (OR=2.405, 95% CI=2.570-47.741)[18].

In this study, maternal age <20 years or ≥35 years was a protective factor for the incidence of LBW just positive in pregnant mother with Covid-19. Most of the subjects in this study were ≥35 years old (22.2%) this occurred due to limited access to health services to obtain family planning services, so that during the Covid-19 pandemic at the research location there were many unplanned pregnancies. Research in Finland states that mothers who delivered at the age of over 30 years have more mature socio-economic characteristics, which are closely related to a more stable household income, so that the fulfilment of nutrition during pregnancy is more easily obtained. In addition, the education of mothers above the age of 30-40 years is considered to have reached the highest level of education. This also identifies that age has become a measurement of a person's maturity, and mothers who become pregnant above the age of 30 years are considered to have a higher maturity trait. Thus, they are considered to be able to go through pregnancy more maturely than those under the age of 30 years[19].

At the Kutai Kartanegara, mothers aged 20-35 years who experienced LBW were due to more pregnant women at that age being exposed to Covid-19. When mothers experience Covid-19, they are at risk of experiencing a cytokine storm. This cytokine storm damages organs in younger people, as the immune system at that age seems stronger and has better recovery capabilities than older ages[20]. In pregnancy conditions, this cytokine storm causes serious pregnancy complications, such as preeclampsia and other organ damage. There is also dysregulation of the immune system resulting in inflammation that affects the placenta and contributes to LBW[21]. Babies born to mothers who have experienced a cytokine storm during pregnancy have a higher risk of LBW due to the non-optimal intrauterine environment due to inflammation[22–24].

Based on a brief interview conducted by the researcher regarding pregnancy during the pandemic and previous pregnancy experiences, the researcher can conclude that age above 35 years is a protective factor in the incidence of LBW, due to the mother's previous experience, the mother has better knowledge from previous pregnancies, the mother becomes more attentive to pregnancy during the pandemic because the mother knows that unfavorable conditions will affect the health of her pregnancy, so the mother tries to improve nutrition during pregnancy. This reason same with literature research which states that older mother has greater emotional maturity and feel more prepared for motherhood. In addition, advanced maternal age appears to exert a protective influence on children behavioral, social and emotional functioning, thus offsetting biological risks and during the Covid-19 pandemic present challenges for women with risk pregnancies, which negatively impacts psychological conditions and health seeking behaviours[25,26].

In this study, there was a correlation between maternal upper arm circumference and the incidence of LBW. Mothers with upper arm circumference less than 23.5 cm have a risk of giving birth to babies with LBW by 2.390 times compared to those with upper arm circumference > 23.5 cm. In the conditions of the Covid-19 pandemic, access to animal protein is limited due to lack of availability or increased prices.

Research in India also shows that upper arm circumference < 23.5 cm is a determinant of LBW incidence (OR 0.57, 95%CI 0.52-0.60), the Odds Ratio obtained in this study is greater at 2.39 times. mentioned the taboo on certain foods makes pregnant women have Upper arm circumference < 23.5 cm, Different things happen at the research location, taboo foods are not well known by pregnant women. Upper arm circumference has a relationship with Chronic Energy Deficiency (CED) in pregnant women, the results of the study mentioned the cause of LBW in West Kutai is the high rate of CED in pregnant women. Kutai Barat and KuKar have similar characteristics [27]. In this study, mothers who suffered from Covid-19 had a greater risk of giving birth to LBW when they had Upper arm circumference <23.5 cm, the risk was 0.811.

Iron requirements during pregnancy increase by 1.25 mg/dl compared to non-pregnant conditions[28]. The

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incidence of LBW is also still strongly related to the incidence of anemia in pregnant women. This study also proved that anemic mothers have a 2,843 times risk of giving birth to LBW babies, compared to mothers who do not have a history of anemia. This is also in accordance with research in India, which states that LBW is 1.5 (OR=1.27-1.9) times more likely to occur in women with severe anemia and 1.14 (1.06-1.22) in women with moderate anemia[29] . Study meta-analysis maternal anemia was associated with low birth weight with an adjusted OR=1.23 (95% CI=1.06–1.43)[30]. The findings of this study are similar to studies reported in China[31], India[32], and Brazil[33]. This is due to intrauterine growth restriction. When maternal hemoglobin levels drop, oxygen circulation in the fetal body is limited. Thus, the fetal placenta is exposed to an oxidative stress environment (chronic hypoxia), which disrupts the transfer of oxygen/nutrient supply, resulting in fetal growth restriction and low birth weight due to placental angiogenesis[34] . Holistic assistance is required to ensure that blood supplement tablets are properly consumed by pregnant women every day, so that the existing program runs effectively and efficiently.

Insurance ownership affects the birth of LBW in the study mentioned that there are still several subjects who do not have health insurance, and the risk of giving birth to a baby with LBW is 2.570. This is in line with the results of research in Indonesia, which states that babies from families participating in Non-ASKESKIN (social health insurance for the poor) health insurance are protected from LBW (OR; 95% CI =0.61; 0.43-0.88)[35]. This is also in accordance with Laksono's research that mothers who have health insurance showed a 1.416 times greater chance of understanding the danger signs of pregnancy compared to those who do not have health insurance[36]. The results of the Crescent study in Simbolon showed that healthcare social secure net program/*Jaring Pengaman Sosial Bidang Kesehatan* (JPS-BK) services for poor families participating in JPS-BK were very beneficial for pregnant women, postpartum women, breastfeeding mothers and other family members, in utilizing antenatal, delivery, post-natal, immunization, and other health services[35]. Another study mentioned that the ownership of health insurance in Indonesia shows an increasing trend although the coverage is still very low, and this low coverage will have an impact on the persistence of nutrition and maternal health problems in Indonesia[37]. Laksono's research states that the determinants of health insurance ownership in Indonesia are the level of education, wealth status, parity (multiparity), and knowledge of pregnancy danger signs, which will lead to greater efforts to have health insurance[37].s

This study found that there was a correlation between the birth spacing and the incidence of LBW. The best distance between pregnancy and the next pregnancy is above 24 month or two years, because with this distance the mother was considered to be better prepared to carry pout pregnancy with the fulfillment of better nutrition. Devagurudi study in India states that mothers with short pregnancies increase the risk of LBW, this occurs due to deteriorating nutritional status during pregnancy[38]. In this study, the Covid-19 situation in Indonesia provided limitations in the fulfillment of daily nutrition due to the unavailability old many foods as before the Covid-19 pandemic[39]. In addition, Covid-19 patient there was a decrease in appetite when they are sick, making it difficult to eat and further increasing pregnant women suffering from Covid-19 experience a decrease in appetite and fulfillment of nutrition during pregnancy[40].

CONCLUSIONS

This study concludes that the internal risk factors for LBW during the Covid-19 pandemic are safe reproductive age, Upper arm circumference <23.5 cm, history of anemia, history of Covid-19 infection, and birth spacing <2 years, and external risk factors are living with smokers, not having health insurance are factors that significantly increase the incidence of LBW during the Covid-19 pandemic. Further studies regarding the internal and external risk factors of low birth weight can be conducted in longitudinal studies.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

LK: conceptualization, investigation, methodology, writing–original draft, and editing; MIK: supervision, methodology; SAN: writing–review, methodology, formal analysis; FA: statistical analysis, writing–review, formal analysis, resources.

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RESEARCH STUDY
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The Risk Factors for Anemia in Women at Third Trimester of Pregnancy in the Primary Health Center of Tanjung Sekayam: A Case-Control Study

Faktor Risiko Anemia pada Ibu Hamil Trimester Ketiga di Puskesmas Tanjung Sekayam: Studi Kasus-Kontrol

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ABSTRACT

Background: The presence of anemia in pregnant women significantly affects the health of both mothers and their fetuses. Around 37% of pregnant women worldwide experience anemia. In the Community Health Center of Tanjung Sekayam, the prevalence of anemia in women at the third trimester of their pregnancy was notably high, at 50.4%.
Objectives: This study aims to identify the risk factors for anemia in women at third trimester of pregnancy in the working area of the Community Health Center of Tanjung Sekayam Subdistrict, Sanggau Regency.
Methods: This study was an observational research with a case-control design. The study population consisted of 153 women at third trimester of pregnancy, receiving antenatal care in the Community Health Center of Tanjung Sekayam. The samples included 62 respondents, selected through a simple random sampling, comprising of 31 cases and 31 controls. Data were collected using questionnaires and analyzed with the Chi-Square test to assess the factors associated with the occurrence of anemia.
Results: There was a relation among maternal age (p=0.000; OR=22.9), interpregnancy interval (p=0.024; OR=6.9), parity (p=0.011; OR=2.2), nutritional status (chronic energy deficiency) (p=0.000; OR=11.3), compliance (p=0.021; OR=3.9), and knowledge (p=0.001; OR=8.2) and the prevalence of anemia in the third trimester. However, the family support did not show any significant relation.
Conclusions: Maternal age, pregnancy interval, parity, nutritional status, compliance with iron tablet intake, and knowledge are related to the prevalence of anemia in third trimester of pregnancy. Family support did not show any significant relation with the incidence of anemia, possibly due to the limitations in measuring the family support itself and other factors, such as discomfort in consuming iron tablets and forgetfulness. More structured interventions and intensive education on the importance of iron and nutrition during the pregnancy are needed to reduce the risk of anemia.

INTRODUCTION

Anemia is a health condition marked by the number of red blood cells which are reduced or lower than the normal hemoglobin concentration, which is vital for transporting oxygen to the body's tissues. Its symptoms can include tiredness, weakness, dizziness, and the difficulty in breathing. Anemia can be caused by nutritional deficiencies, infections (e.g., malaria, tuberculosis, and HIV), chronic diseases, and the inherited red blood cell disorders. Iron deficiency is the most frequent cause, but other deficiencies in folate, vitamin B12, and vitamin A can also lead to anemia. The anemia commonly affects children, adolescent girls, the menstruating women, and pregnant and postpartum women in particular[1].

Anemia is a prominent public health concern at a global scale, particularly in the developing nations, in which the pregnant women are disproportionately affected. According to the World Health Organization (WHO), about 37% of pregnant women globally were affected by anemia[1]. Based on data from the 2023 Indonesian Health Survey, the prevalence of anemia among pregnant women in Indonesia was reported to be 27.7%[2].

Based on the information from the West Kalimantan Health Department on Family Health and

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Nutrition, the prevalence of anemia in pregnant women in 2019 reached 11,456 cases (12.25%), an increase from 10,800 cases (11.17%) in 2018[3,4]. In Sanggau Regency, the prevalence of anemia among pregnant women in 2019 reached 1,106 cases (10.13%). The highest occurrence was reported in the working área of Community Health Center of Tanjung Sekayam, in which 557 pregnant women (50.4%) were diagnosed with anemia[5]. Anemia during pregnancy is linked to several negative outcomes for both mothers and their fetuses, such as a higher risk of preterm labor, low birth weight, postpartum hemorrhage, infections, fetal abnormalities, and miscarriages. The third trimester is particularly crucial as nutritional needs are greater. Pregnant women with iron deficiency face an increased likelihood of the complications during pregnancy[6–8].

Anemia in pregnant women can be affected by a number of factors, such as mother's age, the stage of pregnancy, the number of previous pregnancies, and overall nutritional status. [9]. Other factors include maternal compliance with the iron tablet consumption, interpregnancy interval, maternal knowledge on the iron tablet consumption patterns, and family support, all of which have an effect on the occurrence of maternal anemia[9–11]. This study aims to determine the prevalence of anemia and its causing factors among women at third trimester of pregnancy in the Community Health Center of Tanjung Sekayam Subdistrict, Sanggau Regency.

METHODS

This research was an observational analytical study utilizing a case-control design. The population in this study consisted of a total 153 women at the third trimester of pregnancy, who received the Antenatal Care (ANC) services in the Primary Health Center of Tanjung Sekayam, based on the medical records from January to December 2020. The samples included 62 respondents (1:1 ratio), comprising 31 cases and 31 controls. The case and control samples were obtained using the simple random sampling, in which the case criteria were pregnant women with hemoglobin (Hb) level <11 g/dl and the control criteria were pregnant women with hemoglobin (Hb) level >11 g/dl. Data were collected through the ANC cohort visit book and a developed questionnaire that had been tested for its validity and reliability to capture several variables (e.g., maternal age, interpregnancy interval, parity, nutritional status, compliance, knowledge, and family support) in relation to the anemia status in cases and controls. The study variables included maternal age at risk (<20 years and >35 years) and not at risk (20–35 years), interpregnancy interval at risk (<2 years) and not at risk (≥2 years), parity at risk (>3 children) and not at risk (≤3 children), nutritional status (chronic energy deficiency) at risk (upper arm measurement <23.5 cm) and not at risk (upper arm measurement ≥23.5 cm). The compliance variable was categorized as non-compliant (Fe consumption <90 tablets) and compliant (consumption of 90 Fe tablets). The knowledge variable was assessed through 10 questions and categorized as poor (<7) and good (≥7), while family support was assessed through 4 questions and categorized as poor (<3) and good (≥3). The univariate (descriptive) analysis was used to observe frequency and percentage, while the bivariate analysis was used to test bivariate relation through the chi-square test. Decisions were made based on the p-value, in which a p-value <0.05 was statistically significant, indicating a strong evidence against the null hypothesis and suggesting a significant relation among the variables. All statistical analyses were carried out using Statistical Package for the Social Sciences (SPSS). This study was approved by the Ethics Committee of Muhammadiyah University of Pontianak with the number: 002a/KEPK-FIKES/UM PONTIANAK/2021.

RESULTS AND DISCUSSIONS

Univariate analysis in this study was applied to determine the frequency distribution of dependent and independent variables. In Table 1, it can be observed that most of the respondents from total 62 respondents were housewives in case group (93.5%) and control group (71.0%). In terms of education level, most of the respondents in case group had graduated from senior high school (38.7%), while most of the respondents in control group also had the same level of education (51.6%). In terms of age, 61.3% of respondents in the case group were at risk (<20 and >35 years), while respondents in the control group (93.5%) were not at risk (20-35 years). For the gestational interval, 32.3% of respondents in the case group were at risk (<2 years), while respondents in the control group (93.5%) were not at risk (≥2 years). In terms of parity, 22.6% of respondents in the case group were at risk (>3 children), whereas all respondents in the control group (100%) were not at risk (≤3 children). Concerning nutritional status, 54.8% of respondents in the case group had at-risk nutritional status, while 90.3% of respondents in the control group had non-at-risk nutritional status. Regarding the compliance factor, 69.2% of respondents in the case group were non-compliant in Fe tablet consumption, compared to 63.9% compliance in the control group.

Based on the knowledge category, the case group demonstrated insufficient knowledge (at 87.1%), whereas the control group had adequate knowledge (at 64.5%). Most mothers in both groups were unaware of the Fe tablet, with the percentages of 42% in the case group and 26% in the control group. Similarly, many mothers did not know the consequences of having iron deficiency, with the percentage of 45% in the case group and 29% in the control group. Regarding the family support, the case group (at 29.0%) received inadequate family support, while the control group (at 83.9%) received sufficient family support. Most of the mothers (26% in the case group and 39% in the control group) lacked motivation from their families to consume Fe tablets. The lack of family support in obtaining Fe tablets was also prevalent, with the percentage of 39% in the case group and 26% in the control group. The results of the univariate analysis are presented in Table 1 below.

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Table 1. Frequency Distribution and the Percentage of Respondents Based on Their Occupation, Education Level, Age, Gestational Interval, Parity, Nutritional Status, Compliance, Knowledge, and Family Support for Women at Third Trimester of Pregnancy at Health Center of Tanjung Sekayam Subdistrict, Sanggau Regency, Indonesia through a Questionnaire (n=62)

Variable	Case		Control	
	n	%	n	%
Respondents' Occupations				
Teacher	1	3.2	2	6.5
Housewife	29	93.5	22	71.0
Entrepreneur	0	0.0	1	3.2
Trader	1	3.2	1	3.2
Farmer	0	0.0	2	6.5
Civil Servant	0	0.0	2	6.5
Private Sector Employee	0	0.0	1	3.2
Education Level				
Elementary School	9	29.0	5	16.1
Junior High School	9	29.0	5	16.1
Senior High School	12	38.7	16	51.6
Diploma / Bachelor's Degree	1	3.2	5	16.1
Age				
At Risk (<20 and >35 Years)	19	61.3	2	6.5
Not at Risk (20-35 Years)	12	38.7	29	93.5
Gestational Interval				
At Risk (<2 Years)	10	32.3	2	6.5
Not at Risk (≥2 Years)	21	67.7	29	93.5
Parity:				
At Risk (>3 Children)	7	22.6	0	0
Not at Risk (≤3 Children)	24	77.4	31	100
Nutritional Status				
At Risk (Upper Arm Measurement <23.5 cm)	17	54.8	3	9.7
Not at Risk (Upper Arm Measurement ≥23.5 cm)	14	45.2	28	90.3
Compliance				
Non-Compliant (Consumption of <90 Fe Tablets)	18	69.2	8	30.8
Compliant (Consumption of 90 Fe tablets)	13	36.1	23	63.9
Knowledge				
Insufficient (Score <7)	27	87.1	11	35.5
Adequate (Score ≥7)	4	12.9	20	64.5
Family Support				
Insufficient (Score <3)	9	29.0	5	16.1
Adequate (Score ≥3)	22	71.0	26	83.9

The bivariate analysis in this study was conducted to identify the risk factors associated with anemia among women at third-trimester of pregnancy in the Community Health Center of Tanjung Sekayam Subdistrict, Sanggau Regency. The chi-square test results revealed the significant relation between anemia and several factors, namely age (p=0.000; OR=22.95), gestational interval (p=0.024; OR=6.905), parity (p=0.011; OR=2.292), nutritional status (p=0.000; OR=11.333), maternal compliance (p=0.021; OR=3.981), and knowledge (p=0.001; OR=8.233). However, no significant relation was found between family support (p=0.362; OR=2.127) and anemia in third trimester of pregnancy. The details of bivariate analysis results are presented in Table 2 below.

Table 2. Analysis on the Risk Factors for Anemia in Women at Third-Trimester of Pregnancy at Health Center of Tanjung Sekayam Subdistrict, Sanggau Regency, Indonesia through a Questionnaire (n=62)

Variable	Hb Level		p	OR	95% CI	
	Anemia	Non Anemia			Lower	Upper
Age						
At Risk (<20 and >35)	19 (30.6%)	2 (3.2%)	0.000	22.95	4.613	114.265
Not at Risk (20-35)	12 (19.4%)	29 (46.8%)				
Gestational Interval						
At Risk (<2)	10 (16.1%)	2 (3.2%)	0.024	6.905	1.368	34.846
Not at Risk (≥2)	21 (33.9%)	29 (46.8%)				
Parity						
At Risk (>3)	7 (11.3%)	0 (0.0%)	0.011	2.292	1.697	3.095
Not at Risk (≤3)	24 (38.7%)	31 (50%)				
Nutritional Status						
At Risk (<23.5)	17 (27.4%)	3 (4.8%)	0.000	11.333	2.837	45.272

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Variable	Hb Level		p	OR	95% CI	
	Anemia	Non Anemia			Lower	Upper
Not at Risk (≥23.5)	14 (22.6%)	28 (45.2%)				
Compliance						
Non-Compliant	18 (29.0%)	8 (12.9%)	0.021	3.981	1.358	11.666
Compliant	13 (21.0%)	23 (37.1%)				
Knowledge						
Insufficient (<7)	26 (41.9%)	12 (19.4%)	0.001	8.233	2.482	27.317
Adequate (≥7)	5 (8.1%)	19 (30.6%)				
Family Support						
Insufficient (<3)	9 (14.5%)	5 (8.1%)	0.362	2.127	0.621	7.291
Adequate (≥3)	22 (35.5%)	26 (41.9%)				

Based on the research findings, pregnant women at an at-risk age tended to having anemia (30.6%), contrary to the pregnant women at a non-at-risk age (46.8%). Further analysis revealed a significant relation between maternal age and the anemia occurrence during pregnancy. Age is one of the factors contributing to anemia in pregnant women. Mothers under the age of 20 years have a higher risk of having anemia during pregnancy[12]. Pregnancies at the age below 20 years and above 35 years are associated with an increased risk of anemia[13,14]. In women under the age of 20 years, various bodily organs, including reproductive development, are still in the maturing process, thus requiring a significant supply of nutrients. Consequently, if pregnancy occurs during this age, iron consumed is distributed to the fetus as well as mother's own biological growth, both of which demand substantial iron intake. Insufficient nutrient intake can lead to anemia[15]. Conversely, mothers above the age of 35 years often have the decreased bodily functions and are more susceptible to chronic illnesses, all of which can hinder iron absorption[16]. The ideal maternal age range for pregnancy is between 20 and 35 years, as this group has a lower risk of pregnancy complications and healthier reproductive systems[17]. Recommendations are directed towards mothers under the age of 20 years, encouraging them to delay pregnancy through the use of contraception. Similarly, mothers above the age of 35 years are advised not to get pregnant again.

According to the research findings, there was a significant correlation between how long the pregnancy interval and the incidence of anemia in pregnant women. Maternal pregnancy interval has been identified as a factor affecting the occurrence of anemia. Mothers with a shorter pregnancy interval (≤2 years) are exposed to a higher risk of having anemia, which can affect the well-being of the fetus growth[18–20]. One of the causes of anemia is the repeated pregnancies with a short interval. The reason is that the subsequent pregnancies occurring in a short interval take the mother's iron reserves, which may not have been fully replenished since previous pregnancy[15]. Each pregnancy depletes the body's iron reserves, while it takes time to recover iron reserves. Having pregnancies with too short interval increases the risk of anemia in subsequent pregnancies, as the body does not have sufficient time to replenish the depleted iron reserves. On the other hand, with an optimal pregnancy interval (>2 years), mother's uterus and physical condition have been fully recovered and prepared for another pregnancy[18]. Based on the recommendations, pregnant women are advised to plan their next pregnancy with an interval of longer than 2 years.

The research results indicated a significant association between the number of pregnancies (parity) and the occurrence of anemia in pregnant women. Other research findings also indicated that anemia tended to occur more frequently in multiparous mothers[11,13]. More frequent pregnancies and childbirth in women mean a greater loss of iron. During the pregnancy, there is an increased need for the iron to boost red blood cell production in mother's body and to support the development of red blood cells in her fetus. Mothers with some children must meet nutritional needs, not only for themselves but also for breastfeeding and caring for their children. This heightened nutritional demand can lead to an increased consumption of iron required for red blood cell production. If a mother does not receive sufficient iron intake through her diet, the risk of anemia will rise[21]. Mothers with three or more pregnancies have a higher risk of maternal mortality. The parity increases, so does the maternal mortality rate. In the cases of high parity, mothers have undergone multiple childbirths which can lead to the deterioration of reproductive organ functions. If they fail to maintain a balanced diet and neglect to take iron supplements, it can lead to the anemia during pregnancy. This situation presents dangers for mothers and their fetuses, while affecting the childbirth process. The risk can be minimized or avoided by applying the family planning programs[8]. It is recommended for the pregnant mothers to have children up to 3 (three).

Based on research findings, there was a significant correlation between nutritional status (upper arm measurement) and the occurrence of anemia in pregnant mothers. Mothers with a poor nutritional status (upper arm measurement <23 cm) are at a higher risk of having anemia, compared to mothers with a good nutritional status[22]. Anemia is more prevalent among pregnant mothers with the Chronic Energy Deficiency (CED) / upper arm measurement <23.5 cm, compared to the well-nourished pregnant mothers. This condition may be attributed to the adverse effects of protein-energy malnutrition and deficiency of other micronutrients on iron bioavailability and the storage of other hematopoietic nutrients (e.g., folic acid and vitamin B12). If MUAC measurement in pregnant women shows the result of less than 23.5 cm or falls within the middle portion of the MUAC tape, it indicates the risk of CED. Pregnant women having CED are at risk of developing anemia because CED reflects the inadequate nutritional

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status in pregnant mothers. Insufficient nutritional intake during pregnancy leads to an increased risk of anemia in pregnant mothers with CED[16]. Nutritional deficiency in pregnant mothers can have consequences, such as low birth weight in infants, an increased risk of neonatal mortality, an elevated risk of long-term morbidity including stunting, as well as to higher maternal morbidity and mortality rates[23]. Nutritional requirements during pregnancy vary significantly across trimesters. The nutritional needs increase, along with the pregnancy progress, thus underscoring the importance of interventions targeting women before and during pregnancy. These interventions aim to ensure the controlled nutritional intake and to reduce the incidence of malnutrition throughout the critical 1000-day period[24]. Pregnant mothers are recommended to fulfill their nutritional requirements in order to minimize the risk factors during pregnancy and provide adequate nutrition for their unborn babies.

Based on research findings, there was a significant correlation between the compliance in iron tablet consumption and the occurrence of anemia in pregnant mothers. Similar results also indicated a connection between a mother's compliance in taking iron tablets and anemia during pregnancy. The level of compliance in consuming iron tablets affects the occurrence of anemia in pregnant mothers in the third trimester, with an Odds Ratio (OR) value at 4.154. This indicated the risk of anemia in women at third trimester of pregnancy which was 4.154 times higher for not being compliant in taking iron tablets, compared to mothers compliant in iron consumption[25]. Women need more iron than men because they lose approximately 50 to 80 cc of blood during their monthly menstrual cycle, leading to a loss of 30 to 40 mg of iron. Additionally, pregnancy demands additional iron to increase red blood cells in the fetus and placenta. As an illustration, the iron requirement during pregnancy is approximately 900 mg of iron, including500 mg of iron used to elevate the mother's blood cells, with an additional 300 mg of iron for the placenta and 100 mg of iron for the fetal blood. If iron reserves are already low, each pregnancy will further deplete the body's iron levels, resulting in anemia during the next pregnancies[16]. Compliance in iron tablet consumption can be influenced by several factors, such as inadequate antenatal care, pregnancy examinations conducted by the non-healthcare personnel, rural residence, low socio-economic status, the lack of support from the spouse, the limited awareness on the importance of iron tablets, and the presence of side effects when consuming iron tablets[26–28]. To address these issues, healthcare professionals need to intervene to improve compliance in iron tablet consumption. The current strategy to cure iron-deficiency anemia primarily involves iron supplementation, through iron tablets, to women in their third trimester of pregnancy. It is prescribed that pregnant mothers in the third trimester take 90 iron tablets throughout their pregnancy. Higher compliance in pregnant mothers in consuming iron tablets means more effective prevention of anemia, thus reducing the risk of anemia. Conversely, pregnant mothers, who are less compliant in taking iron tablets, may have insufficient iron intake, leading to an increased risk of anemia[16]. It is recommended for pregnant mothers to regularly consume iron tablets in order to elevate their hemoglobin levels during pregnancy.

The results of this research prove a significant relation between maternal knowledge and the occurrence of anemia in pregnant mothers. Low knowledge levels among pregnant mothers increase the risk of anemia by three times, compared to mothers with sufficient knowledge[29]. In line with this, knowledge is also identified as a factor related to the occurrence of anemia, for being related to a mother's understanding in consuming iron supplements and her adherence to doing so[30–33]. Knowledge is the result of recalling events or incidents that have been experienced, either intentionally or unintentionally, after observing or sensing a specific object, thus being a crucial aspect in taking actions[34]. The analysis of individual questionnaire items reveals that the majority of respondents were not aware that iron deficiency during pregnancy can lead to anemia. The limited information received by respondents with moderate and low levels of knowledge could likely be attributed to internal factors, such as their lack of concern for their pregnancy condition and their limited ability to access information through both mass and electronic media[35]. Knowledge is a crucial domain for shaping an individual's behavior. In general, positive behaviors tend to reduce the risk of health problems or alleviate the suffering that has been experienced. A high level of behavior among pregnant mothers in meeting their needs for iron during pregnancy reflects a low likelihood of anemia occurrence. Providing information about anemia can further enhance the knowledge of pregnant mothers in understanding the anemia itself during pregnancy because knowledge plays a pivotal role, ultimately in leading pregnant mothers to adopt positive behaviors to meet their needs for iron[35,36]. Having nutrition professionals available during antenatal care (ANC) sessions is also crucial to educate pregnant women about benefits, potential side effects, and correct usage of the iron tablets. Furthermore, it is crucial to reactivate the monitoring of iron tablet consumption. This approach ensures that pregnant mothers receive proper information, comprehend the significance of iron supplementation, and correctly adhere to tablet consumption. This, in turn, reduces the risk of anemia and its associated complications[26]. Pregnant mothers are encouraged to continuously expand their knowledge about pregnancy and its care, including measures to prevent anemia. This will allow them to take preventive actions against occurrences that could pose risks to mothers and their expected babies.

