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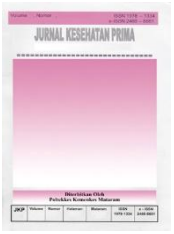

Maternal Height, Maternal Education Level, and Occurrence of Stunting in Families with Overweight or Obese Mothers

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Abstract

Background: Stunting can affect brain development, physical growth, and metabolism, while obesity can increase the risk of hypertension, coronary heart disease, and type 2 diabetes. Maternal and family characteristics may influence obesity in mothers paired with stunting in children in the same household. This study examines the relationship between maternal and family characteristics and the occurrence of stunting in families with overweight or obese mothers in Semarang. Methods: This study used an observational, cross-sectional design. The sample was selected using purposive sampling, with 25 subjects per group, resulting in a total of 50 subjects across the two groups. Data on maternal and family characteristics were obtained through interviews using a validated questionnaire. Anthropometric measurements were conducted to obtain data on the weight, height, and nutritional status of mothers and children. Bivariate analysis used the Chi-square test to examine the odds ratio, while multivariate analysis employed multiple logistic regression. Results: Bivariate analysis showed that the adequacy of energy and carbohydrate intake in toddlers and the maternal education level were significantly associated with stunting occurrence among households with an overweight/obese mother (SCOWT/SCOM). Multivariate analysis showed that the maternal height and education level were significantly associated with SCOWT/SCOM. Mothers with short stature had a 4.613 times higher risk, and mothers with primary to secondary education had an 8.205 times higher risk of SCOWT/SCOM. Conclusion: Maternal height and educational level are key factors in cases of stunted growth with SCOWT/SCOM.

Keywords: Maternal characteristics; Family characteristics; Stunted Children with Overweight/Obese Mothers (SCOWT/SCOM)

INTRODUCTION

Double Burden Malnutrition (DBM) is an increase in the obesity rate, but malnutrition is still a health issue due to globalization. The globalization process has contributed to a sedentary lifestyle with low activity rate and high-calorie intake (Astuti Nur et al., 2020). Obesity is an excess of body fat due to an imbalance of energy intake and output. This condition is marked with a BMI value (Body Mass Index) of > 24,9 kg/m2 according to WHO (World Health Organization) and ≥ 23 kg/m2 according to the Asia Pacific. According to basic health research data in 2018, the prevalence of obesity among women aged > 18 years and above in Indonesia was 29,3%, while in Central Java, it was 27,5% (Kementerian Kesehatan, 2018). Obesity can cause hypertension, coronary heart disease, stroke, and even type 2 diabetes mellitus. Based on some research, an obese mother affects neonatal mortality and morbidities such as stillbirth, congenital anomaly, premature birth, and Low Birth Weight (LBW) (McDonald et al., 2010; Mosha et al., 2021) These impacts might become stunting predictors.

Stunting is when toddlers have less height than their expected age due to a lack of nutrition intake in the long term (Rahmadhita, 2020). This condition is marked with a height age z-score value < - 2 (Standar Antropometri Anak, 2020). Stunting may affect brain development, intelligence, body growth, and metabolism. According to SSGBI (Studi Status Gizi Balita di Indonesia), in 2019, the national prevalence of stunting was 27.3% and 27.2% in Central Java (Kemenkes RI, 2019). Based on the 2021 survey by the Semarang City Health Office, the prevalence of stunting was 3.10%, affecting a total of 1367 toddlers (Dinas Kesehatan Kota Semarang, 2023).

An overweight/obese mother with a stunted child is one of four malnutrition classifications in a household environment known as children with stunting and overweight/obese mothers. The prevalence of Stunted Children with Overweight/Obese Mothers (SCOWT/SCOM) varies in some countries; research in Myanmar in 2021 showed 32,7 prevalence (Hong, 2020). In Mexico, in 2021 was 53,3% (Félix-Beltrán et al., 2021). Research in Indonesia, which was urban-based, showed a 24,7% prevalence (Mahmudiono et al., 2018). Other research in Surabaya, Indonesia, in 2021 showed a 28% prevalence (Rachmah et al., 2021).

