Original Article

Appropriate Complementary Feeding as a Preventive Factor for Growth Faltering in Early Childhood

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ABSTRACT

Background

Growth failure in the First 1,000 days of life can affect nutritional and health problems in the next life cycle. ***Objectives:*** This study aims to analyze the risk factors for growth failure in children under two years of age based on maternal and child factors.

Method and Material

This study is an observational study with a case-control design. The subjects of the study were children aged 0-23 months in the working area of the Rowosari Health Center, Semarang City. Cases are children who experience weight gain for 2 months <5 percentile, while controls are children whose weight gain is in accordance with WHO standards. Cases and controls have complete Maternal and Child Health Book, low to middle socio-economic status, no twins, no physical abnormalities, and only one toddler in the family. A sample of 25 children (1:1), selected non probability sampling . The instruments used were digital scales, infantometers, and Child Health Book. The statistical tests used were chi-square and multiple logistic regression. Most cases and controls had normal birth weight, early initiation of breastfeeding, colostrum, and exclusive breastfeeding.

Results

The feeding pattern in children in most cases did not comply with the guidelines. Risk factors associated with child growth faltering are diet with 95% CI (OR=5.762; CI=1.363-24.362; p=0.027) and birth weight (OR=2.563; CI=1.748-3.757; p=0.002).

Conclusion

Multiple logistic regression test showed that the dominant risk factor for growth failure is dietary practices, after being controlled for birth weight and maternal education factor.

Keywords

Growth Faltering; Toddlers, Maternal Factors; Child Factors; Central Java

INTRODUCTION

Growth begins from conception and continues until the end of adolescence. Children exhibit growth patterns that result from the interaction of various factors. A child's growth status can be monitored through the Maternal and Child Health Book, allowing for early identification of abnormalities if any deviations occur. Graphical representations of growth faltering typically include stagnant growth (no increase in weight over more than one measurement), weight consistently below the 3rd or 5th percentile according to WHO growth standards by age and gender [1], or crossing down major percentile curves over two observation periods. [2] Children from low socioeconomic families—both in urban and rural areas—are at higher risk of growth faltering, particularly in the first 24 months of life. [3] The prevalence of growth faltering is reported to range between 80–94% in children aged 6–24 months.80 – 94 % from age 6 months to 24 months. [3,4]

Growth faltering can be caused by organic factors (such as gastroesophageal reflux, celiac disease, cystic fibrosis, and protein intolerance),

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which may lead to inadequate nutrient absorption and utilization. [5,6] However, most cases are attributed to non-organic causes, primarily environmental and social factors. [5,6] Among these, maternal feeding practices are crucial, as mothers act as the "gatekeepers" of nutrition, and their knowledge and skills greatly influence the quality of child feeding. [7]

Breast milk serves as the most complete source of nutrition until six months of age, starting with early initiation of breastfeeding, colostrum provision, and exclusive breastfeeding. Early breastfeeding initiation plays a critical role in reducing neonatal mortality and facilitates healthy microbial colonization in the infant's gut, offering protection against infections. [8] Lack of early breastfeeding initiation has been linked to an increased risk of stunting. [9] Colostrum, which is the first milk produced, contains vital immunological components essential for growth. A study in Southeast Minahasa found that colostrum was not associated with nutritional status based on WAZ and HAZ indices but was associated with WHZ.[10] Similarly, research in Bangladesh revealed that exclusive breastfeeding was not significantly associated with stunting; however, children breastfed until six months had a 36% lower risk of being underweight. [11]

After six months, breast milk alone becomes insufficient to meet nutritional needs, hence the necessity for complementary feeding (CF). CF should consider appropriate quantity, quality, diversity, and feeding frequency. [12] A study in Aceh showed that inappropriate CF—based on age, quantity, frequency, and variety—was associated with a six-fold higher risk of growth failure. [13]

Dietary practices are among the most fundamental factors in meeting a child's nutritional needs. Important aspects of feeding include age-appropriate portions, frequency, food texture, variety, and hygiene. [14] Poor dietary practices are strongly linked to malnutrition and inadequate weight gain in children..[15]

