Original Article

Prenatal Risk Factors for Stunting in Children aged 12-24 Months in Central Java, Indonesia

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ABSTRACT

Background

The prenatal period is the golden period of a child's growth. Identification of prenatal risk factors can be used as a basis for prevention to decrease stunting incidence.

Objective

This study aimed to identify prenatal risk during pregnancy that contribute to stunting in children aged 12-24 months in Central Java, Indonesia.

Method

This observational study employed a case-control design. The research was conducted in four Central Java districts with the highest prevalence of stunting. Subjects were selected through stratified random sampling at the district, health center, and village levels. A total of 261 children stunting aged 12-24 months and 261 children without stunting were selected. Data collection was conducted through structured interviews using structured questionnaires. Data were analyzed using Chi square test and logistic regression model.

Results

The study showed that 52.4 % among the stunting children were boys. More parents with lower educational background were found in stunting group. There were no difference in parental occupation, marital status, per capita income, abortion history between the case and control groups. Multivariate analysis revealed that prenatal risk factors associated with stunting included short maternal height (OR = 2.68; 95%CI = 1.73-4.14; p = 0.0001), Chronic Energy Deficiency (CED) during pregnancy (OR = 1.63; 95%CI = 1.07-2.48; p = 0.022), non-routine iron supplement consumption (OR = 1.61; 95%CI = 1.12-2.32; p = 0.011) and having more than one child (OR = 1.590; CI = 1.063-2.377; p = 0.024).

Conclusion

It was concluded that prenatal risk factors for stunting in children aged 12-24 months in Central Java were short maternal height, nonroutine consumption of iron supplement and inadequate weight gain during pregnancy.

Keyword

Stunting; Mother; children; prenatal; Health

INTRODUCTION

Stunting under two years is a major nutritional problem in Indonesia. According to data from the Nutritional Status Monitoring over the past three years, stunting has the highest prevalence compared to the other nutritional issues such as underweight, thinness, and obesity[1]. There are many risk factors that lead to stunting, one of which is the health condition of pregnant women[2]. Maternal health during pregnancy is the initial period of human development, beginning from conception when a woman's ovum is fertilized by male sperm to form an embryo continuing until birth. Child's growth and development progress in a systematic, interconnected, and continuous manner, starting from conception and lasting until adulthood. Child development is divided into several stages, and if any problems arise during the prenatal period, they can impact the condition of the fetus in the womb or even after birth. Maternal nutrition significantly influences the growth and development of the fetus.

Chronic energy deficiency (CED) in pregnant women has been shown to increase the likelihood

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of giving birth to low birth weight (LBW) infants, which is a major risk factor for childhood stunting[3]. The crucial first thousand days includes the gestational period, and continues up to the child's first two years of life, from conception to 24 months postpartum[4,5,6]. Fetal development throughout gestation is inherently intertwined with maternal health status. The time in the intrauterine environment sets the stage for all later stages of development, it is a critical developmental time window for physical development[2]. The Mid Upper Arm Circumference (MUAC) is a measurement that can be used as a nutritional assessment of pregnant women and suggest chronic energy deficiency (CED)[6,7]. Mothers with CED history are ten times more likely to have stunted children compared to those whose MUAC measurements are normal[3,8]. Child linear growth is significantly influenced by maternal anthropometric parameters. There are a higher risk of having stunted infants among mothers with low height (<150 cm) and low-weight (BMI <18.5 kg/m²). Besides, maternal hemoglobin levels are essential for fetal development and maternal health. Complementary tests show that anaemia in mothers during pregnancy is one of the factors that causes malnutrition, which is also a contributing factor to stunted childrenAs per studied in Bontoa, South Sulawesi, Indonesia, mothers with anaemia have a risk of giving birth to children with stunting 3.5 times greater than mothers without anaemia (OR=3.5; 95% CI=1.82-6.81)[2]. A different study in Bogor also concluded the same where pregnant women who did not adherently consume Fe tablets have 6.1 times increased risk for the occurrence of stunting in their children, compared to pregnant women with adherence in Fe tablets intake (OR = 6.1; 95% CI = 2.3–16.1; p = 0.0001)[9].

