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Factors Related to Overnutrition in Early Childhood in Urban and Rural Areas of Bangka Belitung Islands Province (An Analysis Of 2023 SKI Data)

Afifa Naura Harahap[1], Nur Hafidha Hikmayani[1,2], Sumardiyono[1,3*]

[1] Department of Nutrition, Faculty of Graduate School, Sebelas Maret University, Surakarta, Indonesia
[2] Department of Pharmacology, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia
[3] Department of Occupational Safety and Health, Vocational School, Sebelas Maret University, Surakarta,, Indonesia

Corresponding Author Email: sumardiyono@staff.uns.ac.id

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ABSTRACT

Early childhood is a critical period for the basic development of physical, social, and cognitive aspects. One of the nutritional problems that often occurs is overnutrition. This study aims to determine the factors of gender, history of birth weight, history of breastfeeding, and consumption of formula milk related to the incidence of overnutrition in early childhood in urban and rural areas. This study uses secondary data from the 2023 SKI data. The design of this study is a cross-sectional study, a population of children aged 0-24 months with a sample size of 417 children. Univariate data analysis, a Chi-square test to explore differences in place of residence in overnutrition status, and bivariate (logistic regression) with the help of Stata software version 17. The results show that 7.26% of early childhood children who experience overnutrition live in rural areas, and 6.83% live in urban areas. There was no significant association between male gender (OR=0.99, 95% CI=0.40–2.46), history of risky birth weight (OR=1.00, 95% CI=0.54–3.28), non-exclusive breastfeeding (OR=1.16, 95% CI=0.40–3.31), or consumption of formula milk (OR=1.32, 95% CI=0.46–3.79) in urban areas with overnutrition (p>0.05). There was no significant association between male gender (OR=0.99, 95% CI=0.25–3.90), history of high-risk birth weight (OR=1.00, 95% CI=0.99–1.00), non-exclusive breastfeeding (OR=0.77, 95% CI=0.15–3.92), or formula milk consumption (OR=0.84, 95% CI=0.16–4.31) in rural areas with overnutrition (p>0.05). These findings suggest that although gender, history of birth weight, history of breastfeeding, and consumption of formula milk were not significantly associated with overnutrition in early childhood, interventions should focus on structural determinants such as maternal education and access to exclusive breastfeeding support, especially in rural communities.

Key Messages:

- Interventions should focus on structural determinants such as maternal education and access to exclusive breastfeeding support, especially in rural communities.
- The high prevalence of formula feeding suggests the need for targeted breastfeeding promotion campaigns in urban areas, especially for working mothers.
- Integrating breastfeeding support into routine postnatal care may help reduce the risk of overnutrition.

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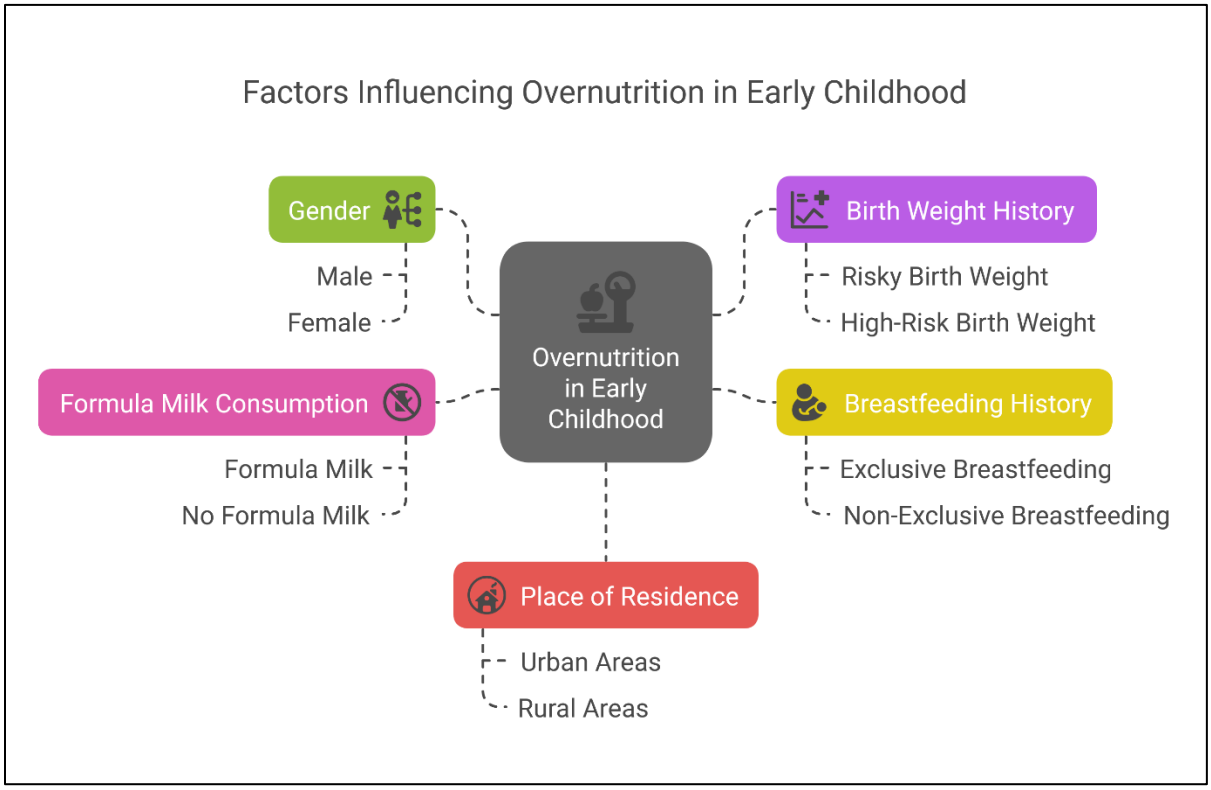
GRAPHICAL ABSTRACT



INTRODUCTION

Nutrition is a crucial factor in the growth and development of early childhood, especially those aged 0-24 months. Early childhood is a critical period for the basic development of physical, social, and cognitive aspects. One of the nutritional problems that often occurs in early childhood groups is overnutrition, which is an imbalance between energy intake and the body's energy needs. According to the Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020, overnutrition in early childhood is defined as a Z-score value that exceeds two standard deviations above the median of the child's growth standard [1] .