A key determinant of feeding behavior is maternal education. Mothers with lower educational levels often face greater challenges in acquiring and applying health and nutrition knowledge. Higher educational attainment facilitates better information access, leading to improved nutritional practices. [15] Several studies show that maternal education influences nutritional knowledge, which subsequently affects growth outcomes in children. [15,16] Adequate maternal knowledge fosters positive attitudes and behaviors, contributing to "nutrition-aware families" (KADARZI)—families that can identify, prevent, and address nutritional issues. [17] Poor maternal feeding behavior is often a contributing factor to nutritional problems in toddlers. [18,19]

KADARZI behavior includes five indicators: regular child weighing at integrated health posts (Posyandu), exclusive breastfeeding, the use of iodized salt, consumption of nutritional supplements, and the provision of diverse foods. [18] Socioeconomic limitations often require mothers to work; however, studies show mixed findings.[19] In Iran, household income was associated with growth failure, [20] while maternal employment was not significantly associated. [21]

Birth weight also plays a critical role in postnatal growth. Birth weight is a strong predictor of perinatal and neonatal outcomes. Optimal birth weight (≥ 2500 grams) offers a better foundation for future growth,[22,23] while low birth weight (<2500 grams) is associated with increased nutritional risks. [23] A study in Uganda found a negative correlation between low birth weight and postnatal growth trajectories. [24]

Although growth failure in children has been extensively studied, most research tends to focus on clinically defined outcomes such as stunting, wasting, or underweight. While important, this approach may overlook early opportunities for intervention. Unlike previous studies, the present research focuses on children who have not yet met clinical criteria for growth failure but exhibit suboptimal weight gain according to WHO standards. This approach aims to identify early risk factors to strengthen preventive and promotive strategies before more severe growth disorders develop. Therefore, this study contributes to expanding perspectives on early detection and management of growth faltering in children.

METHODS AND MATERIALS

Research Subjects

Total population of children aged 6-23 months in study area (n=117)

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Applied inclusion/exclusion criteria:

Inclusion: Children aged 6-23 months with complete growth data

Exclution: Gemelly, children experiencing infection during the study, more than one child under five in the

same household, families with socio-economic outside lower-middle class

↓

First observation (n=58)

↓

Second observation (children with growth failure identified as cases n=25)

↓

Selected as cases (n=25)

Matched controls using random sampling (n=25)

Study Design

This research employed an observational analytic study design utilizing a case-control approach. The study commenced by identifying the outcome (case and control groups) and retrospectively investigated potential exposure or risk factors associated with the observed outcomes..

Variables and Research Instruments

The independent variables included both subject characteristics (age, sex, birth weight) and maternal characteristics (educational attainment, occupational status, and level of knowledge). The dependent variable was the incidence of growth faltering. Data were collected using several instruments, including the Maternal and Child Health (MCH) handbook, a digital weighing scale, a length/height measuring device, and a structured questionnaire designed to assess relevant maternal and household factors.

Data Analysis

Bivariate analysis was performed using the Chi-square (χ^2) test to assess the association between independent variables and growth faltering. To evaluate the relative contribution and influence of multiple risk factors, multivariate analysis was conducted using multiple logistic regression modeling. This analysis aimed to identify the most significant predictors of growth failure among the study population.

RESULT

Subject characteristics

Birth weight and growth failure

As presented in Table 1, low birth weight (LBW) was more frequently observed among children who experienced growth failure. The Chi-square test demonstrated a statistically significant association between birth weight and growth failure. Further risk analysis indicated that children with a history of LBW had a 5.672-fold increased risk of experiencing growth failure compared to those with normal birth weight (Odds Ratio [OR] = 2.563; 95% Confidence Interval [CI]: 1.748–3.757; p = 0.002).

Gender and Growth Failure

Analysis of the distribution of subject characteristics revealed that the proportion of male children was higher in both the case and control groups. However, statistical testing showed no significant association between sex and the incidence of growth failure ($p > 0.05$). Therefore, sex was not identified as a significant risk factor in relation to growth failure in this study.

Age and Growth Failure

The majority of the study subjects, both cases and controls, belonged to the ≥1 year age group. Nevertheless, based on the Chi-square test, no statistically significant relationship was observed between age group and the incidence of growth failure ($p > 0.05$). Consequently, age was not found to be a contributing factor to the occurrence of growth failure in this population.

