ORIGINAL ARTICLE

Impact of Exclusive Breastfeeding on Obesity Risk in Preschool-Aged Children: A Cross-Sectional Study in Serang, Indonesia

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ABSTRACT

Background: As of 2022, an estimated 37 million children younger than five years of age were affected by overweight globally. LMIC countries are experiencing a growing burden of overweight and obesity. There were growing rates of obesity among children in Indonesia. Obesity can lead to lower school performance and psychosocial challenges. One factor that has the potential to protect children is exclusive breastfeeding.

Objective: To assess the relationship between exclusive breastfeeding and obesity in preschool-aged children in Serang, Indonesia.

Methods: A cross-sectional study was conducted involving 134 preschool-aged children enrolled in kindergartens in Serang City, selected through a two-stage sampling. The study was performed from January to June 2023. Data collection involved structured questionnaires and anthropometric assessments. Bivariate analysis was performed, and multivariable analysis was conducted using logistic regression.

Results: The prevalence of obesity among the participants was 15.7%, while 81.3% of the children had a history of exclusive breastfeeding. After adjusting for confounding variables, exclusive breastfeeding was found to reduce the risk of obesity by 88% (aOR=0.12, 95% CI: 0.04-0.36, p<0.001) in preschool-aged children.

Conclusion: A history of exclusive breastfeeding contributes to a reduced risk of obesity in preschool-aged children.

Keywords: Breastfeeding, obesity, preschool, children, exclusive.

INTRODUCTION

Childhood obesity is increasingly recognized as a global health issue [1]. Prevalence rates vary across different countries and regions but generally show an upward trajectory [2-4]. According to the World Obesity Federation, this growing trend continues with projections estimating that 158 million children and adolescents aged 5 to 19 were affected by obesity in 2020, a number expected to rise to 206 million by 2025 and reach 254 million by 2030. In Indonesia, the prevalence of overweight and obesity in toddlers has increased from 3.8% based on the 2018 Basic Health Research to 4.2% according to the 2023 Indonesian Health Survey. In Banten Province, the increasing trend in the percentage of obese toddlers in the 0-59 months age group is also seen. In 2016, the rate was 3.77%, while in 2018 it was 8.60%.

Obesity is a chronic and multifactorial condition characterized by an excessive accumulation of body fat that can adversely affect health. Obesity during childhood is associated with adverse psychosocial outcomes, including impaired academic performance and reduced quality of life, often worsened by experiences of stigma, discrimination, and bullying. Children affected by obesity are more likely to remain obese into adulthood and face an elevated risk of developing non-communicable diseases later in life. It is associated with a heightened risk of developing type 2 diabetes, cardiovascular diseases, and certain types of cancer. Additionally, obesity can impact bone health, reproductive function, and overall quality of life by impairing mobility and sleep. Obesity is predominantly a multifactorial condition influenced by obesogenic environments, psychosocial determinants, and genetic predispositions. However, in certain individuals, specific underlying causes such as pharmacological treatments, medical conditions, physical immobility, iatrogenic interventions, or monogenic disorders can be clearly identified as primary contributors [5].

Obesogenic environments, which increase the risk of obesity across individuals and populations, are driven by systemic barriers including limited access to nutritious and affordable food, inadequate infrastructure that supports daily physical activity, and the absence of robust legal and regulatory frameworks that promote healthy living. Moreover, the progression of obesity is further compounded by weak health system responses, particularly the failure to detect and manage early signs of excessive weight gain and fat accumulation [5].

A significant contributing factor to hypertension in children is an elevated body mass index (BMI), with approximately 25% of obese children being affected. In addition, childhood obesity-related hypertension can be attributed to hyperinsulinemia. Children who are overweight or obese often face psychological

challenges, including low self-esteem and depression, especially during adolescence. These negative emotional experiences may lead to emotional eating, perpetuating a cycle of obesity and mental health issues. Such children are also more likely to be bullied, excluded from athletic participation, and tend to engage in fewer social interactions while spending more time in sedentary behaviors. Research has consistently linked childhood obesity with conditions such as ADHD and anxiety. Moreover, obese children with additional health issues like diabetes, asthma, or sleep apnea often miss more school days, which can negatively impact their academic performance [6, 7].