The cause is inseparable from the mother and family characteristics. According to some research, a maternal characteristic, such as a maternal height < 150 cm, is seven times riskier to have a stunted child due to the maternal limited organs (Agustin & Rahmawati, 2021; Wanimbo & Wartiningsih, 2020). Mother age (<20 years old and > 35 years old) was considered risky because of the nutritional competition between the mother and the future baby, which affects the child's linear growth (Wanimbo & Wartiningsih, 2020). Low knowledge and education level of a mother affect choices of dietary habits, attitude, and behavior in choosing food to eat (Dewi et al., 2017; Géa-Horta et al., 2016; Pramudyat et al., 2017; Sineke et al., 2019). Employed mother affects income, family economics, and parenting (Agustin & Rahmawati, 2021).

According to research, family characteristics such as low family income might cause low purchasing power, which results in buying cheap and low-protein food. Poor environmental sanitation has the potential to cause infection, which leads to stunting(Astuti et al., 2020). Family member ≥ 4 people is four times riskier of hunger, five times riskier of malnutrition, and uneven food distribution; besides that, available food becomes undiversified, which causes obesity and stunting (Dinas Kesehatan Propinsi Jawa Tengah, 2019). Poor access to health facilities leads to public health indifference, which results in obesity and stunting phenomena (Ciptanurani & Chen, 2021; Demment et al., 2014; Sartika, 2010).

Based on the explanation above, it was known that the effects of stunting on children of obese/overweight mothers were problems that require attention, especially in the mother and family factors. Although studies have addressed the relationship between maternal and family characteristics with stunting in various regions, specific investigations focusing on the stunting risks among children of overweight/obese mothers in urban settings like Semarang City remain limited. This research aims to analyze the relationship between maternal and family characteristics and the occurrence of stunting in families with overweight or obese mothers in Semarang.

METHOD

Study Design, Setting, and Duration of Study

This research was in the field of public health and belonged to analytical observational research using a cross-sectional design and was carried out from November 2022–January 2023 in Semarang City.

Population and Subjects

The selection of subjects was based on the prevalence of the newest stunting data in Semarang city as well as on geographic data of Semarang city. The hilly area in Banyumanik covered Srondol, Ngesrep, and Padangsari public health centers, Tembalang area covered Rowosari public health center. The Central area covers central Lamper, Kedungmundu, Candi lama, Miroto, and Miroto public health centers, and the coastal area covers Bandarharjo, Karangdoro, and Bugangan. The total is nine public health centers.

The subject selection used purposive sampling. Subjects were selected based on age and gender before being assigned to either the group of children with stunting and overweight/obese mothers (SCOWT/SCOM) or the group of normal children with overweight/obese mothers (NCOM). The research subject equation used a paired equation, with dropout estimation (Sastroasmoro & Ismael, 2014). The calculated minimum sample size was 25 per group with a total of 50 subjects (Z_α = 1,96; Z_β = 0,842; R from related studies 3,882)(Agustiningrum & Rokhanawati, 2016).

The target population was mother and toddler pairs with the Double Burden of Malnutrition condition in Semarang City. The population of normal and stunted toddlers in the range of 6-36 months with overweight/obese mothers in Semarang City. Included criteria for toddlers were in the range of 6-36 months with body height or length of <- two z-score (stunting) or -2 to + 3 SD (normal), and not having any chronic infection (2 weeks). The inclusion criteria for mothers were mothers with a BMI of ≥ 23 kg/m2 who could communicate and were willing to be research subjects through an informed consent agreement. Exclusion criteria were pregnant mothers, change of address, resignation, or passing away. One hundred stunted children were identified from data from the Semarang City Health Office (located in nine community health centers). These children were then screened to identify obese mothers. Obese mothers with normal weight children were determined by measuring the mothers' BMI after screening normal children at three integrated health posts with the largest populations in the community health center area.

Variables

The dependent variable in this study was the occurrence of stunting in families with overweight/obese mothers. The independent variables in this study were maternal and family characteristics. The confounding variable in this study was macronutrient adequacy in children.