Childhood overnutrition is a significant global health problem, with its prevalence increasing rapidly in both developed and developing countries. The increasing prevalence of overnutrition in some countries has been described as a worldwide pandemic. The World Health Organization (WHO) estimates that 37 million children under five years of age (toddlers) and 390 million adolescents aged 5-19 years are overweight (2). The prevalence of overnutrition in children aged 0-59 months in Indonesia has decreased from 11.9% (2013) (3), to 8% (2018) (4). According to the Indonesian Nutritional Status Survey (SSGI), the prevalence of overnutrition in children aged 0-59 months was 3.8% (2021) (5), decreasing to 3.5% (2022) (6), but the results of the 2023 Indonesian Health Survey (SKI) reported an increase in the prevalence of overnutrition in children aged 0-59 months (4.2%), aged 0-24 months (4.1%) (7).

Overnutrition in early childhood, especially those aged 0-24 months, can lead to serious health complications and psychosocial challenges, later lower academic achievement, reduced quality of life, and increased vulnerability to discrimination and bullying. In addition, overnourished children are five times more likely to remain obese into adulthood, increasing the risk of developing a range of non-communicable diseases such as cardiovascular disorders, diabetes, cancer, neurological conditions, gastrointestinal disorders, and chronic respiratory diseases [8] . Furthermore, overnutrition significantly increases the risk of premature death [9] . Given these risks, early childhood is a critical period for building and maintaining a healthy body condition to prevent adult obesity [10] .

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Prevention and treatment of overnutrition in early childhood is an important step in maintaining health and will affect and determine further development. Various risk factors influence overnutrition. Various theories state the relationship between age, gender (11)**,** birth weight, food intake, history of breast milk (ASI), history of formula milk consumption, physical activity, mother's education level, mother's employment status, number of family members, number of children in the household, mother's nutritional status, and area of residence with overnutrition (12).

Birth weight is the first weight recorded after birth. Ideally, the measurement is done in the first few hours after birth. The birth weight reflects the fetus's growth during pregnancy; this can be influenced by various factors, such as the mother's health during pregnancy, nutrient intake, and genetic factors (13). Research conducted by Rahmadia (2023) found that mothers who have toddlers with risky birth weights have a 9 times greater chance of experiencing overweight in their children compared to those with non-risky birth weights (14). However, in contrast to the results of Shi's study (2024), which concluded that birth weight <2500–2999 grams in females is not associated with overweight (15).

In general, girls have lower birth weights than boys. This is due to differences in prenatal growth patterns, hormones, and body composition (16). In line with Saha's research (2022), it was concluded that boys are 1.08 times more at risk of overnutrition (17). Based on SKI data (2023), in Indonesia, the proportion of nutritional status with the overnutrition category aged 0-24 months in boys (4.3%) is higher than in girls (3.9%) (7). However, this is not in line with research conducted by Tanveer (2022), which concluded that overnutrition is a greater risk in girls living in urban environments (18).

Children living in urban areas tend to have a higher risk of experiencing overnutrition [19]. Based on SKI data (2023), the incidence of overnutrition in children aged 0-23 months in the Bangka Belitung Islands Province in rural areas (4.2%) is higher than in urban areas (4%) (7). In low- and middle-income countries, the prevalence of overnutrition is usually higher in urban areas than in rural areas (19). Based on the facts, it is important to study the differences in overnutrition levels between early childhood living in urban and rural areas and the associated risk factors. Given the knowledge that the proportion of overnutrition is higher in urban areas compared to rural areas, the findings of this study can contribute to the development of overnutrition reduction programs based on specific causes of rural and urban areas (20).

One of the factors that plays a significant role is the practice of non-exclusive breastfeeding and the use of formula milk as a substitute or supplement. Research by Rahmadia and Mardiyah (2022) shows that toddlers who do not receive exclusive breastfeeding have a higher risk of experiencing overnutrition. The study also found that inappropriate feeding patterns, including excessive use of formula milk, are associated with the incidence of overnutrition in toddlers (14).

Lack of education on the importance of exclusive breastfeeding and the negative impacts of inappropriate formula milk provision can worsen and affect nutritional status. The main strategy involves parents, especially mothers, starting during pregnancy, fulfilling balanced nutrition during pregnancy, as well as regular pregnancy check-ups, breastfeeding practices, and the use of formula milk. Therefore, it is necessary to conduct a study that can prove the factors of gender, birth weight history, breastfeeding history, and consuming formula milk related to the incidence of overnutrition in early childhood, urban and rural studies in the Bangka Belitung Islands Province using SKI 2023 data; this approach provides a new perspective on how the geographical environment influences the determinants of overnutrition in early childhood and is based on several considerations, namely data and information available from SKI integrating data from the Basic Health Research (Riskesdas) and the Indonesian Toddler Nutritional Status Survey (SSGI), which provides comprehensive and representative health data from the national level to the district/city level (21).

