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Risks factor of stunting: a case-control study

Faktor risiko kejadian stunting: studi kasus kontrol

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Abstract

Based on the Indonesian Nutritional Status Survey and Indonesian Health Survey data, the prevalence of stunting in Indonesia since 2021 has decreased to 2023 24,4%, 21,6%, and 21,5% by 2023. However, research on the influence of supplementary feeding on stunting is limited. Thus, this study described the determinants of stunting, including SF consumption in the 6-23 months participant group, as this age group is considered part of The First 1000 days. This case-control study was conducted in the Tlogosari Wetan Community Health Center area, Semarang City, between July and August 2024, with 120 study participants aged 6-23 months (60 stunting cases and 60 controls). The prevalence of stunting at the Tlogosari Wetan Community Health Center was 14,1%. SF had a significant effect on stunting (p<0,023), and early breastfeeding initiation (p=0,053) and breastfeeding (p = 0,073) were weakly associated with stunting. However, per capita income (p=0,116), birth length (0,120), fathers' education (0,328), and fathers' body height (p=0,141) had no significant effects on stunting. In conclusion, SF was significantly associated with stunting and accelerated the decline in stunting rate. It is necessary to pay attention to SF consumption to prevent stunting and to increase the knowledge of early initiation breastfeeding (EIB), as it affects the practice of breastfeeding.

Keywords: Breastfeeding, infant nutrition, early initiation of stunting, supplementary feeding

Abstrak

Berdasarkan data SSGI dan SKI, prevalensi stunting di Indonesia sejak 2021 mengalami penurunan setiap tahun hingga 2023, yaitu 24,4%, 21,6%, dan 21,5% secara berurutan. Meski demikian, penelitian yang menjelaskan tentang pengaruh Pemberian Makanan Tambahan (PMT) dengan stunting masih terbatas. Sehingga penelitian ini menjelaskan determinan kejadian stunting termasuk faktor PMT pada anak usia 6-23 bulan yang masih termasuk dalam periode 1000 HPK. Desain penelitian ini adalah Case Control yang dilakukan di wilayah Puskesmas Tlogosari Wetan, Kota Semarang pada Juli-Agustus 2024 yang terdiri atas 120 responden usia 6-23 bulan (60 kasus stunting dan 60 kontrol). Prevalensi stunting di wilayah kerja Puskesmas Tlogosari Wetan Kota Semarang sebesar 14,1%. PMT memiliki pengaruh signifikan terhadap stunting (p<0,023), Inisiasi Menyusui Dini (p=0,053), pemberian ASI (0,073) memiliki pengaruh yang lemah terhadap stunting. Namun pendapatan per kapita (p=0,116), panjang badan lahir (0,120), pendidikan ayah (0,328), dan tinggi badan ayah (p=0,141) memiliki pengaruh yang tidak signifikan terhadap stunting. S,ebagai kesimpulan, untuk mempercepat penurunan angka stunting, perlu memperhatikan pemberian PMT untuk mencegah stunting, serta meningkatkan pengetahuan tentang Inisiasi Menyusui Dini (IMD) karena faktor tersebut mempengaruhi praktik menyusui.

Kata Kunci: Inisiasi menyusu dini, gizi anak, pemberian PMT, stunting

Introduction

Stunting, a consequence of chronic malnutrition, has a significant impact on child growth and development (Schneider 2023; Maigoda et al., 2023). Stunted children are at a higher risk of developmental delay and have lower cognitive, motor, and adaptive behavioral skills and intelligence than normal children (Handryastuti et al. 2020; Mustakim et al. 2022). This condition has adverse health, developmental, and socioeconomic consequences (Handryastuti et al. 2020; Jatnika et al. 2024).

Stunting in children is associated with an increased risk of non-communicable diseases (NCDs) in adulthood. This phenomenon, known as developmental origin of health and disease (DOHaD), involves adaptive epigenetic changes that affect metabolism and other processes (Hanson & Skinner, 2016). Stunted children exhibit altered body composition, impaired lung function, and hormonal imbalances, potentially leading to asthma and other NCDs (Sapartini et al. 2022). Metabolic efficiency in stunted children, characterized by lower resting energy expenditure and fat oxidation, may contribute to obesity risk later in life (Muhammad 2018). The gut microbiome established during infancy also plays a role in the predisposition (Manju, 2024). This intergenerational cycle of poor health and reduced human capital underscores the importance of early interventions to mitigate long-term health consequences and socioeconomic burden.