The research found no significant correlation between family support and the occurrence of anemia in pregnant mothers. However, another perspective from different research states that family support in the form of attention, emotional support, information, advice, motivation, and understanding provided by family members is crucial in preventing anemia and enhancing compliance with iron tablet consumption[10]. Pregnant mothers who receive family support tend to be more compliant in consuming iron supplements[37]. Family support entails the attitude, actions, and acceptance of family members towards one another. Family members

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view supportive individuals as always ready to provide help and assistance when needed. Essentially, a pregnant mother desires a healthy pregnancy and a healthy child. In order for realizing mother's aspirations, family support is necessary since the family itself is a close and trusted unit where pregnant mothers seek support. This support can be encouragement, motivation, attention, or assistance, which can create a sense of happiness, safety, and comfort for the pregnant mother. Consequently, the pregnant mother is motivated to prioritize her health by consistently consuming iron tablets provided by healthcare professionals as a preventive measure against anemia during pregnancy[38,39]. Several factors indicate why family support in this study was not related to the occurrence of anemia. Firstly, the questionnaire used to measure family support had only four questions, which may not be sufficient to capture the full spectrum of family support. Family support is a multifaceted concept that includes emotional, informational, instrumental, and evaluative support, while the limited number of questions may fail to adequately reflect this complexity. Additionally, a short questionnaire may be less sensitive in detecting variations in the level of family support, thus reducing its ability to identify potential relation. Furthermore, other factors (e.g.,discomfort from consuming iron tablets and forgetfulness) may play a more significant role in influencing adherence to iron supplementation. Discomfort and side effects, such as nausea, can deter pregnant women from consistently taking iron tablets, regardless of the level of family support they receive. Finally, forgetfulness can also lead to non-compliance, which may not be effectively addressed by family support if reminders and support are not consistent or structured. Research results suggest that pregnant mothers' non-compliance in taking iron tablets is due to various reasons, including the uncomfortable side effects, such as nausea, from the iron tablets. Some pregnant mothers also fail to take the tablets regularly due to forgetfulness[40].

CONCLUSIONS

The findings of this study indicate a significant association among maternal age, the interval between pregnancies, parity, nutritional status, adherence to iron tablet intake, and knowledge, with the occurrence of anemia in women at the third trimester of pregnancy. Mothers'sage under 20 years or over 35 years, short pregnancy intervals (≤2 years), high parity (≥3 children), poor nutritional status (upper arm measurement <23.5 cm), non-compliance in consuming iron tablets, and low knowledge about the importance of iron are the main risk factors that increase the occurrence of anemia. On the other hand, family support did not show a significant relation with the occurrence of anemia, which may be due to limitations in measuring family support, discomfort when consuming iron tablets, and forgetfulness.

The recommendations from this study highlight the importance of more comprehensive and structured interventions to enhance pregnant women's understanding of the importance of iron and how to manage its side effects. More intensive education on nutrition during pregnancy, as well as health promotion emphasizing optimal pregnancy intervals, can help reduce the risk of anemia. Additionally, consistent monitoring and support from family and healthcare providers are necessary to ensure compliance with iron tablet consumption. Finally, the use of more detailed and valid questionnaires to measure family support is recommended for future research.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors have no conflict of interest in this article. This research is independent research from the researchers.

AUTHOR CONTRIBUTIONS

IA: conceptualized and designed the study; MM: analyzed data; IS: reviewing the article before submission; AR: taking responsibility in the construction of the whole or body of the manuscript; MM: collected data.

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RESEARCH STUDY
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The Maternal, Dietary Diversity, and Immunization Completeness Factors as the Determinants of Two-Year-Old Toddler Stunting in Kalinyamatan District Jepara Regency

Faktor Maternal, Keragaman Pangan dan Kelengkapan Imunisasi sebagai Determinan Stunting Baduta di Kecamatan Kalinyamatan Kabupaten Jepara

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ABSTRACT

Background: Stunting affects the quality of a country's human resources so it is important to prevent and overcome it. Stunting cases in Kalinyamatan Jepara District have increased from 12.4% in 2021 to 18.9% in 2022 and to 19.05% in 2023.
Objectives: This research analyzed the stunting risk factors of two-year-old toddlers in Kalinyamatan district, Jepara Regency.
Methods: This case-control study involved 77 stunting children and 77 normal children. The researchers selected the subjects at the integrated health care service with the highest number of visitors of two-year-old toddlers from 12 villages in Kalinyamatan district, Jepara regency, based on the inclusion and exclusion criteria. The research lasted from March to April 2024. The researchers collected the primary data with a questionnaire and the dietary diversity with a food recall questionnaire for 2x24 hours. Secondary data was collected from the mother-child health book (KIA).
Results: The results showed no differences in terms of ages and sex types from both stunting and normal children. The multivariate analysis with logistic regression test found a correlation between the anemia history during pregnancy (OR:2.75; 95% CI:1.31 – 5.78; p:0.007), career woman status (OR: 2.81; 95% CI: 1.24-6.37; p:0.014), low birth weight (OR: 3.98; 95% CI: 1.54-10.27; p:0.004), low dietary diversity (OR: 3.71; 95% CI: 1.63-8.44; p:0.002), and incomplete immunization (OR: 4.02; 95% CI: 1.66-9.74; p:0.002) with the stunting prevalence.
Conclusions: Maternal (the anemia history during the pregnancy, career woman status, and low birth weight), lack of dietary diversity, and incomplete immunization become the simultaneous determinants of stunting risk factors for two-year-old toddlers in Kalinyamatan district, Jepara Regency.

INTRODUCTION

Stunting cases in the Kalinyamatan district have been on the rise for the last three years. The percentage of stunted children under the age of two reached 11.2% by 2020 and then increased to 12.4%. By 2022, the presentation of stunting cases reached 18.9% and then increased again to 19.05% by 2023. The stunting case rate of Kalinyamatan was mostly observable in Pendosawalan village. This village becomes the stunting locus in Jepara with the stunting case of 23.1%. The other villages with stunting case were Manyargading (22.1%), Margoyoso (21.4%), Bandungrejo (20.9%), Kriyan (20.1%), Batukali (6.1%), Banyuputih (11.8%), Damarjati (8%), Purwogondo (19.9%), Sendang (14.7%), Robayan (9.5%), and Bakalan (11.6%)[1].

Children aged 1 to 5 who suffer from chronic malnutrition sometimes seem shorter than their actual age due to stunting, a condition known as growth failure. Chronic malnutrition and recurrent infection in the first 1,000 days of life are the roots of stunting. A comparison of the z-score value of body height per age <-2 standard deviation on the growth curve set by the WHO in 2005 proves the occurrence of stunting. When the z-score of the high body per age is less than two standard deviations, the WHO's 2005 growth curve indicates stunting[2].

Research found that children suffering from stunting due to malnutrition before the age of two have a higher risk of obesity and diabetes mellitus in adulthood. Stunting is associated with an increase in chronic degenerative disease in adults[3]. Children younger than 2 years old and suffering from stunting are more likely to experience cognitive impairment in the future. Among the children suffering from stunting, those who managed

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to pursue their developmental lag in the future had a better chance of raising their cognitive scores[4].

UNICEF developed the theory that factors such as poor feeding habits, a lack of maternity care, and family food resistance behavior drive stunting problems at the household level. The following aspects of childcare are important: nutrition, health, hygiene, mental stimulation, and breastfeeding. On the contrary, prenatal care and lactation are the most important times for mothers[5]. A mother's lack of understanding influences an imbalanced food supply in terms of nutrition. Factors such as wealth, parity, and the distance between pregnancies can influence the incidence of stunting. The prevalence of stunting is high in children from low-income families. Similarly, poor childcare habits and difficulties in caring for young children are consequences of having a close birth period, influencing family nutrition[6]. The declining stunting rate is associated with mothers' dietary habits, including a variety of foods, nuts, fruits, vegetables, and animal proteins. Consuming a variety of foods boosts nutritional needs. To help them grow and thrive, young people need a variety of foods that provide a wide range of nutrients, including carbohydrates, vitamins, proteins, and calories[7].

The main health problem in Kalinyamatan district is the low rate of exclusive breastfeeding (ASI), according to the results of the Self-awareness Survey (SMD) conducted by the health cadres in 2022 with 600 respondents. As many as 66% of the observed children surveyed did not receive exclusive milk. The investigation's findings revealed that many women work as industrial workers, leading to low exclusive breastfeeding coverage[8]. In Kalinyamatan district, children with mothers suffering from stunting are more likely to work as industrial workers (48%), merchants (21%), unemployed (19%), or in other professions (12%). Because of their increasing concentration on work to meet household needs, women in this scenario are less attentive to the development and growth of their toddlers. Full-time mothers often find it difficult to breastfeed because they have no time to pump the breast milk with their hands. If their babies do not get enough milk, mothers give them more formula milk[9].

The availability of formula milk also affects household spending. Poverty is the root cause of income-related malnutrition; low-income populations have a higher rate of stunting[10]. Inadequate purchasing power due to low household incomes affects the quality and quantity of food available at home, influencing nutrition intake[11]. A household achieves good food security when all members have access to adequate safe and nutritious food within a specific time frame. The study attempted to identify the associated variables with stunting in children in Kalinyamatan District, those aged 6–23 months. Therefore, the researchers design effective treatments to prevent and deal with stunting.

METHODS

This quantitative case-control study in the Kalinyamatan district of Jepara identified the most important variables associated with stunting in children aged 6 months to 2 years old. There are two groups, one representing the case and one representing the control. These groups are formed from samples. The study involved 154 participants, divided evenly between case and control groups. In this study, childhood age, gender, mother's age, parity, and father's employment status were all considered to be potential disruptive factors. In this study, the researchers conducted a comparison test between the two groups (case and control) to identify potential interference factors (Tabel 1). Both the case group and the control group share the same age.

The study was conducted in March–April 2024. The researchers selected the subjects at the Integrated Public Health Care service with high visits of two-year toddlers in Kalinyamatan district, Jepara regency, based on the inclusion and exclusion criteria. The inculcation criteria for the case group are children aged 6 months to 2 years, z-score body length/age <-2 standard deviations, and a mother and child health book. The criteria for inclusion in the control group are 6 months to 2 years old, z-score body length/age >-2 standard deviation, z-score weight/body length >-3 standard deviation, have mother-child book. The exclusion criteria for the case group and the control group are children with a congenital disorder and having no intentions to be respondents.

The calculation of the child's age was based on the full month, meaning the age of 1 month was counted if the infant reached 30 days. The researchers measured the data of the two-year-old toddlers or infants based on the body length with an infantometer. The researchers conducted a total of three times and calculated the mean value. If the infants could not stand properly, the measurement would apply the infants' weight with fewer clothes put on the infants. The researchers measured the weights until the number on the OneMed baby scale screen type 725 did not change. Once an infant could stand, the researchers used digital infant tests to measure their weight. When the digital weight shows the number 00.0, the infant should stand in the middle of the weight and stay until showing a stable figure.

The investigated variables were the mother's characteristics, the child's history of acute respiratory tract infection, the child's history of diarrheic infection, birth weight, food diversity, complementary feeding (MPASI), and drinking water availability. The mother's characteristics included a mother's education, a history of anemia during pregnancy, a maternal employment status, an antenatal care history, a per capita income, nursing patterns, and a mother's knowledge of nutrition. Mother education refers to the number of years of formal education without recurrence. If the mother's education was less than or equal to 9 years, the category of education would be low category. The anemia history refers to the records of suffering from anemia during the pregnancy with Hb lower than 11 g/dL.

The mother's occupational status refers to the jobs the mothers do to earn money. There are two categories: working and not working. Antenatal care history is defined as the number of antenatal care visits made by the mother during pregnancy. The irregular category refers to visiting prenatal care is less than 6 times during pregnancy. The family's monthly income in Rupiahs was divided by the number of family members, known as per capita income[12]. The low per-capita category refers to per-capita earnings of ≤ Rp 479,131.

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The parenting pattern refers to a nutritional fulfillment and hygiene pattern. A questionnaire with a Likert scale measured nursing patterns. The poor category refers to the total score falling below the average. Mother's knowledge of nutrition refers to a percentage of the number of correct answers to questions about child nutrition. When answer scores are ≤75%, categories are less frequent.

An infant's history of acute respiratory tract infections refers to the conditions of the infant after suffering from an upper acute respiratory infection in the last month. Acute respiratory tract infection is a symptom of a fever along with a cold or cough for 1 day, more than two days, or only coughing for more than 2 days. The diarrhea infection of children refers to the diarrhea records of the two-year-old toddler in a recent month with at least runny fecal consistency at least once within 24 hours or mushy fecal consistency three times in a recent month[13].

Food diversity is defined as the number of food groups consumed within the last 24 hours. The food group includes items such as milk, tubers, nuts, roots, grains, dairy products (cheese, yogurt, and formula milk), meat (such as meat, beef, and poultry), eggs, vegetables, and vitamin A-rich fruits, among other vegetables. The low category refers to a consumption habit of less than five food groups. The variable of complementary food for breast milk includes the administration of foods and liquid besides breast milk for children aged younger than 6 months. The basic immunization completeness refers to the basic immunization relevance with the received immunization of the two-year toddlers until the interview session based on the age. The excellence of the drinking water included no smell, taste, or color. In addition, the potential of hydrogen (pH) is 6.5–9.2, and the total dissolved solids (TDS) are <1000 parts per million.

Data from joint interviews with respondents using structured questionnaires are considered primary data sources. The researchers measured nursing patterns and mothers' knowledge variables using questionnaires from previous research and modified them based on field conditions[14]. The researchers used a Likert-scale questionnaire with 20 statement items (value r > r table for each statement) and Cronbach's alpha (0.885). The mother's knowledge questionnaire uses a double selection method with 20 question items, each with a value r > r table and Cronbach's alpha 0,789. The mother's examination history is in the mother-child book, followed by the observation sheet. Physical examination of drinking water samples included observations of odor, color, taste, pH, and TDS tests. Bivariate analysis is performed with a Chi-Square test at a 95% acupuncture rate (α 0.05). The researchers used logistic regression for multivariate analysis. The Ethics Commission of the Faculty of Public Health at Diponegoro University has qualified this research for ethics under Number 224/EA/KEPK-FKM/2024.

RESULTS AND DISCUSSIONS

Respondent Characteristics

Table 1 shows the respondent characteristics. No proportion differences between the infant sex types and ages; and stunting and normal infants. The mean of the infants' ages from the stunting group is 17 months-old while the mean of the normal infant age is 16.4 months old.

Table 1. The characteristics of infant sex types, the parity, and the job statuses of the fathers

Characteristics	Case		Control		p
	n	%	n	%	
The Sex Types of the Infants**					
Males	39	50.6	33	42.9	0.333
Females	38	46.3	44	53.7	
Parity Total					
1	25	32.5	16	20.8	
2	14	18.2	20	26	
3	20	26	22	28.6	0.374
4	17	22.1	19	24.7	
5	1	1.3	0	0	
Father Employment Statuses					
Unemployed	10	13	6	6	0.428
Employed	67	87	71	92.2	

**Infants (younger than two years old)

Table 2. The characteristics of infants and mothers in Kalinyamatan District, Jepara Regency,

Characteristics	Case	Control	p
Ages of the Infants**			
Mean	17.0	16.4	
Median	17.0	16.0	0.594
SD	3.83	4.84	
Min-Max	8 – 23	7-24	
Ages of Mothers			
Mean	31.5	32.1	0.753
Median	32	31	
SD	6.15	6.33	

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Characteristics	Case	Control	p
Min-Max	20-43	21-44	

**chi-square (significant at p<0.05)
**Infants (younger than two years old)

The result shows no significant difference between the age mean of mothers with stunting infants to those mothers with normal infants. The stunting group's age mean is 31.5, while the normal group is 32.1. The age mean of the mothers from both groups is at a safe age, 20 - 35 years old. Mothers are recommended to be pregnant at the age between 20 and 35 years old[15]. Mothers younger than 20 years old still have no optimum reproduction organs and physiological functions[16]. Besides that, their emotional and mental states are not stable. During the pregnancy, the mothers may suffer from gestational complications with the potential to deliver low-weight babies. This matter may lead to stunting. A more mature person will have more life experience and more readily accept behavioral adjustments. Age will also increase a person's maturity and strength in thinking and working[16].

Table 3. The correlation between maternal factors, acute respiratory infection history in children, diarrhea infection history in children, dietary variety, breast milk supplementary meals, basic immunization, and drinking water toward the stunting incidents in Kalinyamatan District, Jepara Regency

Variables	Stunting				p (Chi-square)	OR 95% CI (Upper – lower)
	Yes		No			
	n	%	n	%		
The Anemia History during Pregnancy						
Yes	44	61.1	28	38.9	0.015*	2.3 (1.22–4.46)
No	33	40.2	49	59.8		
The Job Statuses of The Mothers						
Employed	60	55.6	48	44.4	0.053	2.1 (1.05-4.33)
Unemployed	17	37.0	29	63.0		
The Education of The Mothers						
Low	27	65.9	14	34.1	0.029*	2.4 (1.15-5.12)
High	50	44.2	63	55.8		
Antenatal Care Record						
Irregularly	11	55.0	9	45.0	0.811	1.3 (0.49 – 3.24)
Regularly	66	49.3	68	50.7		
The Maternity Nutritional Cognition						
Low	30	63.8	17	36.2	0.036*	2.3 (1.11-4.57)
Excellent	47	43.9	60	56.1		
Parenting Pattern						
Poor	45	59.2	31	40.8	0.036*	2.1 (1.09-3.97)
Excellent	32	41.0	46	59.0		
Per-capita Income						
Low	20	69.0	9	31.0	0.039*	2.7 (1.12-6.28)
Adequate	57	45.6	68	54.5		
The Record of Acute Respiratory Tract Infection on Children						
Yes	40	51.3	38	48.7	0.87	1.1 (0.59-2.09)
No	37	48.7	39	51.3		
The Record of Diarrheal Infection						
Yes	19	46.3	22	53.7	0.715	0.8 (0.40-1.68)
No	58	51.3	55	48.7		
Birth Weight						
Low Birth Weight**	24	72.7	9	27.3	0.006*	3.4 (1.47-7.97)
Normal Birth Weight**	53	43.8	68	56.2		
The Food Diversity						
Low	31	63.3	18	36.7	0.038*	2.2 (1.10-4.44)
Excellent	46	43.8	59	56.2		
The Provision of Breast Milk Food Supplementary						
Early Breast Milk Food Supplementary	31	56.4	24	43.6	0.313	1.5 (0.77-2.89)
Exclusive Breast Milk	46	46.5	53	53.5		
The basic immunization						
Incomplete	27	67.5	13	32.5	0.017*	2.7 (1.25-5.67)
Complete	50	43.9	64	56.1		
Drinking Water Worthiness						
Unworthy	9	47.4	10	52.6	1.000	0.9 (0.34-2.32)
Worthy	68	50.4	67	49.6		

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*chi-square (significant if p<0,05)
**BBLR (Low Birth Weight)
*** BBLN (Normal Birth Weight)
****MPASI (The Breast Milk Food Supplementary)

The bivariate analysis, in Table 3, shows a strong correlation (p<0.05) between the anemia record (p<0.05) and anemia record during the pregnancy (p: 0.05), per capita income (p: 0.039), birth weight (p: 0,006), food diversity (p: 0.038), parenting pattern (p:0,036), basic immunization (p: 0.017), education of mothers (p: 0.029) and the mother nutritional knowledge (p: 0.036) with *stunting* case On the other hand, the variable of job status of the mothers, the upper respiratory infection, the diarrhea infection, the administration of complementary foods for breast milk, and the drinking water reliability have insignificant correlation (p>0.05) toward stunting prevalence.

The results of the independent and dependent variable analysis found 9 variables had a p<0.25 value, i.e., anemia record during pregnancy, maternal employment status, per capita income, birth weight, food diversity, nursing patterns, basic immunization availability, mother education, and mother's knowledge of nutrition. Table 4 shows the multivariate analysis.

Table 4. The determinant of stunting case based on logistic regression

Variables	B	p	Exp B**	95% CI
The record of anemia during pregnancy	1.013	0.007*	2.75	1.31 – 5.78
Employed Mothers	1.032	0.014*	2.81	1.24 – 6.37
Low Birth Weight	1.381	0.004*	3.98	1.54 – 10.27
Food Diversity	1.312	0.002*	3.71	1.63 – 8.44
Complete Basic Immunization	1.391	0.002*	4.02	1.66 – 9.74
Constant	-3.878	0.000*	0.02	1.31

*Logistic regression (significance if p <0,05)
**Exp B (the exponent of logistic regression coefficient)
R^2 = 0,291

The logistic regression shows the variables simultaneously determine the stunting of anemia record during the pregnancy (p: 0,007), employed mothers (p: 0,014), BBLR (p: 0,004), low food diversity (p: 0,002), and incomplete immunization (p*:* 0,002). The influential size of the record of anemia during pregnancy, the career mother, the low birth weight, the low dietary diversity, and incomplete immunization is 29.1% toward stunting prevalence. The logistical regression model determinant of stunting in a child aged 6 months–2 years in the Kalinyamatan district of Jepara is as follows:

$$\text{logit p (stunting incident)} = (-3.87) + (1.013 \times \text{Anemia history during pregnancy}) + (1.032 \times \text{Mother's employment status}) + (1.381 \times \text{Birth weight}) + (1.312 \times \text{Dietary diversity}) + (1.391 \times \text{Immunization completion})$$

Inadequate basic vaccinations make children susceptible to disease and cause growth impairment. The infants will get infected and remain at risk until being managed. Among the risk factors for stunting reported in the Kalinyamatan district of Jepara, inadequate vaccination became the most significant risk factor. (OR: 4.02; 95% CI: 1.66 – 9.74; p: 0.002). Wanda et al. (2021) discovered that stunting was more prevalent in Hegarmanah Village, Jatinagor District[16].

Because the body uses a lot of energy to fight disease, stunting becomes a problem for children whose diet is inadequate and often sick. An infection will disrupt the infants' nutritional condition, and a prolonged illness will increase the risk of stunting[17]. The extent to which mothers vaccinate their children depends on a variety of factors, including education levels, knowledge, support from family and friends, motivation, attitudes, behavior, and access to health services[18]. Previous research on the work area of Public Health Care Citarip Kota Bandung found no significant correlation between stunting incidents and vaccination history in children aged 24-59 months (p: 0.056)[19]. Furthermore, research at Depok found no statistically significant correlation between vaccination status and stunting figures. The p-value is 0.49520[20].

In the bivariate analysis, the odds ratio (OR) of anemia during pregnancy is 2.75, meaning that after controlling for another variable, the risk of stunting is 2.75 times higher in mothers with a record of anemia during pregnancy compared to those who did not. Anggraini et al. found that a mother's anemia increased the risk of stunting in the young (p: 0.001)[21]. Pregnancy anemia disrupts the fetus's nutrition, leading to developmental abnormalities in the early stages of life. These diseases also inhibit the development of the brain, organs, and other tissues[22].

After calculating other factors, the employed mother is associated with an increased risk of growth inhibition in infants (OR: 2.81; 95% CI: 1.24 – 6.37; p: 0.014). According to the real story, unemployed mothers could spend more time in the morning at Integrated Public Health Care, where could buy food and get health education. Because of their low wages, working mothers may have difficulty meeting their family's basic needs, including nutrition for their children[23]. Previous studies in Yogyakarta did not discover a correlation between

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mothers' employment status and the rate of growth inhibition (p: 0.053)[24]. The current result found contradictory results. Even if they have no time to go to Integrated Public Health Care, employed mothers could boost family income, indicating their capabilities to meet their children's nutritional needs, helping them to thrive[25].

In terms of providing adequate childcare and ensuring that infants get attention about their healthy development, family money is a big problem. There appears to be an inverse correlation between income and the incidence of stunting. Statistically, the results show a significant correlation between per-capita income and stunting incidents, (p: 0.031), based on the bivariate analysis. If the economy goes excellently, people will have more income to use for better nutrition, boosting the immune system and making them stronger against disease. It is essential to pay attention to ensuring that the children have enough food[26]. Previous research found no correlation between per capita income and the prevalence of stunting in young people (p: 0.13827). The result is contradictory with the current research[27].

A child's birth weight can be a reliable predictor of their growth chances. Anthropometric assessment, measuring the baby's weight, body length, upper arm circumference, and baby head circle, is one of the significant assessments of baby nutrition. Based on the data in Kalinyamatan district, Jepara Regency, on toddlers aged between 6 and 24 years old, the obtained result shows a significant correlation between birth weight and the stunting prevalence (p: 0.006). The findings of this study align with previous research, indicating that infants with low birth weight had a 3.26 increased risk of stunting compared to those without a history of low birth weight (OR: 3.26; 95% CI: 1.46-7.31). Because of their immature digestive tract, low-birth-weight babies suffer from gastrointestinal disorders. For example, their bodies cannot digest protein or absorb fat, thus causing them to be malnourished[28].

Giving infants a variety of foods is crucial because it covers the various kinds of nutrients that the body needs. Studies about dietary diversity for two-year-old toddlers in Kalinyamatan found many toddlers suffered from stunting due to a lack of dietary diversity (40.3%) than diverse or normal dietary (23.4%). The results of the Chi-square test indicate a significant correlation between food diversity and stunting (OR: 2.2; 95% CI: 1.100-4.435; p: 0.038). Poor dietary diversity over time, low-quality of supplementary foods, and inadequate calorie intake can increase the risk of stunting in infants and children[29]. Food quality refers to the nutrients the body needs to control how much food is consumed and balanced food variation in one dish. The results show no single food that provides all nutrients in good quantity and variation; the more balanced and varied the content and type of food eaten, the higher the quality of the food[30].

Tika (2020) examined the potential relationship between food variety and stunting incidents (p: 0.047)[31]. A child in their first two years of life reaches a high level of growth, requiring a very high micro-nutrient and macro-nutrient content in their diet to achieve optimal growth[32]. Food diversity is an indicator for evaluating the adequacy of child micronutrient and macronutrient intake. Optimum nutrition provision with diverse dietary is a stunting preventive effort[33].

The role of a mother is very important to provide nutrition to her child. Mothers must behave excellently and provide support and attention. The role involves adhering to a proper diet, preparing highly nutritious foods, and maintaining cleanliness and nutritional hygiene[34]. In this research, the researchers found a significant correlation between parenting patterns and stunting prevalence in two-year-old toddlers in Kalinyamatan district (p: 0.036). Parenting patterns in setting up an excellent food menu for the child is important in meeting the adequate nutritional needs of the child, thereby lowering the child's susceptibility to disease[35]. The previous research obtained a result of 69.4%. Poor parenting patterns influenced stunting. On the contrary, an excellent maternal pattern leads to a low incidence of stunting[36]. A mother's knowledge is crucial to foster an individual behavior.

The level of knowledge about nutrition influences the family's ability to adequately nourish the infants. The bivariate analysis found a significant correlation between cognition about nutrition and stunting prevalence (OR: 2.4; p: 0.036). The results indicate that the low educational status of mothers has a higher risk of 2.4 than the high educational status of mothers toward stunting prevalence. The cognition about nutrient-rich foods influences a mother's behavior when feeding infants, as the evolution of this information shapes behavior. Mothers with adequate nutritional cognition should provide appropriate food types and quantities based on the infant's developmental stage so that the infant can grow healthy and avoid complications[36].

Based on the research results, the researchers found two-year-old toddlers suffering from stunting. These toddlers had mothers with low educational statuses, 35.1%. On the other hand, normal two-year-old toddlers had a percentage of 25.6% of mothers with low educational status. The bivariate statistic test obtained a p of 0.029, indicating a significant correlation between the mother's education and stunting prevalence. Mothers with excellent formal education could process various information into new knowledge. This matter influences the health and nutritional status of individuals. Education plays an important role in developing critical thinking skills and communicating health information directly to women, especially mothers. Mothers with a high educational level have excellent skills in planning, preparing, and choosing nutritious food for their children, especially young infants. Higher educational levels in mothers also contribute to increased knowledge and attitude towards nutrition and health-related information[37].

Research shows that antenatal care records are not significantly related to the stunting of infants in the Kalinyamatan district of Jepara (p: 0.811). Based on the observations in the field, most mothers with stunting or normal children already completed routine antenatal care visits and standardized services. The government set a standard for antenatal care, mandating antenatal visits at least six times during pregnancy to maintain the mother's health during pregnancy, and childbirth, and to strive for the health of the newborn[38].

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Amini (2016) found that antenatal care was not correlated significantly to stunting prevalence in two-year-old toddlers in Kalinyamatan district, Jepara regency. The findings revealed that visiting an irregular antenatal care service was 2.1 times more likely to cause stunting in children than visiting a quality antenatal care service[39]. Routine prenatal care visits can predict the mother's early pregnancy risks, particularly those associated with nutritional issues[40]. The study found an insignificant correlation between the time of breast milk supplementary food administration and the risk of stunting (p: 0.313). This result happened because various factors such as the age of the subject influenced the provision of complementary foods for breast milk of the subject and the possible modification from other factors (the adequacy and diversity of complementary foods)[41].

The infections brought on by a lack of access to clean water and poor sanitation hinder growth. This will ultimately inhibit growth by making it harder for the body to absorb nutrients[42]. However, the bivariate analysis results indicate no significant correlation between the frequency of stunting and the availability of drinking water (p: 1.000 > 0.05). These findings differ slightly between the two case and control groups but are not statistically significant. In addition, direct and indirect factors also contribute to the occurrence of stunting. The immediate causes of stunting include the nutrition pregnant mothers consume, the nutrition of their children, and infectious diseases. Meanwhile, water and sanitation were two of the indirect variables. Most citizens in the Kalinyamatan district used well water or groundwater from electric pumps. Some people boil this water before drinking. The water is also useful for bathing and washing.