METHODS

This study uses secondary data from the 2023 Indonesian Health Survey (SKI) data, which was conducted by the Health Development Policy Agency (BKPK) of the Ministry of Health of the Republic of Indonesia. The design of this study is a cross-sectional study. The sample size in this study used census block stratification, which was carried out by explicit stratification and systematic sampling with implicit

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stratification of household head education. The total dataset from the 2023 SKI was then adjusted to the research inclusion criteria. Respondents are distinguished according to administrative areas that describe rural or urban residence. The total dataset is 982 children aged 0-59 months. The inclusion criteria for children aged 0-24 months and complete data were used, and 565 respondents were removed using the listwise deletion method, so the final data analyzed was 417 respondents. The selection of the age of 0-24 months in this study was based on the availability of complete data in the 2023 Indonesian Health Survey (SKI) regarding the history of exclusive breastfeeding and consumption of formula milk. These two variables are not consistently available for age groups over two years. In addition, the age period of 0–24 months is a critical phase of child growth and development that is most sensitive to nutrient intake, so it is considered the most relevant in analyzing the determinants of early overnutrition.

The dependent variable in this study is overnutrition in children aged 0-24 months in urban and rural areas. Overnutrition in the study is categorized if a child weights according to length/height with a Z-score value that exceeds two standard deviations above the median of child growth standards [1] . The independent variables in this study are gender, birth weight history, breastfeeding history, and formula milk consumption. Birth weight history is categorized as at risk if birth weight is <2500 grams or >4000 grams; birth weight is not at risk if it is 2500 grams to 4000 grams. Exclusive breastfeeding history with the exclusive breastfeeding category if the answer is no, and not exclusive breastfeeding if the answer is yes, in the 2023 SKI questionnaire question, namely whether before being breastfed for the first time the respondent was ever given a drink or food other than breast milk? Consumption of formula milk with the category of consuming formula milk if the answer is yes, and not consuming formula milk if the answer is no, in the 2023 SKI questionnaire question, namely what types of drinks/foods have been given to children before starting to be breastfed or before breast milk comes out (formula milk)?.

Age characteristics are divided into three categories: age <6 months, 7-12 months, and 13-24 months. The number of family members is categorized as sufficient if the number of family members is ≤4 people; the category is large if the number of family members is >4 people. Father and mother's education is high if they have graduated from high school and college and low education if they have graduated from elementary school and junior high school. Data processing in this study consists of editing stages (checking the completeness and consistency of the 2023 SKI dataset, data coding (coding the dataset and adjusting it to the research objectives), cleaning (rechecking missing data and data variations), and processing (using a computer program and Stata software version 17). To consider the complex survey design, researchers used svyset in Stata to adjust the stratification, grouping, and sample weights in the 2023 SKI dataset.

Data analysis was carried out in the first stage, calculating the proportion of characteristics using percentages in child respondents aged 0-24 months based on urban and rural areas of residence. Second, conducting a chi-square test to explore differences in residence in overweight status based on age, gender, birth weight history, breastfeeding history, formula milk consumption, children who have been immunized, number of toddlers in the family, number of family members, father's education, mother's education, father's occupation, mother's occupation, district/city. Third, analyzing bivariates by conducting a logistic regression test to see the Odds Ratio (OR) and 95% Confidence Interval (95% CI) on the variables of gender, birth weight history, breastfeeding history and formula milk consumption related to overweight in early childhood in urban and rural areas of the Bangka Belitung Islands Province, with the understanding that if the OR value = 1 there is no association between exposure and outcome, OR> 1 exposure increases the chance of outcome, OR <1 exposure decreases the chance of outcome, with a p-value ≤0.05 there is a relationship, while if the p-value> 0.05 then there is no statistical relationship.

CODE OF HEALTH ETHICS

This study uses secondary data, has requested approval from the data owner, namely the BKPK of the Ministry of Health of the Republic of Indonesia, and has submitted a research ethics application to the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, Sebelas Maret University with the number 01/UN27.06.11/KEP/EC/2025.

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RESULTS

The study results in Figure 1 show that out of 417 respondents of children aged 0-24 months, 293 (70.27%) respondents live in urban areas, and 124 (29.7%) live in rural areas. Most respondents living in urban areas have good nutritional status 273 (93.17%) and are overweight 20 (6.83%). At the same time, respondents living in rural areas have a good dietary status of 115 (92.74%) and overweight 9 (7.26%).

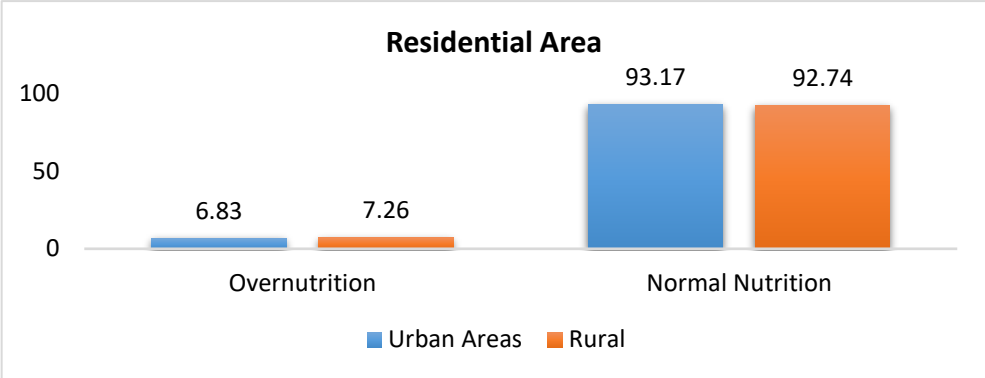

Figure 1. Proportion of Overnutrition in Urban and Rural Residential Areas

The results of the study in Table 1 show that early childhood living in urban areas aged 13-24 months is 146 (49.83%), male 147 (50.17%), with a history of non-risk birth weight 261 (89.38%), history of exclusive breastfeeding 227 (77.47%), most children aged 0-24 months do not consume formula milk 233 (79.52%), toddlers have been immunized 270 (92.15%). More than half of the households only have one child aged 0-24 months, namely 235 (80.20%), with the number of family members ≤4 categorized as sufficient 171 (58.36%).

