LOW BIRTH WEIGHT, BIRTH ORDER, URTI, AND UNIMPROVED LATRINES AS RISK FACTORS FOR GROWTH FALTERING IN RURAL EASTERN INDONESIA

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ABSTRACT

Background: Growth faltering in children remains a major global public health concern because its consequences extend far beyond early life, affecting cognitive development and future economic well being. In Indonesia, children living in rural settings face a greater risk of experiencing growth problems, particularly in contexts marked by infectious diseases, inadequate sanitation, and maternal related factors. This study was conducted to examine the risk factors associated with growth faltering among children under two years of age in rural areas of Eastern Indonesia using data from the 2023 Indonesian Health Survey.
Method: A cross-sectional design was applied, involving 2,672 children aged 6 to 23 months. Data were analyzed using the chi square test and multiple logistic regression.
Result: The findings revealed that a history of low birth weight (AOR = 2.45; 95% CI: 1.755–3.434; p < 0.00), birth order (AOR = 1.23; 95% CI: 1.031–1.481; p = 0.015), a history of upper respiratory tract infection (AOR = 1.28; 95% CI: 1.04–1.57; p = 0.020), and unimproved latrine conditions (AOR = 1.314; 95% CI: 1.046–1.651; p = 0.019) were significant risk factors for growth faltering.
Conclusion: These results suggest that infectious diseases, poor sanitation, and maternal characteristics play a central role in shaping the burden of child growth faltering in rural Eastern Indonesia. Accordingly, efforts to reduce its prevalence should prioritize improvements in maternal health services, stronger family planning programs, prevention of infectious diseases, and better access to basic sanitation in rural communities.

Keywords: growth faltering; maternal factors; infectious diseases; sanitation; rural areas

INTRODUCTION

Growth faltering among children, particularly those under two years of age, continues to be a major public health issue, especially in low and middle-income countries across Africa and Asia[1]. This condition is commonly reflected in stunting, which signals chronic undernutrition, and wasting, which points to acute nutritional deficiency. Both conditions are frequently found among children growing up in resource limited environments, and their consequences extend well beyond childhood, contributing to a higher risk of mortality and morbidity later in life[2]. According to the World Health Organization, there were approximately 148.1 million cases of stunting worldwide in 2023, accounting for 22.3% of children under five years of age[3]. More than 250,000 child deaths each year have also been associated with stunting[4].

In essence, stunting emerges through a process of growth failure accompanied by insufficient catch-up growth, indicating that

a child is unable to achieve optimal physical development[5]. Within this framework, growth failure can be viewed as an early stage that may eventually lead to stunting, making its early detection especially important. This is crucial because the effects of impaired growth are wide ranging, encompassing disruptions in immune function, digestive health, and cognitive, attentional, and behavioral development[6], which may later progress into chronic malnutrition[7]. Growth disturbances in early life are also associated with shorter adult stature and a greater likelihood of death before the age of 24 months[8]. For this reason, the first two years of life represent a particularly critical period, as nutritional and health interventions tend to yield their greatest benefit during this window[9]. When growth failure is not addressed promptly at this stage, it may persist and subsequently contribute to stunting[10].

The magnitude of this problem is also evident in the variation in prevalence across countries. Several studies from India and Sri Lanka have reported relatively high levels of growth disturbance, at 48.6% and 64.2%, respectively[11,12]. In Indonesia, data from the 2023 Indonesian Health Survey showed that 24.9% of children under five experienced growth faltering, with a higher proportion in rural areas at 27.5% compared with 22.4% in urban areas. Eastern Indonesia was recorded as the region with the highest prevalence of growth failure, reaching 25.86%. These findings underscore that growth faltering is not only widespread, but also disproportionately burdens communities living in less favorable social and environmental conditions.