Only 40 stunting infants (51.9%) had previously suffered from acute upper respiratory tract infection. Following the test and the results, p: 0.872 indicates no significant correlation between the history of acute upper respiratory tract infection and the occurrence of stunting. The findings are similar to previous studies, finding no evidence of a significant correlation between acute upper respiratory tract infection frequencies and stunting incidence. Various factors such as adequate nutrition before, during, or after illness, can cause stunting[19].

Acute upper respiratory tract infection is a common infection in children and is very contagious. Most children had mild infections characterized by fever, colds, and coughing that usually lasted less than 3 days[43]. These matters make upper respiratory infections and stunting not correlate. The current research found that stunting in two-year-old toddlers with diarrhea infection for the recent month had a percentage of 24.7% (19 cases) while the normal toddlers with the same infection record had a percentage of 28.6% (22 cases). The test found a p-value The test results revealed a p-value of 0.715, indicating no significant correlation between the risk factors for diarrheal infection and stunting occurrence.

The findings are consistent with previous studies, showing no evidence of a significant correlation between the incidence of stunting and diarrhea[44]. This study may not find a significant correlation between the incidence of stunting and a record of diarrhea because diarrhea has a greater impact on weight loss than height loss. Toddlers suffering from diarrhea may experience anorexia and dehydration. This situation must receive immediate care to prevent weight loss, an indication of acute malnutrition; or stunting, a sign of chronic and recurrent malnourished[45]. A previous study found young people aged 24-59 months in the area of operation Simolawang Public Health Care, Surabaya, with diarrhea records were significantly more likely to experience stunting (OR: 3.61; p: 0.025)[45]. Wicaksono (2020) asserts that a record of diarrheal infection significantly influences the incidence of stunting (OR: 5.41; 95% CI: 2.20-13.29; p: 0.001)[45].

The integrity and memory of the respondents, and the honesty and rigor of the interviewer when performing observations and completing the questionnaires, heavily influenced the accuracy of the data in this questionnaire-based data collection method. This can affect the quality of the obtained data and information. However, the limitations of this research include the use of a case-control design on the population and the presence of direct observations.

CONCLUSIONS

Anemia during pregnancy, low per capita income, low birth weight, poor food diversity, poor nursing patterns, poor maternal education, and poor mothers' knowledge of nutrition are risk factors for stunting infants in the Kalinyamatan district of Jepara. Incomplete immunization, low birth weight, low dietary variety, career woman status, and anemia during pregnancy are simultaneously the determinant factors of stunting in two-year-old toddlers in Kalinyamat district, Jepara Regency. The researchers suggest future researchers put more variables such as the period and frequency of acute upper respiratory tract infection and diarrhea in children, the home environmental factor, and detailed nutritional compounds.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The researchers found no conflict of interest. The researchers used personal funds for this research.

AUTHOR CONTRIBUTIONS

AH: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, roles/writing-original draft; MIK: formal analysis, project administration, supervision, methodology, writing-review, and editing; S: formal analysis, methodology, writing-review and editing; DS: formal analysis, supervision, validation, visualization, roles/writing-original draft; MSA:: formal analysis, supervision, validation, visualization, roles/writing-original draft.

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RESEARCH STUDY
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Association between Fat Intake, Dietary Fiber Intake, Physical Activity with Triglyceride Levels among Type 2 Diabetes Mellitus Patients at Grogol Health Center, Sukoharjo

Hubungan Asupan Lemak, Asupan Serat dan Aktivitas Fisik dengan Kadar Trigliserida pada Penderita Diabetes Melitus Tipe 2 di Puskesmas Grogol, Sukoharjo

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ABSTRACT

Background: Hyperlipidemia is closely associated with dietary intake and physical activity. Excessive dietary fat intake, inadequate dietary fiber, and low physical activity will increase the risk of obesity and lipid profile disorder among type 2 diabetics.
Objectives: This study aimed to identify the association between fat intake, dietary fiber intake, and physical activity with triglyceride levels among type 2 diabetics.
Methods: A cross-sectional study was conducted using Sequential Random Sampling on 31 patients with type 2 diabetes with dyslipidemia from Grogol Community Health Center, Sukoharjo, in March 2023. The 3x24-hour food recall nonconsecutive days was used to collect data on fat and fiber intake, the International Physical Activity Questionnaire-Short Form (IPAQ-SF) was employed to obtain physical activity data, and the patient's medical record for the last month was utilized to obtain fasting blood sugar and triglyceride levels. The statistical test was carried out using the Spearman Rank correlation test.
Results: Around 54.8% of subjects had excessive fat intake (60.90 g/day); 96.8% of subjects had severe deficit fiber intake (9.74 g/day); 51.6% of subjects had low physical activity (894.74 METs/minute/week). A statistically significant association exists between fat intake and level of triglyceride (p=0.005; r=0.493), but there was no significant association between dietary fiber intake and triglyceride levels (p=0.897; r=0.024), and there was no significant association between physical activity and level of triglyceride (p=0.394; r=-0.159).
Conclusions: There is a significant association between fat intake and the level of triglyceride. As such, it is necessary to decrease intakes of saturated fat and trans fatty acids; replacing them with unsaturated fatty acids could be beneficial in lowering triglyceride levels.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is known as a metabolic disorder that is caused by increasing levels of blood sugar due to insulin resistance[1]. Globally, there were 463 million diabetics in 2019, representing 9.3% of the adult population (20-79 years) in the world[2]. Specifically, Indonesia is the seventh-ranked country with diabetics, with 10.7 million cases, around 6.2% of the population[3]. Central Java is the 12th-ranked province of diabetics in Indonesia, with a 2.1% prevalence. Moreover, the prevalence of type 2 DM cases in Sukoharjo Regency was 1.87%. In 2018, the prevalence of dyslipidemia in Indonesia was a concern; as many as 28.8% of Indonesians aged ≥15 years had total cholesterol levels >200 mg/dl, and 27.9% had triglyceride levels >150 mg/dl[4].

Pathogenesis T2DM is caused by insensitive insulin due to impaired secretion from pancreatic beta cells. The risk factor for cardiovascular in type 2 DM is dyslipidemia, i.e., a lipid metabolism disorder characterized by increased total cholesterol levels, increased triglyceride (TG) levels, increased Low-Density Lipoprotein (LDL) levels, and reduced High-Density Lipoprotein (HDL) levels[5].

Moreover, age, stress, food intake, hormones, and physical activity are factors influencing lipid profile disorders, such as triglycerides (TG) in type 2 DM[6]. High-fat intake and low fiber intake are at risk of triglyceride (TG) disorders[7]. The benefit of fiber intake in patients

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with type 2 diabetes is that it can bind excess glucose and cholesterol in the blood. Triglycerides in the small intestine are hydrolyzed into fatty acid and glycerol. The fatty acid could not form into micelles and could not be absorbed in the small intestine due to it being bound by fiber. Furthermore, the fatty acid will go into the large intestine to be excreted as fesses or degraded by intestinal bacteria. Fiber could delay hunger sensation by prolonging fullness sensation and delaying the nutrition transport to the small intestine. Specifically, the water-soluble fiber could increase the viscosity in the small intestine, which result in decreasing amylase activity as well as delay the glucose absorption and reduce glucose[8]. The mean daily fiber intake in patients with type 2 diabetes is 11.5 g/day, with a minimum requirement of 25 g/day, so the fulfillment daily fiber intake is 46%. The mean saturated fat intake is 21.9 g/day, with a requirement of <19 g/day, so the fulfillment of daily saturated fat intake is 115%. The mean daily cholesterol intake is 288.4 mg, with a requirement of <200 mg/day, so the fulfillment daily cholesterol intake is 144%[7].

Further, physical activity become the most dominant risk factor for type 2 DM in Indonesia. Physical activity activities to avoid type 2 DM, namely doing moderate physical activity for a minimum of 30 minutes every day, could decrease and maintain ideal body weight[9]. A person with low physical activity has a 6.2 times higher chance of getting type 2 DM than someone with moderate and high physical activity[10]. A person with low physical activity can have increased triglyceride deposits in adipose tissue and the liver. Therefore, the purpose of this study is to determine the association between fat intake, fiber intake, and physical activity with triglyceride levels in patients with type 2 diabetes at the Grogol Community Health Center, Sukoharjo.

METHODS

An observational study with a cross-sectional design was conducted in May 2023. The subjects of the study were patients with type 2 diabetes at the Grogol Sukoharjo Community Health Center, with a total population of 951 diabetics. Sequential random sampling was used to obtain 31 type 2 diabetics with dyslipidemia. The inclusion criteria were type 2 diabetics with dyslipidemia complication and/or hypercholesterolemia who examined lipid profiles in March 2023, male and female, aged 35-74 years, and able to communicate well. To participate in this study, the subjects signed the informed consent. In comparison, the exclusion criteria included suffering from a stroke and not being able to complete the study.

The subjects' characteristic data encompassed gender, age, family history of disease, length of illness, treatment therapy, and nutritional education. Fat and fiber dietary intake were taken using 3x24-hour food recall nonconsecutive days (2 on weekdays and 1 on weekend days). The dietary intake was analyzed using NutriSurvey 2007, and the result was compared with the recommended dietary allowance value for diabetics.

The fat dan dietary fiber intake was classified based on Widyakarya Nasional Pangan dan Gizi/WNPG (2012), labeled as severe deficit (<70%), moderate deficit (70-79%), mild deficit (80-89%), normal (90-119%), and high (≥120%). Physical activity was obtained using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). Physical activity was categorized into low (<600 METs/min/week), moderate (≥600 METs/min/week) and high (1500-3000 METs/min/week or ≥3000 METs/min/week).

Fasting blood sugar levels and triglyceride levels were obtained from the venous blood examination recorded on the subject's medical records for the last month. Fasting blood sugar was categorized as normal <126 mg/dl and high ≥126 mg/dl. Triglyceride levels were classified as normal <150 mg/dl and high ≥150 mg/dl. The statistical analysis utilized the Statistical Package for the Social Sciences (SPSS) 25 program. The bivariate analysis was presented in frequency distribution tables by also considering the minimum, maximum, and mean±standard deviation. Rank Spearman correlation test was then run to analyze the association between fat intake and triglyceride levels, fiber intake and triglyceride levels, physical activity and triglyceride levels. The association is classified as significant if the p-value is <0.05. In addition, this study was approved by the Health Research Ethics Committee at Kusuma Husada University, Surakarta, with Eligible Letter No. 1030/UKH.L.02/EC/II/2023 on February 13, 2023.

RESULTS AND DISCUSSIONS

Table 1 details that most of the subjects were 61.3% female. Basic Health Research (Riskesdas) in 2018 revealed similar results that the prevalence of diabetics was higher in women by 1.78% compared to men by 1.21%[4]. After the age of 30, women tend to have a higher risk of developing type 2 DM due to a higher increase in body mass index compared to men. In addition to that, premenstrual syndrome and post-menopause are known as a factor that could lead to fat accumulation[11]. The study also uncovered that most subjects, 58.1%, were classified as elderly 55-65 years. Similarly, a study conducted in Korea demonstrated that people aged 35-44 years are 2.91 times more likely to get type 2 DM compared to those aged <35 years, while people aged ≥45 years are 3.69 times more likely to get type 2 DM compared to those aged <35 years[12]. Diabetes mellitus often appears after the age of 45 years old, in line with the decreasing body's physiological function at the age of over 40 years[13].

Table 1. Characteristics of type 2 diabetics at Grogol Community Health Center, Sukoharjo

Characteristics	n	%
Gender		
Male	12	38.7
Female	19	61.3
Age (years)		
45-54	1	3.2

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Characteristics	n	%
55-65	18	58.1
66-74	12	38.7
Family History of Disease		
Available	0	0
None	31	100
Duration of Illness		
<10 years	15	48.4
10-20 years	14	45.2
>20 years	2	6.4
Treatment Therapy		
Metformin + Fonylin	5	16.1
Metformin + Fonylin + Acarbose	4	12.9
Metformin + Fonylin + Rosuvastatin	12	38.7
Metformin + Fonylin + Acarbose + Rosuvastatin	10	32.3
Nutrition Education		
Ever	17	54.8
Never	14	45.2

n: Number of respondents; %: Percentage of respondents

All subjects displayed no family history of diabetes mellitus. In line with research in Buaran, Serpong, most of the subjects, around 107 people (84.9%), had no family history of DM, and another 19 people (15.1%) had a family history of DM in family members[14]. There are modifiable factors that become the dominant factor for the incidence of type 2 DM, such as unhealthy diet, stress levels, obesity, Body Mass Index (BMI) status, and physical activity[15]. Most of the subjects, around 48.4%, had type 2 DM in less than ten years. A person who has experienced chronic disease for a long time will influence his/her experience and knowledge in treatment. Decreasing quality of life in patients could be affected by the chronic nature of the disease, which can have an impact on the treatment and therapy being carried out[16]. In addition, all subjects received combination treatment therapy for DM and triglycerides. Most subjects took Metformin + Fonylin + Rosuvastatin at 38.7%. The combined use of type 2 DM drugs aimed to increase the effectiveness of therapy and reduce the side effects of the drug. Metformin is a drug used to reduce liver glucose production and increase insulin sensitivity. Fonylin is a type of drug aimed at increasing insulin secretion[17]. Meanwhile, Rosuvastatin is an antilipidemic that can significantly reduce TG and increase high-density lipoprotein cholesterol (HDL-C) levels compared to other statins[18]. Most subjects, 54.8%, also received nutritional education. Nutritional education is the main basis for preventing and promoting quality of life for type 2 diabetics. The education can be in the form of counseling, nutritional consultations, or door-to-door consultations, which can be done several times. Education needs are important as a preventive action and part of the four pillars of managing type 2 DM[17].

Table 2. Distribution of fasting blood sugar levels, fiber intake, physical activity, and triglyceride level among type 2 diabetics at Grogol Community Health Center, Sukoharjo

Variables	n	%	Minimum	Maximum	Mean±Standard Deviation
Fasting Blood Sugar Levels (mg/dl)					
Normal	11	35.5	86	122	104.00±12.66
High	20	64.5	127	349	200.05±61.09
Fat Intake (g/day)					
Severe deficit	0	0	0	0	0
Moderate deficit	0	0	0	0	0
Mild deficit	0	0	0	0	0
Normal	14	45.2	36	73	50.21±10.38
High	17	54.8	45	94	69.71±13.70
Fiber Intake (g/day)					
Severe deficit	30	96.8	5	17	9.17±2.54
Moderate deficit	0	0	0	0	0
Mild deficit	0	0	0	0	0
Normal	1	3,2	27	27	27
High	0	0	0	0	0
Physical Activity (METs/min/week)					
Low	16	51.6	302	592	487.31±95.44
Moderate	10	32.3	675	1347	937.60±219.74
High	5	16.1	1759	2890	2112.80±451.44
Triglyceride Levels (mg/dL)					
Normal	18	58.1	51	138	96.17±30.07

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Variables	n	%	Minimum	Maximum	Mean±Standard Deviation
High	13	41.9	150	425	253.23±99.37

n: Number of respondents; %: Percentage of respondents

According to Table 2, most subjects had high fasting blood sugar levels of 64.5%, averaging 200.05 mg/dl. All subjects' mean fasting blood sugar level was 165.97 mg/dl. High blood sugar levels indicate abnormalities in blood circulation as caused by impairment pancreatic function. Consumption of foods containing high sugar induces the increase of high fasting blood sugar levels[19].

Most subjects had a high fat intake of 54.8%, with a mean of 69.71 g/day. The mean fat intake of all subjects was 60.90 g/day. Recommendation daily fat intake was 25% total energy, so the fulfillment daily fat intake was 126.88% (high). Excessive fat intake is known for high dietary consumption of fried foods, meat, fast food, and cooking using coconut milk. In line with a study among older people in Semarang, 96.9% of subjects had high fat intake[20]. The research exhibited an aligned result, stating that fat consumption in type 2 diabetics was 71.4% above normal[21].

Most subjects also had a severe deficit fiber intake of 96.8%, with a mean of 9.17 g/day. The mean fiber intake of all subjects was 9.74 g/day. Recommendation fiber intake was 25 g/day. The fulfillment daily fiber intake was 38.96% (severe deficit). Most subjects rarely consumed fiber and only consumed vegetables in small portions, around 1-2 tablespoons per meal. The result from 3x24 hour recall showed that dietary fiber consumption included bananas, papaya, oranges, red guava, crystal guava, snake fruit, red dragon, jicama, apples, avocado, melon, watermelon, peanuts, long beans, Kapri beans, Chinese petai, cauliflower, bean sprouts, spinach, gambas, cabbage carrots, chayote, eggplant, chickpeas, broccoli, cucumber, kale, celery, cassava leaves, papaya leaves, spring onions, basil, melinjo leaves, moringa leaves, sweet potato leaves, and banana heart. The result is consistent with other studies, which stated that 30.9% were categorized as having adequate fiber intake, and 69.1% were categorized has deficit fiber intake[7]. It is also supported by studies showing that 100% of subjects had a deficit in daily fiber intake[22].

This study unveiled that most subjects had low physical activity, 51.6%, with a mean of 487.31 METs/minute/week. The mean physical activity of all subjects was 894.74 METs/min/week. The result corroborates with a study that revealed that 66.7% of subjects had low physical activity, and 33.3% of subjects had moderate physical activity[18]. The study's subjects were participants in the chronic disease management program (Prolanis) and took part in gymnastics activities, which were carried out once a month. Based on the results of this study, most subjects had a low physical activity category (<600 METs/minute/week). The physical activities usually carried out by the subject were gymnastics, cycling, sweeping, washing dishes, cooking, watering plants, lying down, watching TV, and walking.

The study also uncovered that most subjects had normal triglyceride levels of 58.1%, with a mean of 96.17 mg/dl. The mean triglyceride levels across subjects were 162.03 mg/dl. Triglycerides are stored in the body by fat cells. Lipogenesis is the change of glucose into fat, assisted by insulin. A compound that carries triglycerides and other fats throughout body circulation is called lipoprotein. Triglycerides come from consuming high-fat food and from the formation of glycolysis. As a result, the occurrence of increasing triglyceride levels due to the glycolysis process stored in fat cells in the body could increase blood sugar levels[23].

Table 3. Correlation between fat intake, fiber intake, physical activity, and triglyceride level among type 2 diabetics at Grogol Community Health Center, Sukoharjo

Variables	p-value	r
Fat Intake and Triglyceride Level	0.005*	0.493
Fiber Intake and Triglyceride Level	0.897	0.024
Physical Activity and Triglyceride Levels	0.394	-0.159

p-value: probability value; r: correlation coefficient; correlation test using Rank Spearman,
*Significant if a p-value is <0.05

Table 3 shows a significant association between fat intake and triglyceride levels among type 2 diabetics, with a moderate correlation coefficient (p=0.005; r=0.493). The higher the fat intake, the higher the triglyceride levels. This result agrees with other studies, indicating a significant association between fat intake and triglyceride levels, with a moderate correlation coefficient (p=0.002; r=0.497)[24]. Factors that could trigger obesity and increasing triglyceride levels are caused by excessive consumption of fatty foods and lack of physical activity. In type 2 DM, there are two processes of abnormal triglyceride metabolism. The first is an excessive production of bad cholesterol and small and solid forms of Very Low-Density Lipoprotein (VLDL), and the second is an excessive breakdown of fat resulting in accumulating large amounts of fat in the bloodstream (lipolysis), which is ineffective by lipoprotein lipase. Both could lead to hypertriglyceridemia, which results in an increase in triglyceride levels above normal. Type 2 DM is affected by peripheral insulin resistance and impacts the incidence of dyslipidemia characterized by increased triglycerides, Low-Density Lipoprotein (LDL), Very Low-Density Lipoprotein (VLDL), and decreased High-Density Lipoprotein (HDL). Increasing the production of triglycerides and Very Low-Density Lipoprotein (VLDL) in the liver could lead to resistance insulin[25].

This study exhibited no significant association between fiber intake and triglyceride levels among type 2

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diabetics (p=0.897; r=0.024). This result is in line with other studies, which state that there is no association between fiber intake and triglyceride levels among type 2 diabetics (p=0.433)[26]. A fiber intake of 25-30 g/day is needed to be able to achieve normal triglyceride levels[27]. This study showed different results from the theory that fatty acids and glycerol result from triglyceride hydrolysis in the small intestine. In this process, they cannot form micelles and are not absorbed in the small intestine because fatty acids are bound by fiber; then, the next process goes to the large intestine and is excreted in the form of feces or degradation by intestinal bacteria[28]. This inconsistent result might be due to the fact that most of the subjects had a 96.8% severe deficit in fiber intake, which was thus not significantly related to triglyceride levels.

Additionally, this study demonstrated no significant association between physical activity and triglyceride levels among type 2 diabetics (p=0.394; r=-0.159). Most subjects had low physical activity, averaging 487.31 METs/minute/week. This result substantiates other studies that state no significant association between physical activity and triglyceride levels (p=0.587)[29]. In this study, the subject's physical activity was generally categorized as low physical activity. Low physical activity resulted in low converted energy from fat metabolism. Moreover, it affected the decreasing breakdown of triglyceride in the body. High physical activity will increase the need for Adenosine Triphosphate (ATP), reduce the formation of total cholesterol, Low-Density Lipoprotein (LDL) cholesterol, and triglycerides (TG), and increase High-Density Lipoprotein (HDL) cholesterol. If Adenosine Triphosphate (ATP) formation increases, the body will compensate by forming High-Density Lipoprotein (HDL). The formation of High-Density Lipoprotein (HDL) helps excessive cholesterol in the periphery to be transported to the liver as energy reserves[29].

CONCLUSIONS

The study revealed that most subjects had high fasting blood sugar, fat intake, deficit fiber intake, low physical activity, and normal triglyceride levels. Fiber intake and physical activity exhibited no significant association with triglyceride levels. Otherwise, fat intake had a significant association with triglyceride levels among diabetics at the Grogol Community Health Center, Sukoharjo. To achieve a good quality of life, type 2 diabetics are expected to have proper control and be obedient to DM diet management as well as proper medication, physical activity, and sugar blood checking regularly.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare there is no conflict of interest in this manuscript. This study was conducted with self-funding.

AUTHOR CONTRIBUTIONS

ANS: conceptualization, methodology, data curation, formal analysis, resources, writing-original draft; DK: conceptualization, methodology, data curation, formal analysis, writing-original draft; writing-review and editing; AM: methodology, data curation, supervision, validation; SA: writing-original draft, writing-review and editing.

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RESEARCH STUDY
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The Stunting Determinants in Toddlers from Landak Regency, West Kalimantan: A Cross-Sectional Study

Determinan Balita Stunting *di Kabupaten Landak, Kalimantan Barat: Studi Potong Lintang*

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ABSTRACT

Background: Stunting is a nutrition problem that can slow down the growth. With prevalence at 32.5%, Landak Regency in West Kalimantan has been designated as a stunting hotspot. The lack of a maximum penalty for the stunting case in Landak Regency is not based on factors causing the stunting itself, because there is no identifiable factor causing the stunting in certain area due to narrow roads and sharp curves.
Objectives: The objective of this study was to identify causes and distribution of the stunting case in Landak Regency.
Methods: A total of 330 households in Meranti, Sebangki, and Senakin were included in this cross-sectional study because they were at a risk of the stunting. Toddlers, mothers, health care, and environmental factors were among the found variables. The researchers employed a basic random sampling strategy for the sampling and used the secondary health center data to find out whether or not toddlers were stunted. Researchers in this study collected data on the independent variables by observing and interviewing participants. Using the chi-square test, the data was analyzed.
Results: The results showed that determinants of the stunting in Landak Regency were the history of early breastfeeding initiation (p-value=0.032), exclusive breastfeeding (p-value=0.042), frequency of exclusive breastfeeding (p-value=0.040), the continued breastfeeding (p-value=0.024), complementary feeding (p-value=0.042), immunization history (p-value=0.007), infectious disease history (p-value=0.000), maternal height (p-value=0.046), delivery assistance (p-value=0.000), access to health services (p-value=0.004), the role of health workers (p-value=0.002), and family latrine ownership (p-value=0.000).
Conclusions: Several factors were found to be associated with incidence of the stunting among toddlers in Landak Regency.

INTRODUCTION

Children suffer from a lower quality of life due to the stunting, a nutritional disorder that hinders them from reaching their full genetic potential in terms of growth and development. As a long-term symptom of malnutrition, the stunting can hinder development and growth in toddlers as a consequence of chronic malnutrition or previous growth failure[1]. The term stunting is described a state of chronic malnutrition starting from the womb phase. Children with the stunting experience a faltering growth due to the inhibited growth from womb until the first two years of their life. The stunting conditions only appear after the children are two years old. By comparing the child's age-appropriate body length (PB/U) or height (TB/U) to the standard set by the World Health Organization's Multicenter Growth Reference Study (MGRS), the researchers can identify indicators of the stunted and severely stunted toddlers. Children are considered to be severely stunted for having z-scores less than -3SD, according to the Indonesian Ministry of Health[2].

The stunting remains a national issue in Indonesia, negatively impacting children's physical and functional development as well as increasing their morbidity rates. World Health Organization emphasizes that addressing stunting is a global priority. According to WHO (2018), more than half of the stunted toddlers worldwide in 2017 were from Asia (55%), while over a third (39%) of them were from Africa[3]. WHO data on the stunting prevalence among children under five years shows that the number of the stunting cases in Indonesia was significant, with the third ranking in Southeast Asia. The average stunting prevalence in Indonesia during 2005-2017 period was 36.4%[2]. Basic Health Research

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data shows that the national stunting prevalence among children under five years was 36.8% in 2007, decreased to 35.6% in 2010, and increased to 37.2% in 2013. The 2018 data from Basic Health Research showed a decrease in the stunting prevalence to 30.8%. In West Kalimantan, the stunting prevalence among toddlers was 33.3%, but decreased to 27.8% in 2022. Although reduced, this figure was still far above the national target at 14%. A high stunting rate in West Kalimantan is a major concern, necessitating the immediate identification of its root causes for more effective prevention. In Landak Regency, the prevalence ranked fifth at 32.5%, while local government efforts focused on addressing the stunting case.

Many factors contribute to the stunting, which is a long-term nutritional issue. These include poverty, poor prenatal nutrition, baby health problems (infant morbidity), insufficient infant nutrition, and unsanitary living conditions[4]. Immediate action is necessary to ensure that the stunted children get the best opportunity of reaching their full cognitive and physical potential. Stunting in toddlers might be affected by one's level of knowledge. Parents, mothers in particular, need to understand the importance of antenatal care, proper food intake during pregnancy, appropriate nutrition for newborns, and other stunting prevention efforts which are crucial[5]. Mothers with a height of less than 145 cm bring a risk of the inhibited growth and development in their children. Babies born to women who are under 145 cm tall are more likely to be small-for-gestational-age (SGA), which puts them at a risk of developing into the stunted toddlers later in the next growth phase. Growth hormone insufficiency is a common medical condition among mothers who are under 145 cm tall[7]. Previous studies have identified maternal height as a risk factor for the stunting[8]. Factors existing throughout pregnancy are only one of many impacting a child's growth and development[8]. Regular Antenatal Care (ANC) checks, at least four times, are needed to monitor fetal development. Previous research has shown that ANC visits were a potential factor in the stunting incidence, along with maternal age and pregnancy interval[9].

Infants with low birth weight (LBW) may experience the inhibited growth and development, potentially turning into short children[10]. During early life stages, babies require more protein for their body cell development. Colostrum, rich in protein, is crucial for the baby's growth. If a baby does not sufficiently receive colostrum, the best nutrient for body cell growth is not perfectly obtained[11]. Children who receive exclusive breastfeeding have optimal growth, as colostrum helps form perfect body cells[12]. The correlation between toddler's stunting and non-exclusive breastfeeding has been previously demonstrated to be statistically significant (p-value=0.000)[13]. Research at the Kramatwatu Health Center also highlighted the importance of successful early initiation of breastfeeding (IMD) in preventing the stunting[14]. Immunization plays a role in actively improving health against antigens, while preventing diseases[15]. Previous research supported the role of immunization in preventing the stunting[16]. Proper nutrition significantly impacts toddlers' growth as well as their physical and mental development, so they require a diverse, sufficient, nutritious, and the balanced diet[17]. Protein intake is particularly important, as research has shown a relation between protein intake and the stunting incidence[18]. Sanitation improvement is another factor in preventing the stunting, with significant contribution from the environmental health, including an access to the clean drinking water, availability of latrines, and the hand-washing facilities[19].

