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Association Between the History of Maternal Nutritional Status in the First Trimester and Stunting: A Case-Control Study in Indonesia

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Abstract

Background: This study aimed to analyze the association between maternal nutritional status during the first trimester of pregnancy and the incidence of stunting among infants aged 0–24 months in the working areas of Jember Regency Community Health Centers.

Materials and Methods: A retrospective case-control design was employed, involving 104 families. Participants included 52 families in the case group (infants with stunting) and 52 in the control group (infants without stunting), selected via stratified random sampling from three sub-districts prioritized for stunting reduction. Maternal nutritional status was evaluated using historical Mid-Upper Arm Circumference (MUAC) records extracted from Maternal and Child Health (MCH) books, an approach that effectively minimized recall bias.

Results: Chi-square analysis ($p<0.05$) revealed that 71.15% of mothers in the case group had a MUAC <23.5 cm during their first trimester, whereas 57.69% in the control group had a normal MUAC (≥23.5 cm). A significant association was found between first-trimester maternal nutritional status and stunting ($p=0.003$; OR=3.364; 95% CI=1.490–7.591).

Conclusion: Maternal nutritional status during the first trimester is significantly associated with infant stunting. Mothers experiencing malnutrition during this critical period have a 3.36 times greater risk of having stunted infants compared to well-nourished mothers.

Key Words: Aged 0–24, First trimester, Infants, Maternal nutritional status, Stunting.

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1- INTRODUCTION

Indonesia has the third highest incidence of stunting cases in Southeast Asia (1). On a global scale in 2023, it was found that 22.3% or about 148.1 million children under the age of 5 experienced stunting (2). Meanwhile, the stunting rate in Indonesia reached 21.5% based on the 2023 Indonesia Health Survey data (3). In 2023, the prevalence of stunted children under five in East Java reached 17.7% (3). Jember became the third region with the highest number in East Java, with a stunted prevalence of 29.7% (3). The preliminary study results from 3 sub-districts included in the acceleration locations for reducing stunting in Jember showed stunting prevalence data of 13.80% in Rambipuji, 13.16% in Sumberjambe, and 9.53% in Ledokombo.

Stunting is a condition of delayed growth in children due to poor eating patterns and recurrent infections (4, 5). Dysfunction in family roles, such as a lack of nutrition knowledge and low income, becomes a significant risk factor for the occurrence of stunting as it hinders the fulfillment of nutrition and access to health services (6, 7). The first 1000 days of life, encompassing the period from pregnancy to the first two years of a child's life, are critically influenced by the nutritional status of the mother during this time, which is vital for the growth and development of the fetus (8, 9). During the gestational period of 0–20 weeks, adequate intake of protein and micronutrients is essential for the development of the fetus's height and brain cells, which reach 70–80% of the maximum total brain cells (9). Nutritional deficiencies in pregnant women, especially in the first trimester, can lead to fetal formation disorders in the following trimester (10).

Malnutrition during pregnancy can lead to Chronic Energy Deficiency (CED), characterized by an imbalance in energy and protein intake and inadequate iron levels (11). The risk of CED in pregnant women is assessed using the Mid-Upper Arm Circumference (MUAC) indicator, with a threshold of less than 23.5 cm (Ministry of Health of the Republic of Indonesia, 2023). According to the 2023 SKI data, the prevalence of pregnant women at risk of CED with MUAC <23.5 cm in East Java was 19.6% (3). In Jember Regency, the prevalence of CED among pregnant women was reported at 13.8% in 2023 (Jember District Health Office, 2023). CED is associated with increased risks of preterm birth, low birth weight (LBW), stunting, maternal anemia, and neonatal mortality (12). Considering these issues, this study aims to investigate the relationship between maternal nutritional status during the first trimester of pregnancy and the incidence of stunting among children aged 0–24 months in the Puskesmas areas of Jember Regency.