Data Collection and Measurements

Data collection was done through an interview based on the arranged questionnaire. Mother's age was categorized as risky if < 20 or> 35 years old (Hastuty, 2021). Mother's education level was categorized into basic and moderate level if they graduated from Elementary School, Junior High School, and Senior High School, and categorized as high if they graduated from a University (Pemerintah RI, 2013; Presiden RI, 2003). A family is big if there are > 4 members and small if ≤ 4 members (Illahi, 2017). Mother's occupation was categorized into employed and unemployed mothers (Adla et al., 2022). Anthropometric measurements were conducted to obtain data on the weight, height, and nutritional status of mothers and children. Maternal height was measured using a microtoise and categorized as short stature if < 150 cm (Manggala et al., 2018). Nutrition-related knowledge includes the importance of breastfeeding, feeding guidelines, and obesity prevention. This data was obtained through a validated questionnaire with a p-value < 0.005. The questionnaire consisted of 14 questions, with a score of 1 for each correct answer and a score of zero for each incorrect answer. Knowledge was categorized as good if the score was > 7 and poor if it was ≤ 7 (Demilew, 2017). Families' income data

was obtained from interviews about the total fixed and additional income of all family members in a month. It was categorized as high if it was ≥ IDR 2,835,021.29 and low if it was < IDR 2,835,021.29 (Semarang Minimum Wage in 2021) (Keputusan Gubernur Jawa Tengah Nomor 561/39 Tahun 2021 Tentang Upah Minimum Pada 35 (Tiga Puluh Lima) Kabupaten/Kota Di Provinsi Jawa Tengah, 2022).

Measurements of hygiene and sanitation in the home environment are carried out using the healthy home assessment guidelines based on Minister of Health Decree No. 829/Minister of Health/SK/VII/1999. A home is categorized as meeting health requirements if it scores≥ 1068 in the Healthy Home Assessment (Kepmenkes RI, 1999). Measurements of hygiene and sanitation in the home environment are carried out using the healthy home assessment guidelines (covering three main aspects: home conditions, resident behavior, and environmental sanitation) based on Minister of Health Decree No. 829/Minister of Health/SK/VII/1999. A home is categorized as meeting health requirements if the healthy home assessment score is ≥ 1068 (Badan Penelitian dan Pengembangan Kesehatan, 2013).

The adequacy of macronutrient intake was obtained through interviews on food intake during the last month using the SQ-FFQ (Semi-Quantitative Food Frequency Questionnaire). Energy, carbohydrate, and protein intake were classified as adequate if ≥ 80% and inadequate if < 80% (Susetyowati, 2017).

Data Analysis and Ethical Considerations

The data were analyzed statistically using bivariate analysis with the Chi-square test, with a confidence level of 95% or a significance value of $p < 0.05$, and logistic regression testing for multivariate analysis. This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Diponegoro/Dr. Kariadi General Hospital No. 437/EC/KEPK/FK-UNDIP/XII/2022.

RESULT AND DISCUSSION

Table 1 shows that cases of stunted children and overweight/obese mothers (SCOWT/SCOM) often occur in toddlers aged 13-36 months (52.3%) and females (51.7%). These findings align with a study conducted in South Kalimantan, indicating that stunting tends to occur in infants over six months of age, with an increasing risk trend from 6–11 months and continuing to rise until reaching the highest risk at 24–35 months (Noor et al., 2022). This similarity is because the age of six months is a critical period of growth, and during this period, infants often begin to be given complementary foods or formula, and parenting practices related to feeding patterns can affect the nutritional status of infants (Noor et al., 2022).

The Stunted Children with Overweight/Obese Mothers (SCOWT/SCOM) group was found to have inadequate energy, carbohydrate, and fat intake (78.6%, 64.5%, and 51.1%). Bivariate results indicate that energy intake (p=0.027) and adequate carbohydrate intake (p=0.020) in infants are associated with stunting children and Overweight/obese Mothers with Obesity (SCOWT/SCOM) group.

Based on the research findings, it was found that the mothers in the SCOWT/SCOM group were at a high risk of age (57.1%), and many of them were of short stature (65%). Most of the mothers' educational levels are categorized as basic and intermediate (59%). Unemployed mothers are commonly found (52.8%), and all mothers in the SCOWT/SCOM group have good knowledge. Bivariate analysis results indicate that low and intermediate educational levels of mothers are significantly associated with SCOWT/SCOM (p=0.041).