Landak Regency is one of the districts contributing to the stunting prevalence in West Kalimantan. Despite significant local government support, the prevalence has not been significantly reduced. This research focused on the Meranti Health Center, Sebangki Health Center, and Senakin Health Center, in which their working areas were in Dayak, Malay, and Madurese communities. The study's advantage was in the stunting determinant investigation across three distinct regional characteristics within one district. The dominance of Dayak ethnic community and the presence of other ethnic groups make Landak Regency particularly noteworthy. Difficult road access and long distance from the district center have limited government intervention. This study uniquely identified toddler factors, maternal factors, health service factors, and environmental factors as the stunting determinants. Previous research in Landak Regency has primarily focused on urban areas, leaving the potential stunting causes in the unidentified rural areas. This research aimed to identify the stunting prevalence determinants in Landak Regency, representing three different regional characteristics, to develop strategic measures for addressing the stunting issue

METHODS

Landak Regency Health Office oversaw the execution of this study, which employed a cross-sectional analytical observational design at three health centers, namely Meranti, Sebangki, and Senakin. Secondary data suggested that the study areas were contributing to the stunting problem in Landak Regency where the research took place. Dayak Tribe is the dominant ethnic group, although there are also other significant population from Malay and Madurese.

The study subjects comprised 330 families at a risk of the stunting in each location, selected using a simple random sampling technique. Inclusion criteria included families of toddlers having Maternal and Child Health (MCH) books, registered as Integrated Service Post participants in each region, and willing to participate as respondents, as proven with the informed consent signed by the mothers of toddlers. Exclusion criteria were toddlers in ill condition. The nutritional status of toddlers for the stunting and non-stunting categories was determined through secondary data from health centers and cross-checked during the data collection using the standardized tools, such as stadiometers and scales. Ethical considerations in this study included confidentiality, free exploration, and the freedom to refuse or accept participation, as demonstrated through the informed consent. The researchers ensured the confidentiality of respondents by using the codes, instead of names, and guaranteed the confidentiality of all collected information. With the code 039/KEPK-

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FIKES/UM PONTIANAK/2021, this study was approved by the Health Research Ethics Commission of the Faculty of Health Sciences, Muhammadiyah University of Pontianak.

Toddler factors included several factors, namely vaccination history, infectious disease history, the length of time in breastfeeding, how often they get breastfed exclusively, how long they get breastfed for, how often they continued to get breastfed, and whether or not child's diet is supplemented with other foods. Maternal factors included some aspects, namely height, knowledge, gestational age, antenatal care, childcare practices, and access to the health services. Home environment factors included other matters, like family latrine ownership and water sanitation. Trained enumerators, as aided by Integrated Service Post cadres, were assigned to each household of toddlers chosen as respondents in order to ensure accuracy of the collected data. In order to evaluate the state of water sanitation and latrines, questionnaires and observation sheets were utilized in households who had children younger than five years.

Prior to the data entry, enumerators ensured that all collected data was complete. Data recapitulation was carried out in Microsoft Excel, and the data were imported to SPSS for numerical variable translation and coding. Afterwards, the data was ready for analysis. Univariate data analysis determined the frequency distribution of each variable, presenting the percentage data. Factors pertaining to the environment, health services, mothers, and toddlers were the independent variables that were analyzed in a bivariate data set, while the dependent variable was the stunting. In order to test for the bivariate relation, we utilized the chi-square test at the 95% confidence and 5% significant levels. It was determined that factors were the stunting determinants if the chi-square analysis revealed a p-value less than 0.05, considered to be significant.

RESULTS AND DISCUSSIONS

The study was conducted on 330 families at a risk of the stunting (families of toddlers) in Landak Regency in working area of 3 health centers, namely Meranti Health Center, Sebangki Health Center and Senakin Health Center. Distribution and frequency of each research variable were determined by the univariate data analysis. The following is a compilation of univariate data pertaining to some factors affecting toddlers, mothers, health services, and the environment.

Table 1. Frequency Distribution of Toddler Factors as Potential Determinants of the Toddler Stunting in Landak Regency

Variable	n	%
Immunization History		
Incomplete	100	30.3
Complete	230	69.7
History of Infectious Disease		
Available	106	32.1
None	224	67.9
Exclusive Breastfeeding		
Not Exclusive Breastfeeding	184	55.8
Exclusive Breastfeeding	146	44.2
Breastfeeding Duration		
<30 Minutes	172	52.1
≥30 Minutes	158	47.9
Frequency of Exclusive Breastfeeding		
<12 Times per Day	245	74.2
≥12 Times per Day	85	25.8
Advanced Breastfeeding		
No	153	46.4
Yes	177	53.6
Complementary Feeding		
Not Appropriate	184	55.8
Compliant	146	44.2

Among the characteristics shown to be the stunting determinants in toddlers from Landak Regency, the most common cause was an absence of the exclusive breastfeeding (184 cases, or 55.8% of the total). Regarding the length of breastfeeding, a more dominant group at 172 (52.1%) had the breastfeeding sessions of less than 30 minutes. The frequency of exclusive breastfeeding was also higher among those who were breastfed less than 12 times per day, at 245 (74.2%). Additionally, inappropriate complementary feeding was more common, thus affecting 184 (55.8%) of the toddlers.

Table 2. Frequency Distribution of Maternal Factors as Potential Determinants of the Toddler Stunting in Landak Regency

Variable	n	%
Maternal Knowledge		
Not Good	154	46.7
Good	176	53.3
Maternal Height		

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Variable	n	%
Maternal Height at Risk	17	5.2
Maternal Height Not at Risk	313	94.8
Maternal Gestational Age		
At Risk	32	9.7
Not at Risk	298	90.3
ANC		
Not Conforming to Standard	199	60.3
Conforming to Standard	131	39.7
Delivery Assistance		
Non-Personnel	76	23.0
Health Workers	254	77.0
Parenting Pattern		
Not Good	138	41.8
Good	192	39.7

The frequency distribution of maternal factors, as the stunting determinants in toddlers from Landak Regency, showed that the ANC during pregnancy was more dominant, with 199 cases (60.3%), compared to ANC that met the standards, which accounted for 131 cases (39.7%).

Table 3. Frequency Distribution of Health Service Factors as Potential Determinants of the Toddler Stunting in Landak Regency

Variable	n	%
Access to Health Services		
Not Good	120	36.4
Good	210	63.6
Role of Health Workers		
Not Good	91	27.6
Good	239	72.4

The frequency distribution of health service factors as the stunting determinants in toddlers from Landak District showed that access to the health services was good, with a higher percentage of 210 cases (63.6%), and the role of health workers was also good, at 239 cases (72.4%). Nevertheless, 66 cases (55% of the total) of the stunted toddlers and 54 cases (45% of the total) of the non-stunted toddlers showed a correlation between the availability of health services and prevalence of the stunting in toddlers.

Table 4. Frequency Distribution of Environmental Factors as the Potential Determinants of the Toddler Stunting in Landak Regency

Variable	n	%
Latrine Ownership		
None	113	34.2
Available	217	65.8
Water Sanitation		
Not Eligible	180	54.5
Meeting Requirements	150	45.5

The frequency distribution of environmental factors as the stunning determinants in toddlers from Landak District shows that some families of toddlers still did not have private latrines, accounting for 113 cases (34.2%). Additionally, it is noted that a higher number of respondents, 180 cases (54.5%), did not meet the requirements for water sanitation.

Table 5. Results of Bivariate Analysis of Factors as the Potential Determinants of the Toddler Stunting in Landak Regency (Study at 3 Health Centers)

Variable	Child Nutritional Status		Chi-Squared Test
	Stunted	Not Stunted	
Early Breastfeeding Initiation (IMD)			
Not Performing IMD	88 (50.0%)	88 (50.0%)	0.032*
Performed IMD	58 (37.7%)	96 (62.3%)	
Exclusive Breastfeeding			
Not Exclusive Breastfeeding	91 (49.5%)	93 (50.5%)	0.042*
Exclusive Breastfeeding	55 (37.7%)	91 (62.3%)	
Frequency of Exclusive Breastfeeding			

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Variable	Child Nutritional Status		Chi-Squared Test
	Stunted	Not Stunted	
<12 Times per Day	117 (47.8%)	128 (52.2%)	0.040*
≥12 Times per Day	29 (34.1%)	56 (65.9%)	
Follow-Up Breastfeeding			
Not Provided	57 (37.7%)	96 (62.7%)	0.024*
Given	89 (50.3%)	88 (49.7%)	
Feeding Complementary Foods			
Not Appropriate	91 (49.5%)	93 (50.5%)	0.042*
Compliant	55 (37.7%)	91 (62.3%	
Immunization History			
Incomplete	56 (56.0%)	44 (44.0%)	0.007*
Complete	90 (39.1%)	140 (60.9%)	
History of Infectious Disease			
Available	66 (62.3%)	40 (37.7%)	0.000*
None	80 (35.7%)	144 (64.3)	
Maternal Height			
Maternal Height at Risk	12 (70.6%)	5 (29.4%)	0.046*
Maternal Height Not at Risk	134 (42.8%)	179 (57.2%)	
Delivery Assistance			
Non-Personnel	53 (69.7%)	23 (30.3%)	0.000*
Health Workers	93 (36.6%)	161 (63.4%)	
Access to Health Services			
Not Good	66 (55.0%)	54 (45.0%)	0.004*
Good	80 (38.1%)	130 (61.9%)	
Role of Health Workers			
Not Good	27 (29.7%)	64 (70.3%)	0.002*
Good	119 (49.8%)	120 (50.2%)	
Latrine Ownership			
None	69 (61.3%)	44 (38.9%)	0.000*
Available	77 (35.5%)	140 (64.5%)	

A significant association between the stunting and early initiation of breastfeeding was found in the bivariate analysis (p-value=0.032), as shown above. The newborn is put on the mother's chest and encouraged to independently locate the nipple as part of the Early Initiation of Breastfeeding protocol, which begins shortly after delivery. The first 24 hours after delivery are crucial time for the success of subsequent breastfeeding. During the first hours after delivery, the hormone oxytocin, which is responsible for the milk production, is released[22]. Early initiation of breastfeeding greatly assists in the continuation of exclusive breastfeeding and its duration. According to previous research, failure in the early initiation of breastfeeding missed out on the benefits of colostrum for the infants, which affects their growth. By 12-24 months, these infants are more likely to experience the stunting conditions, as indicated by height that is not in accordance with their age[20]. This aligns with another research conducted in Astra Ksetra Village in 2022, which also found a significant relation between IMD and nutritional status (stunting)[23].

With a p-value of 0.042, this study found a statistically significant association between the stunting and the exclusive breastfeeding. The stunting was found in 91 (or 49.5% of the total) of the 184 individuals whose mothers stopped breastfeeding exclusively before the age of 6 months. Ministry of Health of the Republic of Indonesia has established a target rate of 80% for the exclusive breastfeeding, although this indicates that the percentage is still significantly lower[24]. Interviews with mothers as respondents revealed that some did not provide exclusive breastfeeding due to the perceived decreases in breast milk production, leading them to give formula milk or water instead. These findings were in line with earlier studies carried out in the work area of Hinai Kiri Health Center in Langkat Regency, which also discovered a significant correlation between the stunting and exclusive breastfeeding (p-value=0.001, PR=0.51), suggesting that this practice prevents infants from the stunting[25].

The length of the exclusive breastfeeding frequency also had a significant relation with the stunting incidence in toddlers from Landak Regency (p-value=0.040). According to the Ministry of Health (2021), mothers should breastfeed their babies in the morning, afternoon, and evening with a frequency of 8-12 times per day[26]. The duration of breastfeeding impacts milk production; if the babies are breastfed for the appropriate duration, they will receive the full benefits of both foremilk and hind milk, promoting optimal growth and development. Previous research also explained that non-optimal breastfeeding practices were associated with the stunting[27].

Besides exclusive breastfeeding as well as its frequency and duration, the continued breastfeeding was another significant variable related to the toddler's stunting (p-value=0.024). The continued breastfeeding, ideally until the age of 2 years, was an important intervention for reducing neonatal and under-five mortality[28]. Research by Endah and Titin (2021) stated that breastfeeding until the age of 2 years is crucial for preventing low growth and development in toddlers,

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which can be a risk factor for the stunting[29]. Other studies highlighted that the continued exclusive breastfeeding positively impacts nutritional status due to the minerals and growth factors in breast milk, which affect the development of the gastrointestinal tract, vessels, nervous system, and endocrine system in toddlers[30].

From the time of birth until the age of six months, breast milk should be the only food consumed. From the age of six months to twenty-four months, supplementary foods can be introduced, and breastfeeding should be continued until the kid reaches the age of twenty-four months or older. There is a correlation between the stunting occurrence and the supplemental feeding variable, as seen in the bivariate results above (p-value=0.042). The World Health Organization recommends starting complementary feeding at an age of about 6 months, when breast milk's nutritional value becomes inadequate and the infants requires supplementary food to meet their nutritional demands. Babies begin to be introduced to the finely pulverized complementary foods because they already have the chewing reflexes. Smooth solids include milk porridge, biscuits with milk added, banana and papaya crushed[31]. The accuracy of complementary food given to infants in accordance with their needs can reduce the stunting risk[32]. Research conducted in Majene District showed that early or late age of the first complementary food as well as the lack of consistency from complementary food administration are risk factors for the faltering growth and will affect the intelligence of toddlers in children at the age of 7-24 months[33]. This statement is also supported by another research conducted in Sumberjo Village, Kediri Regency, which reveals a significant relation between the age of first complementary feeding and the stunting incidence, with a ρ value of 0.000[34].

Infant immunization is an attempt to make babies more resistant to disease. Toddlers can develop inadequate immunity due to incomplete immunization, making them more susceptible to infections. The untreated infections in toddlers provide a risk of the stunting[35]. This study stated a significant relation between immunization history and the stunting incidence (p-value=0.007). This was in line with a research conducted by Devi and Sendy (2023) in the working area of Pusat Jaya Public Health Center of Surabaya, which states that the incomplete immunization can increase developmental disorders through the stunting[36]. Evidence from earlier studies suggested a correlation between basic immunization status and the stunting prevalence in toddlers from Hegarmanah Village, Jatinangor District. Specifically, compared to toddlers who received full vaccinations, those with incomplete immunizations had a 4.9-fold increased risk of stunting[37].

Incomplete immunization compromises immunity, leaving toddlers vulnerable to the infectious diseases. These infections can disrupt normal immune responses and drain the body's energy. Toddlers without adequate immunity quickly deplete their energy due to infections, leading to a reduced appetite and refusal to eat. This refusal lowers their intake of the necessary nutrients. Consequently, toddlers are at the stunting risk if they do not receive adequate nutrition and suffer from the recurrent infections[37]. A p-value of 0.000 indicates a statistically significant correlation between a family history of infectious illnesses and the stunting prevalence in toddlers. Yulnefia and Mega (2021) also found a strong correlation between a history of infections and stunting, so our findings were in line with theirs. A p-value of 0.001 and an OR value of 4.200 (1.760-10.020) were reported in their study, suggesting a 4.2-fold increased risk of the stunting in children at the age of 24-36 months who suffered from viral infections more frequently[38].

Maternal height in the above study results showed a significant association with a p-value of 0.046. Low maternal height was positively associated with short stature in children. Low maternal weight is also associated with the stunting risk in children. Underweight is associated with malnutrition as low nutrient intake increases the risk of small gestational size and thus shorter stature[39]. In previous studies, it was explained that mothers with short stature (<145 cm) had twice the risk of having the stunted children[8]. This can be understood by looking at the biomechanical process involving the mother's organs and the biological mechanisms involving her nutrition, as well as the intergenerational relationship between a short mother's stature and the fertilized egg growth in the uterus. A low birth weight (LBW) and the possibility of stunting in a child born to a mother who is small in stature is due to the narrower pelvis that these mothers have during pregnancy[40].

The aforementioned bivariate data also showed a correlation between the stunting prevalence in children younger than five years in Landak Regency and the availability of health services (p-value=0.004). This was due to the fact that accessing health services can be quite a challenge brought by several factors, such as long travel times and the challenging road conditions. A correlation between availability of health care and the stunting prevalence in toddlers (p-value=0.016) was found, in keeping with studies carried out in the Baitussalam Health Center's operational region[41]. The lack of utilization of access to health services results in low delivery assistance for pregnant women carried out by health workers. Pregnant women and childbirth are the most vulnerable groups that require maximum service from health workers. One form of services that must be provided to women giving birth is the delivery assistance by health workers. This delivery assistance is directly related to one of the health indicators, namely the Maternal Mortality Rate (MMR)[42]. Statistically, this study found a correlation between the stunting rates and the presence of unsupervised delivery help (p-value=0.000). Scientific studies carried out at the Martapura Health Center corroborate this, showing a correlation between the location of delivery and the use of the IMD nutritional status assessment in children (ρ value=0.002)[43]. This is related to the role of health workers who deal with the stunting incidence in toddlers with a statistical value obtained at p-value 0.002. The role of health workers can provide information and education and empower women, particularly mothers who play an important role in reducing the stunting[44].

Stunting can arise not only from nutritional deficiencies, but also from poor environmental

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sanitation, such as the lack of toilet ownership. The study results show a significant relation between latrine ownership and the stunting among toddlers in Landak Regency, with a p-value of 0.000. Latrines are essential for preventing the spread of diseases caused by human feces. Improper feces disposal can contaminate water and soil or turn into a source of infection, thus posing significant health risks. Family latrines are crucial in reducing the disease risk. Each family should have its own toilet to avoid the indiscriminate feces disposal, as insects can transfer germs from the exposed feces to food, thus potentially causing diseases like diarrhea[19]. A similar study stated that household sanitation, namely defecation practices, was significantly associated with the stunting incident in children under the age of 25-59 months in Lumajang District with a ρ value of 0.043 with a strong association of 0.218[4]. The use of latrines can contribute to the disease transmission which is also associated with the stunting. In line with a research conducted by Rizki, et al (2023), there was a relation between latrine ownership and the stunting incidence in toddlers from the working area of Penengahan Health Center, South Lampung Regency with an OR value of 7.4, meaning toddlers who had improper latrines had a risk of 7.4 times to experience the stunting, compared to toddlers who have proper latrines[45].

CONCLUSIONS

Determinants of the stunning in toddlers from Landak Regency include early initiation of breastfeeding ,exclusive breastfeeding, frequency and duration of breastfeeding, the continued breastfeeding, complementary feeding, immunization history, infectious disease history, maternal height, delivery assistance, access to health services, the role of health workers, and the limited latrine ownership. The findings of this study can guide the Landak Regency government, particularly the Health Office and Health Centers, in formulating policies and intervention activities to address the stunting issue. One recommendation is the development of an education model for families and mothers of toddlers to prevent the stunting through the "*Rumah Cegah Stunting*" (House of the Stunting Prevention) program, for leveraging the empowerment of the Integrated Service Post cadres and youth organizations in each region.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

ET: conceptualization, methodology, supervision, writing – review and editing; OW: methodology, writing – original draft, writing – review and editing; ES: methodology, formal analysis, writing – original draft; DA: formal analysis, resources, administration.

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RESEARCH STUDY
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The Relation of Infectious Diseases, Water Access, Hygiene Practice, and Sanitation with the Stunting: A Case-Control Study in Sambas Regency

Hubungan Penyakit Menular, Sumber Air Bersih, Praktik Kebersihan, dan Sanitasi dengan Kejadian Stunting*: Studi Kasus Kontrol di Kabupaten Sambas*

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ABSTRACT

Background: The main nutritional problem concerned by the Indonesian government is the stunting. This condition is affected by various aspects, mainly caused by infectious diseases, clean and unharmonious living behavior, the availability of drinking water, and environmental sanitation.
Objectives: The purpose of this study is to determine the relation of infectious diseases, water access, hygiene practices, and sanitation towards the stunting incidence factors in Sambas Regency.
Methods: This research used Ex Post Facto with a case-control design. The study population was residents of Sambas Regency with a total of 535,725 people, a total sample of 241 children aged 0-59 months comprising of 89 respondents as cases and the rest 159 respondents as controls, using inclusion and exclusion criteria both from the control group and from the case group. Data analysis used the chi-square test.
Results: The results showed a relation of infectious diseases (p-value=0.000), drinking water sources (p-value=0.000), clean and healthy living behavior (p-value=0.000), and environmental conditions (p-value=0.000) with the stunting incidences.
Conclusions: The study concludes that there is a significant relation of infectious disease variables, the drinking water sources, hygiene practices, and environmental conditions with the stunting. It requires control and completion of the stunting cases through environmental sanitation improvement, namely the provision of access to clean water, healthy and clean living behaviors, and good cooperation between the government and the community, in educating people through counseling and socialization of the stunting prevention and management.

INTRODUCTION

Children's emotional and physical well-being, how mature they become, and how well they do in school are all affected by their nutritional state[1]. A shocking one-third of the under-five child fatalities worldwide are linked to malnutrition. Characteristically, the stunted growth is permanent in human capital development and affects one out of every five children younger than five years[2].

Indonesia is among the countries with the most malnutrition cases, including the stunting[3]. In 2022, the stunting prevalence in Indonesia was 21.6%, as reported in the Indonesia Nutritional Status Survey. This figure was a decrease in the number of cases, compared to last year's prevalence rate at 24.4%[4]. As a result, the number of stunting cases decreased by 2.8% within a year. Notably, the government's annual goal is to reduce the stunting incidences by 3%, so this decrease was rather close to that target. Resolving the stunting problem demands an improvement strategy that spans multiple sectors, not limited to health only.

Indonesia has demonstrated a promising progress in reducing malnutrition over the past decade. However, the stunting prevalence has hardly decreased. Research has shown that children under the age of five years are more likely to be malnourished for living in the unsanitary and unhygienic environments[5,6]. There are a number of ways in which Water, Sanitation and Hygiene (WASH) practices are associated with the stunting, including environmental intestinal dysfunction, infection

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routes, and recurrent diarrhea[7]. For instance, many people in Indonesia's rural areas drink the polluted surface water, thus putting their health at risk. As an additional concern, many people still defecate in the open space, thus leading to the spread of disease[8].

A disorder known as the pediatric environmental enteropathy has a strong evidence linking environmental causes to a chronic inflammatory sickness of the stomach[9]. A chronic inflammatory condition of the gut known as pediatric environmental enteropathy has been found to be associated with the environmental variables, according to the available evidence[10]. These disorders have the potential to disturb the gut microbiota and have further negative effects on children's development and growth. The diarrhea-causing pathogens are part of the gut microbiota and thought to play a significant role in malnutrition[11]. Even without the outward symptoms of illness, like diarrhea, the subclinical changes in the gut microbiome can lead to the stunting. Children younger than two years are particularly vulnerable to the enteric diseases in areas with extreme poverty and inadequate sanitation. Enteric infections cause malabsorption and intestinal barrier failure, which can contribute to the stunting and wasting. Children's cognitive development and general health are predicted by measuring their height at the age of two years. Nutritional issues in children younger than five years are affected by sociodemographic, environmental, cultural, and economic variables[12,13].

Child healthcare practice is crucial and involves paying attention to the child's condition, practicing good hand washing, maintaining environmental hygiene, and providing proper care for children[14]. This set of behaviors is referred to as Clean and Healthy Life Behavior (CHLB), involving preventive measures against various diseases for individuals and families. It is recommended to incorporate CHLB into daily life, as behavioral factors are known to impact 30-35% of health status. Previous research has found that a lack of access to hygiene was associated with a 52% higher risk of the stunted growth (odds ratio of 1.52, [95% CI (1. 28–1.80)][3].

In West Kalimantan Province, Indonesia, many toddlers were short or had the stunted nutritional status[15]. In particular, Sambas District had one of the highest stunting rates (at 27.67%) in the province[16]. However, the potential causes of this high prevalence have not been explored. Therefore, a study was conducted to assess the prevalence and factors associated with the stunting among children aged 0-59 months in the Sambas Regency, West Kalimantan, in 2020. The study considered several factors, such as infectious diseases, drinking water sources, clean and healthy living behavior, and environmental sanitation.

METHODS

Study Design and Setting

The current study was designed as a case-control study to investigate a specific research question. It was conducted in Sambas Regency, over a period from June to November 2020.

Study Population and Sampling

Research participants were children in the Sambas Regency at the age of at least 59 months with the stunted growth. The study's inclusion criteria were used to select the youngsters. The study included children within the 0-59 month age range at the time of data collection. Information of their weight and height for assessing the stunting was documented at the public health centers situated in the Sambas Regency. The sampling method used was the purposive sampling. The case groups were children with the confirmed stunting and both acute or chronic infection diseases in the past year, using the data recorded by the public health centers. Meanwhile, the control group, those with normal records a year before the study, was taken from the same area.. The sample size reached 89 cases and 159 controls (1:2) based on the formula of different proportions between two groups with 80% power of study. All of the 241 children screened for the assessment were found eligible to participate in this study. The informed consent was obtained before the interview.

Study's Variables

To gather information about the stunting prevalence in Sambas Regency, we conducted interviews with the residents and assessed their homes using the standardized questionnaires. The dependent variable was the stunting incidence, while the independent variables included environmental factors, hygiene practices, water sources, and history of infectious diseases. A history of infectious diseases in children was constituted by more than six illnesses or chronic infections last year, such as tuberculosis, acute respiratory infections, and diarrhea. The drinking water sources are considerable feasible for meeting the standards outlined in Regulation of the Minister of Health No. 492/Menkes/PER/IV/2010 \. To promote children's health, parents should demonstrate good hygiene habits, such as using clean water for bathing and household tasks, washing hands with soap, staying active, and refraining from smoking inside the house. This study also measured environmental variables related to sanitation, such as ownership of latrines, frequency of garbage and waste disposal, and the condition of house. The environment was considered harmful for not meeting any of these conditions[17].

Data Analysis

The children's sociodemographic factors were subjected to a descriptive statistical analysis. To determine whether or not there was a significant link ($p<0.05$) between the predictors and the outcome (potency of the stunting incidence), a cross-tabulation chi-square analysis was carried out. The research was given permission by the Pontianak Ministry of Health's Health Ethics Commission (registration no. 018/KEPK-PK. PKP/II/2021). Every single participant gave their informed consent.

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RESULTS AND DISCUSSIONS

The respondents' characteristics are presented in Table 1. From total 241 respondents, 49.79% were fathers and the rest 52.28% were mothers, while most of them had graduated from elementary or junior high school. In terms of occupations, 52.28% of fathers were farmers, while 64.73% of mothers did not work.

Table 1. Frequency Distribution of Parental Characteristics of the Stunting Respondents with Education and Employment Criteria in Sambas Regency

Characteristics	n	%
Parents' Education		
Father		
Primary/Junior High School	120	49.79
Senior High School	74	30.71
University	47	19.50
Mother		
Primary/Junior High School	126	52.28
Senior High School	69	28.63
University	46	19.09
Parents' Occupation		
Father		
Farmer	126	52.28
Self-Employed	78	32.37
Civil Servant	37	15.35
Mother		
Employed	85	35.27
Unemployed	156	64.73

n: frequency, %: percentage

In Table 2, the study outlines the characteristics of the focus variable. Out of the 241 respondents, 58.51% reported no history of infectious diseases, while 55.19% had access to a reliable drinking water source. Additionally, 55.19% of respondents demonstrated good hygiene and health, while 53.11% reported living in a healthy environment.

Table 2. Frequency Distribution of Respondents based on the Infectious Diseases, Clean and Healthy Living Behavior, and Environmental Conditions in Sambas Regency

Characteristics	n	%
Records of Infectious Diseases		
Yes	100	41.49
No	141	58.51
Source of Drinking Water		
Not Eligible	108	44.81
Eligible	133	55.19
Clean and Healthy Living Behavior		
Less	108	44.81
Good	133	55.19
Environment Condition		
Healthy	128	53.11
Unhealthy	113	46.89

n: frequency, %: percentage

Table 3 shows the statistical analysis on a relation of infectious diseases, clean and healthy living behavior, and environmental conditions with the stunting incidence. The data in Table 3 demonstrate that up to 78% of individuals affected by infectious diseases experienced the stunting. The statistical analysis yielded p-values (0.000) < α (0.05), indicating a correlation between the two. The Odd Ratio (OR) values of 41.901 further emphasized the impact of infectious diseases on the stunting rates in young children. Statistical analysis revealed a p-value of 0.000, lower than the significance level of α (0.05), indicating a relevance between CHLB and the stunting incidence. Additionally, an OR value of 46.875 indicated the effect of CHLB on the stunting incidence in children under 2 years and toddlers, while the majority of respondents on CHLB variable reported a 75% reduction in the stunting. According to the statistical analysis, a p-value of 0.000 was lower than the significance level of α (0.05), indicating a correlation between environmental factors and the stunting incidence. Additionally, an odds ratio (OR) of 37.875 indicated that infectious diseases affected the stunting incidence in infants and toddlers. The majority of environmental variables showed the stunting rates at 71.68%. The results of the correlation between infectious diseases and stunting are detailed in Table 3. It shows a history of infectious diseases associated with stunting, with a p-value of 0.000 and an OR=41.901 value.

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Therefore, it can be concluded that there is a relation between infectious diseases and the stunting. Additionally, it shows that the stunted toddlers are more likely to experience infectious diseases, compared to the typically stunted toddlers.