2- MATERIALS AND METHODS

2-1. Sample and Study Participants

This case-control study involved 104 infants aged 0–24 months living in the working area of Puskesmas Rambipuji, Ledokombo, and Sumberjambe. Participants were selected using a stratified random sampling method and categorized into two groups: the case group consisting of 52 infants with stunting conditions, and the control group consisting of 52 infants without stunting conditions. This study includes families with infants aged 0–24 months living in the operational areas of Puskesmas Rambipuji, Sumberjambe, and Ledokombo in Jember Regency. For the case group, participants are mothers with stunted infants aged 0–24 months registered at the local posyandu and having a Mother and Child Health book (KIA). The control group consists of mothers with non-stunted infants who meet the same registration and documentation criteria. Additional exclusion criteria were strictly applied; subjects were excluded if the infant was severely ill, belonged to a

multiple birth (such as twins or triplets), if the mother had chronic diseases impacting the pregnancy, or if the family refused to participate in this study. A detailed flow diagram illustrating participant selection and exclusions according to STROBE guidelines is provided (Figure 1).

2-2. Data Collection

The research was conducted by collecting data in the form of the socio-demographic conditions of mothers and infants using a respondent characteristic questionnaire, measuring the nutritional status of pregnant women in the first trimester obtained through the MUAC history recorded in the Maternity and Child Health (KIA) book during the first trimester. Because the MUAC data were retrospectively extracted from standardized Maternal and Child Health (MCH) books—which are routinely measured and recorded by trained healthcare professionals using standard MUAC tapes—the risk of recall bias was significantly minimized, ensuring the measurements aligned with clinical standards. The anthropometry of infants was measured using a length board and a digital baby scale, Onemed Model: OD231B. The data from the anthropometric measurements were then collected and inventoried along with several samples that had been calculated, to be subsequently entered into the WHO Anthro application for classification according to the nutritional status categories of infants.

2-3. Research Ethics

This research has passed the ethical feasibility test at the Research Ethics Commission (KEPK), Faculty of Nursing, University of Jember, with No. 298/UN25.1.14/KEPK/2025.

2-4. Data Analysis

The analytical method used in this study was the Chi-square statistical test, performed using SPSS version 25. This test was selected because both variables in the study are categorical, with a significance level set at p-value < 0,05. To evaluate the crude association, bivariate analysis was utilized. However, multivariable analysis to systematically control for confounding socioeconomic and demographic variables—such as maternal education, household income, maternal age, and infant sex—was not performed, which is formally acknowledged as a study limitation.

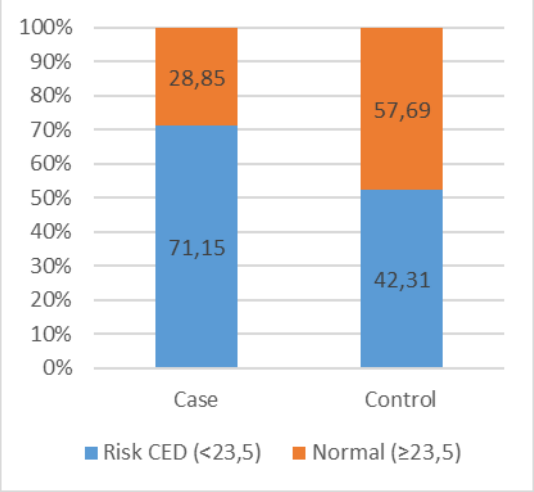

Figure-1: Distribution of mid-upper arm circumference history in pregnant women in the first trimester.

3- RESULTS

The results show that mothers in the case group have an average age of 26.5 years and a median of 25 years. The majority are housewives (75%) and have family incomes below the minimum wage in Jember (86.5%). Maternal education is predominantly junior high school graduates or equivalent (42.3%), with 5.8% not having formal education. Infants in this group have a median age of 15 months and an average of 14 months, with the majority being male (65.4%). In the control group, mothers had an average age of 27 years with a median of 26.5 years. The majority were not employed (71.2%), and most had an income above the Jember minimum wage (55.8%). The education of the mothers was predominantly high school graduates or equivalent (44.2%), and all had received formal education. The infants in this group had a median age of 12.9 months and an average of 13.9 months, with the majority of infants being male (48.1%).

