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The Potential Impact of Pregestational Body Mass Index (BMI), Weight Gain During Pregnancy, and Socio-Economic Determinants on the Risk of Stunting in Kediri City and Sumenep Regency

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Abstract:-

➢ ***Introduction:***

Stunting is a pathological state characterized by impaired growth and developmental processes resulting from prolonged inadequate nutrition, resulting in reduced height and cognitive impairments. East Java has been identified as a significant contribution to the prevalence of stunting in Indonesia, with Kediri City exhibiting the highest rates and Sumenep displaying the lowest rates. Stunting was attributed to multifactorial factors. Intervention endeavors targeting children experiencing stunting mostly concentrate on the cohort known as the First 1000 Days of Life, with a specific emphasis on enhancing the nutritional status of mothers..

➢ ***Objective:***

The objective of this study is to investigate the impact of pregestational BMI, mother weight gain during pregnancy, and socio-economic variables on the occurrence of stunting among infants aged 0-12 months in the City of Kediri and Sumenep Regency.

➢ ***Material and Methods:***

A case-control research was conducted to examine the impact of pregestational BMI, maternal weight gain during pregnancy, and socioeconomic factors on the likelihood of stunting in infants between the ages of 0 and 12 months. A total of 136 women, comprising both those with stunted and non-stunted infants, were evaluated in order to examine and analyze the risk variables they experienced throughout the perinatal period. The statistical study encompassed univariate, bivariate, and multivariate techniques in order to assess correlations and construct a structural model that represents the routes of effects.

➢ ***Results:***

The study found that there was a statistically significant association between maternal weight gain (odds ratio [OR] 5.82) and lower levels of maternal education (OR 2.99) and low birth weight (OR 2.31), which in turn was linked to stunting.

➢ ***Conclusion:***

Insufficient maternal weight gain during pregnancy, below the recommended guidelines set by the Institute of Medicine (IOM), together with socio-economic characteristics such as low maternal education, are likely to contribute to an increased risk of stunting among children aged 0-12 months in both Kediri City and Sumenep Regency.

Keywords:- *Pregestational BMI; Pregnancy Weight Gain; Socioeconomic Factor; Stunting; Low Birth Weight*

I. INTRODUCTION

Stunting is a global burden, including in Indonesia. Inadequate nutrition fulfillment, both prenatal until the baby is born, could cause various health problems, both for the mother and the baby, especially stunting.[1] Factors contributing to stunting include pre-gestational BMI, weight gain during pregnancy and socio economic factors. The socioeconomic factors may contributing to stunting include mother's educational level but not family income and no of family dependents.[2]

The prevalence of stunting in 2019 reached 21.9% globally, with high stunting rates found in countries in South Africa (29.3%), West Africa (29.2%), and Southeast Asia (25%), including Indonesia.3 In Indonesia, the prevalence in 2017 was 29.6% and increased in 2018 to 30.8%. In East Java, it was pretty high nationally, namely 26.7% in 2017.[4] Data obtained from the East Java Provincial Health Office in August 2020 showed the highest percentage of stunting in children under five years old was in Kediri City (22.9%), whereas the lowest was in Sumenep Regency (5.5%).[5,6]

Intervention efforts for children with stunting focus on the First 1000 Days of Life group, comprising pregnant women, breastfeeding mothers, and children aged 0-23 months. This population was noted as a "window of opportunity ".[7,8] There are several factors that could affect a child's nutrition during 270 days intrauterine during pregnancy. These include the mothers' height < 150 cm, pregestational Body Mass Index (BMI) < 18.5 (underweight), maternal weight gain during pregnancy less than the Institute of Medicine (IOM) recommendation, and maternal age at pregnancy < 20 years or > 35 years.[9]

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A previous study showed that mothers with a pregestational BMI < 18.0 had a higher risk of having a child who was stunted at the age of 2 years.[10] Another study showed weight gain during pregnancy less than the IOM recommendation had a relative risk of two-fold greater for giving birth to babies with low birth weight (LBW) and resulting in stunting as toddlers.[11]

In addition to nutritional factors, socio-economic factors are indirectly related to the occurrence of stunting. Low economic status significantly impacts the possibility of children being thin and short.[12] Previous studies pointed out that low family income significantly affected stunting, 3.25x higher compared to adequate family income or more.[13] In addition, families with less food purchasing power (< Rp. 25,000/day to buy food) increase the risk of stunting by 2.3 times greater than families with sufficient one (> Rp. 25,000/day to buy food).[14]