By focusing attention to risk factors for stunting during pregnancy, the timely identification of risk factors may present an opportunity to implement targeted interventions leading to improved growth trajectories for young children during critical windows of developmental plasticity. Targeting high-risk areas may optimize the effectiveness and cost-effectiveness of stunting reduction programs. Prenatal risk factors had heterogeneous results depending on the methodology used and geographical location of studies. As a regional analysis, findings from this investigation of stunting in Central Java may generate region-wise recommendations for stunting intervention strategies that are warranted. Prenatal focus is especially important as it guides preventive programming before the emergence of stunting and lowers incidence rates through effective intervention. We aimed to determine the risk factors of stunting on children aged its 12-24month in Central Java, related to prenatal risk factor.

SUBJECTS AND METHODS

Study setting and participants

This observational study employed a case-control design. Conducted in 2023, the research took place in four districts with the highest stunting rates in Central Java: Brebes, Purbalingga, Magelang, and Temanggung, based on data from Indonesian Nutritional Status Survey (SSGI) in 2022[10] . Each district was represented by two Primary Healthcare centers (PHC), and each PHC was represented by two to three villages.

Sampling

Subjects were selected through stratified random sampling at the district, health center, and village levels in Central Java, focusing on areas with the highest prevalence of stunting among children aged 12-24 months. A total of 261 stunting children aged 12-24 months were selected as cases, and 261 non-stunted children of the same age and areas served as controls. Inclusion criteria were mothers and their children aged 12-24 months, with no congenital diseases or hormonal disorders, not ill during the study, and possessing a Maternal and Child Health (MCH) book which contained recorded data from the pregnancy period. The exclusion criterion was refusal to participate as a respondent.

Data collection and measuring instruments

Data were collected by village midwives who received training from the researchers. Data collection was conducted through interviews using structured questionnaires and data from prenatal check-ups recorded in the MCH book, along with direct measurements of body length and weight of the children. Body length was measured in centimeters with the child lying supine, using a portable infantometer and recorded to one decimal place. Weight was measured using a digital baby scale in kilograms, with results recorded to two decimal places.

Length Age Z (LAZ), Length Age Z dan *Weight Length* Z (WLZ)

LAZ, WAZ and WLZ scores were calculated using

WHO Anthro software by entering data on the child's sex, birth date, and the measured weight and body length.

Maternal Weight Gain (MWG)

Maternal weight gain was calculated as the difference between the mother's weight just before delivery and her weight before pregnancy, in kilograms. Normal or adequate weight gain was determined according to Body Mass Index (BMI) ranges based on WHO classification: for BMI < 18.5 (underweight), should be 12.5-18 kg; for BMI 18.5-24.9 (normal weight), should be 11.5-16 kg; for BMI 25-29.9 (overweight), should be 7-11.5 kg; for BMI 30 and above (obesity), should be 5-9 kg.BB.[11]

Statistical analysis

Univariate analysis was performed for frequency distribution on categorical data variables. Normality tests were conducted for numeric data variables, and as all data were non-normally distributed, they are presented using median, standard deviation, minimum, and maximum values. Bivariate analysis was performed using the Chi-square test, and variables with a p-value < 0.25 were included in multivariate logistic regression using the enter method. Variables with the highest p-values were excluded iteratively until no variables needed removal, either due to an R-square reduction of >10% from the previous value or all variables having a p < 0.05.

Ethical considerations

This study received ethical clearance from the Health Research Ethics Commission of the Faculty of Public Health, Universitas Diponegoro No. 203/EA/KEPK-FKM/2023.

RESULTS

The respondents in this study were mothers and their children aged 12-24 months. The family characteristics measured included the mother's age at the time of the study, age at first marriage, age at childbirth, number of family members in one household, and number of nuclear family in one household. Additional family characteristic data collected included the age of the youngest child at the time of the study, total number of children, and number of children under five years old. A summary of respondent characteristics is shown in Table 1.

