Milk consumption and stunting among children aged 6-59 months in Surabaya, Indonesia

Salma Firdaus[1], Cahyani Tiara Safitri[1], Bellinda Zalzabillah Tazkira[1], Firman Syauqi Maulana Habaib Sulthon[1], *Mira Irmawati[2], Arif Hidayat[3], Satria Yudistira[3]

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Abstract

Background: Stunting impairs child growth and development, affecting millions of children under five years worldwide. Consumption of milk provides important macronutrients and micronutrients that support growth.

Objectives: To assess milk consumption and its associations with stunting in children aged 6-59 months in Surabaya City, Indonesia.

Method: This case-control study compared milk consumption between children aged 6-59 months with stunting (cases) and normal children (controls). Data were obtained from questionnaires and anthropometric databases from five primary healthcare centres in Surabaya city. Data from 94 subjects were analysed using Chi-square and multivariate logistic regression.

Results: Children with stunting had a significantly later age of milk introduction, less frequent daily milk consumption and a lower amount of daily milk consumption than controls ($p<0.05$). Age of milk introduction ≥18 months was a risk factor associated with stunting ($p<0.05$, crude OR= 3.0, 95% CI 1.2-7.4). Daily milk consumption less than twice a day ($p<0.05$, crude OR=3.8; 95% CI 1.4-10.5) and amount of milk less than 500 ml ($p<0.05$, crude OR=2.9; 95% CI 1.2-6.8) were risk factors associated with stunting. After adjusting for other confounding variables, odds of stunting were found to be dominantly higher statistically in children with daily milk consumption of less than twice a day ($p<0.05$, adjusted OR= 3.4, 95% CI 1.0-11.5).

Conclusions: This study concluded that milk introduction at the age beyond 18 months, frequency of daily consumption of less than twice a day and an amount of less than 500 ml a day are significantly associated with higher odds of stunting.

[1]*Medical Study Programme,* [2]*Department of Paediatrics, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia,* [3]*Yayasan Abhipraya Insan Cendekia Indonesia, Tangerang Selatan, Indonesia*
**Correspondence:* irmawatimira@gmail.com
https://orcid.org/0000-0002-6067-5531

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(Key words: Stunting, Milk consumption, Frequency of milk consumption, Amount of milk, Age of milk introduction)

Introduction

Stunting is the result of impaired growth and development due to poor nutrition, repeated infection, and inadequate psychosocial stimulation affecting 161 million children worldwide[1]. In 2021, the prevalence of stunting in Indonesia was 24.4%. Even in Surabaya, the second largest city in Indonesia, the prevalence of stunting was 28.8%[2]. A child's growth needs an adequate intake of macronutrients which are required as the energy source of metabolic body functions and micronutrients required for adequate growth[3]. A large multi-country demographic health survey found that children fed with any animal source foods (ASF) had a lower risk of stunting, and also noted that dairy consumption had the strongest association with stunting reduction amongst all ASF[4]. Dairy products that contain or are made from milk, are included in one of the eight groups included in the recommended minimum dietary diversity (MDD)[5].

Milk consumption has long been assumed to be beneficial for growth[6]. Milk is the most common source of animal protein consumed by children compared to other ASF. Milk provides macronutrients higher in amino-acids than other protein sources such as meat or egg and micronutrients such as phosphorus, iron, calcium, zinc, vitamin A and vitamin D, which may support the immune system and linear growth in children[7,8]. Previous research has demonstrated the importance of household milk consumption for reducing stunting among children, and that recent historical increases in milk consumption at the national level is associated with meaningful reductions in stunting in a large and diverse panel of low middle income countries[9]. Similarly, a study of the Nutritional Surveillance System in Indonesia from January 1999 to September 2003 has shown that consumption of fortified milk is associated with reducing stunting in children[10]. Nevertheless, the milk consumption level in Indonesian children is still low. For example, data from Statistics Indonesia shows that children's milk consumption in Surabaya (per capita per week) decreased from 78g in 2021 to 68g in 2022[11].

Objectives

To assess milk consumption and investigate its association with stunting in children aged 6-59 months in Surabaya City, Indonesia.

Method

This case-control study was conducted from November to December 2022 to compare prior milk consumption between stunted children (cases) and normal children (controls). Five primary healthcare centres were randomly selected as representatives in each Surabaya region. Data

were obtained from the primary healthcare database and questionnaires. The selected primary healthcare centres were briefed on the purpose of the study.