The Indonesian government has prioritized the stunting reduction program since 2013 through Presidential Regulation Number 42 of 2013 regarding the National Movement to Accelerate Nutrition Improvement. The program by the Vice President of the Republic of Indonesia covers 100 priority districts/cities, and the number of priorities continues to increase until 2021, covering 360 priority districts/cities. Despite the program's progress, the remaining stunting cases in Semarang are still quite high.

The projected stunting rate for 2024, according to the National Medium-term Development Plan 2020-2024 is 14%. Despite the existence of a national strategy for accelerating stunting reduction, and since 2018, the government has provided a policy to provide additional food to toddlers, the prevalence of stunting in Indonesia remains high. According to the 2021 Indonesian Nutritional Status Survey (SSGI) was 24,4, in 2022 it decreased to 21,6% and according to the Indonesian Health Survey (SKI) in 2023 it was 21,5%. There will be a 2,8% decrease in stunting between 2021 and 2022. There will be a 0,5% decline from 2022 to 2023. According to the SSGI 2022 (Perpres, 2021), the prevalence of stunting in Central Java is 20,8%, according to SSGI 2022 (Perpres, 2021).

Many factors influence stunting reduction. In addition to the effectiveness of specific and sensitive interventions, conditions and problems related to the determinants of stunting in each region contribute to this problem. According to the 2021 SSGI, the proportion of diverse diets in children under two was 52,5%, the proportion of starting complementary food at six months was 55,3%, children under five who suffered from diarrhea was 9.8%, and Upper Respiratory Tract Infection (URTI) was 24,1%. According to the 2023 SKI, the proportion of animal protein consumption in children aged 6-23 months is 78,4%. This is the basis for the need for adequate protein intake by toddlers. Therefore, the recovery of stunted toddlers must focus on meeting the needs of animal proteins in toddlers according to the availability of local animal protein sources. These include eggs, fish, and chickens (Kementrian Kesehatan RI, 2023).

Other factors contributing to undernutrition in toddlers are poor parenting, lack of knowledge, recurrent infectious diseases, low access to healthcare facilities, and socioeconomic conditions that indirectly affect access to balanced nutritious food (Kementrian Kesehatan RI, 2023). Family independence in providing nutritious food by utilizing local food potential and good nutritious food knowledge is expected to encourage families and communities to consume food with balanced nutrition and take place in a sustainable manner. Supplementary feeding is an alternative method to improve the nutritional status of young children. SF is a government programs that addresses cases of stunting in young children. SF are categorized into 2, that is, Extension SF and restoration SF. Supplementary feeding is additional food given to young children by cadres at integrated health posts as an outreach medium, whereas SF for recovery is additional food given to malnourished or stunted young children for 90 days (Noer Rochman et al., 2022).

Therefore, this study aimed to assess the association between supplementary feeding, early initiation of breastfeeding, breastfeeding

status, per capita income, birth length, protein intake, father's education, father's height, and mother's height on the incidence of stunting, using a case-control design in children age 6-23 months.

Methods

This study used a case–control design (Biggs et al., 2021). Case-control studies are suitable for rare cases, such as stunting, with an incidence rate of less than 20%. In this study, we used unmatched selection.

The primary quantitative data collected in this study included age, anthropometric data (body weight and height), supplementary feeding (SF), early initiation breastfeeding (EIB), breastfeeding, per capita income, birth length, protein intake, paternal education, and paternal and maternal body heights.

This study was conducted from July to August 2024 in the Tlogosari Wetan Health Center Area of Semarang City. The study population comprised of 426 children aged 6-23 months. All 60 children aged 6-23 months who were stunted were selected in the case group (HAZ <-2,0), and 60 children who were not stunted (HAZ ≥ -2,0) were selected from the remaining 366 children (Permenkes RI, 2020; Al Rahmad et al., 2023). The selected study participants' ratio was 1:1, with a total sample size of 120 (60 cases and 60 controls).