Table 1. Risk factors for failure to thrive based on subject characteristics

Characteristics	Group		Rasio Odd's	Confident Interval 95 %	p
	Cases	Control			
	f (%)	f (%)			
Birth Weight < 2500 g ≥ 2500 g	25 (100.0) 0 (0.0)	16 (64.0) 9 (36.0)	2.563	1.748-3.757	0.002*
Gender Man Woman	16 (64.0) 9 (36.0)	18 (72.0) 7 (28.0)	0.691	0.209-2,285	0.762
Age < 1 year ≥ 1 year	10 (40.0) 15 (60.0)	7 (28.0) 18 (72.0)	1.714	0.525-5.603	0.551

Chi-Square Test, p<0,05

Parental Characteristics and Growth Failure

Based on the analysis of respondent characteristics, it was found that the majority of mothers in both the case and control groups had a moderate to high level of formal education. Furthermore, the maternal knowledge regarding child health and nutrition was predominantly categorized as good, and most mothers were identified as housewives.

However, the results of statistical analysis indicated

no significant association between maternal education level, knowledge, or occupational status and the incidence of growth failure among children ($p > 0.05$). This suggests that, within the context of this study, maternal education, knowledge, and employment status were not identified as direct determinants of child growth outcomes (as presented in Table 2).

Table 2. Risk factors for failure to thrive are based on parental characteristics

Characteristics	Group		Rasio Odd's	Confident Interval 95 %	p
	Cases	Control			
	f (%)	f (%)			
Education ≤ 9 years > 9 years	7 (28.0) 18 (72.0)	13 (52.0) 12 (48.0)	0.359	0.111-1.161	0.149
Knowledge Not good Good	7 (28.0) 18 (72.0)	10 (40.0) 15 (60.0)	0.583	0.178-1.906	0.551
Work Work Housewife	7 (28.0) 18 (72.0)	6 (24.0) 19 (76.0)	1.231	0.347-4.371	1.000

Chi-Square Test, p<0,05

Nutritional Parenting

Breastfeeding Practices and Growth Failure

Analysis of breastfeeding practices showed that the majority of mothers in both the case and control groups practiced early initiation of breastfeeding (EIBF), provided colostrum, and offered exclusive breastfeeding during the first six months of life.

However, the results of statistical analysis indicated no significant association between these breastfeeding practices and the incidence of growth failure ($p > 0.05$). Therefore, although optimal breastfeeding practices are theoretically beneficial for promoting healthy child growth, they were not found to have a statistically significant effect in reducing growth failure in this study population.

Complementary Feeding Practices and Growth Failure

As presented in Table 3, appropriate complementary feeding practices were more commonly observed among children without growth failure. The Chi-square test revealed a significant association between complementary feeding practices and the incidence of growth failure ($p = 0.027$). Risk analysis demonstrated that children who received inadequate complementary feeding in terms of quantity, texture, timing, and dietary diversity had a 5.762 times higher risk of experiencing growth failure compared to those who received adequate complementary feeding (Odds Ratio [OR] = 5.762; 95% Confidence Interval [CI]: 1.363–24.362).

These findings highlight the critical role of appropriate complementary feeding in preventing growth faltering during early childhood.

Table 3. Risk factors of growth failure based on Nutritional Parenting

Variable	Group		Ratio Odd's	Confident Interval 95 %	p
	Case	Control			
	N (%)	N (%)			
Early Breastfeeding Initiation No Yes	7 (28.0) 18 (72.0	8 (32.0) 17 (68.0)	0.826	0.246-2.776	1.000
Colustrum No Yes	5 (20,0) 20 (80,0)	3 (12,0) 22 (88,0)	1,833	0,387-8,674	0,702
Exclusive Breastfeeding No Yes	9 (36,0) 16 (64,0)	9 (36,0) 16 (64,0)	1,000	0,315-3,174	1,000
Food Complementary Not Good Good	11 (44,0) 14 (56,0)	3 (12,0) 22 (88,0)	5,762	1,363-24,362	0,027*