Respondents in urban areas mostly have highly educated fathers 165 (56.31%), highly educated mothers 171 (58.36%), with working fathers 292 (99.66%), and unemployed mothers 211 (72.01%). Early childhood living in rural areas is mostly aged 13-24 months, as many as 59 (47.58%), male gender 69 (55.65%), with a history of non-risk birth weight 111 (89.52%), history of exclusive breastfeeding 91 (73.39%), most children aged 0-24 months do not consume formula milk 93 (75%), toddlers have been immunized 117 (94.35%). More than half of the households only have one child aged 0-24 months, namely 106 (85.48%), with the number of family members ≤4 categorized as sufficient 78 (62.90%). Respondents who live in rural areas mostly have fathers with low education 67 (62.90%), mothers with low education 67 (54.03%), fathers working 123 (99.19%), and mothers not working 100 (80.65%).

Table 1. Characteristics of Respondents of Children Aged 0-24 Months Based on Urban and Rural Areas of Residence in the Bangka Belitung Islands Province

Characteristics	Residential Area			
	Urban Areas		Rural Areas	
	n	%	n	%
Nutritional Status				
Overnutrition	20	6,83	9	7,26
Normal Nutrition	273	93,17	115	92,74
Age				
<6 Months	69	23,55	35	28,23
7-12 Months	78	26,62	30	24,19
13-24 Months	146	49,83	59	47,58
Sex				
Male	146	49,83	55	44,35
Female	147	50,17	69	55,65
Birth Weight History				
Not at Risk (2500 - 4000 gr)	261	89,38	111	89,52
At Risk (<2500 gr atau >4000 gr)	31	10,62	13	10,48
Exclusive Breastfeeding History				
Yes Exclusively Breastfed	227	77,47	91	73,39
No Exclusively Breastfed	66	22,53	33	26,61

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Characteristics	Residential Area			
	Urban Areas		Rural Areas	
	n	%	n	%
Formula Milk Consumption				
Consumed Formula	233	79,52	93	75
Did Not Consume	60	20,48	31	25
Immunization History				
Has Been Immunized	270	92,15	117	94,35
Has Not Been Immunized	23	7,85	7	5,65
Number of Children in Household				
One Child	235	80,20	106	85,48
Two Children	54	18,43	18	14,52
Three Children	4	1,37	0	0
Family Size				
Large (>4 members)	122	41,64	49	39,52
Small (≤4 members)	171	58,36	75	60,48
Father's Education Level				
Hig (High school /college)	165	56,31	46	37,10
Low (Elementary/junior high school	128	43,69	78	62,90
Mother's Education Level				
Hig (High school /college)	171	58,36	57	45,97
Low (Elementary/junior high school	122	41,64	67	54,03
Father's Employment Status				
Unemployed	1	0,34	1	0,81
Employed	292	99,66	123	99,19
Mother's Employment Status				
Unemployed	211	72,01	100	80,65
Employed	82	27,99	24	19,35
Regency/City				
Bangka	43	14,68	22	17,74
Belitung	37	12,63	16	12,90
West Bangka	38	12,97	20	16,13
Central Bangka	53	18,09	31	25,00
South Bangka	37	12,63	21	16,94
East Belitung	44	15,02	14	11,29
Pangkal Pinang	41	13,99	0	0
Total	**293**	**70,27**	**124**	**29,73**

Table 2, exploratory analysis of differences in residence in overweight status in the Bangka Belitung Islands Province using the Chi-Square statistical test, explains that respondents living in urban areas with overweight status are mostly aged 13-24 months (7.53%), female (6.85%), with a history of non-risk birth weight (7.28%), history of not exclusively breastfeeding (8.33%), history of consuming formula milk (8.33%), and children have been immunized (7.04%). More than half of households only have one child aged 0-24 months, namely (7.66%), with the number of family members ≤4 categorized as sufficient (8.19%). Respondents with overweight status who live in urban areas mostly have highly educated fathers (7.27%), highly educated mothers (7.02%), working fathers (6.85%), and unworking mothers (7.11%) ($p>0.05$).

Respondents living in rural areas with overweight status were mostly aged 13-24 months (8.47%), female (7.27%), with a history of non-risk birth weight (8.11%), history of exclusive breastfeeding (7.69%), history of not consuming formula milk (7.53%). Children were immunized (7.69%). More than half of the households only had one child aged 0-24 months, namely (8.49%), with the number of family members ≤4 categorized as sufficient (10.67%). Respondents with overweight status who were in rural areas mostly had highly educated fathers (8.70%), low-educated mothers (8.96%), working fathers (7.32%), and unworking mothers (8%) ($p>0.05$).