Data were collected by an enumerator from the Nutrition Department alumnae who had received prior training. Body weight was measured using a baby scale with an accuracy of 10 g and body height was measured using an infantometer or microtome when standing with an accuracy of 0,1 cm. Parents' weight was measured using a digital weight scale with an accuracy of 0,1 kg and parents' height was measured by microtoice with an accuracy of 0,1 cm. Protein intake was measured using 2 x 24-hour non-consecutive recalls that describe eating habits and were conducted by trained enumerators. This method was chosen because it has a high level of sensitivity and specificity in describing eating habits (Biltoft-Jensen et al., 2023). Data on SF, EIB, breastfeeding, per capita income as measured by food and non-food expenditure, and fathers' education were collected through interviews using questionnaire instruments, while birth length was collected from the Road to the Health Card (Indonesian KMS records). Education was classified as primary education if not attending school, completed elementary school, or completed junior high school, and as higher education if completed high school or university. Per capita income was measured by food and non-food expenditures and calculated per capita income which was then classified according to the classification by the Semarang City Central Bureau of Statistics, it is classified as low if per capita income ≤ IDR. 598,598, - and high if > IDR. 598,598, - (Rohmah & Mardiana, 2023). Birth length was recorded from the MCH book and classified as tall if ≥ 48 cm and short if < 48 cm (Jokhu and Syauqy, 2024). Protein intake was classified as deficit if protein adequacy was based on an RDA < 100%, and as no deficit if protein adequacy was ≥ 100%. The father's height was considered high if ≥ 170 cm and not high if < 170 cm. Maternal height was considered high if ≥ 160 cm and low if <160 cm.

Data were analyzed descriptively to describe the sample and family characteristics, bivariate analysis using the chi-square test, and multivariate analysis by Multiple Logistic Regression. A normality test was not performed because of categorical data. No interaction or multicollinearity tests were conducted, because the purpose of the study was not to create a model. The analysis was performed using the SPSS software version 27. This study was approved by the Health Research Ethics Committee of Poltekkes Kemenkes Semarang (no. 0525/EA/KEPK/2024). Written informed consent was obtained from the parents of all children (participants) in both groups.

Result and Discussion

Participant and Family Characteristics

The screening results in the study population, out of 426 toddlers aged 6-23 months in the area of Tlogosari Wetan Health Center, Semarang City, revealed that 60 toddlers were stunted (HAZ < 2,0). Thus, the incidence of stunting in the Tlogosari Wetan Health Center Area was 14,1%. The participants in this study were 120 toddlers aged 6-23 months, consisting of 60 toddlers as cases (stunting) and 60 toddlers as controls (not stunting).

Table 1 presents the characteristics of the study participants and their families.

Table 1. Participant and family characteristics

Variable	Category	n	% (Mean)	±	SD
Age of Children (month)		120	16	±	5,3
Children Age Category	6-12 month	41	34,2		
	13-23 month	79	65,8		
Sex	Male	73	61		
	Female	47	39		
Supplementary Feeding	Given	82	68,3		
	Not Given	38	31,7		
Types of Supplementary Feeding	Local SF	57	47,5		
	Staple food	17	14,2		
	Snack	3	2,5		
	Complete Meals & Snack	5	4,2		
Skin-to-Skin Contact	Yes	110	91,7		
	No	10	8,3		
Duration of Skin-to-Skin Contact		110	18,3	±	17,57
Early Initiation Breastfeeding	<1 hour	97	80,8		
	≥1 hour	23	19,2		
Colostrum	Given all to baby	107	89,2		
	Don't know	13	10,8		
Supplementary Feeding Start		120	6	±	0,9
Supplementary Feeding Category	<5 month	6	5,0		
	5 month	13	10,8		
	6 month	93	77,5		
	>6 month	8	6,7		
Breastfeeding	Not exclusive	19	15,8		
	Exclusive	101	84,2		
Food expenditure		120	2004209	±	2043055
Non-food expenditure		120	1128986	±	1819767
Family member		120	4	±	1,02
Per capita income		120	999583	±	810354
Income category	Low	38	31,7		
	High	82	68,3		
Birth Length		120	49	±	2,1
Birth Length Category	Short	24	20,0		
	Not Short	96	80,0		
Protein Intake		120	23,6	±	15,2
Protein Adequacy (RDA/AKG)		120	131,4	±	74,8
Protein Adequacy Category	Deficit	62	51,7		
	Not Deficit	58	48,3		
Paternal Education	Did not attend school	1	,8		
	Elementary School	2	1,7		
	Junior High School	25	20,8		
	Senior High School	59	49,2		
	Diploma	9	7,5		
	Undergraduate	23	19,2		
	Master/Doctorate	1	,8		
Paternal Education Category	Primary education	28	23,3		
	Higher education	92	76,7		
Paternal Body Height		120	168	±	5,3
Paternal Body Height Category	<170 cm	73	60,8		
	≥170 cm	47	39,2		
Mother Body Height		120	156	±	4,7
Mother Body Height Category	<160 cm	91	75,8		
	≥160 cm	29	24,2		