Maternal socio-economic factors influence the increasing risk of stunting. The previous study had shown that mothers whose education level does not pass high school are at risk of causing stunting 1.23x greater than those whose education level achieved high school graduates. Another socio-economic factor contributing to the risk of stunting is the number of dependents in the family. Research shows that if the number of dependents in the family increases by one person, the possibility of stunting could increase by 0.7%.[15]

Stunting that develops in toddlers before two y.o is predicted to have worse cognitive and educational outcomes during childhood and adolescence. In this study, authors focused on infants aged 0-12 months who were convinced that not much predominated nutritional intake for toddlers' growth.[16]

Therefore, this study aims to determine the effect of pregestational BMI, maternal weight gain during pregnancy, and socio-economic factors, i.e., family income, expenditure on food consumption, mother's education level, and the number of family dependents, on the development of stunting in infants aged 0-12 months in the City of Kediri and Sumenep Regency.

II. METHODS

- *Study Design*

A case control study involving subjects of mothers with infants age 0-12 months old were selected by 4-stage cluster random sampling . The inclusion criteria were mothers with 0-12 months old infants having Z-score < -2SD BMI/Age, keeping a complete record of KIA (Mother and Child Health) book, and submitting informed consent to participate in this study. Mothers with 0-12 months old infants with history of preterm born, gemelli, and history of maternal chronic disease requiring medical attention were excluded. The study was conducted in July to September 2021 in Primary Public Health Service under the governance of Kediri and Sumenep.

- *Data Collection*

The first stage, purposively determines 2 districts/cities which have the highest and lowest percentages of stunting. Based on the preliminary study, it was found that Kediri City had a stunting percentage of 22.9% and Sumenep Regency had 5.5% population.

The second stage is to create layers/strata of the puskesmas. Based on the 2016 Kediri Health Profile, there are 9 Puskesmas spread over 3 sub-districts. Meanwhile, based on the 2018 Sumenep District Health Profile, information was obtained as many as 30 Puskesmas spread over 27 sub-districts.

The third stage, carried out proportional stratified sampling of the health centers studied, namely based on data on the number of births of the 2016 Kediri City Health Profile and the 2018 Sumenep District Health Profile in each Puskesmas.

- *Data Analysis*

Univariate analysis was utilized to describe each variable of interests. Bivariate analysis was used to compare two variables suspected to have a correlation, comprises of Chi-Square, parametric independent t-test, or non-parametric Mann-Whitney test; with $p < 0.05$ considered statistically significant value. Multivariate analysis was conducted with Partial Least Square in SmartPLS 3.2 Software.

- *Ethical Clearance*

This study has received ethical approval from the Ethics Team of RSUD Dr. Saiful Anwar with the number 400/121/K.3/302/2021.

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III. RESULTS

➢ *Characteristics of Subjects*

Subjects of 126 mothers were selected, comprised of 102 subjects in Sumenep and 24 in Kediri. The characteristic of subjects were described in Table 1.

Table 1 Characteristics of Subjects

Parameter	Sumenep Regency	Kediri City	*p-value*
Stunting (n %)			
No	48 (47.1%)	11 (45.8%)	0.914
Stunting	54 (52.9%)	13 (54.2%)	
Low birth weight (LBW) status (n %)			
Non-LBW	87 (85.3%)	17 (70.8%)	0.093
LBW	15 (14.7%)	7 (29.2%)	
Pregestational BMI (median)	21.43 (13.66 - 40.12)	22.86 (15.8 - 40.78)	0.232
BMI Category (n %)			
Underweight	24 (23.5%)	6 (25%)	0.429
Normal	55 (53.9%)	9 (37.5%)	
IOM recommendation of weight gain (n %)			
Under	67 (65.7%)	14 (58.3%)	0.499
Appropriate	35 (34.3%)	10 (41.7%)	
Maternal body height (median cm)	152.5 (140 - 171)	153.5 (142 - 165)	0.670
Family income (median IDR)	1500000 (300000 - 9000000)	1775000 (600000 - 15000000)	0.517
Consumption Expenditure (median IDR)	1000000 (150000 - 6000000)	1000000 (500000 - 6000000)	0.584
Mother's level of education (n %)			
Elementary school	27 (26.5%)	2 (8.3%)	0.113
Junior high school	22 (21.6%)	5 (20.8%)	
Senior high school	35 (34.3%)	14 (58.3%)	
University	18 (17.6%)	3 (12.5%)	
Family number of dependents (median n)	4 (2 - 7)	4 (1 - 6)	0.565
Maternal age (mean ± SD, y.o.)	27.4 ± 6.8	30.3 ± 7	0.066
Sex (n %)			
Male	53 (52%)	10 (41.7%)	0.364
Female	49 (48%)	14 (58.3%)	
ANC routine (n %)			
Yes	101 (99%)	24 (100%)	0.626
No	1 (1%)	0 (0%)	
Health service access (n %)			
Good	101 (99%)	24 (100%)	0.626
Poor	1 (1%)	0 (0%)	
Health insurance (BPJS) (n %)			
Yes	74 (72.5%)	22 (91.7%)	0.048*
No	28 (27.5%)	2 (8.3%)	
Exclusive breastfeeding (n %)			
Yes	70 (68.6%)	13 (54.2%)	0.179
No	32 (31.4%)	11 (45.8%)	