Table 3. The Relation of Infectious Diseases, Clean and Healthy Living Behavior, and Environmental Conditions with the Stunting Incidence in Sambas Regency

Variable	Stunting				Total		p-value	OR (95% Confidence Interval)
	Case		Control					
	n	%	n	%	n	%		
Records of Infectious Diseases								
Yes	78	78.00	22	22.00	100	41.49	0.000*	41.901
No	11	7.80	130	92.20	141	58.51		
Source of Drinking Water								
Not Eligible	77	71.30	31	28.70	108	44.81	0.000*	25.046
Eligible	12	9.02	121	90.98	133	55.19		
Clean and Healthy Living Behavior (PHBS)								
Less	81	75.00	27	25.00	108	44.81	0.000*	46.875
Good	8	6.02	125	93.98	133	55.19		
Environment's Condition								
Unhealthy	81	71.68	32	28.32	113	46.89	0.000*	37.969
Healthy	8	6.25	120	93.75	128	53.11		

n: frequency, %: percentage, chi-square test, *) significant relationship at p-value<0.05

The growth of children under five can be negatively affected by infectious diseases, such as Acute Respiratory Infections (ARI), diarrhea, and worms[18]. The stunted children are more susceptible to illnesses due to their low body resistance. According to the World Health Organization (WHO), common infectious diseases in the stunted children are helminthiasis, diarrhea, inflammation, malaria, and respiratory tract disorders/ARI. Children who have not been fully immunized are at a higher risk of having the infectious diseases, such as diarrhea as well as the stunting. Research conducted in Ethiopia shows that children suffering from diarrhea are more likely to be stunted[19]. In children aged 6–59 months from the low-income urban and rural regions, the stunting was linked to the infectious illnesses, such as diarrhea, respiratory infections, and fever[20].

This study has found that people obtain their drinking water from various sources, such as rainwater, wells, rivers, gallons, and Local Water Company. The majority of respondents used rainwater and the least used water from the Local Water Company. However, well used by one of the respondents was located very close to household waste disposal, at a distance of less than 10 meters. In addition, most people in the area disposed of their household waste directly into the river. Based on the information provided by residents, there have been the unlicensed gold mining activities in the upper reaches of the river in Makrampai Village. This situation can potentially affect safety and quality of the drinking water consumed by families because water obtained from these sources may not be treated independently by individuals. As a result, it may not meet the eligibility requirements for the drinking water, such as water processed by Local Water Company.

A higher stunting risk in children was found to be related to the unfit drinking water, according to a study on the drinking water sources. Those who did not preserve their drinking water sources at home were more likely to have children with the stunted growth. When asked about the origin of their drinking water, most people answered rainwater, while the least said Local Water Company. The household waste disposal site was located near the well used by most respondents, and many people dumped their trash into the river. The respondents' families' access to the safe drinking water may be compromised by these factors.

The stunting prevalence in toddlers is significantly correlated with availability of the safe drinking water. An increased stunting risk in children can be caused by water sources unsuitable for drinking and insufficient waste disposal, according to research. Another study found that the stunting was more common in areas with the unimproved latrines and the unprocessed drinking water, compared to areas with better sanitation and hygiene practices. Although the current explanation for causation has its shortcomings, this study has shown new relevance among stunting, water treatment, and household cleanliness.

Some noteworthy conclusions have been drawn from the statistical analysis performed in this study. Only 8.9% of respondents with good CHLB in place had no stunting, according to the data, but 91% of those who had inadequate CHLB in place had stunting. Additional statistical evidence pointed to a correlation between CHLB and the stunting rates. A statistically significant

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association between CHLB and stunting incidence (at p-value=0.000) ruled out the possibility of random coincidence. Poor CHLB implementation was 46.875 times more likely to result in the stunting than good CHLB, as shown by the OR value of 46.875.

The CHLB implementation in households is crucial for improving the degree of health and nutritional status [21]. Better implementation of good hygiene practices in the family means fewer people getting sick, the stunting in particular. On the other hand, poor hygiene practices could increase the potential for family members and toddlers to experience illness and decrease their nutritional status, leading to a higher stunting risk in children[22,23]. To enhance the nutritional status of family members and toddlers for the stunting prevention, it is crucial to prioritize the establishment of healthy CHLB in families. Even simple habits (e.g., regularly washing hands before and after touching food, drinking, or using the restroom) can have a significant impact on health[24,25].

In addition, factors that contribute to the stunting incidence in toddlers included household poverty, maternal education, government aid, and the availability of proper sanitation[26,27]. As shown in the respondent data, most of the parents have only graduated from elementary or junior high school education, while fathers usually worked as farmers and most mothers were not employed. These socioeconomic factors are likely to have a negative effect on the stunting in toddlers. On the other hand, considering availability of the qualified drinking water sources and healthy environmental conditions, socioeconomic factors can have a positive effect on the stunting in toddlers.

The best policies and initiatives to reduce the stunting in Indonesian children should focus on water, sanitation, and hygiene treatments, according to a comprehensive assessment and analysis of the research and the available data. Sustainable Development Goals and the stunting prevention can be accomplished through such initiatives. The availability of safe drinking water and other forms of clean water is a societal responsibility that falls squarely on local governments. Programs, like Community-Based Drinking Water and Sanitation Provision Program, with a priority on the use of indigenous knowledge and practices in water and sanitation supply, are among approaches to address this problem. To improve health outcomes and reduce the prevalence of water-borne infections, these programs were more than just clean water; they also encouraged better sanitation and hygiene habits. People can improve the quality of life for families and communities across the region by prioritizing these measures and working towards a reduction in the child stunting rates in Indonesia.

CONCLUSIONS

Preventing the stunting in children is crucial for the future of country and health worldwide, intelligence, and economic prosperity. The rising stunting incidence in Sambas was caused, in part, by infectious infections, a lack of the standardized drinking water, inadequate hygiene practices, and the unfavorable climatic factors, according to the present study. This research emphasizes the need of establishing precise and stringent criteria to establish causation to implement transdisciplinary approaches to deal with the stunting.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors have no conflict of interest in this article.

AUTHOR CONTRIBUTIONS

IB: conceptualization, writing–original draft; RNP: formal analysis, writing editing; NA: methodology, writing-review and editing; GH: supervision, writing-review and editing; ET: supervision, writing–review and editing.

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RESEARCH STUDY
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The Effects of Warm Compress and Coconut Water Administration on the Primary Dysmenorrhea in Teenage Girls of the Al Ikhlash Putri Modern Boarding School, Kuningan Regency

Efek Kompres Hangat dan Pemberian Air Kelapa terhadap Dismenore Primer pada Remaja Putri Pondok Pesantren Modern Al Ikhlash Putri Kuningan

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ABSTRACT

Background: The menstruating teenage girls show a high primary dysmenorrhea incidence which is very discomforting, in form of abdominal cramps or pain spread to the back, headache, nausea and vomiting, as well as diarrhea, so they have to take a rest in a certain period of time and stop carrying out their activities and works.
Objectives: This research aims to identify the effects of warm compress and coconut water administration towards the primary dysmenorrhea in teenage girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency.
Methods: This research was the pre-experimental research with one group pretest-posttest design. Total 83 teenage girls from classes 1 to 3 in Senior High School at the age of 14-18 years were selected as population. Instrument used was the Standard Operating Procedure (SOP) and the checklist sheet (observation and interview). Data processing was carried out using the SPSS program. The purposive sampling was applied in taking the sample, so 26 teenagers, relevant to the inclusion and exclusion criteria, were obtained. Data collected were primary data. Univariate and bivariate analyses were utilized with the paired t-test in testing effects and chi-square test in testing correlation of every variable.
Results: There was a difference test with p-value 0.000, while the significant effect was found in menstrual pain before and after warm compress and coconut water administration in teenage girls.
Conclusions: Warm compress and regularly consuming coconut water can minimize the menstrual pain in teenage girls.

INTRODUCTION

Teenage girls as the future mothers need to get special attention, on their health in particular, to be able to give contribution in the future as a good generation, in giving a birth to healthy, smart offspring as the successors of nation's purpose and hope which are noble. Teenage is a period of transition towards the adult, characterized with cognitive, psychosocial, and biological changes. Biological changes are marked with puberty, characterized with the menstruation[1].

The term menstruation is a period when endometrium contains a number of blood vessels. Because of the ruptured blood vessel, blood flows outside the vagina. When menstruation starts because estrogen is secreted by ovary, the uterus layer grows back[2]. A number of women had cramps on the lower stomach (dysmenorrhea)[3]. Complaint generally perceived by women is menstrual pain[4]. Dysmenorrhea or menstrual pain is a sickness generally perceived by teenagers, so the case reached the number 60%-90%[5].

Based on the WHO data in 2020, the dysmenorrhea cases reached 1,769,425 (90%) with severe category up to 10-16%. Over 50% of women worldwide had dysmenorrhea[6]. In the United States of America, almost 90% of women had dysmenorrhea and approximately 10-15% were classified as severe, thus leading to the inability in carrying out activities. According to Pediomaternal Journal in 2021, 85,4% of teenage girls in Africa had primary dysmenorrhea[7].

The dysmenorrhea cases in Indonesia reached a percentage of 60-70%, 107,673 (64.25%) to be exact, including primary dysmenorrhea in 59,671 people (54.89%) and secondary dysmenorrhea in 9,496 people (9.36%). In the least 50 years, 75% of women had the menstrual pain. Primary dysmenorrhea is usually perceived by potentially pregnant women or those who

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have never been pregnant before. This symptom usually occurs in women at the age of 20-24 years or 25 years. Incidence in single women reached 61%[8].

Around 60-75% of teenage girls in Indonesia had primary dysmenorrhea, including light, moderate, and severe pain[9]. Many women felt pain in their period, but they choose not to report it and see doctor because of feeling embarrassed and considering it not important. This condition makes data concerning the primary dysmenorrhea cannot be confirmed completely. Around 90% of Indonesian women had primary dysmenorrhea[10].

According to Sirait, Hiswani & Jemadi (2014), a number of factors are predicted to be related to primary dysmenorrhea, including alcohol consumption, age of menarche, nutrient status, family history, menstruation duration, smoking, and the exercise habit [11]. Primary dysmenorrhea have negative effects in teenagers, namely the reduced capability to study, being absent in school, inability to carry out household work, difficulty to focus during study, and the minimized social interaction. Polycystic ovary syndrome and endometriosis are long-term effects appearing when dysmenorrhea is not immediately managed. A number of factors are capable of reducing the pain, including nutrient food consumption, enough rest, family support, being not anxious, regular exercise, relaxation, pharmacological and non-pharmacological consumption for pain reliever, and entertainment[12]. According to Bonde & Moningka (2014), menstrual pain is managed through the non-pharmacological therapy for dysmenorrhea prevention, through warm compress and coconut water administration. This therapy is believed to minimize pain during period[13-14].

Warm compress is a measure to put small towel which has been soaked in warm water at a temperature of 40-46°C on stomach area in pain for at least 20 minutes, and the fabric is soaked again every five minutes. Warm compress with the principle of heat transmission is conducted through the conduction step, by putting warm water bag on symphysis to ease the blood circulation and relieve muscle tension, until the pain felt by primary dysmenorrhea patients is relieved [15].

The widening of blood vessels by the heat is capable of increasing the blood circulation. The physiological response of body to the heat leads to the widening of blood vessel, minimizes the thick blood, minimizes the muscle tension, and improves capillary permeability and tissue metabolism. Response from the heat is used in the therapy need in a number of situations in body. The widening of blood vessel because of the heat occurs in 15-20 minutes. Compress longer than 20 minutes will lead to the burns in patients and tissue congestion because the blood vessel contraction is not capable of relieving the heat well through blood circulation[16]. According to a research by Maidartati, Hayati & Hasanah (2018), the warm compress technique with fabric or towel at a temperature of 40-46°C was carried out on the lower stomach of teenage girls during menstrual pain. For 20 minutes, hot water is replaced every 10 minutes to maintain the temperature. Thus, warm compress is capable of relieving the menstrual pain[17].

In non-pharmacological therapy, menstrual pain relief is not through warm compress only on lower stomach, but also coconut water administration to cure dysmenorrhea. The use of coconut water is capable of solving a number of medical issues. This efficacy is obtained from important substance to preserve body's health[18]. One of the benefits of coconut is its efficacious water for curing a number of medical issues, namely menstrual pain, hypertension, diarrhea, kidney stones, metabolism issues, constipation, and fatigue. Coconut water has been processed into isotonic drink for having mineral, natural sugar, the balanced electrolyte similar to blood, and approximately 280 mOsm/kg H_2O[19]. Its mineral content includes potassium, sodium, folic acid, magnesium, calcium, iron, manganese, zinc, and selenium, with calcium as the most mineral content, followed by sodium[20].

Body produces blood and liquid during menstruation. Electrolyte in coconut water is capable of hindering dehydration, while folic acid is capable of increasing blood. Nutrient required in the red blood cell production is folic acid, capable of expediting blood flow and meeting the need for nutrient and oxygen, when produced in adequate amount. Its effect is the improvement on body resistance on pain felt during primary dysmenorrhea[21].

Primary dysmenorrhea is a physical disorder in the menstruating women, in pain/cramps on stomach, followed by the spread of pain to back, nausea and vomiting, diarrhea, and headache. This condition is caused early menarche, physical activities, stress, dysmenorrhea history in family and nutrient intake. Primary dysmenorrhea can be prevented by reducing stress, consistent dietary habit followed with nutrient intake, avoiding spicy and acid foods when anticipating menstruation, taking care of body to not feel tired and the depleted energy, taking a rest, sleep as needed, and regular light exercise[22]. The effort of dysmenorrhea management can be in pharmacology and analgesic, but they can bring side effect for a long period of time, while non-pharmacological measure, through warm compress and coconut water administration, does not lead to any side effect. It is required to take a rest and stop activities for some time because of high menstrual pain rate. Thus, a problem is formulated, "Are There Any Effects of Warm Compress and Coconut Water Administration towards the Primary Dysmenorrhea in Teenage Girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency.

Based on the elaborated background of occurrence, this research is intended to identify the effects of warm compress and coconut water administration towards the primary dysmenorrhea in teenage girls of Al-Ikhlash Putri Modern Boarding School in Kuningan Regency. This research is expected to be beneficial for teenage girls with the non-pharmacological therapy method which is independent and easy to be carried out everywhere, through warm compress and coconut water administration towards primary dysmenorrhea.

METHODS

This research was pre-experimental with one group pretest-posttest design and conducted from 1st of

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June to 14th of July 2023 in Al-Ikhlash Putri Modern Boarding School, Kuningan Regency. This research has obtained the permission No.384-54/Ket/III.3-AUM/D/2023 from the Muhammadiyah Institute of Health Science in Cirebon. Population in this research was 83 respondents from classes 1-3 of Senior High School. Teenage girls at the age of 14-18 years were made the research sample. The samples were selected with the purposive sampling technique, so 26 teenage girls matching inclusion and exclusion criteria were gathered. Inclusion criteria were teenage girls with willingness to be respondents, to follow the research until completion, studying in Al-Ikhlash Putri Modern Boarding School in Kuningan Regency, having primary dysmenorrhea, not having allergy to the green and hot coconut water, feeling pain after blood flowing until 48-72 hours, light and moderate pain intensity. Exclusion criteria were respondents not following the stages of research from screening, pretest, intervention, and posttest, having secondary dysmenorrhea, the uncontrolled severe pain intensity, getting stick or unable to attend during the research, being absent in school with permission, not following one of the activities and unable to catching up, and consuming certain medicine.

This research included the bound variable and free variable, with primary dysmenorrhea as the bound variable, while warm compress and coconut water administration were the free variables. Instrument used in warm compress were operational standard of warm compress and coconut water administration. Data processing included editing, coding, tabulating, and entry. Data analysis included univariate and bivariate analyses with chi-square testing, normality testing with kolmogorov smirnov test and the paired sample t-test with Sig. = 0.000 on SPSS application.

RESULTS AND DISCUSSIONS

Characteristics of teenage girls in the research result included age, education, year of first menstruation, first year of menstrual pain, height, weight, and hemoglobin (Hb), while 26 teenage girls had primary dysmenorrhea from 1st of June to 14th of July 2023 in Al-Ikhlash Putri Modern Boarding School, Kuningan Regency. All variables were presented in categorization. Distribution and frequency of every variable are detailed as follows:

Table 1. Frequency Distribution of Characteristics in Teenage Girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency with the Primary Dysmenorrhea Condition

Characteristics	n (N=26)	%
Age (year)		
14	1	3.8
15	3	11.5
16	9	34.6
17	10	38.6
18	3	11.5
Education		
Junior High School	3	11.5
Senior High School	23	88.5
First Year of Menstruation		
2015	2	7.7
2017	3	11.5
2018	4	15.4
2019	8	30.8
2020	9	34.6
Age of Menarche		
10	1	3.8
11	3	11.5
12	10	38.6
13	7	26.9
14	5	19.2
First Year of Menstrual Pain		
2017	1	3.8
2019	2	7.7
2020	5	19.2
2021	4	15.4
2022	2	7.7
2023	12	46.2
Body Height		
<150 cm	7	26.9
≥150 cm	19	73.1
Body Weight		
40-58 kg	22	84.6
59-78 kg	4	15.4
Hemoglobin Level		

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Characteristics	n (N=26)	%
<12 gr%	5	19.2
≥12 gr%	21	80.8
Before Warm Compress and Coconut Water (pre-test)		
Light Pain	16	61.6
Moderate Pain	9	34.6
The Controlled Severe Pain	1	3.8
After Warm Compress and Coconut Water (post-test)		
No pain	12	46.2
Light Pain	13	50.0
Moderate Pain	1	3.8
Hemoglobin Level		

Result of the research in Table 1 shows the characteristics of teenage girl, namely age, education, first year of menstruation, the age of menarche, first year of menstrual pain, height and weight, hemoglobin level. Univariate data were the pain scale before treatment with warm compress and coconut water (pre-test) and after warm compress and coconut water (post-test). Based on the research result, from 26 respondents, most of them (10 people or 38.6%) were 17 years. This research shows the teenage girls in class 3 of Junior High School, classes 1 and 2 of Senior High School in Al-Ikhlash Putri Modern Boarding School, with the age range of 14-18 years. It is in line with the definition of WHO, in which teenage girls are individuals with the age range from 10 to 19 years. As stated in the Regulation of Minister of Health of the Republic of Indonesia No. 25 Year 2014, teenage girls are individuals with age range of 10-18 years. According to National Population and Family Planning Board, the age range of teenage girls is 10-24 years before getting married[23].

According to the research result, most of them (23 people or 88.5%) studied in Senior High School. This finding was in line with a theory by Alimin (2023), in which the education of respondents was dominated by Senior High School because students were enthusiastic and motivated, based on the result of observation during activities in filling questionnaires directly given and filled by students[24]. From the aforementioned explanation, the characteristics of respondents based on majority education level in Senior High School represented the variable in this research.

Based on the characteristics of respondents, most of them (34.6%) had menstruation for the first time in 2020 and the age of menarche at 10-14 years was dominated by the age of 12 years in 10 people (38.6%). The result of research was in line with theory of Prawiroharjo (2014), in which the range of menarche was 10-15 years. Menstruation before 10 years indicated early menarche, while late menarche was when menstruation after 15 years[25]. Respondents with the later menarche were related to other factors affecting the physical growth[25]. Minister of Health of the Republic of Indonesia (2018) revealed that the age of 12.4 was the average age of menarche. It was in line with the obtained finding because most of the respondents were 12 years when having the first menstruation.

This finding was in line with theory by Suwarnisih, Agustin, & Cahyaningtyas (2017), in which ideal menarche age was 13-15 years, while the age of <13 years for menarche was considered early[26]. According to a finding by Wulandari & Ungsianik (2013), the age of <12 years was considered too early in menarche and made teenagers unready to feel pain because of the optimal development of reproductive organ, cervical stenosis, and maturity of the reproductive organ[27]. Age <12 years led to the short-term effect, dysmenorrhea occurrence, thus requiring serious attention[28].

Based on the research result, most of the respondents, in 12 people (46.2%), had the menstrual pain for the first time in 2023. In the age of 10-14 years, menarche occurred in 10 respondents (38.6%), particularly at age of 12 years. This research was in line with a theory, in two and three years after the menarche, dysmenorrhea occurs. If ideal age of menarche is 13-14 years, age of 15-17 years is common for dysmenorrhea[29]. That age is a stage of reproductive organ development and significant hormonal change[29]. Teenage girls in Senior High School are recommended to get reproductive health education, on dysmenorrhea in particular.

Height measurement using microtoise on 26 respondents show the lowest height at 13 cm, while the highest was 168 cm. The average height was 153.27 cm. In line with the finding from Fivi Arnia Sofiyani (2017), average height in students of boarding school was 154.9 cm[30]. The lowest height was 140 cm, while the highest was 165 cm[30].

Height measured on 26 respondents resulted in the lowest weight at 40 kg, while the highest was 70 kg. The average weight was 50.42 kg. In line with a finding by Fivi Arnia Sofiyani (2017), the lowest weight of respondents was 32 kg, while the highest was 71 kg. Average weight was 51.28 kg[30].

Hemoglobin level, using the measuring instrument of EasyTouch GCHB, was grouped into normal and abnormal. It was categorized normal for ≥12 mg/dL, while the abnormal result was <12 mg/dL. Most of the hemoglobin levels were higher than 12 gr/dl, in 21 people (80.8%). In line with a finding by Fera, Merissa, and Sri Ratna (2023), hemoglobin level in teenage girls was mostly in ≥12 mg/dL with normal category[31]. For the finding in Palangka Raya, there was a correlation between hemoglobin level and dysmenorrhea occurrence ($p<0.05$)[32].

Before and After Warm Compress and Coconut Water (pre-test and post-test)

Primary dysmenorrhea level before coconut water administration was 61.5%, belonging to light pain in 16 people, characterized by hissing, grin, capability to point the area in pain, describing what is being felt, and

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obeying instruction. Afterwards, 9 people (34.6%) with a scale of 4-6 had moderate pain, followed with 1 person (3.8%) at scale of 7 having a controlled severe pain. After given coconut water, primary dysmenorrhea level in teenage girls showed that 12 people (46.2%) were not in pain, 13 people (50.0%) had light pain at scale 1-3, and the rest 1 person (3.8%) had moderate pain, as characterized by good communication capability. In 26 teenagers having the decrease of primary dysmenorrhea level, 12 people (46.2%) were not in pain with scale 0, 13 people (50.0%) had light pain with scale 1-3, and 1 person (3.8%) had moderate pain at scale 4. It means that the pain intensity scale decreased after warm compress and coconut water administration.

The cause was that pain was assessed subjectively, so individuals with the related situation were capable of describing the pain scale, thus affecting the decrease in the pain intensity scale in every respondent[33]. This finding was in line with a theory of Asmita Dahlan and Tri Veni (2017), in which pain after warm compress decreased[34]. In line with the finding of Nuryanih & Suhatika (2020), coconut water was capable of relieving menstrual pain, because of having high nutrient[8].

The finding was in line with that of Rahmadhayanti (2017), in which warm compress affected the menstrual pain relief[35]. In other findings, menstrual pain was relieved after warm compress[36]. Average decrease of pain intensity before and after intervention was found. This finding was in line with the research showing that warm compress was capable of expediting the blood flow and causing vasodilation, resulting in the muscle relaxation for obtaining more nutrition from blood. Warm compress caused vasodilation in pubic symphysis capable of opening the blood flow, so the muscle contraction got reduced after relaxation. After prolonged pain was relieved, the respondents felt comfortable, capable to carry out minimum activities, and to control psychological response, leading to the controlled emotion. This compress was efficacious to expand blood vessel, stimulate the stiff joint, and minimize the pain[37]. In other words, warm compress affected the decrease in pain intensity during period[38].

Table 2. Relation between Warm Compress and Coconut Water Administration (Before and After Intervention) in Teenage Girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency, with the Primary Dysmenorrhea

Before treatment Warm Compress and Coconut Water (pre-test)	After Warm Compress and Coconut Water (post-test)						Total	p-value	α
	No pain		Light Pain		Moderate Pain				
	F	%	F	%	F	%			
Light Pain	11	7.4	5	8.0	0	0.6	16	0.049	0.028
Moderate Pain	1	4.2	7	4.5	1	0.3	9		
The Controlled Severe Pain	0	0.5	1	0.5	0	0	1		

Pre-test (before intervention); post-test (after intervention)

Based on the analysis result in 26 samples, 12 respondents (46.2%) had no pain, 13 (50.0%) had light pain, and 1 person (3.8%) had moderate pain. Result in chi-square testing was p-value at 0.049, meaning that p-value<α. Number 0.05 means correlation was found in warm compress and coconut water administration towards the primary dysmenorrhea in teenage girls. This research was also in line with that of Shopia (2013), with p-value resulted at 0.019, meaning that correlation was found in warm compress and coconut water administration towards primary dysmenorrhea[39].

Table 3. Normality Test of Primary Dysmenorrhea before and after Warm Compress and Coconut Water Administration in Teenage Girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency

Normality Test	pre-test and post-test			Explanation
	t-statistic	Sig	df	
Shapiro-Wilk	0.944	0.163	26	Normal
One Sample Kolmogorow-Smirnov Test	0.238	0.001	26	Normal

Sig (Significance); DF (Degrees of Freedom)

In identifying the data distribution, normality testing was carried out with Shapiro-Wilk in pre-test and post-test, while Sig. level in pre-test and post-test variables was 0.163>0.05. It means that data distribution was normal. In testing normality with One Sample Kolmogorov Smirnov Test, the result was 0.238>0.001 = 0.05. It was concluded that probability t-statistic>Level of Significant = 0.05, meaning that data met the normality assumption and data distribution in every variable was considered normal.

Table 3. Effects of Warm Compress and Coconut Water Administration towards the Primary Dysmenorrhea in Teenage Girls of Al-Ikhlash Putri Modern Boarding School, Kuningan Regency

Variable	t-count	Sig	Level of Significance	N
pre-test and post-test	7.939	0.000	0.05	26

Sig (Significance); N (Amount of Valid Observation for Variable)

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Result of the difference test with the paired sample t-test was Sig. = 0.000<(α) = 0.05, thus there was a significant difference between pre-test and post-test. Table t shows positive t-count at 7,939, which means that the average was lower before intervention, compared to the average after intervention. Thus, warm compress and coconut water administration had effect from pre-test to post-test. Significant difference was found in warm compress and green coconut water towards the change of pain scale in primary dysmenorrhea.

This finding was in line with that of Pattiiha and Suciawati (2021), in the reaction of 30 teenagers consuming coconut water, in which post-test result showed that 16 respondents (53.3%) did not feel pain[40]. It was proven with p-value 0.000<0.05, meaning that green coconut water administration affected primary dysmenorrhea pain[40]. This result was supported by the finding from Lestari (2015), with Asymp. Sign (2-tailed) 0.000 (<0.05), meaning that coconut water affected the menstrual pain level[41].

Dysmenorrhea treatment using warm compress and coconut water are recommended because they are proven to be effective. This technique does not show any side effect, unlike the treatment with chemical medicine, so it is considered to be efficient because its implementation is independent and affordable. Coconut water is used in general for reducing pain, at 14%. Blood produces blood and fluid during period. Electrolyte content in coconut water is capable of hindering dehydration and bringing analgesic effect because of its vitamin[42].

As predicted by researchers after conducting research, electrolyte with high nutrient in green coconut serves as analgesic. On the contrary, the use of chemical drugs is costly in terms of economy. Thus, it is recommended to reduce its use, by consuming ingredients which are natural, easy to get, and affordable.

CONCLUSIONS

Based on the result of research related to the effect of warm compress and coconut water administration on the primary dysmenorrhea in teenage girls, there is a relation among warm compress, coconut water administration, and primary dysmenorrhea in teenage girls of Al-Ikhlash Putri Modern Boarding School, Kuningan regency. There is a difference test or significant effect between menstrual pains before and after warm compress and coconut water administration in teenage girls. Thus, it can be concluded that warm compress and coconut water administration has been used as non-pharmacological therapy which is effective in relieving menstrual pain in teenage girls.

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AUTHOR CONTRIBUTIONS

OSR: conceptualization, investigation, methodology, supervision, writing-review and editing; RY: methodology, writing-original draft; DK: methodology; formal analysis, writing-original draft; NRN: formal analysis, resources; OSR: writing-original draft, writing-review and editing.

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Association between Six Key Messages Behaviour and Incidence of Stunting in Under-Two-Year-Old Children in Central Java Province

Hubungan antara Perilaku Enam Pesan Kunci dengan Kejadian Stunting pada Anak dibawah Dua Tahun di Provinsi Jawa Tengah

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Stunting, Iron folate tablet, Exclusive breastfeeding, Handwashing, Under-two children

ABSTRACT

Background: The stunting prevalence in Central Java Province remains high. Six key messages, i.e. iron tablet supplementation, healthy latrines, exclusive breastfeeding, Integrated Health Care Post (Posyandu) visit, hand washing, and Antenatal Care visit are the efforts to reduce the prevalence of stunting.
Objectives: This study aimed to analyse the relationship between the behaviour of the six key messages and the stunting prevalence in four districts of Central Java Province.
Methods: This cross-sectional study was conducted in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City with 424 mothers who have under two-year-old children randomly selected as sample. Data were collected by interview using a structured questionnaire with the results grouped into attitude and practices categories. The body's weight and length were measured by a digital scale and infantometer. Data were analysed using the chi-square test.
Results: The findings indicated that 21.5% of children under two had stunting. Besides, behaviour regarding six key messages were mostly good. There was no association between mothers' iron tablet consumption behaviour and the nutritional status of under-two children. There was an association between maternal attitudes about exclusive breastfeeding and knowledge about hand washing with length for age index (p=0.004). There was also an association between antenatal care and Posyandu visits practice with weight for age index (p=0.004 and 0.018). There was a relationship between attitude regarding the use of latrines and the weight for length index (p=0.001).
Conclusions: Only the key messages of exclusive breastfeeding attitude, antenatal care visit practice, Posyandu visit practice, and hand washing attitude were associated with the nutritional status of under-two children.