According to family characteristics data in the SCOWT/SCOM group, many families were classified as large families, with a percentage of 59.1%. Families with low household income were more dominant (56.7%). The category of environmental hygiene had

the same frequency in both groups, while the categories of easy and moderate access to health services also had the same percentage (50%) in the SCOWT/SCOM and NCOM groups.

Table 1. Toddler, mother, and family characteristics

No	Characteristics	NCOM		SCOWT/SCOM		p	OR	(95% CI)	
		n	%	n	%			Min	Max
	Toddler Characteristics								
1.	Toddler's Age								
	- 0-12 months	4	66,7	2	33,3	0,667	1		
	- 13-36 months	21	47,7	23	52,3		2,190	0,363	13,219
2.	Toddler's Gender								
	- Female	14	48,3	15	51,7	1,000	1		
	- Male	11	52,4	10	47,6		0,848	0,276	2,611
3.	Toddler's energy intake adequacy								
	- Enough (≥ 80%)	22	61,1	14	38,9	0,027	1		
	- Lacking (< 80%)	3	21,4	11	78,6		5,762	1,363	24,362
4.	Toddler's protein intake adequacy								
	- Enough (≥ 80%)	24	49,0	25	51,0	1,000	1		
	- Lacking (< 80%)	1	100	0	0		0,490	0,368	0,652
5.	Toddler's fat intake adequacy								
	- Enough (≥ 80%)	22	48,9	23	51,1	1,000	1		
	- Lacking (< 80%)	3	60	2	40		0,638	0,097	4,188
6.	Toddler's carbohydrate intake adequacy								
	- Enough (≥ 80%)	14	73,7	5	26,3	0,020	1		
	- Lacking (< 80%)	11	35,5	20	64,5		5,091	1,446	17,922
	Maternal Characteristics								
7.	Maternal age during pregnancy								
	- Risk-free (20-35 years old)	19	52,8	17	47,2	0,753	1		
	- Risky (<20 and >35 years old)	6	42,9	8	57,1		1,490	0,429	5,127
8.	Maternal height								
	- Normal stature (≥150 cm)	18	60,0	12	40,0	0,149	1		
	- Short stature (<150 cm)	7	35,0	13	65,0		2,786	0,861	9,010
9.	Maternal education level								
	- High (University)	9	81,8	2	18,2	0,041	1		
	- Basic and moderate (senior high school or below)	16	41,0	23	59,0		6,469	1,230	34,012
10.	Maternal occupation								
	- Employed	8	57,1	6	42,9	0,753	1		
	- Unemployed	17	47,2	19	52,8		1,490	0,429	5,172
11.	Maternal knowledge								
	- Good (>7 skor)	25	50,0	25	50,0	1,000			
	- Poor (≤7 skor)	0	0	0	0				
	Family Characteristics								
12.	Family size								
	- Small (≤ 4 people)	16	57,1	12	42,9	0,393	1		
	- Big (> 4 people)	9	40,9	13	59,1		1,926	0,621	5,977
13.	Family income								
	- High ≥ IDR 2.835.021,29	12	60,0	8	40,0	0,386	1		
	- Low	13	43,3	17	56,7		1,962	0,621	6,193

No	Characteristics	NCOM		SCOWT/SCOM		p	OR	(95% CI)	
		n	%	n	%			Min	Max
	< IDR 2.835.021,29								
14.	Environmental hygiene sanitary								
	- meeting health requirements (≥ 1068)	13	50,0	13	50,0	1,000	1		
	- Does not meet health requirements (<1068)	12	50,0	12	50,0		1,000	0,330	3,033
15.	Access to Health Services								
	- Easy	24	50,0	24	50,0	1,000	1		
	- Moderate	1	50,0	1	50,0		1,000	0,059	16,928

Multivariate tests were conducted to determine which factors were most closely related to stunted children and overweight/obese mothers (SCOWT/SCOM). Testing was carried out on all dependent variables, which were later compared with confounding variables. The most relevant variable can be seen in Table 2.