Preventing obesity is essential and should begin not only in childhood but also during pregnancy, given that maternal obesity can increase the likelihood of obesity in offspring. Breastfeeding has been proposed as a potential strategy to prevent obesity, potentially lowering long-term adverse health outcomes for both mothers and children. Research suggests that exclusive breastfeeding for a minimum of four months may help reduce the risk of childhood overweight and obesity, while also aiding mothers in managing their postnatal weight. It is essential to inform expectant and new mothers about the health benefits of breastfeeding and to implement supportive measures that encourage its initiation and continuation. However, despite numerous studies highlighting the protective impact of breastfeeding on maternal and childhood obesity, some research has failed to support these findings, leading to inconsistent and inconclusive evidence. Therefore, further research is warranted. Based on these considerations, the present cross-sectional study aims to assess the possible protective effect of breastfeeding against obesity in children within a representative sample of the Indonesian population, while controlling for various confounding factors [8].

MATERIALS AND METHODS

This research employed a cross-sectional design during a single observation period. For site selection, one public and one private kindergarten in Serang City, Indonesia. The study was conducted from January to June 2023. The inclusion criteria for this study included kindergarten children aged 4-6 years in Serang City, both boys and girls, and biological mothers who agreed to participate by signing an informed consent form. The exclusion criteria for this study were mothers who could not speak Indonesian and children with deformities that could affect anthropometric measurements.

A two-stage sampling method was used. First, samples were chosen through non-probability sampling (convenience sampling) to represent both types of private and public kindergarten institutions. Second, based on the sample size calculation, 134 participants, 67 from each kindergarten, were selected using probability sampling (simple random sampling) within each school, as shown in Fig. **(1)**.
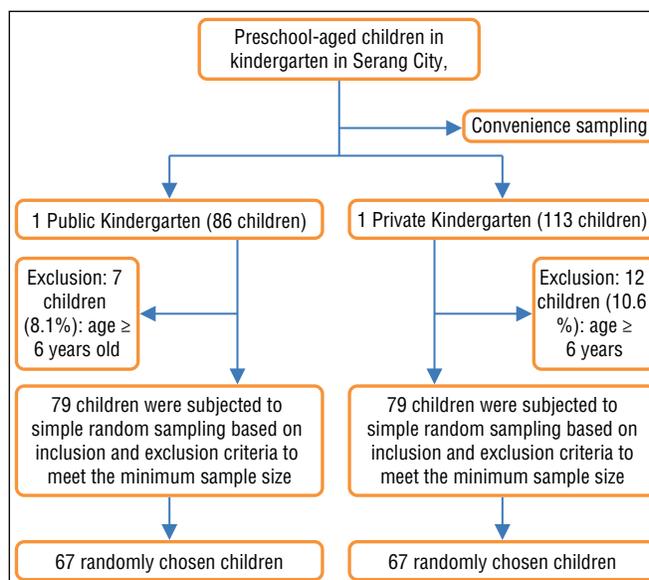

Fig. (1): Sampling process.

The standard sample size formula estimates a population proportion and calculates the minimal sample size for comparing two proportions in a cross-sectional or prevalence study by counting manually [9]. A sample drawn from a population that meets the inclusion criteria and is representative of the entire population. The survey sample is calculated using the formula:

$$n = \frac{Z_\alpha^2 \, PQ}{d^2}$$

n = 121 samples

Description:
n = sample size
Zα = 1.96 (95% confidence level)
P = 0.086 (proportion of obesity in toddlers based on literature) [10]
Q = 1 - P = 0.914
d = Margin of error (0.05)

After calculating the minimum sample size using the difference between 2 proportions formula, the minimum total sample was 54 respondents. However, based on the calculation of the population proportion for obesity in toddlers, the minimum sample size calculation was 121 samples. Based on this, this study's largest minimum sample size was taken, namely a total sample of 121 respondents. To anticipate incomplete data during data collection, 10% was added to the sample, resulting in 134 children.

Data collection involved administering a questionnaire to collect general data on respondent characteristics, which was conducted through interviews using a respondent identity questionnaire. Before the interviews, the researchers obtained informed consent from the subjects' mothers. Data on breastfeeding history were obtained through interviews with the mothers using a questionnaire adapted from previous research [11]. The

mothers were asked to read the questionnaire instructions. The researchers allowed them to ask questions if anything was unclear and to complete the questionnaire with the researcher nearby. Exclusive breastfeeding is giving only breast milk to a baby immediately after birth until 6 months without any other food or fluids, including water [11]. The definition of maternal knowledge about breastfeeding is all information related to exclusive breastfeeding, by assessing the quality or otherwise of the mother's knowledge regarding exclusive breastfeeding. The maternal knowledge questionnaire on breast milk includes the definition of breast milk, exclusive breastfeeding, giving food and drinks other than breast milk, and the duration of breastfeeding [12].