* p value < 0.05

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➢ *Risk Factors of Stunting in Sumenep and Kediri*

Bivariate or comparative analysis for the development of stunting in Sumenep and Kediri were represented in Table 2 and 3. In both Sumenep and Kediri, low birth-weight status and under recommendation of IOM weight gain in pregnancy were statistically significant risk factors in developing stunting. In Sumenep, additional risk factors were lower level of mothers' educational status and history of no exclusive breastfeeding.

Tabel 2 Risk Factors of Stunting in Sumenep and Kediri Regions

Parameters	Sumenep Regency		*p-value*	Kediri City		*p-value*
	Not Stunting (n %)	Stunting (n %)		Not Stunting (n %)	Stunting (n %)	
Low birth weight (LBW) status						
Non-LBW	48 (100%)	39 (72.2%)	0.000*	11 (100%)	6 (46.2%)	0.004*
LBW	0 (0%)	15 (27.8%)		0 (0%)	7 (53.8%)	
Pregestational BMI	22.54 (15.4 - 40.12)	20.82 (13.66 - 31.18)	0.147	22.71 (15.8 - 37.04)	24.14 (16.63 - 40.78)	0.543
BMI category						
Underweight	9 (18.8%)	15 (27.8%)	0.335	3 (27.3%)	3 (23.1%)	0.964
Normal	26 (54.2%)	29 (53.7%)		4 (36.4%)	5 (38.5%)	
Overweight	7 (14.6%)	8 (14.8%)		3 (27.3%)	3 (23.1%)	
Obesity	6 (12.5%)	2 (3.7%)		1 (9.1%)	2 (15.4%)	
IOM recommendation in pregnancy weight gain						
Under	22 (45.8%)	45 (83.3%)	0.000*	4 (36.4%)	10 (76.9%)	0.045*
Appropriate	26 (54.2%)	9 (16.7%)		7 (63.6%)	3 (23.1%)	
Family income (median IDR)	1850000 (700000 - 5000000)	1500000 (300000 - 9000000)	0.075	1750000 (1000000 - 15000000)	2000000 (600000 - 3500000)	0.907
Consumption expenditure (median IDR)	1000000 (500000 - 3000000)	1000000 (150000 - 6000000)	0.176	1000000 (600000 - 6000000)	1000000 (500000 - 2000000)	0.216
Mothers' level of education						
Elementary school	9 (18.8%)	18 (33.3%)	0.040*	0 (0%)	2 (15.4%)	0.497
Junior high school	7 (14.6%)	15 (27.8%)		2 (18.2%)	3 (23.1%)	
Senior high school	20 (41.7%)	15 (27.8%)		7 (63.6%)	7 (53.8%)	
University	12 (25%)	6 (11.1%)		2 (18.2%)	1 (7.7%)	
Family number dependents	4 (2 - 7)	4 (2 - 7)	0.874	3 (2 - 6)	4 (1 - 5)	0.292
Maternal age (mean ± SD, y.o.)	27.6 ± 6.2	27.2 ± 7.3	0.723	27.6 ± 6.8	32.5 ± 6.5	0.091
Health insurance (BPJS)						
Yes	34 (70.8%)	40 (74.1%)	0.714	11 (100%)	11 (84.6%)	0.174
No	14 (29.2%)	14 (25.9%)		0 (0%)	2 (15.4%)	
Exclusive breastfeeding						
Yes	38 (79.2%)	32 (59.3%)	0.031*	6 (54.5%)	7 (53.8%)	0.973
No	10 (20.8%)	22 (40.7%)		5 (45.5%)	6 (46.2%)	

* p value < 0.05

ISSN No:-2456-2165

➢ *Structural Model of Determination Coefficient*

Direct effects structural model risk factors of interest towards the development of stunting was depicted in Figure 1. Risk factors that were statistically significant ($p < 0.05$) included low birth weight, inadequate weight gain during pregnancy, and mothers' level of education.