Table 2. Maternal and family characteristics associated with stunting occurrence among households with an overweight/obese mother

Variabel	Crude Odd Ratio[1]		Adjusted Odd Ratio[2]	
	OR (95% IC)	p	OR (95% IC)	p
Maternal height				
- Normal stature (≥150 cm)	1	0,050	1	0,048
- Short stature (<150 cm)	3,815 (0,999; 14,566)		4,613 (1,012; 21,021)	
Maternal education level				
- High (University)	1		1	
- Basic and moderate (senior high school or below)	7,912 (1,290; 48,459)	0,025	8,205 (1,135; 59,296)	0,037

[1]Multivariate without confounding variable;
[2]Multivariate with confounding variable: energy, carbohydrate intake on toddlers

Based on the results in Table 2, the most significant variables associated with SCOWT/SCOM before and after controlling for confounding variables were maternal height (p=0.048) and maternal education level (p=0.037). Overweight/obese mothers with height < 150 cm had a 4.613 times higher risk, and mothers with primary to secondary education had an 8.205 times higher risk of having stunted children.

This study is in line with SCOWT/SCOM studies in Mexico and Indonesia, which found that stunting in toddlers had a higher prevalence in mothers with a weight < 150 cm (Félix-Beltrán et al., 2021; Mahmudiono et al., 2018). Research in Bantul Yogyakarta on stunting toddlers also shows that mothers with height < 150 cm were 2,7 times riskier to have stunting toddlers (Andari et al., 2020). The relationship between maternal height and stunting in toddlers can be due to interactions between genetic factors, nutritional problems, disease, and the environment (Qurani et al., 2022). Mothers who are less than 150 cm tall are at higher risk of having short children, because short genes can be inherited. However, short genes will not be inherited if they are caused by disease or nutritional problems (Agustin & Rahmawati, 2021). Lower maternal height due to genetic factors will inhibit fetal growth because of limited maternal organ function, so the amount of nutritional intake will adjust to the capacity of the maternal organs. This can also affect the baby's size at

birth, which will later affect postnatal growth (Sumarsono & Irwanto, 2022; Wanimbo & Wartiningsih, 2020). Maternal height can also be an essential parameter for fat accumulation and distribution. According to research, shorter women tend to be overweight, and children tend to experience stunted growth compared to those of normal height (Félix-Beltrán et al., 2021).

Maternal education level is significantly associated with SCOWT/SCOM (p=0.037). Mothers with primary (elementary school, junior high school) and secondary (high school) education levels have an 8.205 times higher risk of having SCOWT/SCOM. This is consistent with several studies on SCOWT/SCOM in Indonesia, which indicate that stunted infants of mothers with low education levels have a higher prevalence compared to those of mothers with high education levels (Astuti et al., 2020; Rachmah et al., 2021). Research in Indonesia on stunting in toddlers also shows that at least a Senior High School education level might reduce stunting risk (Noor et al., 2022). Maternal education can influence and facilitate the acceptance of information about nutrition and family health, thereby improving critical behavior in child care, hygiene and sanitation, and health awareness. The level of education can also influence family income to meet family nutritional needs (Noor et al., 2022).

This influence is important due to the maternal role in preparing food, from planning menus, buying ingredients, cooking, and serving meals to family members. Mothers with low levels of education may have inadequate encouragement in child-rearing, lead unhealthy lifestyles, have limited availability and consumption patterns in the household, play a minor role in household decision-making, and be unresponsive to nutritional problems in the family (Astuti et al., 2020; Azqinar & Himayani, 2020). All mothers with low education levels in the stunted children group had good maternal knowledge. This may be due to easy access to technology because they live in urban areas, and the availability and ease of access to counseling and nutrition education facilities. This ease and availability of access can broaden mothers' knowledge, including mothers with low education levels (Hestuningtyas & Noer, 2014). However, maternal education is crucial because it is associated with a reduced risk of obesity. According to a study in Saudi Arabia on adult subjects, low obesity prevalence was associated with higher levels of education (Mosli et al., 2020). Individuals with higher levels of education will choose available nutritious foods and change their eating habits to meet their nutritional needs (Mosli et al., 2020).