Growth faltering in children does not arise from a single cause. Rather, it develops through the interaction of several interrelated conditions. UNICEF identified infectious disease as one of the direct causes of impaired child growth[13], with acute respiratory infection and diarrhea being the forms of infection most frequently implicated[14]. Infection can suppress appetite, disrupt swallowing and digestion, and ultimately reduce nutritional intake[15,16]. At the same time, poor sanitation remains an important determinant. A study in Uganda found that children living in households with drinking water contaminated by Escherichia coli experienced more severe health problems, including an increased lactulose:mannitol ratio, a marker of environmental enteric dysfunction that reduces the intestine's ability to absorb nutrients and, in turn, contributes to stunting[17]. Other studies have likewise reinforced that contaminated water and poor WASH conditions are closely associated with impaired nutrient absorption and suboptimal child growth[18–20].

Beyond infection and environmental conditions, maternal factors and caregiving practices also have a substantial role. A history of low birth weight has consistently been linked to growth faltering[21,22], since children born with low birth weight tend to have limited nutritional reserves and are more vulnerable to infection during early life[23]. This risk becomes even greater when feeding practices are inadequate, access to health services is restricted, or exclusive breastfeeding is not optimally practiced[24,25]. In this setting, good caregiving, including the provision of nutritious foods, psychosocial stimulation, and careful attention to hygiene and sanitation, becomes especially important. WHO and UNICEF recommend exclusive breastfeeding during the first six months of life because breast milk provides essential nutrients while also protecting infants from infection[26]. On that basis, this study was designed to analyze the risk factors for growth faltering among children under two years of age in rural Eastern Indonesia, particularly because this region continues to face a high burden of infection, poor sanitation, and maternal risk factors, while specific evidence based on the

most recent 2023 Indonesian Health Survey data remain limited.

METHODS

Population and Sample

This study drew on data from the 2023 Indonesian Health Survey, a national cross sectional survey covering households across Indonesia. The analysis focused on rural households with children aged 6 to 23 months who had complete maternal, child, household, and anthropometric data. Records were excluded when information was incomplete, values were extreme, or the mother was younger than 15 years or older than 49 years. The final study population therefore consisted of parents of rural children aged 6 to 23 months. The process of sample selection applied in this study is presented in the figure below.

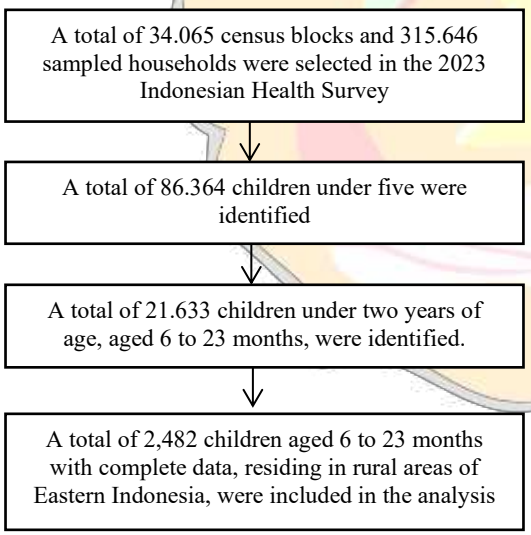

Figure 1. Flow of Data Selection from the 2023 Indonesian Health Survey

Study Variables

The dependent variable in this study was growth faltering. Children were classified as experiencing growth faltering when their body weight was below the 5th percentile, while those with body weight at or above the 5th percentile according to the WHO weight for age standard were categorized as normal.33,34 The independent variables examined in this study included history of low birth weight, history of upper respiratory tract infection, history of diarrhea, birth order, unimproved latrine conditions, history of exclusive breastfeeding, early complementary feeding, handwashing behavior, dietary diversity, meat protein consumption, birth spacing, and drinking water quality.