INTRODUCTION

Stunting is a chronic nutritional problem that remains a global issue. Stunting refers to a condition where a child's height is below average due to long-term malnutrition, which can cause delays in brain development and growth[1]. Based on the Joint Child Malnutrition Estimates (JME) Report for 2023 by the United Nations Children's Fund (UNICEF), World Health Organization (WHO), and the World Bank, the prevalence of stunted toddlers in Indonesia is the second highest in the Southeast Asian region behind Timor Leste[2]. The results of the Indonesian Nutrition Status Survey (SSGI) show a downward trend, namely 27.7% in 2019, 24.4% in 2021, and 21.6% in 2022[3–5]. The prevalence is still relatively high because it exceeds the WHO target of 20%. Indonesia's National Medium-Term Development Plan (RPJMN) targets a reduction in stunting prevalence to 14% by 2024[6]. SSGI data in 2022 in Central Java Province recorded 20.8% of toddlers experiencing stunting[5]. Although this figure is lower than that of the national figure, it still exceeds the WHO target of 20%.

Stunting in Indonesia is associated with a complex combination of factors, including inadequate maternal nutrition, hygiene habits, low maternal and paternal education, and parenting practices characterised by poor dietary diversity and suboptimal feeding practices[7]. The Indonesian government has launched a campaign to promote several key behaviours to educate the public about stunting. These key behaviour consist of taking iron tablet supplementation, attending classes for pregnant women, exclusive breastfeeding until six months of age,

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regularly attending Posyandu, washing hands with soap, and using healthy latrines[8].

Improving maternal nutrition during pregnancy is a public health priority for stunting prevention in Indonesia. Antenatal care is strongly associated with improving maternal and child health. Several studies have shown that stunting is caused by a chronic process that lasts from pregnancy to early infant life. Therefore, improving antenatal care can play an important role in reducing stunting[9]. A system-strengthening approach during antenatal care was shown to improve maternal nutrition and reduce child stunting in West Bengal, India. In Ethiopia, higher levels of maternal education, better maternal autonomy, average or higher maternal height and weight, at least four antenatal care (ANC) visits, and delivery in a health facility were significantly associated with lower levels of stunting. Improved antenatal care, including nutrition and maternal health, can play an important role in reducing child stunting[10].

Iron-folic acid (IFA) supplementation during pregnancy has been shown to have a positive impact on child development, including reducing the risk of stunting in children under two years of age. A study conducted in South Asia found that iron and folic acid supplementation in the antenatal period increased linear growth and reduced the risk of stunting or *severe* stunting in children less than two years old[11]. Adherence to iron tablet supplementation during pregnancy is critical in reducing the risk of stunting in children. A systematic review found that iron tablet supplementation adherence in adolescent girls is influenced by various factors, including knowledge, attitudes and beliefs about anaemia and Iron tablet supplementation, side effects of iron tablets, and social support[12]. Overall, although the search results did not provide specific information on iron tablet supplementation adherence and stunting, it is clear that iron-folic acid supplementation during pregnancy can have a positive impact on child development, including reducing the risk of stunting in children from 2 years of age[11]. Therefore, it is critical to promote adherence to iron tablet supplementation during pregnancy to maximise its benefits. Factors affecting adherence should be identified and addressed to improve adherence to iron tablet supplementation.

Exclusive breastfeeding is associated with a reduced risk of stunting in children aged 12-23 months. A study conducted in Banjar Margo Sub-district found that exclusively breastfed children had a lower risk of stunting compared to those who were not exclusively breastfed[13]. Another study from Eastern Indonesia also found that exclusive breastfeeding protects children from stunting in low-income populations[14]. However, a study from Jatinangor Sub-District, Sumedang, Indonesia, found no significant difference in the proportion of stunting between exclusively breastfed and non-breastfed children[15]. The association between exclusive breastfeeding and stunting may vary depend on the context and the presence of effect modifiers such as socioeconomic status and access to health services.

Regular visits to Posyandu are essential for monitoring child growth and preventing stunting[16]. Posyandu, a community-based health effort, plays an important role in providing health and nutrition services for pregnant women and children, including monitoring growth through activities such as weighing, height measurement, and counselling[17]. Regular attendance at Posyandu enables timely interventions, referrals and education on nutrition and child growth to effectively reduce stunting.

Handwashing with soap is significantly associated with stunting in children. Research shows that there is a strong correlation between handwashing with soap in running water and stunting in children under five. Mothers with good handwashing habits have a lower risk of stunting in children compared to those with poor handwashing habits[18]. Proper handwashing with soap can prevent diarrhoea, which is a risk factor for stunting. Therefore, regular handwashing with soap is essential to prevent stunting in children.

Poor sanitation is closely associated with the transmission of diseases such as diarrhoea and environmental enteric dysfunction (EED), which leads to decreased nutrient absorption and consequent stunting[19,20]. Furthermore, infectious diseases can lead to low nutrient intake, absorption and utilisation, resulting in stunting[21–23]. A study conducted in Indonesia found that children who did not dispose of faeces in latrines were more likely to be stunted[24]. Another study in Indonesia found that the availability of healthy latrines was associated with a lower prevalence of stunting[25]. Maternal behaviour that follows the six key messages can be an effort to prevent stunting. Several studies on the six key messages which include exclusive breastfeeding such as a study conducted in Nigeria[26], iron tablet supplementation[27], posyandu visits[28], have been conducted. However, very few studies have explored these six key messages combined with the nutritional status of children under two years old. This study aimed to analyse the association of 6 key messages behaviour with the incidence of stunting in children aged 6-23 months in the Central Java region.

METHODS

This study was an analytical observational study with a cross-sectional approach with the subject of mothers who have children aged 6 - 23 months and are willing to become respondents totalling 424 mothers. This study was conducted in four regencies in Central Java, namely Brebes Regency (Negla Village, Kluwut Village, Losari Kidul Village), Tegal Regency (Tuwel Village and Kalisapu Village), Banyumas Regency (Cilongok Village and Gandatapa Village), and Semarang City (Bandarharjo Village and Mijen Village). The sampling technique used the following steps, which included purposively selecting four regencies. Two villages were chosen for each district based on the number of stunting cases. After obtaining the selected villages, respondents were selected through simple random sampling. The independent variables in this study were mothers' knowledge, attitudes, and practices on six key stunting messages (blood addition tablet, healthy latrine, exclusive breastfeeding, child check-up at posyandu, handwashing, and ANC). The dependent variable was the incidence of stunting. Data on knowledge, attitudes, and practices were obtained by interview using a structured questionnaire adapted from previous research that was

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conducted in different locations and has been validated and tested for reliability. The incidence of stunting in children under two years old was obtained by measuring body length using an infantometer. Under-two-year-old children were categorised as stunted if the z score on the body length index according to their age was < -2SD. This study has received ethical approval from the Health Ethics Commission, Faculty of Public Health, Diponegoro University with number 365/EA/KEPK/2022.

RESULTS AND DISCUSSIONS

Table 1 shows that most of the respondents (47.4%) were less than 31 years old. Most of the subjects (58%) had a basic education level (elementary or junior high school graduates), while 9.2% had a higher education level. Most of the subjects were housewives (79.2%). Respondents with medium and low family expenditure were almost equal at 50.6% and 41.1%. Respondents came from Brebes Regency (35.1%), Banyumas Regency (21.2%), Tegal Regency (22.4%), and Semarang City (21.2%).

Table 1. Characteristics of mothers of under-two-year-old children (6-23 months) in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City

Characteristics of respondents	Frequency (n=424)	%
Age		
< 31 years old	201	47.4
31-35 years old	127	29.8
>35 years	96	22.7
Education Level		
Not completed primary school level	14	3.3
Primary education level	246	58
Secondary education level	125	29.5
Higher education level	39	9.2
Employment Status		
Working	88	20.8
Unemployed	336	79.2
Family expenses		
Low	174	41.1
Intermediate	215	50.6
High	35	8.3
Region		
Brebes Regency	149	35.1
Banyumas Regency	90	21.2
Tegal Regency	95	22.4
Semarang City	90	21.2

Figure 1 shows that 14.4% of the children were underweight according to the weight for age indicator, 21.5% were stunted, and 11.8% were malnourished. Table 2 shows that more than 50% of mothers' knowledge, attitudes, and practices related to taking iron tablet supplementation, exclusive breastfeeding, ANC visits, visit to Posyandu, and handwashing were in the good and recommended categories. For key immunisation messages, there was a gap between knowledge and practice results. Almost all mothers had good knowledge while the practice was only 41.5% as recommended, the rest were not as recommended (58.5%). The opposite results were seen in the healthy latrine key message, where the percentage of mothers who did not know it was more than half (51.7%), while the percentage of mothers' attitudes and practices were good and as recommended >50% (92.5% and 66.3%).

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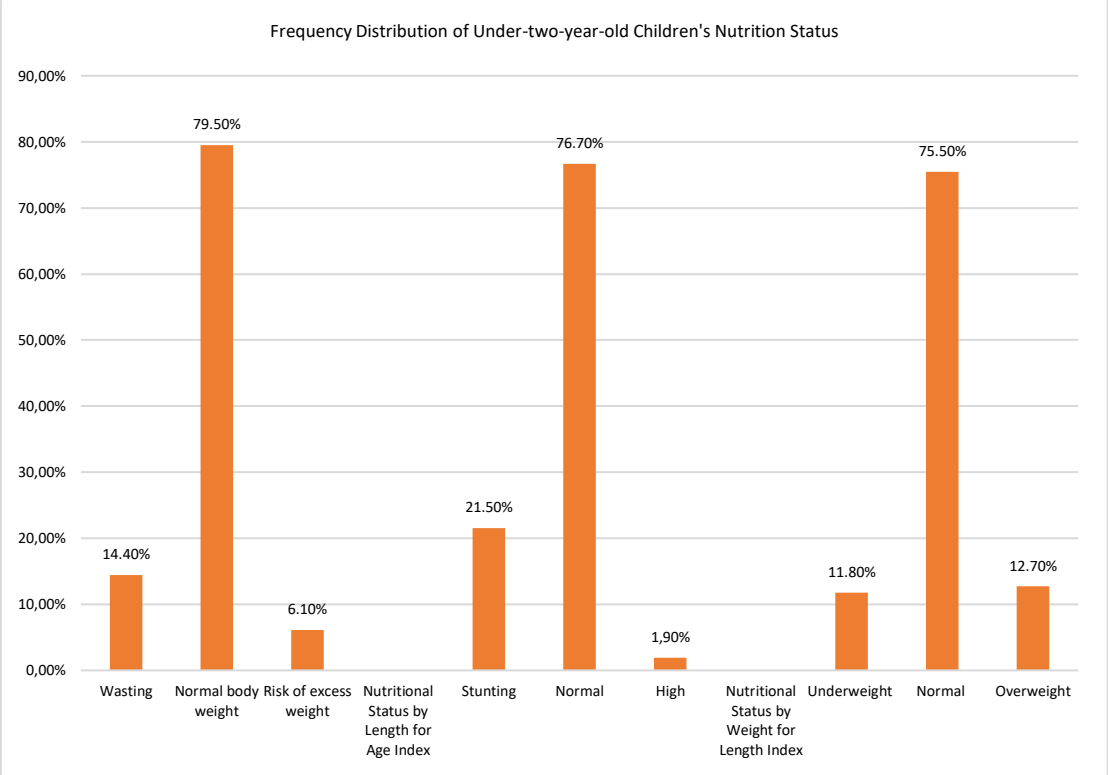

Figure 1. Frequency distribution of under-two-year-old children's nutrition status

Table 2. Frequency distribution of knowledge, attitude and practices of mothers of under-two-year-old children related to six key messages in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City

Variables	Frequency (n=424)	%
Iron tablet supplementation		
Mother's knowledge		
Lack of knowledge	136	32.1
Good knowledge	288	67.9
Mother's attitude		
Poor attitude	15	3.5
Good attitude	409	96.5
Mother's practice		
Not as recommended	142	33.5
As recommended	282	66.5
Exclusive breastfeeding		
Mother's knowledge		
Lack of knowledge	125	29.5
Good knowledge	299	70.5
Mother's attitude		
Poor attitude	63	14.9
Good attitude	361	85.1
Mother's practice		
Not as recommended	160	37.7
As recommended	264	62.3
ANC visits		
Mother's knowledge		
Lack of knowledge	78	18.4
Good knowledge	346	81.6
Mother's attitude		
Poor attitude	43	10.1
Good attitude	381	89.8
Mother's practice		
Not as recommended	39	9.2

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Variables	Frequency (n=424)	%
As recommended	385	90.8
Visit to Posyandu		
Mother's knowledge		
Lack of knowledge	180	42.5
Good knowledge	244	57.5
Mother's attitude		
Poor attitude	17	4.0
Good attitude	407	96.0
Mother's practice		
Not as recommended	51	12.0
As recommended	373	88.0
Immunisation		
Mother's knowledge		
Lack of knowledge	2	0.5
Good knowledge	422	99.5
Mother's practice		
Not as recommended	246	58.5
As recommended	176	41.5
Handwashing		
Mother's knowledge		
Lack of knowledge	124	29.2
Good knowledge	300	70.8
Mother's attitude		
Poor attitude	4	0.9
Good attitude	420	99.1
Mother's practice		
Not as recommended	143	33.7
As recommended	281	66.3
Healthy Latrine		
Mother's knowledge		
Lack of knowledge	219	51.7
Good knowledge	205	48.3
Mother's attitude		
Poor attitude	32	7.5
Good attitude	392	92.5
Mother's practice		
Not as recommended	143	33.7
As recommended	281	66.3

Association between Knowledge, Attitude, and Practice of Six Key Messages on Nutritional Status of Under-two-year-old Children

Table 3 shows that mothers with poor knowledge and attitudes tend to have iron tablet supplementation drinking practices that are not as recommended (50.7% and 93.3%). The results of statistical tests showed a relationship between iron tablet supplementation drinking knowledge and attitude towards iron tablet supplementation drinking practices. Mothers who have good knowledge and attitudes also have good iron tablet supplementation drinking practices. The results of statistical analysis (table 3) showed a significant association between mothers' knowledge and attitudes about iron tablet supplementation and the practice of taking iron tablet supplementation. Similar studies conducted in Kenya found that knowledge and attitude towards iron tablet supplementation were associated with iron supplement consumption among pregnant women[29]. Knowledge about the importance of iron and folate supplementation and women's attitudes can contribute to overall practice. This is important not only in improving the health status of infants but also mothers[30].

This could also be seen from the results of knowledge and attitudes regarding exclusive breastfeeding which indicated that mothers who had poor knowledge and attitudes regarding exclusive breastfeeding, almost equally had exclusive breastfeeding practices that were not as recommended (76.8% and 73%). The statistical test results showed that there were associations between knowledge and attitude regarding iron tablet supplementation and iron tablet supplementation drinking practice, as well as a relationship between knowledge and attitude regarding exclusive breastfeeding and exclusive breastfeeding practices. Meanwhile, maternal attitudes about exclusive breastfeeding were associated with exclusive breastfeeding practices (Table 3). According to a 2022 National Center for Biotechnology Information (NCBI) study, mothers who had higher knowledge about exclusive breastfeeding and positive attitudes towards it were more likely to exclusively breastfeed[33]. The study also found that mothers who received breastfeeding information had a 73% higher chance of doing exclusive

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breastfeeding[34]. Another study found that mothers who had higher knowledge about exclusive breastfeeding were 5.9 times more likely to exclusively breastfeed compared to mothers who had high knowledge and positive attitudes showing a 74% higher chance of doing exclusive breastfeeding[35].

There was a significant relationship between ANC knowledge and ANC practice (p<0.05). Mothers who had good knowledge tended to have recommended ANC practices (92.5%). Maternal attitude towards ANC was not significantly associated with ANC practice. Both mothers with good and poor attitudes were equally likely to have recommended ANC practices. Mothers' attitudes regarding Posyandu visits had a significant association with Integrated Health Care Post (Posyandu) visits practices. Among the 407 mothers who had good attitudes related to Integrated Health Care Post (Posyandu) visits, 89.2% had high practices of recommended posyandu visits. In contrast, the results of maternal knowledge related to Posyandu visits were not significantly associated with the practice of Posyandu visits. Both mothers with good and poor knowledge had almost the same percentage of recommended Posyandu visits.

Handwashing knowledge was associated with handwashing practices. Mothers who had good handwashing knowledge practiced handwashing as recommended and vice versa. This result was not in line with handwashing attitudes that showed no relationship. The table shows that mothers who had a poor attitude toward all practice hand washing as recommended (100%). The table also shows there was no significant relationship between knowledge and attitude about healthy latrines with healthy latrine practices. Mothers who had poor knowledge and attitudes about healthy latrines were almost equally likely to have healthy latrine practices that were not recommended.

Table 3. Association between knowledge and attitude on maternal practice of six key messages in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City

Variables	Practice				p-value
	Not as recommended		As recommended		
	n	%	n	%	
Iron tablet supplementation drinking					
Knowledge					
Lack of knowledge	69	50.7	67	49.3	0.000*
Good knowledge	73	25.3	215	74.7	
Attitude					
Low attitude	14	93.3	1	6.7	0.000*
Good attitude	128	31.3	281	68.7	
Exclusive breastfeeding					
Knowledge					
Lack of knowledge	96	76.8	29	23.2	0.000*
Good knowledge	64	21.4	235	78.6	
Attitude					
Poor attitude	46	73.0	17	27.0	0.000*
Good attitude	114	31.6	247	68.4	
Antenatal Care					
Knowledge					
Lack of knowledge	13	16.7	65	83.3	0.021*
Good knowledge	26	7.5	320	92.5	
Attitude					
Poor attitude	3	7.0	40	93.0	0.784
Good attitude	36	9.4	345	90.6	
Posyandu Visit					
Knowledge					
Lack of knowledge	26	14.4	154	85.6	0.245
Good knowledge	25	10.2	219	89.8	
Attitude					
Poor attitude	7	41.2	10	58.8	0.001*
Good attitude	44	10.8	363	89.2	
Handwashing					
Knowledge					
Lack of knowledge	98	79.0	26	21.0	0.000*
Good knowledge	45	15.0	255	85.0	
Attitude					
Poor attitude	0	0.0	4	100.0	0.305
Good attitude	143	34.0	277	66.0	
Healthy latrine					
Knowledge					
Lack of knowledge	78	35.6	141	64.4	0.454

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Variables	Practice				p-value
	Not as recommended		As recommended		
	n	%	n	%	
Good knowledge	65	31.7	140	68.3	
Attitude					
Poor attitude	0	0.0	4	100.0	0.783
Good attitude	143	34.0	277	66.0	

*Significantly associated with the chi-square test, p-value <0.05

Table 4 shows that the attitude and practice of iron tablet supplementation drinking did not show a significant relationship with nutritional status according to weight for age, length for age, and weight for length. Mothers who had good attitude and practice of taking iron tablet supplementation tended to have children with normal weight for age index, length for age index, and weight for length index. On the other hand, a high number of mothers who had a poor attitude also had stunted children, which was 40%. Both mothers who had good and appropriate attitudes and practices and those who did not, were equally likely to have well-nourished infants (>70%), but there was a tendency that mothers who had poor attitudes and practices tended to have infants with poor nutritional status.

Good maternal knowledge about iron tablet supplementation can lead to good iron tablet supplementation drinking practices and may reduce the risk of anaemia during pregnancy. Anaemia during pregnancy can impact various aspects, including maternal health, fetal growth, and birth[31]. A case-control study in Purbalingga showed that maternal factors also had a significant effect on child factors. This means that all maternal factors can affect child factors, namely low birth weight, prematurity, lack of exclusive breastfeeding and formula milk, and children with infectious diseases. Among these factors are low education, gestational age (too young or too old), low socioeconomic conditions, unwanted pregnancy, closely spaced pregnancy, anaemia during pregnancy, poor nutritional status, low weight gain, infection during pregnancy, and hyperemesis gravidarum[32].

There was no association between the attitude and practice of exclusive breastfeeding and the nutritional status of weight for age, length for age, and weigh for length. The results of the analysis also showed that mothers with good and appropriate attitudes and practices of exclusive breastfeeding and those without good and appropriate attitudes and practices of exclusive breastfeeding were likely to have equally normal-weight infants. The exclusive breastfeeding attitude variable is significantly associated with length for age index, which means that mothers who had good exclusive breastfeeding attitudes tended to have under-two with the normal length for age index. On the other hand, the results of the analysis showed that mothers who had a poor attitude towards exclusive breastfeeding had more stunted children than mothers who had a good attitude (28.5% and 20.2%, respectively). Both good and poor attitudes and practices of exclusive breastfeeding among mothers showed a tendency to have infants with normal al status. The statistical test results showed that there was no relationship between knowledge, attitude, and exclusive breastfeeding practices with nutritional status according to the weight for length indicator.

Mothers with recommended ANC practices tended to have normal-weight infants (81.6%). The results of statistical analyses showed that there was a significant relationship between ANC practices and the nutritional status of under-five children according to the weight for age indicator. Different results were seen in the ANC attitude variable. Mothers who had good and bad ANC attitudes both had normal-weight infants. Mothers who had good and appropriate ANC attitudes and practices or those who did not, were likely to have infants with equally normal length for age index. The results of statistical analysis showed that there was no significant relationship between mothers' knowledge, attitudes, and practices related to ANC and nutritional status according to the length for age index(p>0.05). The results of the analysis showed that the attitudes and ANC practices of mothers who were poor and inappropriate as well as those who were good and appropriate, both had a high percentage of infants with normal al status (>70%). The results of statistical analysis showed that there was no relationship between mothers' knowledge, attitudes, and ANC practices with nutritional status according to the weight for length indicator.

ANC practices had a significant association with the nutritional status of weight for age index (table 4). Among the 385 mothers who had recommended ANC practices, 81.6% of them had normal-weight infants. A study cinducted by Juneja *et al*. in Uttar Pradesh state in India found that low birth weight was associated with a low number of ANC visits and use of iron supplements for less than 100 days[38]. Other analyses also showed that ANC knowledge was significantly associated with weight for length index. Adequate knowledge and positive attitudes are a must for implementing good practices on ANC.

Mothers' knowledge of ANC also influenced ANC practices (table 2). More than three-quarters of the mothers were aware of ANC visits. In the study of Bashir, *et al,* the overall level of knowledge had a significant positive correlation with practices towards ANC[36]. Whereas previous studies conducted by Patel, *et al,* showed 58%, 100%, and 69.3% had adequate knowledge, good attitude, and good practice towards ANC and Ibrahim et al. [37] showed 86%, 96.0%, and 76.3% of pregnant women had a high level of knowledge, positive attitude and good practice score regarding ANC.

The attitude variable of Posyandu visits was significantly associated with visit to Posyandu practices (Table 3). Among the 407 mothers who had a good attitude, 89.7% of them had recommended child examination practices. Posyandu visits included utilisation of health services and regular visits to the

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Posyandu. A positive attitude leads to good and appropriate practices.

Handwashing knowledge variables were significantly associated with handwashing practices and length for age index (Table 3). Adequate knowledge is a necessity to implement good practices on handwashing. In Table 3, among the 300 mothers who had good knowledge, 79% of them had infants with normal height. Another study also mentioned that children whose mothers did not wash their hands with water and soap before feeding their children had a 1.7 times higher chance of being stunted[24]. Similarly, the results of the maternal handwashing attitude variable were significantly associated with the weight for length index (Table 22). Among 420 mothers who had a good handwashing attitude, 76% of them had normal status. A Positive attitude is a must for implementing good practices about handwashing. The results showed that there was no direct relationship between handwashing habits and nutritional status[40]. However, handwashing with soap is an important factor in achieving and maintain normal status[41]. Handwashing plays an important role in preventing various infections, including those that can affect nutritional status. Research conducted on the relationship between handwashing and basic household sanitation on the nutritional status of under-fives in Bojonegoro Regency found that there was no significant relationship between handwashing and nutritional status[40]. However, this does not mean that handwashing is not important for nutritional status.

Posyandu visits attitudes were also associated with weight for age index (Table 4). Among the 373 mothers who had recommended child examination practices, 81.3% had underweight children. Good child examination practices mean that mothers also routinely bring their children to Posyandu. The Posyandu aims to provide basic health services such as family planning, maternal and child health, nutrition (growth monitoring, supplementary feeding, vitamin and mineral supplementation and nutrition education), immunisation, and disease control (diarrhoea prevention)[39].

The results of the analysis showed that mothers with recommended Posyandu visiting practices had more normal-weight infants compared to those who were not recommended. Statistical analysis showed that there was a significant relationship between the practice of Posyandu visits and nutritional status according to the weight for age indicator. Different results were shown in the attitude variable, which showed that both good and bad attitudes had normal-weight infants. Statistical analysis showed that there was no significant relationship between knowledge and attitude of Posyandu visits with nutritional status according to the weight for age indicator. Mothers who had good and appropriate attitudes and practices regarding Posyandu visits and those who did not, were equally likely to have infants with normal length for age index. The results of statistical analysis showed that there was no significant relationship between mothers' attitudes and practices related to Posyandu visits and nutritional status according to the length for age index (p>0.05). Mothers who had good attitudes and practices related to Posyandu visits and those who did not, are equally likely to have well-nourished children. The results of statistical analysis showed that there was no significant relationship between mothers' attitudes and practices related to Posyandu visits and nutritional status according to the weight for length index (p>0.05).

Mothers who had good and appropriate attitudes and handwashing practices and those who did not, had almost the same percentage of normal-weight infants. The results of statistical analysis showed that there was no significant relationship between mothers' attitudes and practices related to child examination and nutritional status according to the weight for age index (p>0.05). The variables of attitude and handwashing practice both showed no association with length for age index (p>0.05). The results of the analysis stated that both mothers who had good attitudes and hand washing practices had children with normal length for age index. The percentage of stunted and normal children was the same among mothers who had poor handwashing attitudes. Mothers who had good handwashing attitudes had more well-nourished infants than mothers with poor attitudes. The statistical test results showed that there was an association between handwashing attitude and the nutritional status of under-five children according to the weight for age and length for age index(P<0.05).

Different results were shown in the practice variable. Mothers who had good and appropriate handwashing practices and those who did not, had almost the same percentage of well-nourished infants. The results of statistical analysis showed that there was no significant relationship between mothers' practices related to hand washing and nutritional status according to the weight for length index(p>0.05). Mothers who had good and appropriate attitudes and practices of healthy latrines and those who do not, have almost the same percentage of normal weight infants The results of statistical analysis show that there is no significant relationship between maternal attitudes and practices related to healthy latrines and nutritional status according to the weight for age index (p>0.05). Mothers who have good and appropriate attitudes and practices of healthy latrines and those who did not, had almost the same percentage of infants with normal length for age index and weight for length index. The results of statistical analysis show that there was no significant relationship between mothers' attitudes and practices related to healthy latrines and nutritional status according to length for age and weight for length index (p>0.05).