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Table 2. Exploration of Differences in Residence in Overnutrition Status in the Bangka Belitung Islands Province

Variables	Residential Area									
	Urban Areas				*p-Value*	Rural Areas				*p-Value*
	Normal Nutrition		Overnutrition			Normal Nutrition		Overnutrition		
	n	%	n	%		n	%	n	%	
Age										
<6 Months	64	92,75	5	7,25	**0,784**	32	91,43	3	8,57	**0,636**
7-12 Months	74	94,87	4	5,13		29	96,67	1	3,33	
13-24 Months	135	92,47	11	7,53		54	91,53	5	8,47	
Sex										
Male	136	93,15	10	6,85	**0,987**	51	92,73	4	7,27	**0,996**
Female	137	93,20	10	6,80		64	92,75	5	7,25	
Birth Weight History										
Not at Risk (2500 - 4000 gr)	242	92,72	19	7,28	**0,398**	102	91,89	9	8,11	**0,286**
At Risk (<2500 gr / >4000 gr)	30	96,77	1	3,23		13	100	0	0	
Exclusive Breastfeeding History										
Yes Exclusively Breastfed	212	93,39	15	6,61	**0,784**	84	92,31	7	7,69	**0,757**
No Exclusively Breastfed	61	92,42	5	7,58		31	93,94	2	6,06	
Formula Milk Consumption										
Consumed Formula	218	93,56	15	6,44	**0,604**	86	92,47	7	7,53	**0,842**
Did Not Consume	55	91,67	5	8,33		29	93,55	2	6,45	
Immunization History										
Has Been Immunized	251	92,96	19	7,04	**0,623**	108	92,31	9	7,69	**0,446**
Has Not Been Immunized	22	95,65	1	4,35		7	100	0	0	
Number of Children in Household										
One Child	217	92,34	18	7,66	**0,502**	97	91,51	9	8,49	**0,199**
Two Children	52	96,30	2	3,70		18	100	0	0	
Three Children	4	100	0	0		0	0	0	0	
Family Size										
Large (>4 members)	116	95,08	6	4,92	**0,274**	48	97,96	1	2,04	**0,070**
Small (≤4 members)	157	91,81	14	8,19		67	89,33	8	10,67	
Father's Education Level										
Hig (High school /college)	153	92,73	12	7,27	**0,731**	42	91,30	4	8,70	**0,636**
Low (Elementary/junior high school	120	93,75	8	6,25		73	93,59	5	6,41	
Mother's Education Level										
Hig (High school /college)	159	92,98	12	7,02	**0,878**	54	94,74	3	5,26	**0,430**
Low (Elementary/junior high school	114	93,44	8	6,56		61	91,04	6	8,96	
Father's Employment Status										
Unemployed	1	100	0	0	**0,786**	1	100	0	0	**0,779**
Employed	272	93,15	20	6,85		114	92,68	9	7,32	
Mother's Employment Status										
Unemployed	196	92,89	15	7,11	**0,758**	92	92	8	8	**0,516**
Employed	77	93,90	5	6,10		23	95,83	1	4,17	
Regency/City										
Bangka	42	97,67	1	2,33		22	100	0	0	
Belitung	32	86,49	5	13,51		13	81,25	3	18,75	
West Bangka	34	89,47	4	10,53	**0,328**	17	85	3	15	**0,158**
Central Bangka	51	96,23	2	3,77		29	93,55	2	6,45	
South Bangka	36	97,30	1	2,70		20	95,24	1	4,76	
East Belitung	40	90,91	4	9,09		14	100	0	0	
Pangkal Pinang	38	92,68	3	7,32		0	0	0	0	

*Chi-Square Statistical Test (p<0.05).

The results of the bivariate analysis using logistic regression analysis in Table 3 show that children aged 0-24 months who live in urban areas with formula milk consumption factors have a 1.321 times greater chance of experiencing overweight (p = 0.605; 95% CI = 0.460-3.792), followed by a history of not

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exclusively breastfeeding has a 1.158 times greater chance of experiencing overweight (p = 0.784; 95% CI = 0.404-3.315).

The results in Table 4 show that children aged 0-24 months who live in rural areas with a history of birth weight factors have a 1.001 times greater chance of being overweight (p = 0.329; 95% CI = 0.999-1.001).

Table 3. Bivariate Analysis of Factors Related to Overnutrition in Early Childhood Based on Urban Residential Area in the Bangka Belitung Islands Province

Individual Variables	Urban Areas			
	OR	SE	*p- value*	95% CI
Being Male	0,992	0,459	0,987	0,401 – 2,461
Birth Weight History	1,001	0,443	0,412	0,548 – 3,285
History of not exclusively breastfeeding	1,158	0,621	0,784	0,404 – 3,315
Consumed Formula Milk	1,321	0,710	0,605	0,460 – 3,792

OR: *Odds Ratio*, SE: Standard Error, CI 95%: *Confidence Interval* 95%. *Significant at p<0.05 level

Table 4. Bivariate Analysis of Factors Related to Overnutrition in Early Childhood Based on Rural Residence Area in Bangka Belitung Islands Province

Individual Variables	Rural Areas			
	OR	SE	*p- value*	95% CI
Being Male	0,996	0,693	0,996	0,255 – 3,901
Birth Weight History	1,001	0,001	0,329	0,999 – 1,001
History of not exclusively breastfeeding	0,774	0,641	0,757	0,152 – 3,929
Consumed Formula Milk	0,847	0,703	0,842	0,166 – 4,310

OR: *Odds Ratio,* SE: Standard Error, CI 95%: *Confidence Interval* 95%. *Significant at p<0.05 level

DISCUSSION

This study shows that the prevalence of overnutrition in children aged 0-24 months in the Bangka Belitung Islands Province who live in urban areas is (6.83%), and in rural areas, it is (7.26%). These results illustrate that overnutrition in rural areas is higher than children aged 0-24 months who live in urban areas. This finding indicates the potential for changes in the epidemiological trend of overnutrition, which was previously more associated with metropolitan areas. Based on SKI data (2023), the incidence of overnutrition in the Bangka Belitung Islands Province in urban areas (4.0%) is lower than in rural areas (4.2%) (7). This study's results align with Crouch et al. (2023), showing that toddlers who live in rural areas are at greater risk of overnutrition than children who live in urban areas (22).