A history of low birth weight was categorized as low birth weight if birth weight was below 2500 grams and normal if birth weight was 2500 grams or higher. A history of upper respiratory tract infection and diarrhea was coded as yes if the respondent had ever been diagnosed with either condition by a health professional, and no if there had been no such diagnosis. Birth order was categorized as high risk when the number of children exceeded two and as low risk when the number was two or fewer. Latrine quality was considered improved when the household had a private or shared toilet that was in use, used a water sealed toilet, and was equipped with wastewater disposal facilities and a septic tank. In contrast, latrine conditions were classified as unimproved when the household had no healthy toilet facility, had a facility that was not used, did not use a water sealed toilet, and lacked wastewater disposal facilities and a septic tank.

Exclusive breastfeeding history was classified as exclusive when the child received only breast milk for the first six months without any additional food or drink, and nonexclusive when breastfeeding lasted for less than six months or when food or drink was introduced before the child reached six months of age. Early complementary feeding was categorized as before six months if the child received food or drink prior to six months of age, and at or after six months if complementary foods were introduced once the child was six

months or older. Handwashing behavior was categorized as good when handwashing was performed with running water and soap, and when it took place at critical times, namely when hands were dirty, before preparing food or eating, and after defecation. Minimum dietary diversity was classified as adequate if the child consumed five or more food groups and inadequate if fewer than five food groups were consumed. Meat protein consumption was categorized as adequate if the child had consumed meat within the previous 24 hours and inadequate if no meat had been consumed during that period. Birth spacing was considered high risk when the interval between births was less than 24 months and low risk when it was 24 months or more. Drinking water quality was categorized as improved when the source of drinking water came from bottled water, refill water, piped water, boreholes or pumps, rainwater collection, public hydrants, protected dug wells, protected springs, or retail water vendors. It was categorized as unimproved when the source came from surface water, unprotected springs, or unprotected dug wells.

Data Analysis

The data analysis in this study consisted of univariate, bivariate, and multivariate analyses. Univariate analysis was used to describe the distribution of variables, with means and standard deviations presented for interval and ratio scale variables, while nominal and ordinal variables were summarized as percentages. Bivariate analysis was conducted to examine the association between each independent variable and growth faltering using the chi square test. Multivariate analysis was then performed to identify the variables with the strongest influence on growth faltering and to obtain the best fitting model for determining risk factors for growth faltering among children under two years of age in Eastern Indonesia. The analytical approach applied was multiple logistic regression. Independent variables that were significant in the bivariate analysis at $p < 0.25$ were entered into the multivariate regression model.

Ethical Procedures

This study received approval for the use of data from the Indonesian Health Survey from the Center for Data and Information Technology of the Ministry of Health under approval number FRM/SMKI-PUSDATIN/70/0452/2024. In addition, the 2023 Indonesian Health Survey had obtained ethical clearance from the Health Research Ethics Committee of Poltekkes Jakarta under approval number LB.02.01/KEL/L/287/2023.

RESULTS AND DISCUSSION

Characteristics of the Study Subjects and Factors Associated with Growth Faltering among Children Under Two Years of Age

This study included 2,483 children under two years of age living in rural areas of Eastern Indonesia. The mean age of the children was 14.5 months. Children who experienced growth faltering tended to be older than those with normal nutritional status. The average age in the growth faltering group was 16 ± 4.76 months, whereas the mean age in the normal group was 14.13 ± 5.22 months (Table 1). This pattern suggests that the prevalence of growth faltering increases as children grow older. Such a finding is consistent with earlier studies showing that growth faltering is cumulative in nature[10], begins to emerge toward the end of the first year of life [9], and becomes more prevalent between 12 and 24 months of age.[27]

Table 1. Description of Subject Characteristics

Variable	Child Nutritional Status (N= 2482)				*p*
	Growth faltering (n=654) mean/median±SD	n(%)	Normal (n=1828) mean/median±SD	n(%)	
child age (months)[a,b]	16.00 (4.76)[a]		14.13 (5.22)[b]		0.00[c]
maternal age (year)[a]	31.36 (6.27)[b]		31.00 (6.23)[a]		0.43[c]
child sex					
boys		381(29.9)		894(70.1)	0.00[d]
girls		273(22.6)		934(77.4)	
maternal education					
low		343(28.6)		858(71.4)	0.01[d]
high		311(24.3)		970(75.7)	