The tools and materials used for the Nutritional status data for the obese and non-obese groups were collected through height and weight measurements. Weight was measured using an Onemed-brand weighing scale, while height was measured using a calibrated portable stadiometer. The children's weight and height data were then plotted with the anthropometric measurements onto a CDC graph to determine the children's nutritional status [13]. Additional variables collected included formula feeding, physical activity, family support, maternal breastfeeding knowledge, maternal education, and maternal employment status. In this study, physical activity data in children were taken using the Early Years Physical Activity Questionnaire (EY-PAQ questionnaire). The EY-PAQ is a proxy-reported questionnaire that measures habitual moderate to vigorous physical activity (MVPA) and sedentary time (ST) levels in young children. Questionnaires are available in Indonesian. Parents were asked to report the frequency and duration of their children's various MVPA and ST activities the previous week [14].

Data processing and analysis involved several stages: editing, scoring, entry, coding, and tabulation. Data analysis was performed using Stata version 16 (Stata Corp., College Station, TX, USA). The analysis began with univariate analysis to describe variable distributions. Odds ratios (ORs) and 95% confidence intervals were calculated for the risk factors using binary logistic regression. If a significant association was found, multivariate logistic regression was conducted to adjust for confounding factors and to develop a parsimonious and well-fitting model. Statistical significance was determined at a confidence level of 95%, with a significance threshold set at p-value ≤0.05.

RESULTS

In this study, a higher proportion of the participants were girls (53.8%) than boys. The prevalence of obesity among the children in this study was 15.7%. Most children (81.3%) had a history of exclusive breastfeeding, and most (91.8%) engaged in adequate physical activity. Additionally, 81.3% of the children had not consumed formula milk from an early age. Most participating

mothers were between 25 and 35 years old, with nearly all demonstrating good knowledge about breastfeeding (97%). Most had attained higher education (82.8%), and more than half (59.7%) were full-time homemakers. Furthermore, families generally supported breastfeeding as the primary source of nutrition for children, as detailed in Table **1**.

Table 1: Frequency distribution based on mother and child characteristics (n=134).

Child Characteristics	Frequency	Percentage
Gender		
Girl	72	53.8
Boy	62	46.2
Obesity Status		
Obesity	21	15.7
Not Obesity	113	84.3
History of Breastfeeding		
Not Exclusive Breastfeeding	25	18.7
Exclusive Breastfeeding	109	81.3
Physical Activity		
Insufficient Physical Activity	11	8.2
Sufficient Physical Activity	123	91.8
Formula Milk Consumption		
Given formula milk	25	18.7
Not given formula milk	109	81.3
Mother Characteristics		
Age		
<25 years old	5	3.7
≥25 years old	129	96.3
Knowledge about Breastfeeding		
Not good	4	3
Good	130	97
Level of Education		
Elementary School/Equivalent	3	2.2
Junior High School/Equivalent	5	3.7
High School/Equivalent	15	11.3
College/Equivalent	111	82.8
Employment Status		
Housewife	80	59.7
Trader	3	2.2
Private sector employee	9	6.7
Self-employed	12	9
Civil servant	30	22.4
Family Support		
No support	0	0
Quite supportive of Mother	134	100

Based on bivariate analysis, a history of exclusive breastfeeding was significantly associated with obesity in preschool children (p<0.001). Children with a history of exclusive breastfeeding had a reduced risk of 87% (OR=0.13, 95% CI: 0.05-0.36, p=0.001) of obesity compared to children who did not have a history of exclusive breastfeeding. The relationships between the gender of the child, formula milk consumption, physical activity of the child, age of the mother, level of education of the mother, employment status of the mother, and family support for obesity in children are shown in

Table 2: The relationship between independent variables and childhood obesity in Serang, Indonesia (n = 134).