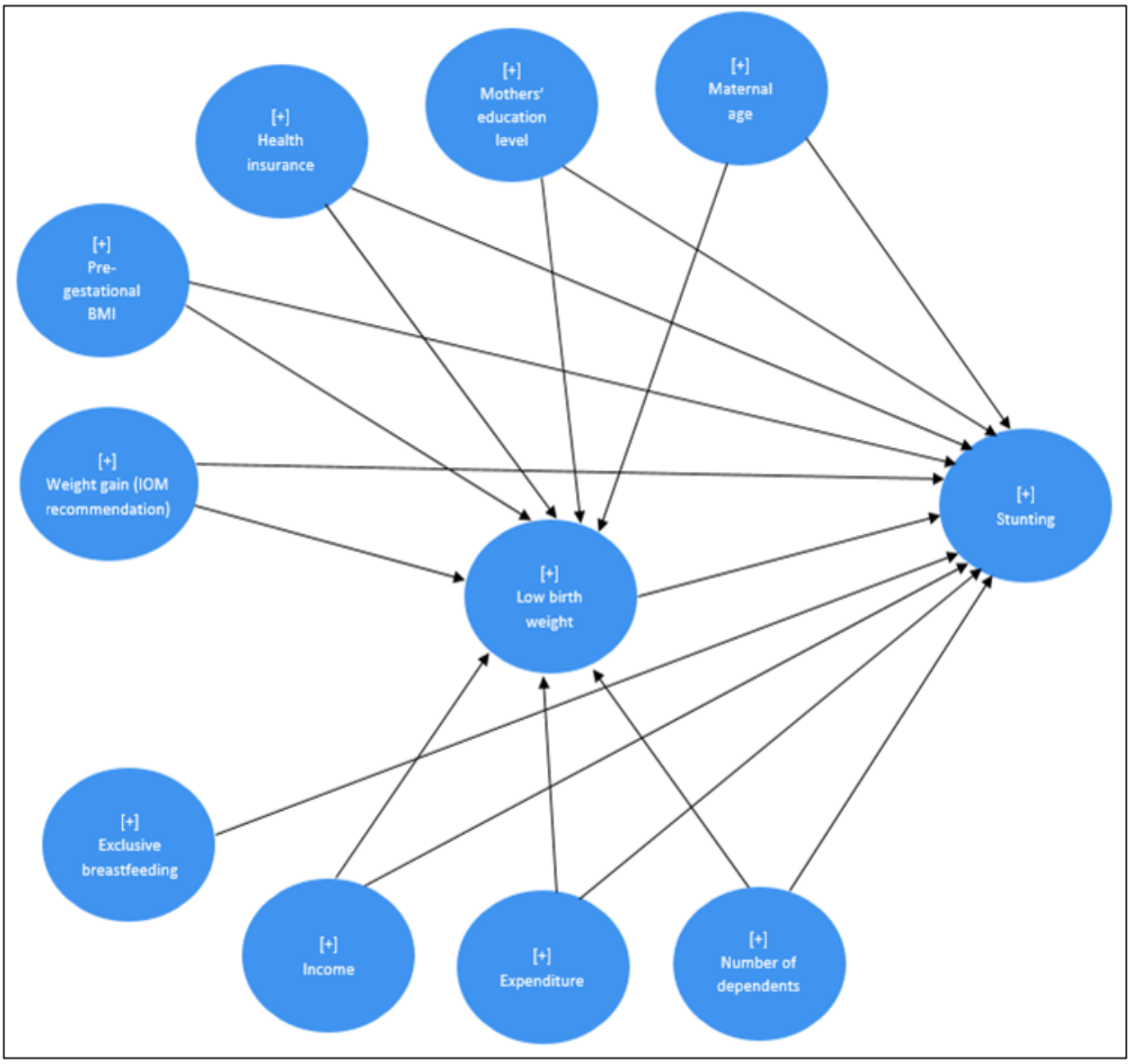

Fig 1 Structural Model of Direct Effect Pathway Coefficients

Structural model of direct effect pathway coefficients. Various risk factors were proposed to contribute in the development of stunting in infants aged 0-12 months. Exclusive breastfeeding were proposed to be directly contribute in the development of stunting, whereas the other factors, i.e. pregestational BMI, weight gain during pregnancy, maternal age, and socioeconomic factors (mothers' level of education , health insurance, income, expenditure, and numbers of family dependents) were both directly and indirectly to contribute in stunting development or through the occurrence of low birth weight status leading to stunting.