Notes: Data presentation was based on the normality of distribution. a. Non normal distribution, presented as median ± standard deviation). b. Normal distribution, presented as mean ± standard deviation). c. Mann Whitney Test d. Chi Square Test

Table 2. Association Between Infectious Diseases and Sanitation Factors and Growth Faltering

Variable	Child Nutritional Status (N=2482)				PR	95%CI	p
	Growth faltering (n=654)		Normal (n=1828)				
	n	%	n	%			
History of URTI							
yes	174	30.2	402	70.2	1.47	1.036-1.388	0.019
no	480	25.2	1426	74.8			
History of Diarrhea							
yes	68	29.2	165	70.8	1.12	0.906-1.384	0.340
no	586	26.1	1663	73.9			
Handwashing Behavior							
poor	531	27.1	1430	72.9	1.14	0.967-1.360	0.123
good	123	23.6	398	76.4			
drinking water quality							
unimproved	50	22.1	176	77.9	0.82	0.641-1.065	0.152
improved	604	59.4	1652	73.2			
latrine quality							
unimproved	139	31.0	309	69.0	1.22	1.047-1.434	0.015
improved	515	25.3	1519	74.7			
exclusive breastfeeding							
no	503	27.1	1351	72.9	1.12	0.964-1.321	0.143
yes	151	24.0	477	76.0			
early complementary feeding							
yes	155	23.6	502	76.4	0.86	0.738-1.009	0.069
no	499	27.3	1326	72.7			
low birth weight (<2500 g)							
yes	68	44.7	84	55.3	1.77	1.471-2.151	0.000
no	586	25.2	1744	74.8			
birth order							
too many	323	28.8	800	71.2	1.18	1.036-1.347	0.015
ideal	331	24.4	1028	75.6			

Table 2 presents the associations between infectious diseases, poor sanitation, maternal factors, and growth faltering among children under two years of age. Among the infectious disease variables, a history of upper respiratory tract infection was significantly associated with growth faltering, whereas a history of diarrhea showed no significant relationship with this outcome. In the sanitation domain, latrine quality was significantly related to growth faltering, while drinking water quality did not demonstrate a significant association.

In addition, within the maternal factor domain, a history of low birth weight and birth order were both significantly associated with growth faltering among children under two years of age. By contrast, exclusive breastfeeding and early initiation of complementary feeding were not significantly associated with growth faltering.

Table 3. Determinant Analysis of Growth Failure Based on Logistic Regression Results

Variable	B	p	AOR	CI95%	
				lower	upper
low birth weight	.898	0.000	2.455	1.755	3.434
birth order	.212	0.022	1.236	1.031	1.481
History of URTI	.248	0.020	1.282	1.040	1.579
latrine quality	.273	0.019	1.314	1.046	1.651

$R^2 = 0{,}028$

The multivariate analysis presented in Table 3 indicates that the determinants of growth failure were birth weight (AOR: 2.455; 95% CI: 1.755–3.434), history of acute respiratory infection or ARI (AOR: 1.282; 95% CI: 1.040–1.579), number of births (AOR: 1.236; 95% CI: 1.031–1.481), and unimproved latrine quality (AOR: 1.314; 95% CI: 1.046–1.651). Taken together, these findings suggest that infectious disease, sanitation, and maternal factors play a substantial role in shaping the risk of growth failure among children living in rural areas of Eastern Indonesia.

At the same time, the relatively low R^2 value of 0.028 suggests that the model explains only a limited proportion of the variation in growth failure. This implies that, although several of the variables examined were found to be statistically significant, other factors not captured in the present study are also likely to contribute to the occurrence of growth failure.