Variables	Obesity	No Obesity	p-value	Crude Odds ratio (95% CI)*	Full-model*1 Adjusted odds ratio (95% CI)	p-value
Breastfeeding History						
Exclusive Breastfeeding	10(9.2)	99(90.8)	0.001	0.13 (0.05-0.36)	0.12 (0,04-0.36)	<0.001
Non-Exclusive Breastfeeding	11(44)	14(56)		1.00 (reference)	1.00 (reference)	
Gender of Child						
Boy	11(17.7)	51(82.3)	0.636	1.38 (0.53-3.40)	-	-
Girl	10(13.9)	62(86.1)		1.00 (reference)	-	-
Formula Milk Consumption						
Given formula milk	3(12)	22(88)	0.759	0.69 (0.19-2.55)	-	-
Not given formula milk	18(16.5)	91(83.5)		1.00 (reference)	-	-
Physical Activity of a Child						
Sufficient Physical Activity	18(14.6)	105(85.4)	0.378	2.12 (0.53-9.03)	-	-
Insufficient Physical Activity	3(27.3)	8(72.7)		1.00 (reference)	-	-
Age of Mother						
<25 years old	1(20)	4(80)	0.580	1.36 (0.15-12.83)	-	-
>25 years old	20(15.5)	109(84.5)		1.00 (reference)	-	-
Employment Status of Mother						
Working	11(20.4)	43(79.6)	0.235	0.56 (0.22-1.43)	2.03 (0.72-5.75)	0.180
Not Working	10(12.5)	70(87.5)		1.00 (reference)	1.00 (reference)	

*Values are presented as odds ratios (95% confidence interval)
1Significant at p<0.25 (or p>0.25 for a variable considered sufficiently important) and analyzed in the whole model.

Table **2**. None of these covariates was associated with the occurrence of obesity in children. However, maternal employment status can be included as a complete model for multivariate analysis with logistic regression because the p-value <0.25.

In the complete model, there is a change in the significance value of the relationship between the history of breastfeeding and obesity in children (p-value <0.001). Children with a history of breastfeeding reduce the risk of obesity by 88% in preschool (aOR=0.12, 95% CI: 0.04-0.36, p<0.001). The mother's employment status was not significantly related to obesity (aOR=2.03, 955 CI: 0.72-5.75, p=0.180) (**Table 2**).

DISCUSSION

Obesity typically develops due to an imbalance in the body's energy regulation, where energy intake exceeds the body's energy expenditure. This energy balance is influenced by the intake of energy-yielding nutrients, namely carbohydrates, fats, and proteins [15]. Energy balance in the body is affected by a combination of internal factors, such as physiological regulation and metabolism. Besides that, external factors, including lifestyle and environmental influences like dietary habits and physical activity levels, are also important. Excessive energy intake (EI) relative to energy expenditure is the primary factor contributing to weight gain. The energy obtained from food is converted into substrates used through oxidation to generate energy for various biological functions or stored as fat when consumed in surplus [16]. Condition with positive energy balance was predominantly observed among those classified as obese [17]. Numerous studies indicate that obesity, characterized by increased body fat, is influenced by

environmental factors by approximately 70%, while genetic factors contribute around 30% [18].

In this study, childhood obesity was assessed by measuring each child's height and weight with calibrated equipment, and the results were plotted on the CDC growth chart. The research took place after the COVID-19 pandemic, a period that may have contributed to rising obesity rates among children in 2023, partly due to increased sedentary behavior during that time [19]. Childhood obesity arises when energy intake exceeds energy expenditure. Excessive energy intake is often linked to the consumption of high-calorie, high-fat foods, while low energy expenditure typically results from insufficient physical activity and a predominantly sedentary lifestyle [20]. Obesity negatively affects children by contributing to reduced academic performance and psychosocial issues, including low self-confidence [21]. Therefore, preventing obesity in children involves managing factors directly linked to its development, with one key factor being dietary intake. A balanced diet with appropriate portion sizes should include a variety of fruits and vegetables, whole grains, protein sources, and low-fat dairy products, while limiting the consumption of sodium, solid fats, and added sugars [22].

The research findings indicate that more mothers provide exclusive breastfeeding than those who do not. This trend can be attributed to a growing awareness among mothers about the benefits of breastfeeding, stronger family support for breastfeeding, and increased encouragement from healthcare professionals. Breast milk is the optimal source of nutrition for infants. It is hygienic, safe, and contains antibodies that help protect against many common childhood diseases. Breast milk supplies all the energy and nutrients an infant requires

during the first months of life. It meets up to half or more of a child's nutritional needs during the latter half of the first year, and around one-third during the second year. Breastfed children tend to score higher on intelligence tests, have a lower risk of becoming overweight or obese, and are less likely to develop diabetes later in life [23].