Multivariate analysis conducted with Multi Group Analysis between Sumenep and Kediri was summarized in Table 3. The results showed that the effects of various risk factors on the occurrence of LBW in the two regions was similar with a p-value of more than 0.05. This also applies to the occurrence of stunting. The effect of various risk factors on the occurrence of stunting in the second region is the same with a p value > 0.05. There is no significant direct impact pathway in both regions (All p values were >0.05).

Table 3 Comparison of Direct Impact Pathways between Sumenep and Kediri Regions

Effect (Impact) Pathway	Direct Impact Pathway Coefficients		*p-value*
	Sumenep	Kediri	
Exclusive breastfeeding → *Stunting*	0.159	0.015	0.318
Low birth weight (LBW) → *Stunting*	0.259	0.516	0.784
BMI → (LBW)	-0.125	-0.133	0.499
BMI → *Stunting*	-0.020	0.209	0.754
Health insurance (BPJS) → (LBW)	-0.112	-0.097	0.430
Health insurance (BPJS) → *Stunting*	-0.021	0.160	0.806
Pregnancy weight gain (IOM) → (LBW)	-0.191	-0.096	0.672
Pregnancy weight gain (IOM) → *Stunting*	-0.286	-0.484	0.261
Income → (LBW)	-0.239	1.317	0.933
Income → *Stunting*	-0.105	-0.112	0.504
Level of education → (LBW)	-0.233	0.005	0.696
Level of education → *Stunting*	-0.160	-0.422	0.280
Expenditure → (LBW)	0.394	-1.509	0.056
Expenditure → *Stunting*	0.122	0.144	0.570
Number of family dependents → (LBW)	-0.153	0.034	0.700
Number of family dependents → *Stunting*	-0.017	-0.196	0.246
Maternal age → (LBW)	-0.043	-0.031	0.587
Maternal age → *Stunting*	-0.047	0.041	0.652

Furthermore, to compare the coefficient of indirect influence between Sumenep and Kediri regions, we conducted Multi Group Analysis approach summarized in Table 4. The results of the indirect effect pathway coefficient between Sumenep Regency and Kediri City, it was found that the influence of various risk factors on the occurrence of stunting through the occurrence of LBW in both regions was the same with a p-value of more than 0.05.

Table 4 Comparison of Indirect Impact Pathways between Sumenep and Kediri Regions

Effect (Impact) Pathway	Indirect Impact Pathway Coefficients		*p-value*
	Sumenep	Kediri	
BMI → LBW → *Stunting*	-0.032	-0.069	0.580
BPJS → LBW → *Stunting*	-0.029	-0.050	0.312
Pregnancy weight gain (IOM) → LBW → *Stunting*	-.050	-0.050	0.552
Income → BBLR → *Stunting*	-0.062	0.679	0.929
Level of education → BBLR → *Stunting*	-0.061	0.003	0.513
Expenditure → LBW → *Stunting*	0.102	-0.778	0.066
Number of family defendents → LBW → *Stunting*	-0.040	0.018	0.664
Maternal age → LBW → *Stunting*	-0.011	-0.016	0.526

➢ *Odds Ratio of Risk Factors in Developing Stunting*

The odds ratio (OR) of various risk factors in developing stunting was depicted in Table 5. From Chi-Square test, the OR of LBW status to stunting was 2.31. This showed that babies with LBW will be at risk of stunting by 2.31x greater than babies who were not LBW. Weight gain during pregnancy less than the IOM recommendation would have a 5.81 times greater risk of stunting in their child compared to pregnant women whose weight gain during pregnancy was in accordance with IOM recommendations. Also, it was found that the OR of a low mother's education level to the occurrence of stunting was 2.98.