Table 1 Family Characteristics

	Stunting		*p
	Stunted (%)	Non-stunted (%)	
Mothers's Education			
Low (elementary-Junior High School))	194(53.6%)	168 (46.4%)	0.006
High (Senior high school-University)	64(40.5%)	94(59.5%)	
Father's Education			
Low (elementary-Junior High School))	197(53.2%)	173 (46.8%)	0.013
High (Senior high school-University)	61(41.2%)	87(58.8%)	
Father's Occupation			
Irregular Income	113(53.1%)	100(46.9%)	0.247
Fixed income	148(47.9%)	161(52.1%)	
Mother's Occupation			
Working	37(44.0%)	47(56%)	0.750
Homemaker	224(51.1%)	214(48.9%)	
Marital Status			
Divorced Widow	1(50.0%)	1(50.0%)	0.711
Widowed	2(33.3%)	4(66.6%)	
Intact Family	255(49.9%)	256(50.1%)	
Income per Capita			
< 477.580 (thousands Rupiahs)	9(39.1%)	14(60.9%)	0.268
≥ 477.580 (thousands Rupiahs)	242(50.9%)	233(49.1%)	
History of Abortion			
No	246 (94.3%)	244(93.5%)	0.844
Yes	15 (5.7%%)	16 (6.1%)	
Parity			
1-2 Children	75 (53.6%)	65(46.4%)	0.028
>2 Children	185(48.7%)	195(51.3)	
Child's Gender			
Male	144 (52.4%)	131 (47.6%)	0.254
Female	117 (47.4%)	130 (52.6%)	
Contraceptive Use			
No	32 (39%)	50 (61%)	0.054
Non-long term	153 (50.3%)	151 (49.7%)	
Long term	76 (55.9%)	60 (44.1%)	

**Chi square*

The family characteristic variables with numerical data included the mother's current age, age at first marriage, age at the birth of the youngest child, number of n in one nuclear family household, number of family members in one household, total number of children, and number of children under five, as shown in Table 2. Analysis of differences using the Mann-Whitney test for family characteristics showed significant differences between the stunted and non-stunted groups in the mother's current age, mother's age at the birth of the youngest child, number of family members in one household, and number of children under five. There were no differences in the variables of age at first marriage and number of nuclear family in one household.

Table 2. Subject Characteristics

	Stunting				Non-Stunting				
Variable	Med	SD	Min	Maks	Med	SD	Min	Maks	p*
Current age of mother (years)	31	5.89	19	44	30	5.97	17	45	0.060
Age of mother at first marriage (years)	21	3.20	16	34	20	3.36	14	37	0.340
Age of mother at last childbird (years)	29	6.14	17	45	28	6.26	17	43	0.061
Number of nuclear family in one house	1	0.50	1	3	1	0.48	1	2	0.619
Number of family member	5	1.707	2	12	5	1.346	2	8	0.002
Number of children	2	0.977	1	6	2	0.913	1	6	0.050
Number of children under five	1	0.34	1	3	1	0.19	1	2	0.015

**Mann-Whitney*

The characteristics of study subjects, including age, gender, body length, and weight, can be seen in Table 3. Mann-Whitney analysis in Table 3 shows that in both the stunted and non-stunted groups, there was no difference in age and weight-for-height scores (WAZ). There was a different in median WAZ score between the case (WAZ = -2.12) in underweight catagory and the control group (WAZ = -0.94) in the normal weight catagory. Age, WLZ score, gender, and nutritional status showed no differences between the case and control groups. The results of the analysis of prenatal factors on the incidence of stunting can be seen in Table 4.

Table 3. Description of subject characteristics

	Stunting				Non-Stunting				
Variable	Med	SD	Min	Max	Med	SD	Min	Max	p*
Child's age (months)	18	3.808	12	24	18	3.709	12	24	0.298
WAZ Score	-2.12	1.025	-4.35	1.05	-0.94	1.060	-3.97	2.37	0.000
WLZ Score	-0.59	1.372	-6.3	3.67	-0.34	1.456	-5.08	5.86	0.235
	n	%			n		%		p**
Gender									
Male	144	52.4%			131		47.6%		0.254
Female	117	47.4%			130		52.6%		
Nutritional Status									
Severe Malnutrition	7	30.4%			16		69.6%		0.351
Malnutrition	31	55.4%			25		44.6%		
Good nutrition	195	51.0%			187		49.0%		
Risk of overweight	19	42.2%			26		57.8%		
Overweight	4	57.1%			3		42.9%		
Obesity	4	50.0%			4		4.0%		

**Mann Whitney* ***Chi Square*

Table 4. Prenatal Risk of Stunting at Age 12-24 Months in Central Java, Indonesia