Table 2 shows a significant difference in the median LiLA values between the case group (22.5 cm) and the control group (24.75 cm) based on the Mann-Whitney test ($p = 0.001$). These results indicate a relationship between the LiLA of mothers and the nutritional status of their children. The distribution of the prevalence of LiLA among pregnant mothers in the first trimester in the areas of Rambipuji, Ledokombo, and Sumberjambe is displayed in Figure 1.

Table-1. Demographic characteristics of families.

Variable	Case (n=52)	Control (n=52)	Total (n=104)
Mother's age (years)			
Md (P_{25}-P_{75})	25(21-31)	26,5(22-29)	26 (22-30)
M (SD)	26.5(5.69)	27(5.13)	26.63 (5.38)
Occupation (f %)			
Housewife	39(75)	37(71.2)	76 (73.1)
Laborer	0(0)	0(0)	0 (0)
Farmer	2(3.8)	6(11.5)	8 (7.7)
Entrepreneur	11(21.2)	9(17.3)	20 (19.2)
Civil Servant	0(0)	0(0)	0 (0)
Monthly Income (f %)			
< Regency Minimum Wage Jember Rp. 2.838.642,00	45(86.5)	23(44.2)	68 (65.4)
≥ Regency Minimum Wage Jember Rp. 2.838.642,00	7(13.5)	29(55.8)	36 (34.6)
Last Education (f %)			
No Formal Education	3(5.8)	0(0)	3 (2.9)
Elementary School	13(25)	9(17.3)	22 (21.2)
Junior High School	22(42.3)	16(30.8)	38 (36.5)
Senior High School	14(26.9)	23(44.2)	37(35.6)
Diploma or Bachelor's degree	0(0)	4(7.7)	4 (3.8)
Infant's age (months)			
Md (P_{25}-P_{75})	15(7-20)	12(9-16)	13 (9-17)
M (SD)	14(6.78)	12(4.46)	12 (15.76)
Infant's Gender (f %)			
Male	34(65,4)	25(48,1)	59 (56.7)
Female	18(34.6)	27(51.9)	45 (43.3)
Stunting Incidence (f %)			
Stunting	52(100)	0(0)	52 (50)
Normal	0(0)	52(100)	52 (50)

The results indicate that the prevalence of pregnant women in the first trimester with a MUAC <23.5 cm (risk of chronic energy deficiency) is higher in the case group (71.15%) compared to the control group (42.31%). Conversely, mothers with MUAC ≥23.5 cm (normal category) were fewer in the case group (28.85%) compared to the control group (57.69%).

The median height of infants in the case group (71.75 cm) was found to be shorter compared to the control group (75 cm). Significant differences were observed in height, weight, and the height for age (HFA) and weight for age (WFA) indices ($p < 0,05$), but no significant differences were found in the weight per height (WHZ) and body mass index for age (BFA) indices ($p > 0,05$) (Table 3). The distribution of infant nutritional status in the case group is shown in Figure 2.

Table-2. Nutritional status distribution of pregnant women in the 1st trimester.

Variable	Case (n=52)			Control (n=52)			Total (n=104)
	Md(P_{25}-P_{75})	Z	P-value[a]	Md(P25-P75)	Z	P-value[a]	P-value[b]
Maternal MUAC History in the 1st Trimester	22.5 (21 – 23.5)	0.396	0.000	24.75 (21.5 - 29)	0.362	0.000	0.001

Table-3. Distribution of nutritional status of infants aged 0-24 months.