This result is irrelevant to the research of Nurwanti et al. (2019), which reported that children living in urban areas are 1.33 times at risk of overnutrition (19). Research conducted by Gan et al. (2021) reported that 19.3% of children from urban areas were overweight and obese, compared to 13.2% of children from rural areas (23). This finding is consistent with research conducted by Oktaviani et al. (2023), which reported that children are more at risk of overnutrition if they live in urban areas than in rural areas (aOR=1.36; p<0.001)) (24).

In theory, urban areas are considered obesogenic environments with high access to less nutritious food. People from urban areas are more likely to have a sedentary lifestyle than those from rural areas) (24). In developing countries, economic growth resulting from the nutrition transition affects individuals and families, increasing access to processed and fast foods. Formula milk advertisements prominently convey messages to increase the consumption of fast food processed foods high in carbohydrates, sugar, fat, and salt (19).

Gan et al.'s (2021) research found that older children, children from urban areas, and children with higher socioeconomic status were likelier to consume risky foods such as sweet foods and drinks too early (23). The study results in Table 2 show that children aged 0-24 months with higher nutritional status living in urban areas were mostly aged 13-24 months, namely (7.53%).

The differences in the results in this study can be triggered by other factors, such as the parents' condition, especially the mother's education and knowledge. The results in Table 2 show that mothers aged

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0-24 months who live in rural areas mostly have mothers with low education, namely (8.96%). Mothers with low levels of education and children experience overnutrition due to limitations in knowledge and understanding of healthy eating patterns. Low education affects the way mothers respond to their children's nutritional needs, including a lack of knowledge of the importance of exclusive breastfeeding. In line with research by Rachmawati et al. (2022), which shows that children from parents with lower levels of education tend to experience overnutrition (12).

This result is inconsistent with the research of Firginia et al. (2024), who reported that 52% of mothers who had a high school education and 40% of mothers who worked as private employees had children who were overweight (25). Research conducted by Hasyim et al. (2022) reported that high maternal education levels were associated with toddler obesity (26). Higher education can be related to higher income, thus providing greater access to high-fat and high-sugar snacks (12). Family income levels significantly impact children's nutritional status, including the risk of being overweight. Families with high incomes have greater access to processed and fast foods high in calories, fat, sugar, and salt. High parental financial ability but lack of nutritional knowledge causes children to consume unhealthy foods more often, either as a form of affection or as a gift. In addition, the urban lifestyle is identical to low physical activity, such as playing with gadgets or watching television, and it also increases children's excess energy stored as body fat (19). Low-income families are also at risk of overnutrition due to consuming cheap, energy-dense, but low-nutrient foods, such as fried foods and instant foods (27). However, secondary data limits the variables available for analysis and does not delve into the extent of family income, the level of nutritional knowledge in mothers, and food consumption in children aged 6-24 months; therefore, the researcher made it a limitation of the study.

Gender

This study explains that there is no relationship between individual factors of male gender and overnutrition in toddlers in urban areas (OR = 0.992; p = 0.987; 95% CI = 0.401-2.461) or in rural areas (OR = 0.996; p = 0.996; 95% CI = 0.255-3.901). The same analysis results were also shown by Wirakesuma's study (2022), which reported that the male gender was not related to the incidence of overnutrition (28), other studies also reported that the male gender tends to have a lower chance OR = 0.58 of experiencing overnutrition compared to girls (p = 0.191) (29). Research conducted by Hasyim et al. (2022) reported that male gender was unrelated to overnutrition status in toddlers (26).

In this study, no statistically significant relationship was found between male gender and the incidence of overnutrition in early childhood, both in urban and rural areas. The relatively low prevalence of overnutrition in boys in both regions is due to the incidence of overnutrition in boys at a fairly low level. In addition, the limited sample size of boys, especially in rural areas (only 62 children), also affected the power of the analysis. Small samples cause high data variability and reduce the possibility of finding a significant relationship, especially for variables with small effects.

These results contradict the research of Zhang et al. (2024), which states that obesity is more common in boys than in girls (30). In theory, a child's gender refers to the biological identity of a toddler as a boy or girl, which is determined by physical and genetic characteristics (31). Gender can affect physical development, eating behavior, and physical activity, which are at risk for overnutrition due to biological, hormonal, and behavioral differences between boys and girls (32).

In theory, biological differences in body composition between the sexes emerge quite early, during the fetal and postnatal periods. Female fetuses have significantly smaller growth rates in the late second and third trimesters than male fetuses. After birth, females generally have greater fat mass and less fat-free mass, ultimately associated with lower energy intake and calorie requirements for females than males. Females also show higher leptin concentrations than males. Leptin is a hormone that fat tissue (adipose) produces and regulates appetite and energy metabolism. When body fat levels increase, blood leptin levels also rise, sending signals to the brain (hypothalamus) to suppress appetite and increase energy expenditure (33).