Variable	Stunting (%)	Non-Stunting	OR	CI 95%	p*
Anemia in the first Trimester Yes (Hb: < 11 g/dL)	42(47.2%)	47 (52.8%)	0.764	0.471-1.239	0.275
To (Hb≥ 11 g/dL)	138(53.7%)	138(46.3%)			
Anemia in the Second Trimester Yes (Hb < 10.5 g/dL)	18(48.6%)	19 (51.4%)	1.256	0.609-2.598	0.535
No (Hb: ≥ 10.5 g/dL)	61(43%)	81(57%)			
Hemoglobin in the Third Trimester Yes (Hb: < 11 g/dL)	27(48.2%)	29 (51.8%)	2.19	0.987-4.877	0.887
No (Hb: ≥ 11 g/dL)	132(49.3%)	136(50.7%)			
Iron Table Consumption Behavior Not Routine Routine Daily	160(54.6%) 94(50,0%)	133 (45.47%) 128 (57.7%)	1,638	1,152–2.329	**0,006**
At Risk of Chronic Energy Deficiency (CED) LiLA < 23,5 cm LiLA ≥ 23,5 cm	83(57.6%) 178(47.1%)	61(42.4%) 200 (52.9%)	1.529	1.038-2.252	**0.031**
Short Maternal Height Yes (Height < 150 cm) No (Height ≥ 150 cm)	82(67.2%) 174(44.3%)	40 (32.8%) 219 (55.7%)	2.580	1.683-3.955	**0.000**
ANC Frequency Inadequate (ANC < 6 times) Adequate (ANC ≥ 6 times)	58(53,3%) 203(50.1%)	58 (30,0%) 202 (49.9%)	0.99	0.659-1.504	0.980
Reading maternal and child health booklet No Yes	67(56.3%) 174(47.1)	52 (43.7) 209 (51.9%)	1.388	0.920-2.095	0.118
History of Hyperemesis Yes No	125(53.0%) 131(48.7%)	111(47.0%) 138(51.3%)	1.186	0.836-1.683	0.339
Maternal Weight Gain During Pregnancy Inadequate	166(53.2%)	146(46.8%)	1.460	1.022-2.085	**0.037**
Adequate	88(43.8%)	113(56.2%)			
Maternal History of Hospitalization During Pregnancy Yes No	21(60.0%) 240(49.6%)	14(40.0%) 245(50.4%)	1.531	0.761-3.081	0.230
Number of Children					
>2 Children	75(53.6%)	65(46.4%)	1.216	0.825-1.793	0.323
1-2 Children	185(48.7%)	195(51.3%)			
Pregnancy Interval At Risk (< 2 years or >10 years) Not at risk (2-10 years)	33(52.4%) 219(50.3%)	50(61.0%) 216(49.7%)	1.085	0.639-1.841	0.763

Tabel 5. Parental Factors as Risk Factor for Stunting

Varible	Coefficient	OR	CI 95%		p*
			Lower	Upper	
Short Maternal	.957	2.604	1.688	4.016	.000
Non-routine consumption of iron (F_e) Tablets	.467	1.631	1.072	2.482	.012
Inadequate maternal weight gain during pregnancy	.387	1.473	1.063	2.377	.039
Constant	-2.858	.057			.000
R Square	0.080				

**Regresi logistic*

The results of logistic regression analysis indicated that prenatal variables that the risk factors for stunting in the model include irregular consumption of iron (Fe) tablets, short maternal height, chronic energy deficiency (CED) during pregnancy, and inadequate maternal weight gain during pregnancy. Pregnant women who do not routinely consume Fe tablets were 1.61 times more likely to have a stunted child compared to those who take Fe tablets regularly. The variable with the greatest contribution to stunting was maternal height. Short mothers (height <150 cm) were 2.68 times more likely to have a stunted child compared to taller mothers (height ≥150 cm). Pregnant women with CED (upper arm circumference <23.5 cm) had a 1.631 times higher risk of having a stunted child compared to those without CED. Mothers with more than one child were also 1.59 times more likely to have a stunted child compared to mothers with only one child.

DISCUSSION

In this study, short maternal stature was the strongest determinant of stunted growth. The short stature mothers (<150 cm) have a 2.68 times risk to have stunted children than the tall mothers (≥150 cm). Short mothers (<150 cm) are associated with stunting via some epigenetic and intrauterine environmental pathways. Epigenetic events during the growth period of the mother of chronic malnutrition can result in epigenetic changes that will be transferred to the offspring, influencing growth. Children of mothers with childhood starvation may inherit 12 DNA methylation changes. A study of more than 200 daughters born to Dutch women pregnant during the 1944 -1945 famine indicated that these daughters experienced reduced DNA methylation levels, an increased risk for disease and possibly changed gene activity in subsequent generations that resulted in stunting[14,15].