Crude Odds Ratio (cOR) of Stunting Determinants

The strength of the relationship was indicated by the crude Odds of each factor tested using the chi-square test. Father's education had a highly significant relationship with the incidence of stunting (p=0,010), and EIB (p = 0,011), per capita income (p=0,050), and birth length (p=0,022) were significantly associated with the incidence of stunting, while the other variables were not significantly associated with stunting (p>0,1).

Table 2. Crude odds ratios (cOR) of SF, EIB, breastfeeding, per capita income, birth length, protein intake, father's education, paternal height, and paternal height on the incidence of stunting.

Variables		Stunting		cOR	95% CI OR	p*
		Yes (%)	No (%)			
Supplementary Feeding	Given	35 (58,3)	47 (78,3)	0,4	0,2 - 0,9	0,190
	Not Given	25 (41,7)	13 (21,7)			
Early Initiation Breastfeeding	<1 hour	54 (90,0)	43 (71,7)	3,5	1,3 - 9,8	0,011
	≥1 hour	6 (10,0)	17 (28,3)			
Breastfeeding	Not exclusive	14 (23,3)	5 (8,3)	3,3	1,1 - 9,9	0,240
	Exclusive	46 (76,7)	55 (91,7)			
Income category	Low	24 (40,0)	14 (23,3)	2,2	0,9 - 4,8	0,050
	High	36 (60,0)	46 (76,7)			
Birth Length Category	Short	17 (28,3)	7 (11,7)	2,9	1,1 - 7,9	0,022
	Not Short	43 (71,7)	53 (88,3)			
Protein Adequacy Category	Deficit	33 (55,0)	29 (48,3)	1,3	0,6 - 2,7	0,465
	Not Deficit	27 (45,0)	31 (51,7)			
Father Education Category	Primary	20 (33,3)	8 (13,3)	3,2	1,3 - 8,1	0,010
	Higher	40 (66,7)	52 (86,7)			
Paternal Body Height Category	<170 cm	40 (66,7)	33 (55,0)	1,6	0,8 - 3,4	0,190
	≥170 cm	20 (33,3)	27 (45,0)			
Maternal Body Height Category	<160 cm	46 (76,7)	45 (75,0)	1,1	0,5 - 2,5	0,831
	≥160 cm	14 (23,3)	15 (25,0)			

**Chi-Square*

Adjusted Odds Ratio (aOR) Determinants of Stunting

Table 3 shows the results of the multiple logistic regression analysis, which shows the strength of the adjusted association, as indicated by the aOR value. The table shows that children receiving SF have a 0,33 risk of being stunted compared to children who did not receive SF.; in other words, infants receiving SF were 67% less likely to be stunted than infants not receiving SF (OR: 0,33, 95%CI: 0,13-0,86, p=0,023).

Similarly, infants who did not receive EIB or were placed on the mother's breast immediately after birth and nursed for <1 h did not show statistically significant odds 3,02 times of stunting compared to infants who received EIB (OR: 3,02, 95%CI: 0,99-9,27, p=0,053). Children who were not exclusively breast-fed had likelihood of stunting 2,98 times compared to infants who were exclusively breast-fed, although it was not statistically significant (OR: 2,98, 95%CI: 0,90-9,82, p = 0,073).