Variable	Case (n=52)			Kelompok Control (n=52)			Total (n=104)
	Md (P_{25}-P_{75})	Z	P-value[a]	Md(P_{25}-P_{75})	Z	P-value[a]	P-value[b]
Body Length	71.75 (62.175-75.84)	0.145	0.008	75 (70.05-78.95)	0.097	0.200	0.003
Body Weight	8.18 (6.725-9.065)	0.111	0.148	9.33 (8.19-9.8)	0.106	0.200	0.001
Nutritional Status							
HFA	-2.73 (-3.13 – -2. 48)	0.083	0.200	-0.36 (-1.02 – 0.22)	0.066	0.200	0,000
WFA	-1.76 (-2.17 – -1.35)	0.070	0.200	-0.18 (-1.04 – 0,39)	0.110	0.163	0.000
WHZ	0.03 (-1.09 – 0.62)	0.161	0.002	0.4 (-1.07 – 0.5)	0.137	0.016	0.848
BFA	-0.5 (-0.64 – 0.6)	0.102	0.200	0.08 (-1.02 – 0.53)	0.149	0.006	0.545

Note: HFA: Height for age; **WFA:** Weight for age; **WHZ:** Weight per height; **BFA:** Body mass index for age

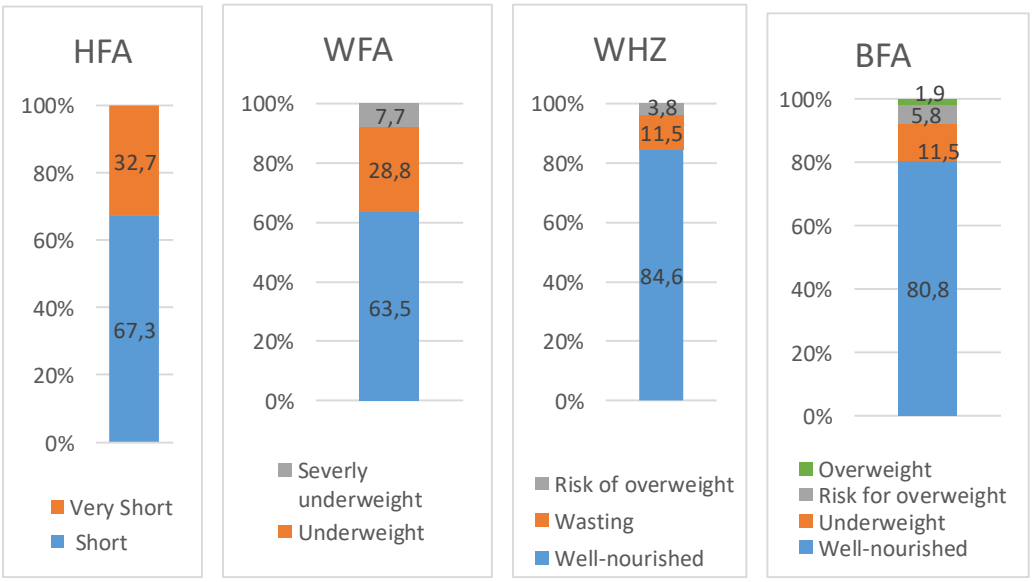

Figure-2: Nutritional status distribution of infants in the case group (n=52).

The results showed that all infants in the case group experienced stunting based on the height-for-age index. The majority had normal weight (63.5%), and most fell into the good nutritional category according to the weight-for-height index (84.6%) and the BMI-for-age index (80.8%). The distribution of the nutritional status of infants in the control group is displayed in Figure 3**.**

Figure 3 shows that all infants in the control group fall into the normal category based on the HFA index (100%). Most infants have a normal weight (88.5%), and the majority are classified as well-nourished according to the WHZ and BMI/U indices, with the same percentage (82.7%).

The results indicate that pregnant women with a history of nutritional risk are more prevalent in the stunted baby group (71.15%) compared to the non-stunted baby group (42.31%). The Chi-square test results show a significant relationship between the nutritional status history of pregnant women in the first trimester and the incidence of stunting in infants aged 0-24 months in Jember Regency (p-value = 0.003). The odds ratio (OR) calculation of 3.364 with a 95% confidence interval (1.490 - 7.591) indicates that mothers with a history of nutritional risk in the first trimester of pregnancy are 3.36 times more likely to give birth to a stunted child compared to mothers with a good nutritional status history during the first trimester of pregnancy (Table 4).