Boys have higher muscle mass than girls, which requires more energy intake. However, at the age of toddlers (0-24 months), physical activity is not enough to balance the high energy intake, so it is easier to experience fat accumulation, which leads to overnutrition. In addition, lower testosterone levels in toddler

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boys than in adult males may contribute to greater fat storage during early growth. Boys are typically more physically active than girls after reaching school age. However, in toddlerhood, the difference in physical activity levels between boys and girls is insignificant. If boys have high energy intake but are not active enough, the energy will be stored as fat, increasing the risk of overnutrition (31).

Birth Weight History

This study explains that there is no relationship between individual factors of risky birth weight history and overnutrition in toddlers in urban areas (OR=1.001; p=0.412; 95% CI=0.548-3.285) or in rural areas (OR=1.001; p=0.329; 95% CI=0.999-1.001). In urban areas, the odds ratio (OR) value of 1.001 indicates that children with a history of risky birth weight have almost the same chance (not significantly increased) of experiencing overnutrition compared to children with non-risky birth weight; in rural areas, the OR value is also 1.001 with p>0.05, this indicates that there is no significant difference in risk between children with a history of risky birth weight and those who are not at risk. This aligns with Xia's research (2019), which reported that toddlers with a history of 2500-3100 grams birth weight are not associated with overnutrition (34). Shi's (2024) study also noted that there was no relationship between a history of birth weight <2500 grams and the incidence of overweight (15).

This result is in contrast to the study conducted by Rahmadia (2023), which reported that birth weight is related to the incidence of being overweight in toddlers; birth weight at risk has a 9 times greater chance of being overweight compared to birth weight that is not at risk (14). A study in 22 countries in the European Region also reported the same results, namely that there was a relationship between a history of birth weight >4000 grams and the risk of overweight or obesity (35).

Birth weight is the weight that is first weighed in a baby immediately after birth. Weight measurement is done as soon as possible to avoid postnatal weight loss. The condition of overweight in toddlers can be influenced from the beginning of life, which is reflected in the baby's weight at birth. Birth weight describes the condition and nutritional intake of the mother during pregnancy. A baby is considered to have a normal birth weight if it reaches or is more than 2,500 grams, while a low birth weight is defined as less than 2,500 grams. In this study, the history of a child's birth weight is at risk if the birth weight is <2500 grams or >4,000 grams, while the birth weight is not at risk if it is ≥2,500 grams to ≤4,000 grams. The results in Table 1 show that most of the child's birth weight history is categorized as not at risk living in urban areas (89.38%) or rural areas (89.52%). Babies with low birth weight have a greater risk of experiencing physical problems, cognitive disorders, and chronic diseases related to nutritional status (36). Children with a history of LBW can have chronic diseases in the future, such as coronary heart disease, cardiovascular disease, and diabetes mellitus. Children with a history of LBW have slower growth followed by rapid weight gain, so they are at risk of overnutrition (35).

History of Exclusive Breastfeeding

The results of this study explain that there is no relationship between the history of not getting exclusive breastfeeding and overnutrition in early childhood in urban areas (OR=1.158; p=0.784; 95% CI=0.404-3.315) or in rural areas (OR=0.774; p=0.757; 95% CI=0.152-3.929). In urban areas, early children who do not get exclusive breastfeeding have a 1.158 times greater chance of experiencing overnutrition compared to children who get exclusive breastfeeding. Meanwhile, in rural areas, early children who do not get exclusive breastfeeding have a smaller chance of experiencing overnutrition, which is 0.774 times compared to children who get exclusive breastfeeding (OR = 0.774), but this relationship is also not significant. These results are relevant to research conducted by Fajariyah (2022), who reported that there was no significant difference between the history of exclusive and non-exclusive breastfeeding and the incidence of overnutrition in children (p = 0.053) (37). However, these results are irrelevant to those conducted by Rahmadia (2023), who reported a relationship between the history of breastfeeding and the incidence of overnutrition in toddlers. A history of not exclusively breastfeeding is 12 times more likely to experience overnutrition in toddlers (14).

In theory, proper breastfeeding can prevent the occurrence of overnutrition in early childhood because it can help control energy intake related to internal responses in realizing satiety; exclusive breastfeeding has a statistically significant protective effect against overnutrition. This is related to cow's milk's higher fat and protein levels, the higher bioactive substances (leptin and ghrelin) in breast milk, and

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the different intestinal microflora content in breastfed and formula-fed babies. It is explained that breastfed babies can avoid overnutrition because they have more balanced levels of insulin and leptin hormones (14).

Awareness of family health status is influenced by the number of family members, which is related to the risk of overnutrition in children through parenting patterns, attention given, and resource allocation that affect early childhood diet and physical activity (38). The results of the study in Table 2 show that in children with overnutrition status, most families only have one toddler, namely (7.66%), a sufficient number of family members (8.19%) in urban areas, and the rural regions have one toddler (8.49%) and an adequate number of family members (10.67%). Diallo's research (2023) shows that a small number of family members increases the risk of overnutrition (39). Research conducted by Saha (2022) also concluded that families with less than four children have a 1.44 times higher risk of overnutrition in children (17).

Families with more members are related to attention and time, such as breastfeeding time, which can be divided, especially if the mother has to care for other children and play multiple roles in the family. This can affect the duration and frequency of breastfeeding, which potentially causes babies not to get optimal breast milk. Exclusive breastfeeding for the first six months has been shown to reduce the risk of overnutrition. Conversely, babies who do not get breast milk or are given formula milk earlier have a higher risk of overnutrition. Based on SKI data (2023), the proportion of exclusive breastfeeding for 6 months in infants aged 6-23 months in the Bangka Belitung Islands Province (49.6%) is lower than the national figure for Indonesia (55.5%), and the proportion of prelacteal feeding of formula milk in infants aged 0-23 months in the Bangka Belitung Islands Province (90.9%) is higher than in Indonesia (90%). These results illustrate that the coverage of exclusive breastfeeding and the high provision of formula milk in infants aged 0-23 months in the Bangka Belitung Islands Province is still low (7).