The average level of energy intake adequacy in the SCOWT/SCOM group was 97.68±30% while in the NCOM group it was 125.93±46%. Based on bivariate analysis, adequate energy and carbohydrate intake were also found to be variables associated with stunting in families with overweight/obese mothers. These results are consistent with a study in Central Java on stunting in toddlers (Latifahanun et al., 2021; Nugraheni et al., 2020). Energy has a function as a support for growth, development, metabolism, and physical activity (Ayuningtyas et al., 2018). Inadequate energy intake in toddlers can affect brain and cognitive function, as well as hinder linear growth (Fakhrizawaty et al., 2022). Inadequate energy intake can be caused by feeding factors such as irregular eating patterns, smaller portions because children tend to play more, poor eating habits such as sucking on food, and parental influences such as food availability, lack of food variety, and inadequate nutritional knowledge.

The adequacy of carbohydrate intake is significantly associated with the occurrence of stunting in families with overweight/obese mothers (p=0.020). This is in line with research on stunting in Semarang City and East Java (Azmy & Mundiastuti, 2018;

Siringoringo et al., 2020). Carbohydrate intake is very important because carbohydrates are needed to produce energy. Carbohydrates function as metabolic regulators and the primary source of energy for the brain and nerves, especially for the activities of toddlers, which mainly consist of playing and exploring. In addition, compared to other nutrients, carbohydrates are relatively cheaper (Ayuningtyas et al., 2018; Azmy & Mundiastuti, 2018). The level of carbohydrate consumption that is not adequate may be caused by irregular eating patterns, small meal portions, a lack of variety in food, and a tendency for toddlers only to eat side dishes at every meal. Although macronutrient intake in infants was not associated in multivariate analysis, energy and carbohydrate intake were associated in bivariate analysis, supported by univariate SCOWT/SCOM results showing low energy intake at 78.9% and low carbohydrate intake at 64.5%.

Based on these results, the adequacy of other macronutrient intake in toddlers, such as protein and fat, was not significantly associated with stunting in families with overweight/obese mothers (p=1.000). This result was because most toddlers had adequate protein and fat intake. Adequate protein intake in the bivariate analysis was not in line with *other studies* in urban areas of Indonesia, which reported that toddlers with inadequate protein intake had a higher prevalence of stunting (Rachmah et al., 2021). However, this study aligns with research on stunted toddlers in Central Java, which showed that protein intake is not associated with stunting (Nugraheni et al., 2020). This finding that there is no relationship between adequate fat intake and stunting in toddlers is consistent with *other* studies that found no relationship between fat intake in toddlers and SCOWT/SCOM (Rachmah et al., 2021).

Protein is an essential nutrient that builds and maintains cells and tissues, and replaces damaged cells (Ayuningtyas et al., 2018). In addition, adequate protein consumption can prevent stunting because protein stimulates growth hormones and insulin-like growth factor (IGF)-1, a stimulant for bone cell growth (Kundarwati et al., 2022). Fat serves as a source of energy and plays a role in dissolving vitamins (A, D, E, K), thereby facilitating the absorption process by the intestines (Azmy & Mundiastuti, 2018). The adequate protein and fat intake in the stunted group in this study may also be due to the tendency of toddlers only to consume side dishes. In addition, in the city of Semarang in 2022, the government held a program for stunted toddlers. The program provided ten months of supplementary food and formula milk for stunted toddlers (Dinkes, 2022; Pemkot, 2022). Adequate protein and fat intake among stunted children in this study may also be influenced by the nutritional knowledge of their mothers (all of whom were classified as having a good level of nutritional knowledge).

This study has strengths because the subjects were selected from each region with different topography and demographics, including coastal, urban, and mountainous areas, thus providing a broader picture of the characteristics of infants, mothers, and families. This study has limitations because the researchers did not directly observe household cleanliness and sanitation, and data on household environmental hygiene and sanitation were only obtained through interviews, which could affect the validity of the data.

CONCLUSION

Characteristics of mothers, such as maternal height and educational level, are significantly associated with stunting in families with overweight/obese mothers. Mothers who are short in stature with a primary to secondary educational level have a higher risk of having stunted children. Recommendations from this study include the need for supporting activities such as health monitoring,

nutritional counseling, and nutrition education/socialization on stunting regularly for women of reproductive age and pregnant women (especially those of overweight/obese with a history of primary (elementary and junior high school) and secondary (high school) education, as well as those with short stature) to prevent new cases of stunting.

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