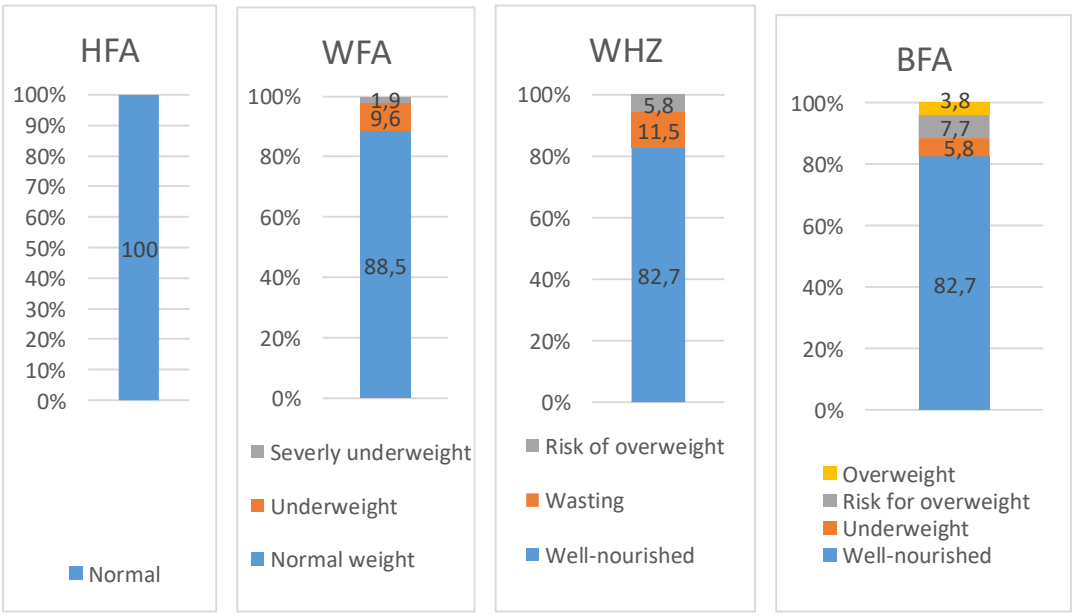

Figure-3: Nutritional status distribution of infants in the control group (n=52).

Table-4. Analysis of the relationship between maternal nutritional status during the first trimester and the incidence of stunting in infants aged 0-24 months in Jember Regency (n=104).

Maternal Nutritional Status 1st Semester	Stunting Incidence				χ^2	P-value	OR	95% CI
	Stunting		Normal					
	f	%	f	%				
Risk for CED	37	71.15	22	42.31	8.814	0.003	3.364	1.490 – 7.591
Normal	15	28.85	30	57.69				

Note: OR: Odds Ratio; **95% CI:** Confidence Interval

4- DISCUSSION

Research findings indicate that the majority of stunted infants in the case group were born to mothers with poor nutritional status during the first trimester, marked by a MUAC of <23.5 cm (71.15%). This condition is associated with low maternal education, with most having only graduated from junior high school (42.3%) and some not having received formal education (5.8%) (13, 14). Low education levels influence nutritional knowledge, thereby affecting nutritional intake during pregnancy. Additionally, the majority of mothers in the case group were unemployed (75%) and earned below the regional minimum wage of Jember (86.5%), further hindering their nutritional needs (15). These factors indicate a failure in family care and economic functions, leading to an undetected risk of CED in mothers and increasing the likelihood of their infants experiencing stunting.

Different results were found in the control group, where the majority of infants with normal nutritional status were born to mothers with an upper arm circumference (LiLA) ≥23.5 cm (57.69%) and higher educational backgrounds, primarily high school graduates (44.2%) and some university graduates (5.8%). Good nutritional knowledge enables mothers to maintain their nutritional intake during pregnancy, even when experiencing disturbances such as nausea and vomiting (13, 16). Although there were mothers with a risk of chronic energy deficiency (CED) (42.31%) in this group, the infants did not experience stunting, likely influenced by other factors such as higher family income (≥ minimum wage, 55.8%), which contributes to meeting the nutritional needs of pregnant mothers (15).