The high provision of formula milk in infants in the Bangka Belitung Islands Province is closely related to parental employment and economic status. In line with the study's results, Table 1 shows that respondents who live in urban areas mostly have working mothers (27.99%). Working parents are required to have time and energy, and families with middle to upper economic status tend to choose formula milk as a practical alternative to meet the nutritional intake needs of children.

Formula Milk Consumption

The results of this study explain that there is no relationship between individual factors of formula milk consumption and overnutrition in toddlers in urban areas (OR=1.321; p=0.605; 95% CI=0.460-3.792) or in rural areas (OR=0.847; p=0.842; 95% CI=0.166-4.310). In urban areas, toddlers who consume formula milk have a 1.321 times greater chance of experiencing overnutrition than children who do not consume formula milk. In line with Mannan's research (2018) reported that children who were introduced to formula milk or solid foods at the age of four months were about 1.95 times more likely to be overweight or obese ($p<0.05$) (40). A meta-analysis study conducted by Yopiana et al. (2020) concluded that giving formula milk to toddlers increased the incidence of overnutrition in toddlers by 1.10 times (aOR=1.10; 95% CI= 0.78-1.56; p=0.570)) (41).

Early introduction of formula milk or solid foods can be considered a risk factor for overweight or obesity in toddlers; this is due to the higher energy and protein content in formula milk and higher consumption volume, which can lead to greater weight gain in infants who are given formula milk compared to infants who are breastfed during infancy. Infants who are given formula milk in the first week after birth have higher energy and protein intake than infants who are only breastfed. Energy intake in formula milk is recorded as 1.2-9.5 times higher, while protein intake is 1.2-4.8 times higher compared to infants who are only breastfed (42). Using formula milk and complementary foods from an early age can increase the risk of overnutrition and the risk of diarrhea in infants (43).

Infant formula is thought to contribute to increased weight gain and obesity in children, compared with breast milk. Breast milk has both short-term and long-term health benefits for infants and mothers. Therefore, support and promotion of breastfeeding by health professionals is essential, as breastfeeding can have a preventive effect on the development of overnutrition. Formula-fed infants are bottle-fed, thus losing the ability to self-regulate their intake and delaying the satiety response compared with breastfed

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infants. The faster weight gain in formula-fed infants may be mediated through amino acid-induced insulin and insulin-like growth factor I (IGF-I) secretion; breast milk provides major benefits through its content of adipokines such as leptin and adiponectin, and hormones such as IGF-I, ghrelin, obestatin, and resistin, all of which play a role in regulating food intake and maintaining energy balance (44).

Leptin and ghrelin help control satiety in infants, thus contributing to long-term energy regulation and providing protection against obesity. Obestatin functions to reduce food consumption, slow weight gain, slow gastric emptying, and suppress intestinal motility. Meanwhile, IGF-I, a hormone similar to insulin and a major mediator of growth hormone (GH), plays an important role in embryonic and postnatal growth. Adiponectin in breast milk functions in regulating energy balance and is specifically able to influence the neuroendocrine pathways involved in weight management. Infants given formula milk show higher levels of IGF-I than breastfed infants (45). The difference in energy and protein content between breast milk and formula milk can explain this difference. Generally, formula milk has a higher energy density and protein content than breast milk. High protein intake in infancy has been associated with increased insulin and IGF-I secretion, which promotes cell proliferation, accelerates growth, and increases fat tissue accumulation. Formula milk feeding also causes an increased insulin response that can lead to fat accumulation and an increase in fat cells (adipocytes) (40).

The Hopkin study examined the effects of the type and volume of milk given during infancy on child growth. The results showed that providing infants with large amounts of formula milk (≥600 ml/day) was associated with increased weight and height up to 3 years of age and suggested that milk intake be measured in detail in future studies (46). In line with the study of Huang et al. (2018) showed that giving formula milk with a higher volume (≥840 ml/day) at 3 months of age was associated with greater weight and a higher risk of being overweight at 6 and 12 months of age compared to breastfeeding (47).. The results in Table 2 show that 8.33% of toddlers living in urban areas consume formula milk, but this study did not explore how much formula milk was consumed. Therefore, the researchers made it one of the limitations of the study.

CONCLUSION

The prevalence of overnutrition in children aged 0-24 months did not differ significantly between urban (6.83%) and rural (7.26%) areas in the Bangka Belitung Islands Province. Children aged 0-24 months in urban areas mostly consumed formula milk and were not exclusively breastfed. There was no relationship between male gender, history of birth weight, history of not being exclusively breastfed, consumption of formula milk with overnutrition in early childhood in urban and rural areas of the Bangka Belitung Islands Province. Although there was no significant relationship, interventions should be focused on structural determinants such as maternal education and access to support for exclusive breastfeeding, especially in rural communities. The high prevalence of formula milk provision indicates the need for targeted breastfeeding promotion campaigns in urban areas, especially for working mothers. Integrating breastfeeding support into routine postnatal care may help reduce the risk of future overnutrition.

This study has several limitations, namely, the use of secondary data limits the variables available for analysis, such as dietary intake of children aged 0-24 months, physical activity, genetic factors, family income, and recall bias, which may have affected the accuracy of reporting breastfeeding and formula feeding.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest associated with this study.

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