Table 5 Odds Ratio (OR) between Various Risk Factors in Developing Stunting

Parameters	Development of *Stunting*		*p-value*	OR	95% CI
	Stunting	Not *Stunting*			
Low birth weight (LBW) status					
LBW	22 (32.8%)	0 (0%)	0.000	2.311	1.85 - 2.88
Non LBW	45 (67.2%)	59 (100%)			
IOM recommendation of pregnancy weight gain					
Under	55 (82.1%)	26 (44.1%)	0.000	5.817	2.59 - 13.06
Appropriate	12 (17.9%)	33 (55.9%)			
Mothers' level of education					
Lower	38 (56.7%)	18 (30.5%)	0.003	2.985	1.43 - 6.23
Higher	29 (43.3%)	41 (69.5%)			

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IV. DISCUSSION

Children with history of LBW were significantly at higher risk of developing stunting in age of 0-12 months, both in Sumenep and Kediri. This finding was in concordance with previous studies, all emphasized infants with LBW were in a higher risk of developing stunting compared with infants with normal birth weight[17], although they were born aterm.[18] LBW infants would be less likely to catch up with normal growth during childhood and would also in high risk of growth failure in the first two years of life.[19,20]

In our study, maternal pregestational BMI < 18.5 kg/m^2 did not affect the development of stunting in infants aged 0-12 months, both in Sumenep and Kediri. It was different from the results of previous studies. Previous study stated infants born to mothers with a BMI < 18.5 kg/m^2 would be at risk of stunting 1.6 times higher.[11] However, another studies also showed the same results as our study. Another study taking into account several variables, showed that pregestational BMI did not significantly affect the occurrence of stunting in children under five years old.[21]

Maternal weight gain during pregnancy less than the IOM recommendation significantly affected the development of stunting in children aged 0-12 months, in both regions. The results of this study were in accordance with the results of other studies. A previous study showed stunting in children aged 6-23 months occurred likely because the mother's weight gain during pregnancy was less than IOM recommendation, were 3.53 times higher.[22] Another study stated pregnant women whose weight gain less than the IOM recommendations had a higher risk of giving birth to babies with LBW,[11] ultimately leading to higher risk of stunting. Therefore, maternal weight gain during pregnancy less than IOM recommendations would likely increase the risk of stunting in infants aged 0-12 months, through the occurrence of LBW in these population. With sufficient family knowledge, the mother will easily meet her nutritional needs. In addition, even with less family income, mothers with a high level of education will be able to take advantage of existing resources to be able to meet their nutritional needs during pregnancy. Mothers with a high level of education will more easily understand the macro- and micronutrients needed in pregnancy.[22]

Family income did not affect the occurrence of LBW nor stunting in infants aged 0-12 months. The results of this study were different from previous studies that stated lower income family had a 3.25 times higher risk of stunting.[13] In this study, it was presumably due to several factors. Higher income was not always spent on fulfilling nutrition in the family, thus their nutritional needs were unmet, possibly due to a lack of knowledge about the nutritional needs especially during pregnancy.

Expenditure on food consumption does not affect the development of stunting in infants aged 0-12 months. The results of this study differed from previous study that stated the higher family expenditure to buy food, the more the nutritional needs of the family fulfilled, leading to reducing risk of stunting.[14] In this study, these results would be likely due to purchasing power of food in each group in the two regions was sufficient to meet their nutritional needs.

Mothers' lower education level significantly affected the development of LBW, ultimately leading to higher risk of stunting. The results of this study were in concordance with previous study stated that mothers whose graduated from high school, i.e. higher education level, would have lower risk of stunting 0.81 times compared to whose did not.[15] Mothers with a higher level of education would find it easier to access and receive information about nutritional needs during pregnancy. Several studies that have been conducted previously only showed that the level of maternal education was strongly related to the occurrence of stunting in children under five, but did not conduct a path analysis of this relationship as it did in our study.[23]

The number of family dependents did not affect the occurrence of stunting in infants aged 0-12 months. This result differed from previous study,[15] possibly since the smaller number of family dependents did not reflect the nutritional status. Families with a higher number of dependents, but supported by a good resources management and higher education of family members, especially mothers, would likely be able to manage income and family needs better. There is still no meta-analysis from epidemiological studies to demonstrate the risk factor of stunting in children. This study requires a larger number of samples and multicenters with similar characteristics to be able to generalize the conclusions.

V. CONCLUSION

Our study concluded that maternal weight gain in pregnancy less than the IOM recommendation and socio-economic factors, comprises of lower level of mothers' education, would likely to increase the risk of stunting in children aged 0-12 months in both Kediri City and Sumenep Regency. Increased maternal weight and maternal education level significantly affect the occurrence of stunting in children aged 0-12 months through the occurrence of low birth weight in the City of Kediri and Sumenep Regency. Further investigation is required to understand risk factors and directions of causality in the development of stunting in children. Stunting may be avoided with proper maternal nutrition during pregnancy, and maternal education can improve birthing outcomes and consequently the growth of their children

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