However, Children from low-income families had likelihood of stunting 2,12 times compared to children from high-income families (OR: 2,12, 95%CI: 0,83-5,51, p=0,116). Children who were classified as short at birth had insignificant odds 2,40 times to being stunted than children classified as tall at birth (OR: 2,40, 95%CI: 0,80-7,21, p=0,120). Children whose fathers had only a primary education had an insignificant odds ratio of 1,67 for stunting compared to children whose fathers had a high secondary education (OR: 1,67, 95%CI: 0,59-4,91, P =0,328). Children whose fathers were classified as short had an insignificant 1,88 × odds of stunting compared to toddlers whose fathers were tall (OR: 1,88, 95%CI: 0,81-4,37, p=0,141).

Tabel 3. Adjusted Odds Ratio (aOR) of receiving sf, eib, breastfeeding, income category, birth length, father's education, and paternal height on the incidence of stunting

Variable		B	aOR	95% CI OR	p*
Supplementary Feeding	Given	-1,12	0,33	0,13-0,86	0,023
	Not Given	0			
Early Initiation Breastfeeding	<1 hour	1,11	3,02	0,99-9,27	0,053
	≥1 hour	0			
Breastfeeding	Not exclusive	1,09	2,98	0,90-9,82	0,073
	Exclusive	0			
Income category	Low	0,76	2,12	0,83-5,51	0,116
	High	0			
Birth Length Category	Short	0,88	2,40	0,80-7,21	0,120
	Not Short	0			
Paternal Education Category	Primary	0,53	1,67	0,59-4,91	0,328
	Higher	0			
Paternal Body Height Category	<170 cm	0,63	1,88	0,81-4,37	0,141
	≥170 cm	0			

*Multiple Logistic Regression

Incidence of Stunting

The incidence of stunting in the Tlogosari Wetan Community Health Center is 14,1%, while the national target set by the government is to reduce stunting by 14% in 2024 (Kementerian Kesehatan RI 2022). The ages of the study participants ranged from 6 to 59 months. At this age, toddlers are still nutritionally vulnerable because of high nutritional problems. This can impact infectious diseases and hinder the growth and development of children. Sixty-one total of 61% male and 39% of women participated in the study.

Provision of Supplementary Feeding

A total of 68,3% of the children in the survey received supplementary feeding in the previous 12 months. The supplementary feeding provided was mostly (47,5%) local supplementary food, while some were in the form of staple foods (rice, oil, sugar), snacks (pudding, potato patties, stuffed white bread, cheesy sweet corn (jasuke), mayonnaise rissole, bananas), and complete meals and snacks.

The results of this study concluded that children who received supplemental food had significantly lower odds of stunting (67 %) than children who did not receive supplemental food. The results of this study are consistent with those of previous research, which found that supplementation can help prevent stunting (Kusnadi et al., 2023). In Philippines, supplementary feeding programs have shown positive effects on children's weight and height, particularly in addressing malnutrition among indigenous populations (Cabaddu, 2020)

Providing supplementary food to young children is essential because it can help meet their nutritional needs, especially in children affected by stunting. Complementary foods can be provided in the form of healthy foods that are rich in nutrients at both macro- and micronutrient levels. Insufficient supplemental food can affect the growth of young children by increasing their risk of inadequate or insufficient nutrient intake.

Indonesia is the third-largest country in the world in terms of biodiversity. There are at least 77 carbohydrate sources, including 26 nuts, 389 fruits, 228 vegetables, and 110 spices and herbs (Badan Ketahanan Pangan, 2020). There are seven animal food groups: marine fish, shrimp, freshwater fish, salted fish, meat, eggs, and milk. This indicates that the potential for local food utilization is very wide open for family food provision, including improving the nutrition of children under five years of age.

Early Initiation of Breastfeeding (EIB)

Attachment during EIB is the process in which the baby searches for the nipple and areola in the mother's breast. Prior research has found that the average duration of EIB attachment in maternity wards is only 10 minutes. This means that it falls into the inappropriate category. In this case, the role of midwives or other healthcare workers is very important in motivating mothers to initiate breastfeeding (Anastasya & Nurchasanah, 2023). In this study, 91,9% of the infants were attached to their mothers' nipples at birth for an average of 18

minutes. However, 19,2% were attached after ≥ 60 min (1 h). Immediately after latching, the majority of mothers (89,2%) provided colostrum to their infants.