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Table 4. Associations between attitudes and practices of six key messages on the nutrition status of under-two-year-old children in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City

Variables	Weight for Age index			p-value	Length for age index			p-value	Weight for length index			p-value
	Wasting	Normal	Risk of Overweight		Stunting	Normal	High		Underweight	Normal	Overweight	
	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
Maternal Iron Tablet Supplementation Drinking												
Attitude												
Poor	4 (26.7%)	10 (66.6%)	1 (6.7%)	0.376	6 (40%)	8 (53.3%)	1 (6.7%	0.065	1 (6.7%)	12 (80%)	2 (13.3%)	0.822
Good	57 (13.9%)	327 (80%)	25 (6,1%)		85 (20.8%)	317 (77.5%)	7 (1.7%)		10 (2.7%)	308 (83.2%)	52 (14.05%)	
Practice												
Not as recommended	23 (16,2%)	121 (75.6%)	11 (6.9%)	0.416	37 (26.1%)	121 (75.6%)	11 (6.9%)	0.243	18 (12.7%)	111 (78.2%)	13 (9.1%	0.287
As recommended	38 (13.3%)	216 (81.8%)	15 (5.7%)		54 (19.2%)	216 (81.8%)	15 (5.7%)		32 (11.5%)	209 (75.1%)	37 (13.3%)	
Exclusive breastfeeding												
Attitude												
Poor	13 (20.6%)	48 (76.2%)	2 (3.2%)	0.206	18 (28.5%)	41 (65.1%)	4 (6.3%)	0.004*	13 (20.6%)	42 (66.7%)	8 (12.7%)	0.059
Good	48 (13.3%)	289 (80.1%)	24 (6.6%)		73 (20.2%)	284 (78.7%)	4 (1.1%)		31 (10.2%)	278 (77%)	46 (12.7%)	
Practice												
Not as recommended	28 (17.5%)	121 (75.6%)	11 (6.9%)	0.206	18 (28.5%)	41 (65.1%)	4 (6.3%)	0.004*	13 (20.6%)	42 (66.7%)	8 (12.7%)	0.059
As recommended	33 (12.5%)	216 (81.8%)	15 (5.7%)		73 (20.2%)	284 (78.7%)	4 (1.1%)		31 (10.2%)	278 (77%)	46 (12.7%)	
Antenatal Care (ANC)												
Attitude												
Poor	8 (18.6%)	33 (76.6%)	2 (4.7%)	0.668	10 (23.35%)	33 (76.7%)	0 (0%)	0.614	6 (14%)	32 (74.4%)	5 (11.6%)	0.886
Good	53 (13.9%)	304 (79.8%)	24 (6.3%)		81 (21.3%)	292 (76.6%)	8 (2.1%)		44 (11.5%)	288 (75.6%)	49 (22.8%)	
Practice												
Not as recommended	11 (28.2%)	23 (59%)	5 (12.8%)	0.004*	12 (30.8%)	26 (66.7%)	1 (2.6%)	0.302	6 (15.4%)	27 (69.2%)	6 (15.4%)	0.629
As recommended	50 (13%)	314 (81.6%)	21 (5.5%)		79 (20.55)	299 (77.7%)	7 (1.8%)		44 (10.8%)	293 (76.1%)	48 (12.5%)	
Integrated Health Care Post (Posyandu) Visits												
Attitude												
Poor	5 (30.4%)	11 (64.7%)	1 (5.9%)	0.195	5 (29.4%)	12 (70.5%)	0 (0%)	0.625	4 (23.5%)	10 (58.8%)	3 (17.7%)	0.217
Good	56	326 (80.1%)	25 (6.1%)		86 (21.1%)	313 (76.9%)	8 (2%)		46 (11.3%)	310 (76.2%)	51 (12.5%)	
Practice												

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Not as recommended	14 (27.4%)	34 (66.7%)	3 (5.9%)	0.018*	14 (27.4%)	35 (68.6%)	2 (3.9%)	0.256	11 (21.5%)	33 (64.7%)	7 (13.7%)	0.060
As recommended	47 (12.6%)	303 (81.2%)	23 (6.2%)		77 (20.65)	290 (77.7%)	6 (1.6%)		39 (10.4%)	287 (76.9%)	21 (5.6%)	
Handwashing												
Attitude												
Poor	1 (25%)	2 (50%)	1 (25%)	0.212	2 (50%)	2 (50%)	0 (0%)	0.371	0 (0%)	1 (25%)	3 (75%)	0.001*
Good	60 (14.3%)	335 (79.8%)	25 (6%)		89 (21.2%)	323 (76.9%)	8 (1.9%)		50 (11.9%)	319 (76%)	51 (12.1%)	
Practice												
Not as recommended	15 (10.5%)	118 (82.5%)	10 (7%)	0.418	32 (22.4%)	107 (74.8%)	4 (2.8%)	0.570	14 (9.8%)	109 (76.2%)	20 (14%)	0.602
As recommended	46 (16.3%)	219 (77.9%)	16 (5.7%)		59 (21%)	218 (77.6%)	4 (1.4%)		36 (12.8%)	211 (75.1%)	34 (12.1%)	
Healthy Latrine												
Attitude												
Poor	4 (12.6%)	26 (81.3%)	2 (6.3%)	0.951	10 (31.3%)	21 (65.6%)	1 (2.1%)	0.305	4 (12.5%)	22 (68.8%)	6 (6.3%)	0.547
Good	57 (14.5%)	311 (79.3%)	24 (6.1%)		81 (20.6%)	304 (77.6%)	7 (1.8%)		46 (11.7%)	298 (76%)	22 (5.6%)	
Practice												
Not as recommended	21 (14.7%)	111 (77.6%)	11 (7.7%)	0.618	33 (23.1%)	108 (75.5%)	2 (1.4%)	0.752	22 (15.4%)	98 (68.5%)	23 (16.1%)	0.060
As recommended	40 (14.2%)	226 (80.4%)	15 (5.3%)		58 (20.6%)	217 (77.2%)	6 (2.1%)		28 (10%)	222 (79%)	32 (11%)	

*Significantly associated with the chi square test, p-value <0.05

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Knowledge about healthy latrines was associated with weight for length index (Table 4). Among the 205 mothers who had good knowledge about healthy latrines, 79% of them had under-fives with normal status. Improved access to latrines and water sources can lead to better nutritional outcomes. This is because increased access to latrines can reduce the transmission of enteric pathogens[42]. According to one study, children living in homes with better latrine hygiene were less likely to be malnourished[43]. The limitation of this study was due to the unrepresentative sample that represents the entire population in the selected regencies/cities. The recommendation for the next research is to conduct a longitudinal study in which the six key messages are given intensively for several months and the impact is observed.

Multivariate Analysis Results

Multivariate analysis is conducted if the results of the bivariate test between the independent variable and the dependent variable have a p-value <0.25. These results show that the practice of Integrated Health Care Post (Posyandu) visits is associated with nutritional status based on body weight with an OR value of 2.285, which means that mothers of under-two-year-old children who practice Posyandu visits as recommended have a likelihood of their children having normal body weight 2.285 times greater than mothers whose Posyandu visit practices are not as recommended. However, different results were seen in the attitude of washing hands, which had an OR value of -3,04 which means that, a good handwashing attitude in mothers had a three times smaller chance of having a normal nutritional status of under-two-year-old children according to the indicator weight for length.

Table 5. Multivariate analysis between attitudes and practices on nutritional status by weight-for-age and weight for length on mother of under-two-year-old children in Brebes Regency, Tegal Regency, Banyumas Regency, and Semarang City

Variable	Coeff B	p-value	OR
Weight-for-age			
Posyandu visit practice	0.151	0.023*	2.285
Weight for length			
Hand washing attitude	-0.746	0.003*	-3.040

*Significantly associated with the multivariate linear regression, p-value <0.05

CONCLUSIONS

Among all six key message behaviour, only the key messages of exclusive breastfeeding attitude, antenatal care visit practice, Posyandu visit practice, and hand washing attitude were associated with the nutritional status of children under two years old. Variables that were not associated were due to good and poor attitudes, as well as the recommended and not recommended practices had children with almost the same percentage of nutritional status according to the weight for age index, length for age index, and weight for length index. The delivery of the six key messages needs to be continued by considering strategies and interpersonal approaches to support the acceleration of stunting reduction.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

MIK: Conceptualizing, determining methodology, writing review, and supervising; AFA: Writing-original draft, supervising, editing; HMD: Supervising, investigating; DZN: Supervising, conducting data curation, doing formal analysis, validating, doing visualization; LTD: Doing formal analysis, validating.

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Analysis of Factors of the Use of Food Additives in the Elementary School

Analisis Faktor-faktor dalam Penggunaan Bahan Tambahan Pangan di Sekolah Dasar

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ABSTRACT

Background: Merchants sell a variety of food for schoolchildren. In an attempt to make the food they offer more enticing and long-lasting, dealers frequently add food additives, sometimes prohibited food additives which is against the law. Predisposing conditions affect the addition of additives to snacks.
Objectives: The study aimed to determine the factors that influence the addition of food ingredients not allowed by snack vendors in snacks sold around elementary schools
Methods: This study used a survey approach with a cross-sectional design. The 99 traders that made up the study's sample were chosen randomly. The use of food additives was the dependent variable and the independent variables were gender, education, knowledge, age, and length of selling. Test kits were used in laboratories to analyze snack samples sold by traders in order to identify food additives (formalin, borax, Rhodamine B, and Yellow Methanol). Multivariate, bivariate, and univariate analysis were used in the research process. The multiple logistic regression with 95% Confident Interval and chi-square statistical tests were employed in this investigation.
Results: The number of snacks checked by test-kit with the result was 21.2% of snacks containing prohibited food additives with a good level of knowledge on the sword as much as 52.5%. The results of the chi-square test statistics for knowledge (p=0.001), age (p=0.010), length of sale (p=0.022) was related to the use of prohibited food additives. The results of multivariate analysis showed that knowledge was the most influential factor in the use of food additives.
Conclusions: Traders' knowledge about the use of food additives was the main factor, besides that relate factors were age and length of selling.

INTRODUCTION

School is a public facility or place available both in urban and rural areas which has many educational activities at every level. This is In accordance with the law No 20/2003 which states that education, culture, science, and technology are part of the development components that are the basic foundation of various national ideals[1]. The environment around the school is an economic location, especially for traders to sell snacks, because not all schools have canteens implementing the system of catering so that children can buy snacks outside the school. According to decision of Minister of Health of the Republic of Indonesia Number 942/MENKES/SK/VII/2003. In addition to the food offered by food services, restaurants, and hotels, snack food is defined as food and beverages prepared by food traders at points of sale and served as ready-to-eat food sold to the general public. Snacks are all kinds of snacks sold on street streets, roadsides, markets, residential areas and similar places[2].

There are various types or kinds of school children's snacks sold by merchants. In the school environment, snack food is sold at common place, so that children's consumption and habits for snacks affect the adequacy of energy and nutrients that can result in the condition of children's nutritional quality. In addition to being safe from physical, chemical, and biological hazards, food/drinks in the school cafeteria must also be nutritious[3]. Hazardous ingredients in snacks are usually obtained from food additives deliberately added by traders to their snacks. These food additives are types of preservatives, dyes and sweeteners. There are two food additives, which are permitted food additives and food additives that are not permitted[4].

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Prohibited Food additives have a negative impact on health, especially if consumed by children who are still in elementary school. Food additives must be considered both in type and concentration because if they are not appropriate, they will be carcinogenic for the body[5]. The addition of food additives that pose a risk to health by traders needs to know whether what is added is included in the allowable or impermissible class. The addition of food additives to snacks is influenced by knowledge. Knowledge is information obtained by a person, both in terms of description, hypothesis, theory, concept, principle and procedure obtained from reason and thought[6]. Two species of salted fish have been detected as positively containing formalin, and the degree of knowledge among salted fish vendors in the Kedungprahu traditional market is 20% lower[7].

Elementary school snack traders in the Kartasura region are easy to find, considering the number of elementary schools or similar institutions in the Kartasura region, counted 48 equivalent elementary schools. In accordance with the theme of the National Research Master Plan (RIRN) on the sub-theme of health and welfare, this research is important to be carried out in order to provide information related to food safety, especially snacks consumed by elementary school children in the Kartasura area. This research involved students who were compiling a final project with the same theme as the research we submitted. The purpose of this study was to identify the variables that affect food ingredient addition not allowed by traders in snacks sold around elementary schools in Kartasura District. This study was important to determine how food additive in snacks were usually consumed by the children especially in elementary school area.

METHODS

This study was a quantitative study that aimed to determine the correlation between factors that affected the use of food additives for school children's snack traders with the use of formalin, borax, Rhodamin B and Yellow Methanol. The design of this study was cross sectional with survey method where all variables were collected at the same time. Measurement of factors variables (age, knowledge, education and length of trade) was carried out using questionnaires while measurement of prohibited food additives (borax, formalin, Rhodamine B and Yellow Methanol) used test kits. Before taking data to respondents, questionnaires were tested for validity and reliability in snacks in the environment elementary school of Laweyan Surakarta area as many as 20 respondents with r table 0,6664. The questionnaire was equipped with a letter of inform consent and consists of data on name, gender, age, length of trade education level and 20 questions about knowledge related to adding food additives. This research was carried out during January-February 2024 in Kartasura, Sukoharjo and measurements of food additives in snacks were carried out at the Microbiology Laboratory of Health Science Faculty, Universitas Muhammadiyah Surakarta. The population of this study was all snack traders around elementary school in Kartasura as many as 99 traders, the sample of this study was taken by accidental sampling where traders who were selling at the time of the study were 99 snack samples. His research was conducted received approval from the Health Research Ethics Commission of the Universitas Muhammadiyah Surakarta Number: 246/KEPK-FIK/III/2024.

In order to collect data, questionnaires were given to all respondents who were snack traders and who we also purchased treats for added nutritional analysis. The questionnaire was filled out directly by the respondents with paper based. The questionnaire consisted of questions containing respondents' characteristics, length of trade, types of snacks sold and knowledge related to food additives. Other data taken were samples of snacks sold by the trader including *cilok* and sauce, *pentol* and sauce, fried vermicelli, fried Sausage, meatball tofu and tempura.

Three steps in the research analysis process were taken: univariate, bivariate, and multivariate analysis. In order to ascertain the frequency distribution and characterize the properties of the variable sample, univariate analysis was utilized to characterize the variables under investigation. Bivariate analysis was used to determine the correlation between independent variables (education, knowledge, age, length of trade) and dependent variables (use of food additives is not permitted). The chi-square test, with a 95% confidence level and a significant level of $p<0.05$, was the statistical test employed in this investigation. The determinants factors for the use of food additives that were prohibited were modeled using multivariate analysis and the several logistic regression test, based on several factors that were analyzed with a 95% Confidence Interval.

RESULTS AND DISCUSSIONS

This study was carried out in 19 primary schools in the Kartasura subdistrict, comprising 4 (four) private and 15 public elementary schools. Geographically, Kartasura is one of the sub-districts of Sukoharjo Regency. It occupies 2081 Ha, or roughly 4.25% of the regency's total size of 48,912 Ha, and is situated in a region that is 121 meters above sea level. based on information from Sukoharjo Regency's Central Statistics Agency in 2021, it is also known that the educational facilities available in Kartasura District include 57 kindergartens, 48 elementary schools, 9 junior high schools and 16 equivalent high schools, while Madrasah Ibtida'iyah has 7 schools, Tsanawiyah has 1 school and Aliyah has 1 school.

This study involved 99 respondents with 99 samples of snacks sold by traders around elementary schools in Kartasura sub-district. Measurement of respondents' knowledge was carried out using questionnaires that had been tested for validity and reliability. The snack samples obtained were laboratory tested using a test kit to identify the presence or absence of food additives that were not permitted by the government including borax, formalin, Rhodamine B and Yellow Methanol.

The use of food additives is not new in the food world. Research related to food additives is also often carried out and even supervision from various government parties is also often encountered. This research involved all elementary schools in Kartasura District, Sukoharjo Regency, totaling 19 elementary

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schools. The elementary school as the scope of the study had been surveyed and found vendors selling snacks outside the school (around the school). The number of snacks checked by test-kit was 99 snacks with the result that 21.2% of snacks contained prohibited food additives either borax, formalin, Rhodamine B or Yellow Methanol.

The respondents used in this study were traders from snacks used as a sample with a total of 99 traders. It was known that traders who had good knowledge of food additives as much as 52.5%. The following table displays the findings of the investigation that was conducted.

Table 1. The result of testing food additive in snacks

No.	Snack	Location code	Food Additives					
			Borax		Formalin		Food coloring	
			Positive	Negative	Positive	Negative	Rhodamin B	Yellow Methanol
1	*Cilok*	IA-1*	-	-	-	-		
2	*Pentol*	IA-2	-	-	-	-		
3	*Pentol Ayam*	IA-3	-	-	-	-		
4	Fried Vermicelli	KK-1	-	-	-	-		
5	*Tahu Bakso*	KW-2	-	-	+	-		
6	*Cilok Goreng*	KW-2	-	-	+	-		
7	*Cilok*	KW-2	-	-	+	-		
8	*Pentol Ayam*	IA-2	-	-	+	-		
9	Tempura	GO-1	+	-	-	-		
10	*Cilok Goreng*	PB-2	+	-	-	-		
11	*Tahu Bakso*	PB-3	-	-	-	-		
12	Tempura	GO-2	-	-	-	-		
13	Fried Vermicelli	GO-2	-	-	-	-		
14	*Tahu Bakso*	GO-2	-	-	-	-		
15	*Cilok Goreng*	GP-1	-	-	-	-		
16	Tempura	GP-1	+	-	+	-		
17	Fried Vermicelli	GP-1	-	-	-	-		
18	Fried Vermicelli	GP-1	-	-	+	-		
19	*Cilok*	GP-1	-	-	+	-		
20	Fried Vermicelli	GP-1	-	-	-	-		
21	*Cilok Goreng*	KT-1	-	-	+	-		
22	*Cilok*	KT-1	+	-	-	-		
23	*Pentol*	KT-2	-	-	+	-		
24	Fried Vermicelli	KT-2	-	-	-	-		
25	Fried Vermicelli	KT-2	-	-	+	-		
26	*Cilok*	KN-2	+	-	-	-		
27	*Cilok*	KN-2	-	-	-	-		
28	*Pentol Sapi*	MH-3	-	-	+	-		
29	*Tahu Bakso*	MH-3	-	-	+	-		
30	*Cilok*	MH-5	-	-	+	-		
31	*Pentol*	MH-5	-	-	+	-		
32	*Pentol Ayam*	NR-2	+	-	-	-		
33	*Tahu Bakso*	NR-2	+	-	+	-		
34	*Pentol*	NR-2	-	-	-	-		
35	*Tahu Bakso*	PB-3	-	-	-	-		
36	Tempura	PC-3	-	-	-	-		
37	*Pentol*	PC-3	-	-	-	-		

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No.	Snack	Location code	Food Additives					
			Borax		Formalin		Food coloring	
			Positive	Negative	Positive	Negative	Rhodamin B	Yellow Methanol
38	*Tahu Bakso*	PC-5	-	-	+	-		
39	Fried Vermicelli	PC-5	-	-	+	-		
40	Tempura	PC-5	-	-	+	-		
41	Fried Vermicelli	SP-1	-	-	-	-		
42	Fried Vermicelli	SP-1	-	-	-	-		
43	Tempura	SP-1	-	-	-	-		
44	*Bakso Goreng* Sauce	IA-1					-	-
45	Sausage Sauce	IA-2					-	-
46	*Pentol* Sauce	IA-3					-	-
47	*Bihun Gulung* Sauce	KK-1					-	-
48	*Cilok* Sauce	KW-2					-	-
49	Kentucky Sauce	KW-2					-	-
50	*Cilung* Sprinkle Seasoning	KW-2					-	-
51	*Cilor* Sprinkle Seasoning	IA-2					-	-
52	Syrup Ice	GO-1					-	-
53	Sausage Sauce	PB-2					-	-
54	*Basreng* Sauce	PB-3					-	-
55	Tofu Sauce	GO-2					-	-
56	*Sostel* Sauce	GO-2					-	-
57	*Pentol* Sauce	GO-2					-	-
58	*Cilok* Sauce	GP-1					-	-
59	*Cilok* Sauce	GP-1					-	-
60	*Telur gulung* Sauce	GP-1					-	-
61	Sausage Sauce	GP-1					+	-
62	*Pentol* Sauce	GP-1					-	-
63	*Telur Gulung* Sauce	GP-1					-	-
64	*Siomay* Sauce	KT-1					-	-
65	*Pentol* Sauce	KT-1					-	-
66	*Cilok* Sauce	KT-2					-	-
67	*Cilok* Peanut Sauce	KT-2					-	-
68	*Bihun Gulung* Sauce	KT-2					-	-
69	*Cilok* Sauce	KN-2					-	-
70	*Cilok* Sauce A	KN-2					-	-
71	Cilok Sauce B	MH-3					-	-
72	*Telur Gulung* Sauce	MH-3					-	-
73	Sausage Sauce	MH-5					-	-
74	*Pentol* Sauce	MH-5					-	-
75	*Telur Gulung* Sauce	NR-2					-	-
76	*Siomay* sauce	NR-2					+	-
77	*Pentol* Sauce	NR-2					-	-
78	*Cilok* Sauce	PB-3					-	-
79	Peanut Sauce	PC-3					-	-

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No.	Snack	Location code	Food Additives					
			Borax		Formalin		Food coloring	
			Positive	Negative	Positive	Negative	Rhodamin B	Yellow Methanol
80	*Bihun Gulung* Sauce	PC-3					-	-
81	*Pentol* Sauce	PC-5					-	-
82	*Cilok* A Sauce	PC-5					-	-
83	*Cilok* B Sauce	PC-5					-	-
84	Sausage Sauce	SP-1					-	-
85	Fried *Aci* Sauce	SP-1					-	-
86	*Siomay* Sauce	SP-1					-	-
87	*Es Campur*	IA-1					-	-
88	*Pentol* Sauce Soup	IA-2					-	-
89	*Cireng* Sauce	IA-3					-	-
90	Ice syrup	KK-1					-	-
91	*Mi Lidi* Sprinkle Seasoning	KW-2					-	-
92	*Batagor* Sauce	KW-2					-	-
93	*Telur Gulung* Sauce	KW-2					-	-
94	*Cireng* Sauce	IA-2					-	-
95	Fried *Cilok* sauce	GO-1					-	-
96	*Batagor* Sauce	PB-2					-	-
97	*Telur Gulung* Sauce	PB-3					-	-
98	*Cilok* Sauce	GO-2					-	-
99	Seasoning Sprinkle	GO-2					-	-

Bivariate analysis was used to determine the correlation between independent variables (knowledge, age, length of trade) and dependent variables (use of food additives is not permitted). The statistical test used in this study was the chi-square *test* with a confidence level of 95% with a significant level of p<0.05. Complete results of the study consisting of respondents' characteristics and food additives in snacks can be seen in Table 2.

Table 2. Respondent characteristic

Characteristic	Frequency	Percentage (%)	p-value
Gender			
Male	57	57.6	0.592
Female	42	42.4	
Age (years)			
20-30	14	14.1	**0.010***
31-40	45	45.5	
>51	9	9.1	
Education level			**0.022***
Elementary	73	73.7	
High school	26	26.3	
Knowledge level			**0.001***
Low	47	47.5	
High	52	52.5	
Length of selling (years)			
1-3	12	12.1	**0.022***
4-6	18	18.2	
7-10	42	42.4	
>10	27	27.3	
Food addictive			
Negative	78	78.8	
Positive	21	21.2	
Total	99	100	

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*chi-square (significant if p<0.05)

Table 3. Multivariate analysis

Variable	First model 95% CI		p-value	Rank
	Lower Bound	Upper Bound		
Knowledge	0.439	0.138	0.000*	I
Length of selling	0.000	0.035	0.048*	III
Age	0.023	0.004	0.007*	II
Education level	0.329	0.014	0.072	IV

*Multiple logistic regression (significant if p<0.05)

Food additives are substances added to food with the intention of changing the composition, form, or nature of food or food products, as per Government Regulation Number 28 of 2012. According to Minister of Health Regulation Number 033 of 2012, food additives are classified into two categories: permitted and prohibited. These groups include those that function as antioxidants, anti-clogging agents, preservatives, developers, emulsifiers, thickeners, hardeners, sweeteners, flavor enhancers, stabilizers, and others[8].

Food additives are substances that are purposefully added to food in tiny amounts to enhance its texture, flavor, and appearance while also extending its shelf life. In addition, it can also increase nutritional value such as protein, minerals and vitamins Food additives that are often used by traders are preservatives and dyes. Food additives that are prohibited to be mixed into food but are still often found in food are formalin, borax, Yellow Methanol and Rhodamine B. Snacks containing prohibited food additives are sometimes distinguished from those that are not added permitted food additives.

Food additives are regulated in several regulations including the Regulation of the Minister of Health of the Republic of Indonesia Number 33 of 2012 concerning Food Additives which explains that the types of formalin preservatives, types of borax preservatives and chewers, and types of textile dyes (Rhodamine B and Yellow Methanol) is a chemical that is prohibited from use in food products because it is harmful to health[8]. The role of food additives in food is considered important because by adding food additives food will be more durable, attractive and tastier. However, the use of food additives should be controlled by both producers and consumers because these food additives not only have a positive impact but also bring a negative impact. One reason traders continue to use hazardous materials in their merchandise is because they obtain greater profits. Lack of awareness of traders about the dangers of borax for health is often only punished by coaching and warnings from the officer so that there is no deterrent effect for the traders [9].

Knowledge has a correlation with the perceived risk of using food additives[10]. The importance of providing information about the negative effects of food additives on health and prevention, in the hope of increasing knowledge related to the negative effects of prohibited food additives[11]. When it comes to forming one's own activities, knowledge becomes a crucial domain. In terms of food additive selection, someone with good knowledge will choose or make the food safe for consumption. Trader knowledge is influenced by several factors, such as education level and length of selling or experience, because the higher one's education level and the more experience one has, the more knowledge one will gain. The results of the study conducted showed significant results between knowledge and education level, the correlation coefficient result revealed that the strength of the association between the variables under examination fell into the medium group and was unidirectional, meaning that knowledge increased with education level and vice versa[12]. When forming one's own acts, knowledge becomes a crucial domain. Knowledge is a crucial component since it interacts with other variables. According to one of them, 71.8% of boarding students had a moderate level of awareness about snack selection. When it came to boarding students' snack-selection behavior, 59.1% of them demonstrated good behavior[13].

A person's work experience is a measurement of how long they have worked and how well they have understood the jobs they have completed during that time[14]. It explains that work experience is a person's degree of mastery over the information and abilities they possess at work, and it is determined by the sort and duration of job they've done over a given period of time[14]. The experience that matters in trading is the amount of work put in. The duration of business is the amount of time a trader has spent managing his enterprise; this is typically expressed in years or months[15]. The duration of a business is significant since it can lead to business experience, and experience can influence an individual's behavior[16].

Age is the span of time between a person's birthday and birth. Age will affect a person's physical and psychological state. A person's physical and psychological characteristics (mental) will also alter as they age. An individual's strength and level of maturity increase with age, as does their capacity for thought and productivity. Age has an impact on health knowledge and awareness. One's comprehension and mentality regarding anything can also be influenced by age; as one ages, their comprehension and mindset get more developed, leading to a greater acquisition of knowledge. In terms of the selection of food additives, increasing age is expected to be able to influence someone to be wiser in choosing because as is known the mindset and comprehension of a person will increase with age[17]. According to other research, variations in age will lead to variations in product preferences and tastes, making age one of the individual elements influencing customer behavior[18]. Age has an impact on health knowledge and awareness. A

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person's perception and attitude toward something will also change with age. Selling plays a significant role because the duration of a business can caused business experience, which can affect a person's experience in behavior. Growing older is expected to be able to influence someone to make wiser decisions because it is well known that a person's mindset and comprehension will increase with age.

The chi-square test analysis yielded p-values <0.05 for each age level variability and length of selling, indicating a correlation between the age level and length of selling regarding the amount of food additives in snacks. A p-value of 0.001 (<0.005) was obtained for the knowledge level variable. Chi-square analysis revealed a significant correlation between traders' knowledge and the use of borax in food sold in schools in the area of Kartasura, although the results of research on the correlation between the level of knowledge and the use of food additive did not match the research conducted[19]. The absence of a significant correlation between the level of knowledge and length of selling with the use of coloring food additives (Rhodamine B) could occur due to several factors including bias in research and the acquisition of information about food additives by traders. Bias can occur because traders sometimes change the food products they use, especially if the availability of product stocks is running low or even runs out, so there is a possibility that food products that are checked for food additive content are prohibited from containing negative food additive which causes the factor to be studied to be invisible because it is covered by other factors. In terms of obtaining information, traders generally obtain information from various media, such as print and electronic media in the form of news circulating on social media. The acquisition of this information will influence the knowledge of traders to take a stance or action in the selection of food additives[20].

Food additives (food additives) are compounds that are not normally consumed as food by themselves and are not usually used as primary raw materials in food but are intentionally added in the manufacture, processing, preparation, care, packing, packaging, and transport of food to perform technological functions[21]. Use food additives aims to improve the quality of the final product and shelf life of foodstuffs in retail[22]. In general, the basic function of food additives is to make food look nicer, taste better, make food safer, and prevent oxidation or other chemical changes[23].

Formalin, borax, Rhodamine B and Yellow Methanol are examples of food additives that are prohibited from use. Formalin is a chemical compound in the form of a gas or solution and in it is added 10-15% methanol[24] and contains 37% formaldehyde. Formalin has no color and has a very pungent odor. Formalin is commonly used in medicine as a preservative for corpses. In addition, formalin can be used as an antibacterial and for needs homogeny, such as floor cleaners, and as laundry detergents[25]. According to studies on the description of formalin use and knowledge, vendors of salted fish in the Kedungprahu traditional market may know as little as 20% less than other vendors, and of the salted fish sold, two varieties have been found to be positively identified as containing formalin[7]. Borax is one of the dangerous chemicals that is often used as preservatives in food. Borax which has the chemical formula $Na_2B_4O_7.10H_20$ is in the form of a white fine powder odorless and when dissolved in water will form sodium hydroxide and boric acid[26]. Borax is used in food products because it can improve the structure and texture of food, for example, meatballs with borax added will be very chewy and durable when compared to meatballs without borax. Although eating meals containing borax does not directly harm a person, the material will gradually build up in the body due to cumulative absorption. Food high in borax will damage the kidneys, liver, and brain when consumed frequently. Borax enters the body through the skin in addition to through digestion. Borax can obstruct the function of metabolic enzymes[25].