Discussion

Child growth disorders, including growth faltering, continue to represent a major global public health concern, one that is felt most acutely in rural areas of low and middle income countries[28,29]. In Indonesia, this issue remains highly visible, particularly in rural communities where access to resources, health services, and environments that support optimal child growth and development is still limited[30,31]. The gap between rural and urban settings further illustrates this inequality, as children under two in rural areas face a greater vulnerability to growth problems, especially because of adverse environmental conditions and the high burden of infectious disease[32]. This pattern is especially apparent in Eastern Indonesia, a region that continues to carry a substantial burden of nutritional problems. Earlier studies have likewise shown that growth disorders in this part of the country are closely linked to maternal factors, infectious disease history, and inadequate sanitation [33–36].

Among the factors most consistently associated with growth disorders is low birth weight. Children born with low birth weight begin life with more limited energy reserves and weaker physical resilience, which places

them at greater risk of impaired growth when nutritional intake is insufficient or when they are repeatedly exposed to infection[37–40]. In rural settings, this challenge is often intensified by long distances to health facilities, heavy parental workloads, and constraints in caregiving, all of which may delay recovery when a child becomes ill or when nutritional needs are not adequately met[41]. A growing body of evidence has confirmed that children with low birth weight are far more likely to experience stunting or other forms of growth impairment [42–44]. For that reason, these findings highlight the need to strengthen maternal nutrition during pregnancy, improve antenatal care services, prevent infection during gestation, and ensure regular growth monitoring from the earliest stages of life.

Even so, attention to children with low birth weight should not focus solely on attempts to accelerate growth. Not all children are able to achieve catch up growth optimally, and excessively rapid growth may itself increase the risk of later metabolic disorders, including obesity and type 2 diabetes. Interventions for this group therefore need to be carefully designed and firmly grounded in evidence so that healthy growth can be achieved without creating long term health consequences. In other words, preventing growth disorders among low-birth-weight children require a balanced approach that combines nutritional recovery, close monitoring of growth, and protection against future metabolic risk[45].

In addition to low birth weight, birth spacing also emerged as an important factor affecting child growth in Eastern Indonesia. When births occur too close together, children are raised in households where resources are under greater strain and caregiving capacity must be divided across several young children. In families with limited means, parental attention, the quality of feeding practices, and developmental stimulation often cannot be provided at an optimal level[46–48]. In rural communities, this situation becomes even more difficult because early initiation of breastfeeding, exclusive breastfeeding, and age-appropriate complementary feeding are often constrained by the demands of agricultural work and the distance to health services[49]. During the age of 6 to 24 months, the quality of feeding practices, including dietary diversity and feeding frequency, plays a crucial role in determining whether children can recover growth. However, these practices often deteriorate as the number of children in the household increases, particularly in low-income families[49–51].

Closely spaced births are also associated with greater vulnerability for both mothers and children during the perinatal period, especially in rural areas that remain difficult to reach through formal health services[52]. In larger families, household spending and caregiver attention are often absorbed by basic daily needs, which means that visits to community health posts, the provision of diverse complementary foods, and timely follow up when children begin to show signs of growth or developmental problems are frequently postponed[42]. This suggests that preventing growth disorders in such contexts requires a more integrated strategy, one that combines child nutrition interventions with stronger family planning, improved maternal nutrition literacy, and practical support for responsive feeding in households with many children[51,53,54].

A history of upper respiratory tract infection was also shown to be an important risk factor for growth disorders among children under two in Eastern Indonesia. The analysis found that children with a history of upper respiratory tract infection were 1.28 times more likely to experience growth disorders than those without such a history, and this result is consistent with earlier studies conducted in rural settings[36]. Biologically, upper respiratory tract

infection can reduce appetite, increase nutrient requirements because of elevated body temperature, and eventually lead to malnutrition when a child's intake during illness is inadequate[55]. In many rural communities, upper respiratory tract infection is frequently triggered by unhealthy household environments, including the use of traditional fuels, exposure to dust, poor ventilation, and the presence of cooking smoke and cigarette smoke indoors. Repeated exposure to these conditions increases children's susceptibility to recurrent respiratory infection, which in turn disrupts normal growth[56–59].