The statistical analysis results using the univariate analysis showed a significant relationship between breastfeeding history and childhood obesity. This finding contrasts with research from the Cincinnati Children's Hospital Medical Center, which concluded that breastfeeding was not linked to obesity in children, and other studies in Indonesia that found no significant association between breastfeeding history and childhood obesity. Exclusive breastfeeding is thought to have a protective effect against obesity, which could be attributed to differences in study methodologies or uncontrolled confounding variables [13].

Several factors contribute to mothers not providing exclusive breastfeeding. A study conducted in China identified that many mothers cited insufficient breast milk supply as the main reason for supplementing with formula. Other factors included the involvement of grandmothers as primary caregivers, nipple pain due to cracking, and lack of sleep. Additionally, environmental influences, such as other mothers also using formula, as well as media portrayals of infant growth and the perceived importance of formula, played a role in shaping mothers' decisions [24].

Several mechanisms link the excessive consumption of formula milk during infancy to obesity in toddlers. First, consuming large amounts of formula milk can contribute to weight gain in children up to 7. Second, infants who consume a significant amount of formula milk may develop a tendency to continue drinking milk into their toddler years. While the nutritional content of formula milk is designed to be similar to breast milk, it typically contains more energy. For example, 100 ml of formula milk provides 77.6 kcal, higher than breast milk's 63.9 kcal per 100 ml. If this overconsumption continues, it leads to an energy intake that exceeds the child's needs, increasing the risk of obesity [25]. The lower protein concentration in breast milk may play a role in influencing infant growth, and reduced protein intake could potentially help prevent childhood obesity [26].

LIMITATIONS

This study has several limitations. Its cross-sectional design restricts the ability to establish causality between exclusive breastfeeding and obesity risk, allowing only the identification of associations; a longitudinal approach would be required to determine causal relationships. Data collection relied on structured questionnaires, which may have introduced recall bias, particularly in maternal reporting of feeding practices, and children's dietary intake was not assessed, despite being an essential confounding factor in obesity research. Moreover, the study did not evaluate mothers' knowledge of parenting styles and balanced nutrition. At the same time, the statistical analysis was constrained by zero-value distributions in variables such as maternal knowledge and family support, preventing the calculation of odds ratios and limiting exploration of their potential influence on obesity. During data collection, especially when measuring children's nutritional status, many children were initially reluctant to participate, requiring persuasion from researchers, with support from parents or teachers proving crucial to ensure cooperation and accurate measurements. Nonetheless, the study also has strengths, including using a double-stage sampling method and data collection from both a public and a private kindergarten, enhancing the representativeness of the findings for the Serang area of Indonesia.

CONCLUSION

The history of exclusive breastfeeding is significantly associated with the occurrence of obesity in preschool children in Serang City. Children who are not exclusively breastfed have a higher risk of developing obesity during the preschool years. As a result, continuous education about the importance of exclusive breastfeeding in preventing obesity is essential. Mothers need to enhance their knowledge on how to provide exclusive breastfeeding for the first six months properly, assess whether their breastfeeding supply is adequate, and learn more about obesity. Additionally, mothers should monitor their children's physical activity to help reduce the risk of obesity.

ETHICS APPROVAL

The study protocol was approved by the Institutional Review Board of the Faculty of Medicine and Health Sciences, Sultan Ageng Tirtayasa University (IRB No. 217/UN.43.20/KEPK/2023). The research data came from primary data of kindergarten children in Serang City, Indonesia. All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

All participants (or their legal guardians) provided informed written consent to publish their anonymized data.

AVAILABILITY OF DATA

The datasets generated and analyzed during the current study are not publicly available due to participant confidentiality, but are available from the corresponding author on reasonable request.

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None.

CONFLICT OF INTEREST

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AUTHORS' CONTRIBUTION

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors made limited use of ChatGPT (GPT-4, OpenAI) during manuscript preparation, primarily for language suggestions and minor corrections in some sections. All subsequent content was independently reviewed and edited by the authors, who are solely responsible for the accuracy, interpretation, and scientific content of the published article.

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