Inclusion and exclusion criteria: The study was conducted among children aged 6-59 months. Primary healthcare anthropometric databases were used to identify cases and controls. Cases were defined as children with stunting (HAZ <-2 SD) and controls as normal children (HAZ ≥-2 SD) based on WHO growth standards. Both cases and controls had at least a history of consuming milk besides breastmilk so that milk consumption and its history could be evaluated. Children with their mothers/ caregivers who lived in the coverage area were included. Children with a history of congenital abnormalities, chronic infections, genetic syndromes and illiterate mothers/caregivers were excluded.

Sample size calculation: The sample size was determined by a standard formula of matched case-control study by considering the following assumptions: proportion of milk consumption among cases (p) was 43.1%, effect size (odds ratio [OR]) of 3.75, 95% confidence interval (CI) or (Zα/2=1.96), 5% significance, 80% specified power (Zβ =0.84) and control to case ratio =1[7]. The total sample size for this study was 94, with 47 cases with 47 matched controls. After establishing the sampling frame, subjects were selected using consecutive sampling techniques until sample size was achieved.

Data collection: Data were collected from face-to-face interviews with mothers/caregivers through a structured questionnaire that recalls the milk introduction and consumption history. Variables assessed under milk consumption consisted of age of milk introduction, frequency, amount, and type of routine milk. Confounding variables, such as parents' education and income, were also collected.

Ethical issues: This study was approved by the Airlangga University Faculty of Medicine Ethical Committee (Letter No. 257/EC/KPEK/ FKUA/2022) and Surabaya Regional Public Health Office (Letter No. 072/3303.436.7.2/2022). Written informed consent was obtained from the parents of the study participants.

Statistical analysis: All collected data were processed through data entry, coding, and cleaning using Google Sheets. Statistical analyses were performed using Statistical Package for the Social Sciences version 23. Numerical data were tested using an independent t-test or Mann-Whitney test, depending on the normality of the data. Bivariate analysis of categorical data was done using Chi-Square or Fisher's-Exact Test to assess the predictors of stunted growth. Crude ORs (COR) and 95% confidence interval (CI) were calculated for the bivariate analysis. Multiple logistic regression analysis was used to examine the relationship between milk intake and stunting after controlling for confounding variables that were statistically significant, with adjusted ORs (AOR) also being calculated.

Results

Table 1 shows the socio-demographic characteristics of cases and controls. Children with stunting were mostly found in families with lower parental education and socioeconomic status. Bivariate analysis showed that maternal education, paternal education, and family income had a significant relationship with stunting ($p<0.05$). Lower maternal education (COR=3.7; 95%CI 1.5 – 9.1), paternal education (COR=2.9; 95%CI 1.2 – 6.9), and family income (COR=2.6; 95%CI 1.1 – 6.1) contributed 3.7, 2.9, 2.6 times higher odds of stunting consecutively.

Table 1: ***Socio-demographic characteristics***

Variable	Total n (%)	Cases n (%)	Controls n (%)	p-value	COR (CI 95%)
Gender					
Female	53 (56)	27 (51)	26 (49)	1.000	1.1 (0.4-2.5)
Male	41 (44)	20 (49)	21 (51)		1.0
Age of child					
>24-59 months	75 (80)	37 (49)	38 (51)	1.000	0.9 (0.3-2.4)
6-24 months	19 (20)	10 (53)	09 (47)		1.0
Maternal education					
< Senior High School	33 (35)	22 (67)	11 (33)	**0.031***	**3.7 (1.5-9.1)**
≥ Senior High School	51 (54)	25 (41)	36 (59)		1.0
Paternal education					
< Senior High School	36 (38)	25 (69)	11 (31)	**0.006***	**2.9 (1.2-6.9)**
≥ Senior High School	58 (62)	22 (37)	36 (62)		1.0
Family income					
≤ 2.500.00 IDR	53 (56)	32 (60)	21 (40)	**0.037***	**2.6 (1.1-6.1)**
> 2.500.000 IDR	41 (44)	15 (37)	26 (63)		1.0

**p-value <0.05 and Crude ORs (COR) of bivariate analysis with dependent variable (stunting).*

The history of milk introduction and consumption in children aged 6-59 months is shown in Table 2. Daily milk consumption less than twice a day was associated with a 3.8 times higher risk of stunting compared to children with at least twice a day (COR=3.8; 95%CI 1.4-10.5). Children consuming milk less than 500 ml daily had a greater risk of stunting than children consuming ≥500 ml daily (COR=2.9; 95%CI 1.2 - 6.8). A significant relationship exists between the age of milk introduction, frequency, and amount of daily milk consumption and stunting in children aged 6-59 months

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Table 2: ***History of milk introduction and consumption in children aged 6-59 months***