Multinational cohort study by Addo et al. of 7,630 subjects from five developing countries (Brazil, Guatemala, India, the Philippines, and South Africa) confirmed that maternal height was a significant determinant of child linear growth (PR = 3.20; 95% CI: 2.80-3.60; p=<0.0001).[15] The etiology of stunting is complex and multifactorial, due to not only genetic but also an interplay of nutritional status, exposure to infections, and socioeconomic determinants. Stunting not only impairs growth, but also associated with body development. Empirical evidence has shown that children born to mothers with a history of chronic malnutrition were more likely to become stunting[13].

The result of this analysis shows that mothers who experienced inadequate weight gain during pregnancy were 1.47 times higher at risk of having stunted children compared to mothers who had adequate weight gain. Maternal gestational weight gain being suboptimal or excessive can influence stunting in children possibly through several interrelated mechanisms like intrauterine growth, birth weight and postnatal nutritional status.

Poor gestational weight gain is commonly related to insufficient maternal nutrition and is a risk factor for intrauterine growth restriction (IUGR). Low birth weight (LBW) is known to be related to Intrauterine growth restriction (IUGR) and this condition estimated contribute to 32% of the stunting among children[16].

Maternal weight gain is commonly associated with targeted nutritional status; inadequate maternal weight gain can decrease the potential supply of vital nutrients for fetal growth and development. Maternal malnutrition or insufficient nutrient supply during gestation increases the risk of growth retardation in offspring, which could appear during various developmental stages. Poor supply of nutrition results deficiency of placental growth and the perfusion which causes hypoxia to the fetus[17]. Maternal lack of energy and protein may suppress synthesis of an important fetal growth hormone[18]. Malnutrition enhances oxidative stress and inflammation which in turn can add another factor to the poor fetal growth[16]. Micronutrient deficiency of Iron, folate acid, and zinc can have an impact on metabolism, placental function, and fetal growth[8.] Insufficient gains in weight had been linked to preeclampsia resulting in altered blood flow to the fetus and IUGR[19].

Insufficient weight gain during gestation is generally associated with maternal malnutrition, contributing to intrauterine growth restriction (IUGR). IUGR Intrauterine growth restriction (IUGR), which is associated with low birth weight (LBW), is estimated to contribute to 32% of stunting cases in children[16]. Inadequate maternal weight gain is closely linked to suboptimal nutritional status, potentially limiting the availability of essential nutrients for fetal growth and development. Insufficient maternal nutritional intake during gestation increases the risk of growth issues in offspring that may manifest throughout developmental stages. Inadequate nutrition intake insufficiency the placental growth and the blood flow leading to lack of oxygen to the fetus[17]. Maternal energy and protein deficiency may reduce the production of growth hormone playing a crucial role in the fetal development[18]. Malnutrition increases oxidative stress and inflammation contributing to the poor fetal growth[16]. Deficiency in micronutrients such as Iron, folate acid, dan zinc can affect the metabolism, placental function dan fetal growth[8]. Inadequate weight gain has been associated with preeclampsia leading to the disturbance of blood flow to the fetus and IUGR[19].

Excessive maternal gain also matters for stunting. Mothers may be overweight, but an imbalanced diet or diet dominated by low-nutrient processed foods may result in nutrient deficiencies[17]. Gaining too much weight during a pregnancy increases the risk of complications such as gestational diabetes and hypertension that can affect the fetus's health and growth[19]. These complications may compromise uteroplacental perfusion and transportation of nutrients to the fetus, and ultimately challenge growth in the uterine environment[13].

According to a study by Gonete, mothers with gestational diabetes had a higher risk of giving birth to children at risk of growth problems, including stunting[14]. Obese mothers have higher levels of body fat, which can alter fetal metabolism and cause inflammation[20]. Chronic inflammation impairs placental function, alters blood flow and damages the maternal-fetal interface, resulting in IUGR. chronic inflammation can impair the placenta's function and affect transfer of blood flow and nutrients to the fetus, which causes IUGR[21]. An environment of excess glucose and fat can impair normal fetal growth, resulting in IUGR and low birth weight (LBW)[22].