In this study, infants who did not receive EIB or were placed on the mother's breast immediately after birth had nearly significant 3.02 times greater odds of stunting than infants who received EIB. This aligns with a recent study, which suggested that infants who are delayed in initiating breastfeeding are at a greater risk of stunting than infants who are initiated within 1 h of birth (Astuti et al., 2024).

The early initiation of exclusive breastfeeding (≥1 h) is a protective factor against stunting (Nadiyah et al., 2014). Colostrum nutrients contain immunoglobulin A protein that can protect infants up to 6 months of age (Nurqalbi Sampara & Hasriani Saleng, 2022), which enhances immunity, increases the likelihood of exclusive breastfeeding, and ensures adequate nutritional intake, lowering the chance of stunting (Kahssay et al., 2020; Steven Christian Susianto et al., 2022).

However, EIB practice remains inadequate. Barriers to EIBF include cesarean delivery, prelacteal feeding, and a lack of antenatal care (Shakya & Shakya, 2021). Mothers who deliver vaginally have higher rates of EIBF than those who undergo cesarean section (Ulfa et al., 2023). However, even among women undergoing cesarean delivery, EIBF rates can improve. The factors associated with successful EIBF after cesarean delivery include skin-to-skin contact, exclusive breastfeeding during hospitalization, and infant alertness during feeding attempts (Johar et al., 2021). To promote EIBF, healthcare providers should offer breastfeeding education and support, emphasizing its importance in the antenatal period, particularly for women planning cesarean deliveries (Johar et al., 2021; Ulfa et al., 2023).

Exclusive Breastfeeding

The results of this study indicate that at 5 months of age, on average, infants have received foods other than breast milk, leaving 15,8% of infants who are not exclusively breastfed. This findings are lower than national data, which was 44,5% children 6-23 months are not receiving exclusive breastfeeding

In our findings, children who are not exclusively breastfed are 2,98 times more likely to stunt than those who are exclusively breastfed. This finding is consistent with prior research, which found that mothers who do not exclusively breastfeed their children have a higher risk of stunting than those who exclusively breastfeed their children (Riza & Ristiani, 2023). Similar findings were observed in East Nusa Tenggara; a higher proportion of mothers who exclusively breastfeed their children in the first six months of life is associated with lower stunting in young children (Suratri et al., 2023).

Children who are not breastfed are at a risk of developing nutritional deficiencies that can lead to malnutrition and stunting. The benefits of exclusive breastfeeding can help maximize growth because it contains calcium (Koffi et al. 2023). It also increases stamina and intelligence in young children. Therefore, non-exclusive breastfeeding may cause stunted growth (SJMJ et al. 2020).

Nonexclusive breastfeeding among young children is associated with the incidence of stunting. This is because mother's milk is the most important component in the growth and development of young children. Breast milk boosts the immune system and infants who are exclusively breastfed have a higher level of protection against infections. Breast milk also helps infants obtain sufficient protein to prevent stunting (Riza and Ristiani, 2023).

Some studies found a significant association, with non-exclusively breastfed children having a 2,45 to 3,1 times higher risk of stunting than exclusively breastfed children (Umiyah & Hamidiyah, 2020). These findings suggest that exclusive breastfeeding may play a protective role against stunting.

Family Income

The results of this study show that the average income from food is the IDR. 2,004,209 and that for non-food was IDR. 1,128,969. The average per capita income was IDR. 999,583; 31,7% of families had a low income. Although our analysis showed a weak association between family income and stunting ($p = 0,116$), the results indicated that toddlers from low-income families have likelihood of stunting 2,12 times compared to toddlers from high-income families.

The results of this study indicate that family income is related to stunting in children, similar to the findings of Amalia et al. (2023). A high family income indicates that a family can meet its needs. On the other hand, low family income means that a family is struggling to meet its needs, which can affect the quality of food

choices (Amalia et al., 2023). This is consistent with the research by Yunitasari et al. (2022), who found that low-income families are unable to meet nutritional needs and health services that can support them. This affects the lack of nutritional intake used in the growth and development of young children (Yunitasari et al., 2022).