Variable	Total n (%)	Cases n (%)	Controls n (%)	p-value	COR (CI 95%)
Age of milk introduction					
>18 months	40 (61)	25 (63)	15 (37)	**0.028***	**3.0 (1.2-7.4)**
≤18 months	54 (39)	22 (51)	32 (49)		1.0
Average age of introduction of milk (months)		16.38	9.96	**0.015***	
Frequency of milk consumption					
<2 times a day	59 (63)	34 (68)	25 (32)	**0.011***	**3.8 (1.4-10.5)**
≥2 times a day	35 (37)	13 (37)	22 (63)		1.0
Amount of milk consumption					
<500 ml daily	54 (56)	33 (61)	21 (39)	**0.022***	**2.9 (1.2-6.8)**
≥500 ml daily	40 (44)	14 (35)	26 (65)		1.0
Milk type					
Formula milk	70 (74)	34 (49)	36 (51)	0.127	
UHT milk	15 (16)	06 (40)	09 (60)		
Soybean milk	02 (02)	01 (50)	01 (50)		
Without milk	07 (08)	06 (98)	01 (12)		
Average					
Frequency of weekly milk consumption	22.8	18.8	26.9	0.061	
Frequency of daily milk consumption	03.3	02.6	04.0	**0.006***	
Amount of daily milk consumed (ml)	557.9	438.1	677.7	**0.009***	

*ml: milliliters; UHT: Ultra-high temperature; *p <0.05 and Crude ORs (COR) of bivariate analysis with dependent variable (stunting).*

Table 3 shows the results of multivariate regression analysis with AOR after being controlled by confounding variables. Father's last educational background and frequency of daily milk consumption per day have a significant relationship with stunting in children aged 6-59 months after adjusting for confounding variables (p<0.05). Lower paternal education without reaching senior high school was significantly associated with 3.6 times higher odds of stunting in multivariate models (p= 0.021, AOR 3.6 95% CI 1.2-10.9). Children aged 6-59 months with daily milk consumption less than twice a day had 3.4 times greater odds of stunting than those consuming at least twice or more a day (p=0.07, AOR 3.4 95% CI 1.0 0.9-11.5). The age of milk introduction at 18 months was associated with higher odds of stunting, but the association was not significant (p= 0.07, AOR 2.9 95% CI 2.9 0.9-8.9) in the multivariate models.

Table 3. ***Results of multivariate regression analysis***

Variables	B	S.E	Wald	p-value	AOR (CI 95%)
Maternal education	0.493	0.575	0.735	0.391	1.6 (0.5-5.1)
Paternal education	1.296	0.559	5.368	**0.021***	**3.6 (1.2-10.9)**
Family income	0.302	0.557	0.293	0.588	1.3 (0.5-4.0)
Age of milk introduction	1.050	0.579	3.289	0.070	2.9 (0.9-8.9)
Frequency of daily milk consumption	1.230	0.621	3.92	**0.048***	**3.4 (1.0-11.5)**
Amount of daily milk consumption	0.360	0.570	0.400	0.527	1.4 (0.5-4.4)

**p-value <0.05 and Adjusted ORs (AOR) of multivariate analysis with dependent variable - stunting.*

Discussion

The results of this study were in line with studies conducted in Bangladesh and Indonesia that indicated higher levels of parental education was related to a high HAZ in children[12]. Higher education could influence wiser decision-making and weighing risks and benefits. Maternal education level could influence the way of thinking and understanding of a child's nurture indirectly[13]. Mothers, as caregivers, are responsible for providing nutritious and healthy food. Meanwhile, paternal education usually affects the level of family income, welfare and economic stability for children[12]. As known, family income is a determinant factor of stunting where children from low-income families of less than 2.5 million IDR had a greater risk compared to children with family incomes higher than 2.5 million IDR (Table 1). A study conducted in Indonesia also showed that children from low family income had a three times greater risk of stunting[13]. United Nations Children's Fund (UNICEF) states that poverty and education are the root causes of children's nutritional status as they affect family purchasing power and access to food, information, and health services[14].

Around the age of 6 months, a child's need for energy and nutrients starts to exceed what is provided by breast milk. Breastmilk can only provide half or more of a child's energy needs between the ages of 6 and 12 months, and one third of energy needs between 12 and 24 months[15]. Introduction of nutritionally adequate and safely prepared complementary foods are necessary to meet those needs. Delayed introduction of proper complementary food compromises its quality and/or quantity for children's dietary requirements which in turn could result in stunting. This study has shown that a late age of milk introduction is a risk factor for stunting. The risk of stunting was greater in children who started drinking milk at the age of ≥18 months compared to children who started drinking milk at <18 months (Table 2). The significant findings regarding the age of milk introduction are in line with other studies, which stated that children who had only received milk at an older age were found to be more stunted than those who had received milk in the first six months[16]. Other studies also showed the risk of stunting was found to be 4.1 times greater in 24-month-olds toddlers who started drinking milk at the age of ≥12 months compared to children who started drinking milk at the age of <12 months[17].