These findings indicate that child health interventions in rural areas cannot be limited to nutritional improvement alone. Preventing repeated infectious diseases, particularly upper respiratory tract infection, must be treated as an essential component of any strategy to address growth disorders. In settings where access to health care is limited, maternal education remains low, and environmental exposures are high, nutrition programs need to be integrated with environmental health promotion, family capacity building for the care of sick children, and broader cross sectoral efforts such as improving household ventilation and reducing indoor air pollution. Such an integrated approach is also crucial for strengthening early detection and follow up of upper respiratory tract infection cases at the village level through community health volunteers and local health workers, so that the cycle of disease and malnutrition can be interrupted as early as possible.

Beyond infectious disease, poor environmental sanitation, especially the limited availability of healthy latrines, remains a very prominent issue in rural areas. Many households still do not have adequate toilet facilities, and some continue to practice open defecation. Research conducted in rural Cambodia showed that children living in communities where open defecation was still practiced had up to twice the risk of growth disorders compared with children living in open defecation free environments[8]. In the same direction, this study found a higher proportion of diarrhea among children under two who lived in households without healthy latrines than among those living in households with proper latrines. In rural Eastern Indonesia, some latrines still fail to meet health standards, including pit latrines that discharge directly into the soil, thereby creating the potential for environmental contamination and increasing children's exposure to fecal matter. Under such conditions, children may come into contact with contamination through soil, water, or unclean hands, which ultimately raises the likelihood of recurrent diarrhea and interferes with nutrient absorption.

Taken together, these findings make it clear that efforts to improve child nutrition in rural Eastern Indonesia cannot be separated from efforts to improve household sanitation. The provision of healthy latrines should be understood not merely as a matter of basic sanitation, but as a strategic intervention to prevent chronic malnutrition and support children's linear growth. The policy implication is that cross sectoral action must position adequate sanitation as an integral part of efforts to accelerate stunting reduction, including the construction of healthy family latrines, the elimination of open defecation, the provision of safe water, and education on clean and healthy living behaviors. Strengthening implementation of the first pillar of Community Based Total Sanitation, namely Stop Open Defecation, is therefore essential, because access to a healthy latrine is, in practice, a direct investment in improving the nutritional status and overall quality of life of children living in rural Eastern Indonesia.

CONCLUSION

The findings of this study indicate that the main determinants of growth faltering among children under two years of age in agricultural areas of Indonesia are a history of low birth weight, short birth spacing, a history of upper respiratory tract infection, and poor latrine quality. These results reinforce the view that the burden of growth faltering in agricultural communities is shaped by a combination of maternal, infectious, and environmental factors that are closely interconnected. Children born with low birth weight enter early life in a more vulnerable condition and are therefore more likely to experience disrupted growth. This vulnerability becomes even more pronounced when it is accompanied by short birth intervals, which can complicate childcare practices and reduce the ability of families to adequately meet children's nutritional needs and support optimal growth and development.

At the same time, the environmental conditions commonly found in rural areas increase the likelihood of recurrent upper respiratory tract infection, which in turn reduces the chances of proper growth recovery. Inadequate sanitation further aggravates this situation by increasing exposure to fecal contamination and intensifying the burden of infection. Taken together, these conditions suggest that growth faltering cannot be addressed through nutrition specific interventions alone. Rather, it requires sustained and well coordinated cross sectoral action in rural Eastern Indonesia, with particular attention to services for pregnant women, the strengthening of family planning programs, prevention of infectious diseases, and improvement of basic rural sanitation.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the writing and publication of this manuscript.

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