Research results indicate that all infants in the case group experienced stunting, which is a chronic growth disorder in infants due to inadequate nutritional intake (17). The role of the family is crucial in preventing stunting, especially during the first 1000 Days of Life (HPK). However, the majority of infants in the case group come from families with an income below the regional minimum wage in Jember (86.5%), which indicates that economic limitations are a risk factor for stunting due to the inability to meet nutritional needs from pregnancy. In contrast, all infants in the control group were classified as normal based on height-for-age, with most having good nutritional status according to weight-for-age, height-for-weight, and body mass index-for-age indices. This is supported by the majority of families having an income equal to or above the regional minimum wage in Jember (55.8%), allowing for optimal fulfilment of nutritional needs for mothers and children (18). Therefore, improving the quality of nutritional intake for infants aged 0–24 months is essential to support optimal growth and prevent prolonged stunting.

The results of the analysis show a significant relationship between the nutritional status of pregnant women in the first trimester and the incidence of stunting in infants aged 0–24 months in Jember Regency ($p = 0.003$). Mothers with poor nutritional status (mid-upper arm circumference <23.5 cm) are 3.36 times more likely to give birth to stunted infants compared to mothers with good nutrition (upper arm circumference ≥23.5 cm), with 71.15% of stunted infants born to undernourished mothers and 57.69% of normal infants born to well-nourished mothers. The WHO (2016) states that maternal malnutrition from pre-conception to breastfeeding is a risk factor for stunting (19). Nutritional deficiencies during pregnancy disrupt fetal growth and increase the risk of stunting (20). Families play an important role in fulfilling the nutritional needs of pregnant mothers through decision-making support and economic functions (21). Thus, optimal

nutritional fulfillment during pregnancy becomes a crucial strategy in preventing stunting.

The results of the study showed that the nutritional status of pregnant women in the first trimester was significantly associated with the incidence of stunting in infants aged 0–24 months. Pregnant women with a LiLA <23.5 cm had a greater risk of giving birth to stunted babies compared to mothers with a LiLA ≥23.5 cm. The study findings indicate that many mothers still experience malnutrition during pregnancy, especially in the first trimester, which results in stunted babies being born. Therefore, intervention efforts are needed to monitor and improve the nutritional status of pregnant women from the first trimester, both through integrated health service posts (Posyandu), antenatal care services, and nutrition education by health workers (22–24). Families as companions of mothers need to be directly involved to increase knowledge and attention to maternal nutritional intake during pregnancy, especially from the beginning of pregnancy, to prevent stunted babies (25–27).

4-1. Study Limitations

This study possesses several limitations that should be carefully considered when interpreting the findings. First, while utilizing historical secondary data from MCH books effectively minimized recall bias, the accuracy of the data relies entirely on the precision of the initial healthcare providers who recorded the MUAC measurements. Second, the statistical analysis was restricted to bivariate Chi-square tests; multivariable logistic regression was not performed to systematically adjust for potential confounding socioeconomic and demographic variables—such as maternal education, household income, maternal age, and infant sex. Finally, due to sample size constraints, subgroup analyses stratified by specific infant age ranges were not conducted. Future research employing larger sample sizes and multivariable analytical models is recommended to address these methodological gaps.

5- CONCLUSION

This case-control study shows that the nutritional status of pregnant women in the first trimester is significantly related to the incidence of stunting in infants aged 0–24 months. Pregnant women with a MUAC of <23.5 cm have a higher risk of giving birth to stunted infants compared to those with a MUAC of ≥23.5 cm. The findings of this study indicate that many mothers still experience malnutrition during pregnancy, especially in the first trimester, which results in stunted children. Thus, there is a need for intervention efforts to monitor and improve the nutritional status of pregnant women from the first trimester, through programs such as integrated health post services, antenatal care, and nutritional education by health workers. Families, as companions to mothers, need to be directly involved to enhance knowledge and attention to the nutritional intake of mothers during pregnancy, especially from the early stages, to prevent infants from being born stunted.

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