The importance of milk consumption and its age of introduction to children can prevent stunting as children need additional nutritional intake other than breastmilk to support their growth. However, milk is not a substitute for breastmilk, especially for healthy children under 6 months of age. Use of formula milk should accord with recommended guidelines for infants with supplemental ingredients added to better approximate the composition to human breast milk such as iron, nucleotides and compositions of fatty acids of arachidonic acid (AA) and docosahexaenoic acid (DHA) and probiotics[18]. Meanwhile, whole cows' milk, commonly marketed in the form of UHT milk, should only be introduced to children at the age of 1 year when its ingredients are well-tolerated by most children and digestive systems have matured.

WHO-UNICEF recommended that complementary feeding practices reach at least five food groups per day from a total of eight groups of MDD. In addition to proper complementary solid food, dairy is one of the recommended MDD groups that can be beneficial to support a child's growth[5]. This study showed that less frequency and amount of daily milk consumption had a significant relationship with stunting. Frequency and amount of daily milk consumption, which follows serving recommendations and the appropriate amount on the packaging, were important factors in supporting children's normal growth. This study is in line with a study in Indonesia, which concluded that frequency and amount of milk consumption had a significant relationship with the incidence of stunting[17]. Results of a study in 73 low- and middle-income countries also found a relationship between milk consumption and the addition of HAZ score and a decrease in stunting incidence in children[19]. Milk contains sufficient proportions of essential amino acids for various regulatory roles in human growth and metabolism. When the proportion of one or more essential amino acids is deficient, it could limit the body's capacity for synthesizing other proteins. Hence, if the amount of milk consumption is inadequate, one of the impacts on the human body is the lack of growth and development[20]. Milk also has micronutrients that can stimulate gene expression related to growth hormone and insulin-like growth factor-1 (IGF-I) receptor synthesis[21]. IGF-1 plays a role in increasing the absorption of amino acids, which will be combined into new proteins and further contribute to bone length growth. Higher concentrations of IGF-I indicate catch-up growth in a child's height[16]. In this study, the milk most widely used was formula milk.

Milk, especially formulated milk for children under five years, is fortified with micronutrients required for children, such as iron, zinc and vitamins. Fortification of micronutrients and milk protein in milk helps children meet their requirements in addition to food intake[10]. A study found that consumption of fortified milk is associated with decreased odds of stunting among Indonesian children[17]. Besides, milk contains one other component that plays a significant role in bone growth, namely calcium[19]. Milk consumption after the age of six months improves the adequacy of micronutrients and can stimulate growth in subsequent years. Thus, regular milk consumption fulfils children's nutrition and is a source of calcium and other micronutrients that support bone growth and growth hormone[8]. According to an analysis, cost-effectiveness of micronutrient fortification, especially milk, prevents a significant number of deaths in children through reduction of micronutrient deficiencies, underweight, and stunting in developing countries[22]. However, it is necessary to conduct specific cost–benefit estimates considering economic and environmental conditions as well as local and national resources. Besides, adding proper standardized fortified milk as a complementary food in addition to solid food may be warranted particularly where access to nutritious food with proper food handling and storage is limited[23].

This study signifies the importance of milk consumption in prevention of stunting. Complementary feeding, with introduction of milk after exclusive breastfeeding and before 18 months of age is recommended to provide adequate nutrients for children's growth. Results of this study can be the basis for formulating policies regarding promotion and prevention of stunting, as daily milk consumption should be considered an important strategy in reducing the prevalence of stunting in Indonesia. In addition, the potential implication of dairy promotion is that it needs to be strongly accompanied by appropriate nutrition education and campaigns to promote exclusive breastfeeding. This study is limited to mother's ability to recall the history of milk consumption in children. Further cohort research design with a larger scale is needed to examine children's milk consumption and assess milk's nutrition in-depth regarding its role in preventing stunting.

Conclusions

Children with stunting had a significantly lower parental education and family income. Introduction of milk beyond the age of 18 months, frequency of daily consumption less than twice and less than 500ml a day were significantly associated with higher odds of stunting. After 6 months of exclusive breastfeeding, the role of milk as one of the complementary feeding practices besides solid food needs to be considered when breastmilk alone can no longer provide complete nutrition for infants. Milk consumption, which follows the serving recommendations, is important in supporting the normal growth for children aged 6-59 months to prevent stunting.

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