Family income is a risk factor for stunting, which affects families' ability to provide children with nutrition, food choices, timing, and healthy lifestyles. Access to better public services, such as education, health services, food insurance, and sanitation, is also influenced by economic status or family income. Thus, income and economic status affected the incidence of stunting. The higher the family income, the better the fulfillment of nutrients and choice of food types consumed by toddlers, which also affects the nutritional status of good toddlers (Rahma and Mutalazimah, 2022).

Children Birth Length

The children in this study had an average birth length of 49 cm and 20% were classified as short (PB <48 cm). Although our analysis showed a weak association between birth length and stunting (p = 0,120), the result indicates that children with a shorter birth length have likelihood of stunting 2,40 times compared to children with a short birth length.

The birth length of an infant describes its growth among women. Birth length was also associated with the incidence of stunting. Infants born small have several factors that affect their growth in utero, including economic factors, disease, nutritional deficiencies, and growth that can be monitored during pregnancy and postnatal visits (Dasantos et al., 2020).

Birth length describes the physical measurement of a newborn's body length at birth, typically measured from head to foot (Jamshed et al., 2020). The birth length of a child can be influenced by the mother's condition during the pregnancy. Fetal growth and development can be affected by poor maternal conditions such as malnutrition, stress, or comorbidities.

Impaired fetal growth and development will later influence fetal birth length, which can affect height in early childhood and adulthood. Thus, the birth length of children under five years of age may be a determinant of stunting (Rahmawati, 2020). Young children who were classified as short at birth had 2,40 times lower odds (probability) of stunting than those who were tall at birth. This is consistent with a previous study that found that the proportion of stunted toddlers was higher in toddlers with low birth length (50%) than in those with normal birth length (26,8%) (Illahi, 2017).

Paternal Education

Parental education is one of the factors that influence the incidence of stunting. The young children in this study had fathers with varying levels of education ranging from no education to master's degree graduates. Most participants (49,2%) had completed senior high school or professional school, 23,3% had primary education (≤ junior high school), and 76,7% had secondary education (≥ senior high school).

Toddlers whose fathers had a primary education were 1,67 times more likely to be stunted than those whose fathers had a secondary education. The results of this study are consistent with prior research, where parental education level in terms of stunting incidence is largely influenced by a relatively low father's education level (Roostriyani & Eka Sugiantini, 2023).

This relationship operates through complex interconnected pathways involving socioeconomic factors, health knowledge, parenting practices, and household resource allocation. Understanding these mechanisms is crucial for developing comprehensive stunting prevention strategies that recognize fathers as key stakeholders in child health outcomes.

Education improves fathers' employment prospects, job security, and family access to nutritious foods. This influences their understanding of household budget allocations and nutritional priorities. Educated fathers are more aware of age-appropriate feeding practices, vaccination schedules, and growth tracking, leading to better child health outcomes and reduced stunting risks. They prioritize spending on child health and nutrition over competing household demands (Beal et al. 2018).

Paternal Height

The fathers of the young children in this study had an average height of 167,8 cm, and 60,8% were classified as ≤ 170 cm. Children whose fathers were classified as having short body height had a non-significant odds ratio (OR) of 1,88 times more likely to stunt than toddlers whose fathers were tall. The results of this study

are similar to those of another study that found that paternal height influences stunting in children (Wu et al., 2021).

Height affects the occurrence of stunting (Sugianti et al. 2024). The genetic influence of parents (7th, 8th, 20th, and sex chromosomes), which is involved in the development of human height, explains the relationship between parental height and stunting incidence (Wu et al., 2021). Fathers' height reflects their own early life nutrition and health status, which can influence the child's growth potential through epigenetic and biological pathways (Wu et al., 2021). Indirectly, paternal height may reflect socioeconomic and environmental conditions that further affect child growth outcomes.

Conclusion

The provision of SF had a significant effect on preventing stunting. However, EIB and exclusive breastfeeding had significantly weaker effects. Among the young children who were administered SF, local SF demonstrated efficacy in preventing stunting. A combined approach targeting maternal and child nutrition (e.g., supplementary feeding and breastfeeding support) alongside socioeconomic empowerment is likely to be the most effective.

Further research with larger samples could clarify the roles of borderline-significant factors (e.g., EIB and income). There is also a need for education and training on SF made from local food for cadres and the integration of the CF program with Posyandu.

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