Excess fat can cause the levels of pro-inflammatory cytokines in the circulation of mother and placenta to increase. Maternal obesity has been shown to increase inflammation associated cytokines like TNF-α and IL-6, contributing to chronic placental inflammation that alters placental function, including reduced blood flow and the capacity for the fetus to receive nutrients[23,24]. Mitochondrial function in human placental trophoblast cells may be impaired by oxidative stress from excess body fat. Lipid levels are positively correlated with reactive oxygen species (ROS) generation, resulting in placental dysfunction, cellular damage, placental-hypoperfusion, and nutrient transfer impairment to the fetus, according to research by Liang et al. (2021)[24,25,26].

Studies by Reynolds et al. and Zhou et al. reported that a high-fat diet leads to increased accumulation of lipids in the placenta, which affects its structure and normal function, involving decreased placental blood supply and transport/co-transport of basic nutrients including glucose and fatty acids to the fetus[25,26]. Also, excessive fat may lead to structural modifications of the khan17placenta, including increased trophoblast interhemal membrane thickness that decreases substrate transfer, most notably passive apical-to-basolateral diffusion of solutes such as oxygen, leading to limited fetal growth[25].

The analysis in this study indicates that pregnant women who do nonroutine consume iron tablets have a 1.61 times greater risk of giving birth to stunted children. Iron tablets help increase hemoglobin (Hb) levells, a vital component of red blood cells essential for oxygen transport to body tissues. This finding aligns with a cohort study by Nisar et al. of 5,235 samples, reporting that iron supplementation of 90 tablets before six months of pregnancy significantly reduced stunting risk by 33% (aRR = 0.77; 95% CI = 0.64-0.92 ; 0.002) and increased birth weight[26]. Haider et al. also confirmed the significance of prenatal iron supplementation in increasing birth weight and reducing LBW[27]. Iron deficiency can induce maternal anemia, reducing oxygen transport capacity to the fetus and hindering optimal development, including cognitive and motor growth linked to physical growth[26]. Another study in New Delhi India also reported that iron supplementation during pregnancy is important because it affects the iron profile of the newborn[28].

While postnatal factors such as environmental enteropathy and complementary feeding habits have a greater influence on longitudinal child growth, maternal anemia may limit intrauterine growth. Stunting and anemia did not significantly correlate, according to this study. In contrast, anemic pregnant women had a 5.19-fold increased chance of giving birth to stunted newborns compared to non-anemic mothers (OR = 5.19; 95% CI = 1.69-15.99; p = 0.002) in a Surakarta research included 184 mother-newborn pairs[27]. Since not all kids born to anemic moms would experience growth retardation, anemia is not linked to the incidence of stunting in this study. Their ability to withstand environmental pressures will determine this. Environmental enteropathy and postnatal supplemental feeding are more important factors in determining longitudinal growth [25].

The Primary health care (PHC) programs for stunting prevention involves monitoring iron tablet consumption, dietary intake, and regularly measuring the mother's weight to ensure weight gain during pregnancy aligns with WHO standard recommendations. During the first antenatal care (ANC) visit, if a pregnant woman is found to have short stature, supplementary feeding (PMT) should be provided, along with education promoting a healthy diet rich in protein, energy, and balanced nutrients. Micronutrient supplements, such as iron, folic acid, and calcium, are given to meet the nutritional needs of pregnant women.

The intervention also tracks weight gain in pregnancy to prevent low birth weight, ensured consistent and quality antenatal checkups to detect complications early (so they can be managed), and make interventions to control infectious and non-communicable diseases that could interfere with fetal growth. These centers provide health education and counselling to promote the practices of good pregnancy care

The stunting prevention programs from PHC include monitoring the consumption of iron tablets, food intake, and periodic maternal weight monitor in order to maintain the weight gain according to WHO recommendations. It is important to note that PHC need to establish specific programs aiming pregnant women of short stature along with their children for preventive measure of stunting.

CONCLUSION

In conclusion, the dominant prenatal risk factors for stunting in children aged 12-24 months in Central Java included short maternal stature, irregular iron tablet consumption, maternal weight gain, and upper arm circumference (Lila) <23.5 cm. Maternal anemia, ANC frequency, and maternal behaviors, such as reading health books, were not risk factors for stunting in children aged 12-24 months in Central Java.

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Conflicts of Interest:

None

Ethical clearance

Health Research Ethics Committee of the Faculty of Public Health, Diponegoro University No. 203/EA/KEPK-FKM/2023..

Authors's contribution

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