An amino xanthene dye known as Rhodamine B (RhB) is widely employed in fluorescent dyes for a variety of uses, including glass, fireworks, paper, textiles, paint, drawings, and colored insecticides[27]. Humans should not consume rhodamine B as it is known to irritate the skin, eyes, and respiratory system. It has been demonstrated that rhodamine B causes cancer in both people and animals. It was categorized as a Group 3 carcinogen by the International Agency for Research on Cancer in 1978 and 1987[28]. Furthermore, animals are exposed to rhodamine B through genotoxicity, neurotoxicity, and chronic toxicity. Additional research conducted on animal models revealed that a three-month oral rhodamine B 1% diet caused significant weight loss and hepatic hypertrophy. The most notable problem found during autopsy was an enlarged liver. An in vitro study revealed that the liver methylation rhodamine B to produce three less harmful metabolites: 3,6-diaminofluoran, N,N'-diethyl-3,6-diaminofluoran, and monoethyl-3,6-diaminofluoran[29].

Yellow Methanol is a synthetic chemical used to make food brighter and more appealing. Yellow methanol is often used for economic reasons or inappropriate processing conditions. Yellow Methanol is a synthetic azo dye that is banned from food coloring, but is used by unscrupulous traders in many areas. Yellow Methanol has the chemical formula $C_{18}H_{14}N_3NaO_3S$ and a molecular weight of 375.4. Yellow Methanol is a yellow powder that dissolves in water under normal conditions[30]. The physical characteristics of foods containing this dye are that they are strikingly bright yellow, and there are white spots because they are not homogency[31]. Long-term consumption of Yellow Methanol can cause various health problems. If ingested, in the short term it can cause nausea, vomiting, diarrhea and abdominal pain[32]. A 2014 study reported that ingestion of Yellow Methanol for 30 days could cause histological changes in rat kidneys[33]. Yellow Methanol also showed acute oral LD50 toxicity in rats at concentrations in excess of 2000 mg/kg[32].

Traders who sold snacks around elementary schools in the Kartasura sub-district area had not received information related to food safety. They also did not have any groups to make coordination to control the products they sold so that they were free to sell any profitable snacks without paying attention to the safety of their goods. The snacks were not only sold in one

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location but moved around according to school breaks and student returns. Knowledge is the most influential factor in this study. Besides, it is known that age and length of selling also have a correlation with the use of food additives. This research had not identified food additives quantitatively level with method spectrophotometer or the other method and the respondents used were only those who were on site when the study was conducted. In other words, researchers did not conduct selection of respondents.

CONCLUSIONS

The use of food additives that were prohibited specifically formalin, borax, Rhodamine B and Yellow Methanol by traders was influenced by several factors, including knowledge, age and length of selling (experience). Traders' knowledge of food additives was a major factor in the selection of food additives used. In terms of food additive selection, someone with good knowledge will choose or make the food safe for consumption. Moreover, age and length of selling (experience) also had a correlation in terms of the use of food additives. This study had not tested the levels of food additives quantitatively so that it can be done by future researchers.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare there is no conflict of interest in this article. This research received by Universitas Muhammadiyah Surakarta.

AUTHOR CONTRIBUTIONS

Conceptualization: R.A., R.A.W and W.N.W; Methodology: R.A., J.B.N., A., and F.; Formal analysis: R.A.; J.B.N, and D.A.; Writing—original draft preparation: R.A.; Writing—review and editing: R.A., and S.R.M.Y; Supervision: R.A. All authors have read and agreed to the published version of the manuscript.

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META-ANALYSIS
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Stunting Prevention through Exclusive Breastfeeding in Indonesia: A Meta-Analysis Approach

Pencegahan Stunting *melalui Pemberian ASI Eksklusif di Indonesia: Pendekatan Meta-Analisis*

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ABSTRACT

Background: The direct cause of stunting in toddlers is nutritional intake, one of which is because babies do not receive exclusive breastfeeding for up to 6 months.
Objectives: The purpose of this study is to measure the effect of exclusive breastfeeding on stunting prevention through a meta-analysis approach.
Methods: This study uses a meta-analysis approach by searching for research articles from various databases such as Google Scholar, PubMed, and Science Direct. The keywords used are by the Medical Subject Heading (MeSH), namely "exclusive breastfeeding", "stunting", "infant", "exclusive breastfeeding", "linear growth disorder", and "stunted toddlers". The criteria for the article are publications from 2013 to 2021, can be downloaded in full text, using a cross-sectional and case-control study design, and effect size data is available in the form of Odds Ratio (OR). The process of submitting articles is presented in a PRISMA diagram. Data analysis using the Review Manager 5.4.1 application with a random effect analysis model. Presentation results in the form of forest plots and funnel plots.
Discussions: 26 research articles are worthy of analysis, consisting of 9 from international journals and 17 from national journals. The Heterogeneity test results showed a p-value of 0.00001 and an I^2 value of 85%. The results of the analysis with a random effect model were obtained from the forest plot which showed a pooled Odds Ratio of 2.90 (95% CI: 2.07-4.08), meaning that babies who did not receive exclusive breastfeeding had a 2.9 times higher risk of stunting compared to babies who received exclusive breastfeeding. These findings show a significant influence of non-exclusive breastfeeding on the incidence of stunting (p-value 0.0001 < 0.05).
Conclusions: Exclusive breastfeeding can effectively prevent stunting.

INTRODUCTION

Stunting, a serious impact of malnutrition, is suffered by children when they do not get adequate nutritional intake to meet their dietary needs. Inadequate nutritional intake in the early stages of life can lead to a higher susceptibility to disease, suboptimal body growth, and an increased risk of mortality in children[1]. A child's normal growth in length or height at an early age is a crucial indicator of optimal development, which is directly associated with the development of the nervous system in the brain[2]. Moreover, an imbalanced diet is one of the main causes of stunting. Even though breast milk is widely recognized as the optimal source of nutrition for infants, the prevalence of exclusive breastfeeding in practice remains low due to the early introduction of complementary foods (CF) before the suggested minimum age of 6 months[3]. Infants are considered to receive exclusive breast milk if they are solely breastfed without the addition of any other foods or drinks, such as water, except for medicines and vitamin and mineral supplements, as well as expressed breast milk[4].

Ensuring that infants receive exclusive breastfeeding and are weaned appropriately is essential for supporting their growth and development and protecting them from infectious diseases. Furthermore, key factors in addressing the nutritional needs of infants include breastfeeding frequency and duration, as well as the volume of breast milk given[5]. In contrast, non-exclusive breastfeeding can cause health problems and increase the risk of stunting, which can result in shorter heights for children compared to other children of their age due to inadequate nutritional intake[6]. Stunting has been found to increase the risk of disease, increase mortality rates in children, reduce cognitive ability, and cause degenerative health problems such as diabetes, hypertension, heart disease, and kidney disorders in adulthood[7].

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According to the Indonesia Nutrition Status Study (SSGI), the prevalence of stunting was 27.7% in 2019, which decreased to 24.4% in 2021 and further decreased to 21.6% in 2022[9]. Stunting remains highly prevalent in Indonesia and has not reached the target set by the 2024 National Medium-Term Development Plan, which aims for a rate below 14%[10]. Additionally, the practice of exclusive breastfeeding in Indonesia remains low, with only 48.2% of infants receiving exclusive breastfeeding in 2021, which decreased to 14.6% in 2022[9,11.] Exclusively providing breast milk is the best way to supply infants with essential nutrients, resulting in a decrease in the prevalence of childhood pain and mortality[12]. The World Health Organization (WHO) recommends that infants be exclusively breastfed from their first day of life until 6 months, continuing breastfeeding until the child is two years old or older, and introducing safe and appropriate complementary foods (MPASI) with adequate nutritional intake. The presence of inadequate nutrition is closely related to the high prevalence of malnutrition and can increase health problems and mortality, particularly in low-income countries[13].

Research conducted in Sleman Regency found that there was a significant relationship between exclusive breastfeeding and stunting incidence[14]. Moreover, research conducted in various places discovered that breast milk was not given exclusively, which has an impact on stunting[15,16,17,18]. However, quite a few research results revealed that there was no relationship between exclusive breastfeeding and stunting [19,20,21]. The existing research results remain limited, as researchers used meta-analysis to summarize and measure the extent to which non-exclusive breastfeeding affected the incidence of stunting in toddlers. The majority of previous studies were based on a literature review approach[22,23,24,25]. Therefore, the researchers aimed to synthesize the results of previous studies and employ a meta-analysis method to examine the effect of exclusive breastfeeding on the incidence of stunting in toddlers. In the preparation of the meta-analysis, searches were carried out from various sources to get access to relevant articles on the topic of this study. The researchers limited the number of research articles published in the last 8 years (2013–2021). This study aimed to investigate the effect of exclusive breastfeeding on the incidence of stunting in toddlers using a meta-analysis method. The results of this study were expected to serve as valuable evidence supporting the importance of exclusive breastfeeding in preventing stunting in toddlers.

METHODS

The application of the meta-analysis method began by conducting a comprehensive search for research articles from reputable national and international journals, which can be accessed through accredited databases such as Google Scholar, Science Direct, and PubMed. Moreover, the independent variable examined in this study was exclusive breastfeeding, while the dependent variable examined was the incidence of stunting in toddlers. Furthermore, the inclusion criteria for conducting research article searches are as follows: the articles must have been published online between 2010 and 2021, must be accessible in full text, and must be downloadable. Article searches were conducted using keywords that were organized using Boolean to either expand or narrow the search, according to Medical Subject Heading (MESH). Keywords used include “exclusive breastfeeding,” “stunting,” “infants,” “exclusive breastfeeding,” “linear growth disorders,” and “stunted toddlers.” Additionally, a total of 32,800 articles were identified from Google Scholar, while a total of 10,006 articles were identified each from PubMed and Science Direct. In the next stage, the articles were filtered based on their abstracts, with the main goal of ensuring that each article meets the specified independent and dependent variables. Articles that were not available in full text or were inaccessible were excluded from the analysis. A total of 26 articles that met the inclusion criteria were selected to be included in the Review Manager Application (RevMan).

This study controlled bias by carefully selecting research articles that met the predetermined inclusion and exclusion criteria. The selection of research articles was carried out using the Population, Intervention, Comparison, Outcome, Time, and Study (PICOTS) approach, in which the population was all mothers with toddlers, the intervention was exclusive breastfeeding, the comparison was non-exclusive breastfeeding, the result was stunting incidence, the time was limited to articles published between 2013 and 2021, and the type of study was cross-sectional and case-control. The data collected was presented in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) chart. Furthermore, data analysis was carried out using the RevMan 5.4 application, with the analysis model selected depending on the variation between the studies found, using a fixed effect model if the variation is not significant or a random effect model if the variation is significant. The results of the analysis were presented in the form of a forest plot and a funnel plot using the odds ratio (OR) effect measure. This study did not require additional ethical approval as it employed a meta-analysis design to review published research results.

DISCUSSIONS

Figure 1 illustrates the sequential steps involved in the process of selecting research articles, starting with the initial identification stage and progressing to the selection of eligible articles for review. Based on the PRISMA diagram, 26 primary research articles that examined the relationship between exclusive breastfeeding and stunting incidence were selected. These articles include research with case-control and cross-sectional study designs. Each article was assessed for quality using a critical assessment checklist tailored for research with a cross-sectional or case-control design. After assessing the quality of the article, statistical data processing and analysis were carried out using RevMan 5.4.1 software.

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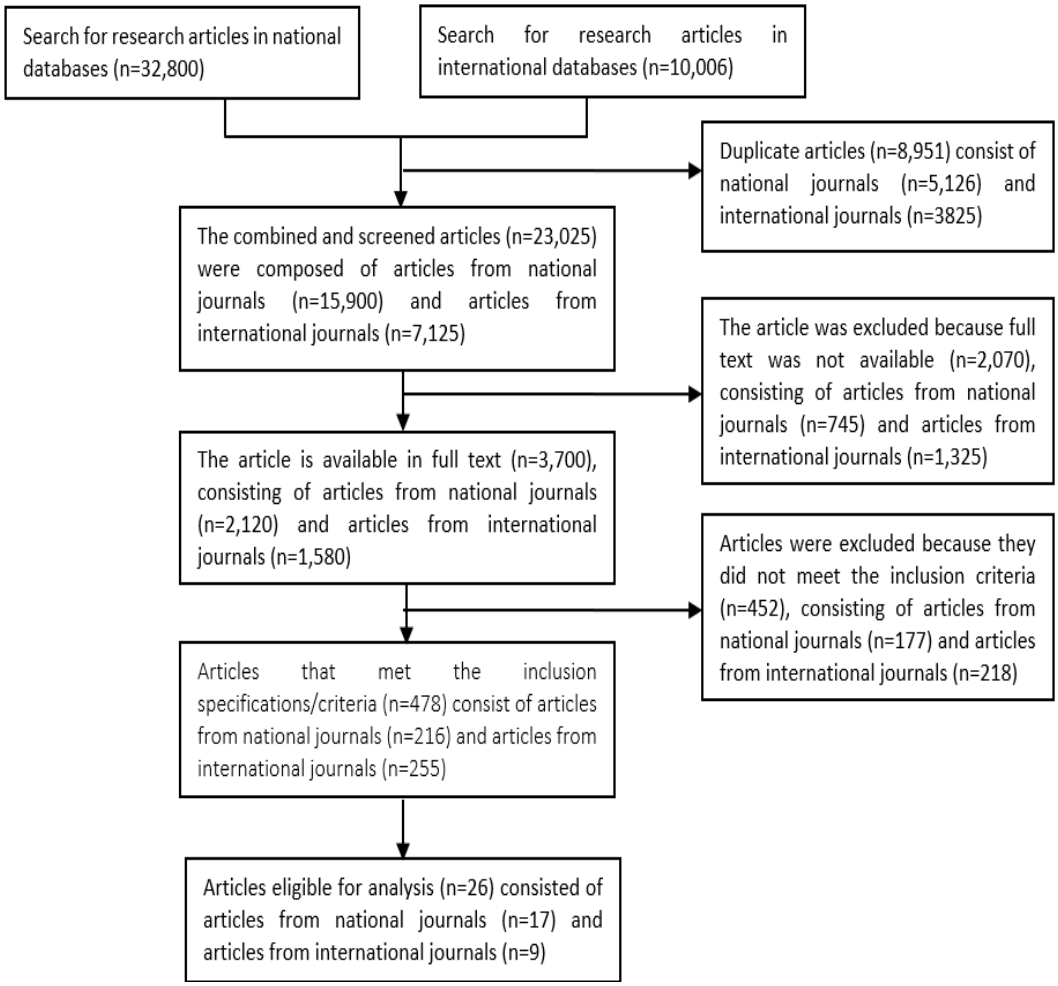

Figure 1. PRISMA Diagram of the Research Article Selection Process

Table 1 shows that 30.61% (95% CI: 7.3%-82.9%) of infants received exclusive breastfeeding, while 53.74% (95% CI: 19.6%-91.7%) of those did not receive exclusive breastfeeding. The research revealed that the *Kawangkoan Public Health Center in Minahasa* Regency had the lowest rate of exclusive breastfeeding, with a percentage of 7.3%, while those who did not receive exclusive breastfeeding reached 43.7%[26]. According to Dini Nugraheni's (2020) research, the largest percentage of exclusive breastfeeding in Central Java Province is 82.9%. Exclusive breastfeeding refers to the practice of giving infants only breast milk, without any additional liquids, for the first six months of their lives. Breast milk contains nutrients that have great benefits for infants, including protecting children from the risk of gastrointestinal infections, reducing the risk of infant mortality due to diarrhea and infectious diseases, meeting sufficient energy needs, and meeting the essential vitamin and nutrient needs of children aged 6 to 23 months[27].

Table 1. Exclusive and Non-Exclusive Breastfeeding Proportions from Selected Research Articles

Author	Exclusive Breastfeeding		Non-Exclusive Breastfeeding	
	n	%	n	%
Christin Angelina F, 2018	8	11.4	25	26.6
M Rizal Permadi, 2017	4	9.5	29	50.0
Riza Savita, 2020	30	38.0	50	61.7
Sr. Anita Sampe,SJMJ, 2020	6	8.3	66	91.7
Biruk Bogale, 2020	152	38.7	161	61.7
Fauzan I. Pratama, 2019	17	37.0	29	63.0
Aniqoh Raudlatul Wardah, 2019	39	48.8	41	51.2
Ruri Widyasari, 2018	18	40.1	12	75.0
Hana Ilmi Khoiriyah, 2021	13	24.5	19	63.3
Giyawati Yulilania Okinarum, 2021	13	16.25	27	33.75
Indah Suwartini, 2020	28	65.1	15	34.9
Dini Nugraheni, 2020	271	82.9	429	19.6

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Author	Exclusive Breastfeeding		Non-Exclusive Breastfeeding	
	n	%	n	%
Siti Wahdah, 2015	17	36.2	39	53.4
Khoirun Ni'mah, 2015	4	11.8	30	88.2
Winny Rambitan, 2014	7	7.3	41	43.7
Agus Hendra, 2013	12	25.0	36	75.0
Evi Sri Dahlianti, 2021	23	54.8	18	45.0
Resqita Chayani, 2019	27	49.1	28	50.9
Joko Sugiyanto, 2019	61	29.0	11	73.3
Baroroh Barir, 2019	17	13.9	33	42.3
Sumiaty, 2017	12	26.1	5	26.3
Ivanda Glanny, 2020	31	42.5	26	61.9
Nancy Swanida, 2020	2	3.0	50	36.5
Sri Yuliastini, 2020	58	33.7	187	43.3
Rasyika Nurul, 2021	7	23.3	23%	76.7
Nurhalina Sari, 2021	25	19.7	32	48.5
Sum	**902**	**7.3-82.9**	**1.462**	**19.6-91.7**
Average		**30.6**		**53.7**

n: Number of samples of each research article that performs exclusive breastfeeding and non-exclusive breastfeeding
%: The amount of proportion that provides exclusive breastfeeding and non-exclusive breastfeeding

Figure 2 displays the heterogeneity test results, with a p-value of 0.00001 < 0.05 and an I^2 value of 85%, indicating that the subsequent analysis used a random effect model. The forest plot featured a pooled odds ratio of 2.90 (95% CI 2.07-4.08), which showed that infants who received non-exclusive breastfeeding were 2.9 times more likely to be stunted than infants who received exclusive breastfeeding. The overall effect test results showed that exclusive breastfeeding significantly prevented the incidence of stunting in toddlers (p-value < 0.00001). The findings of this study are in line with previous research showing that exclusive breastfeeding is effective in preventing stunting in infants. According to research conducted at Bintang Sub-district, Central Aceh Regency, the lowest odds ratio is 0.23, which indicates that exclusive breastfeeding can protect against the incidence of stunting in toddlers (p-value = 0.041< 0.05)[28]. Furthermore, research conducted at *Buntu Malangka* Sub-district, Mamasa Regency, obtained the highest odds ratio value of 61.00, indicating that infants who did not receive exclusive breastfeeding are 61 times more likely to experience stunting compared to those exclusively breastfed. In addition, non-exclusively breastfed infants had a 98% risk of suffering from stunting[29].

The results of this study are consistent with the findings of research conducted at the *Manado* City Public Health Center, which show a significant relationship between exclusive breastfeeding and stunting incidence. Good breastfeeding by mothers greatly contributes to maintaining a healthy nutritional balance in children, which in turn supports optimal growth. Extensive research has shown that breast milk contains a variety of macro- and micronutrients, such as vitamins and minerals, which play a crucial role in supporting children's nutrition and growth. The composition of breast milk is highly digestible for the infant's digestive tract. In addition, research conducted at the Selo Public Health Center in *Boyolali* Regency showed a relationship between exclusive breastfeeding and the incidence of stunting in infants aged 6–24 months. This is because breast milk provides various benefits, including increasing the infant's immune system against diseases, reducing the risk of ear infections, and reducing the incidence of diarrhea and chronic constipation[30].

The findings of this study are also in line with the findings of research conducted in the working area of the *Boyolali* Regency Public Health Center, which concluded that there was a significant relationship between exclusive breastfeeding and the incidence of stunting[31]. Furthermore, research conducted in Lampung Province showed a significant relationship between exclusive breastfeeding and the incidence of stunting. Additionally, the incidence of stunting in toddlers can be influenced by exclusive breastfeeding. This is because if infants under the age of six months are given food (MPASI) other than breast milk, their intestines will be more susceptible to infectious diseases. Infants who frequently suffer from infectious diseases will experience stunted growth, thereby preventing them from achieving optimal growth[32].

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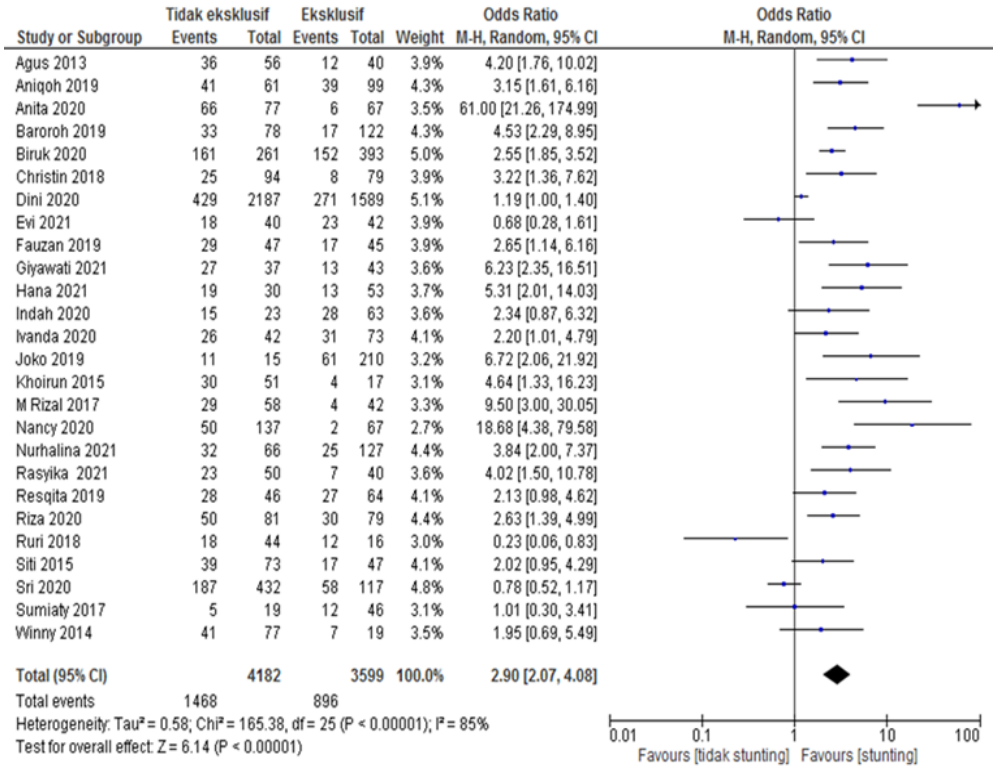
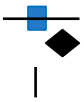


Figure 2. Forest Plot of the Effect of Non-exclusive Breastfeeding on the Risk of Stunting in Infants



: Blue square depicts the weight of each study
: Black diamond depicts the pooled mean difference
: Horizontal lines illustrate 95%

According to research conducted at *Bantargadung* Village, there was a significant relationship between exclusive breastfeeding and the incidence of stunting in toddlers[33]. This research is in line with research by Khoirun Ni'mah (2015), in which she discovered that there was a relationship between exclusive breastfeeding and the incidence of stunting[34]. Moreover, research conducted at Arba Minch Zuria District showed that exclusive breastfeeding is an independent predictor of stunting in toddlers. Exclusive breastfeeding has been identified as an indispensable way to provide ideal food for the healthy growth and development of infants[35]. In contrast, research conducted at the *Pajangan* and *Pleret* Public Health Centers in Bantul Regency discovered that there was no significant relationship between exclusive breastfeeding and stunting. These results suggest a potential correlation between breastfeeding practices and economic conditions, with children from families with lower economic backgrounds being more vulnerable to stunted growth compared to children from families with higher economic backgrounds[36].

Exclusive breastfeeding has been associated with a positive effect on infant growth, particularly in terms of height because the body absorbs calcium more efficiently from breast milk compared to formula milk. As a result, infants who receive exclusive breastfeeding are more likely to have a height that aligns with the expected growth curve, in contrast to those who are only fed formula milk. Breast milk contains more calcium and is more easily absorbed, making it essential for optimal growth, particularly in terms of height, and reducing the risk of stunting. The lack of exclusive breastfeeding increases the risk of stunting, particularly in early life. In addition, inadequate dietary intake is associated with an increased prevalence of malnutrition, which can increase morbidity and mortality rates among children, particularly in low-income countries[37].

Breastfeeding plays a crucial role in providing children with essential nutrition in the early phases of life because it has immunological and hormonal benefits that promote optimal growth and protection. Breast milk contains antibodies that boost the immune system and help expedite the recovery process from illness. The oligosaccharides in breast milk can inhibit pathogens and toxins from binding to host receptors, thus aiding in the prevention of infections[38]. Breast milk is an ideal nutritional choice to meet children's nutritional needs. In low-income countries, breastfeeding is essential to ensuring the survival of children. Breast milk is also rich in high-quality protein that is easily absorbed by the body and contains essential amino acids necessary for child development. Children who do not receive exclusive breastfeeding have a higher risk of stunting compared to those who do[39]. According to various studies, it is crucial to prepare every pregnant woman for breastfeeding. This preparation will ensure that mothers are adequately prepared to provide exclusive breastfeeding, which plays a vital role in preventing stunting[40].

In Figure 3, the plot funnel shows the standard error of the left plot between 0.1 and 0.6, while the standard error of the right plot is between 0.3 and 0.7.

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The funnel plot shows the distribution of research results that are asymmetrical or unbalanced between the left and right sides of the center line, which indicates the existence of publication bias. Publication bias is one of the limitations of meta-analysis research. This happened because researchers published significant research results, so studies with results that did not show a significant or negative relationship were not published. However, by carefully selecting research articles with the right method (PICOTS) and employing the correct statistical method, a large number of samples, and an in-depth explanation of the discussion, the results of the meta-analysis research can be accepted. In addition, for further research, it was suggested to use both online and manual searches to access research articles available in the libraries of the universities or institutions conducting the research.

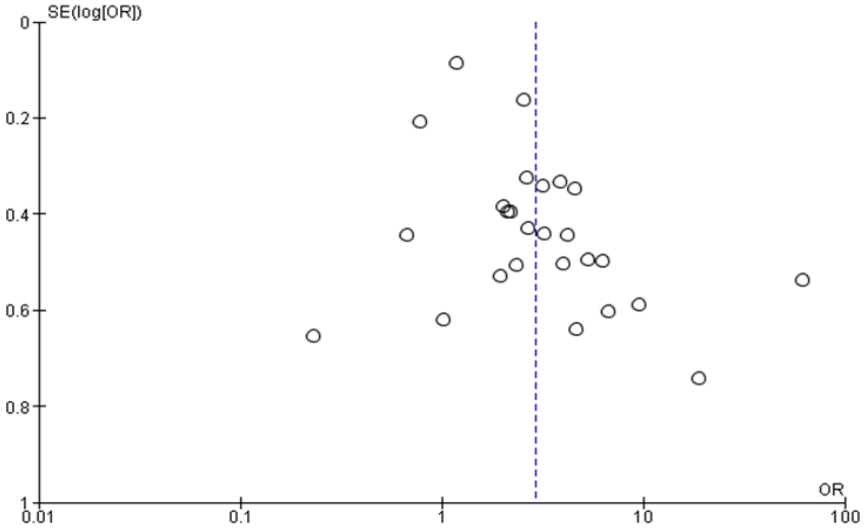

Figure 3. The Funnel Plot of the Effect of Non-exclusive Breastfeeding on the Risk of Stunting

SE : Standard Error
O : Representing Articles
------- : Center Line to See Plot Symmetry

CONCLUSIONS

The results of the meta-analysis proved that exclusive breastfeeding can significantly prevent the incidence of stunting in toddlers. Furthermore, it was discovered that an overall decrease in the incidence and prevalence of stunting among toddlers will be achieved by implementing exclusive breastfeeding. In order to reduce the stunting rate, it is crucial to implement policies and programs that focus on nutrition education and provide assistance through healthcare workers, which aim to promote exclusive breastfeeding and provide active support for pregnant and lactating women through maternal and child health service activities. In addition, for future studies, it was suggested to employ meta-analysis methods that include a larger number of articles from various countries, thereby providing a strong evidence basis for policymakers in designing strategies aimed at promoting exclusive breastfeeding.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors state that there is no conflict of interest. This research did not receive financial assistance.

AUTHOR CONTRIBUTIONS

DS: *conceptualization, data curation, investigation, methodology, supervision, validation, visualization, writing–review and editing*; NP: *project administration, methodology; resources, formal analysis, software, writing–original draft*; *writing–review and editing*.

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