Chi-Square Test, p<0,05

Table 4. Multiple logistic regression test results

Variabel	B	SE	p	Exp (B)	95 % CI Exp (B)	
					Lower	Upper
Birth Weight	-21.554	13041.080	0.999	0.000	0.000	
Knowledge	-1,202	0,807	0,136	0,282	0,118	1,863
Food Pattern	1,705	0,857	0,047	5,550	1,026	29,478

R Square 42,8

The results of the multivariate logistic regression analysis demonstrated that the quality of complementary feeding is a significant determinant of growth failure in children aged 6–23 months, even after controlling for potential confounding variables such as maternal education and birth weight.

These findings indicate that the provision of appropriate complementary feeding independently contributes to the prevention of growth failure, regardless of the mother's educational level or the child's birth weight

status (see Table 4). This underscores the pivotal role of complementary feeding practices as a key modifiable factor in early childhood nutritional interventions.

DISCUSSION

This study identified birth weight as a significant child-related risk factor associated with growth failure. These findings are in line with previous studies, including research conducted in India, which demonstrated that low birth weight (LBW) is a major predictor of growth faltering in later stages of childhood. [16] Children born with LBW often face challenges in nutrient absorption due to the immaturity of digestive enzymes. In addition, birth weights under 2,500 grams are associated with compromised immune function, which increases susceptibility to infections that directly affect weight gain.[23] Other studies have also reported a significant association between LBW and increased risk of mortality among children under two years of age. [25]

The study also found that the proportion of male children experiencing growth failure was higher than that of females. This differs from several population-based studies, including one in Sub-Saharan Africa, which reported higher growth failure prevalence among boys. This discrepancy could be explained by differences in energy expenditure, as boys are typically more physically active, requiring greater caloric intake. When nutritional intake is inadequate, boys may be at higher risk of growth faltering. However, in the present study, the association between gender and growth failure was not statistically significant ($p > 0.05$).[1]

Similarly, age group did not show a significant association with growth failure based on the Chi-square test. This suggests that growth faltering may occur across all age ranges and is not necessarily influenced by chronological age alone. Growth is a complex process influenced by biological, genetic, environmental, and nutritional factors. Children of the same age may exhibit varying growth patterns depending on their developmental trajectories. One possible limitation of this study is the narrow age range and small sample size, which may have limited the statistical power to detect significant differences across age groups. However, other studies, such as those conducted in East Nusa Tenggara Province and Kenya, observed that growth faltering predominantly occurs in the second year of life (24–25 months).[26] Likewise, a Kenya study found that failure to thrive occurred in the second year of life. [27]

Moreover, anatomical and metabolic differences also suggest that boys may be more vulnerable to growth failure during early childhood due to higher muscle mass, which requires greater energy intake.[26] In situations of inadequate nutrition, boys may be at a relatively higher risk of faltering compared to girls.. [28]

Regarding breastfeeding practices, this study did not find a significant relationship between early initiation of breastfeeding (EIBF), provision of colostrum, exclusive breastfeeding, and the incidence of growth failure. . This is likely because the majority of respondents had already practiced optimal breastfeeding. Nevertheless, EIBF and exclusive breastfeeding remain critical according to WHO and UNICEF, as they are strongly associated with neonatal survival and the development of a healthy gut microbiota [29] Early breastfeeding initiation performed 1 hour after birth can maintain safe bacterial colonization from the mother in the baby's belly, thus providing infection protection.[29] Although no significant association was found in this study, previous research has shown that infants who did not receive EIBF had a threefold increased risk of stunting. Other studies, such as in Southeast Minahasa, indicated that colostrum was related to WHZ (Weight-for-Height Z-score) but not WAZ or HAZ indices. [10] Similarly, studies in Bangladesh have shown that exclusive breastfeeding reduces the risk of nutritional problems by 36%, even though its relationship with stunting and wasting was not always consistent.. [11]

Complementary feeding was identified as a significant risk factor for growth failure, particularly during the critical first 1,000 days of life. Appropriate feeding—covering meal frequency, portion size, texture, variety, and hygiene—plays a crucial role in supporting optimal growth [30,31] Poor feeding practices were significantly more prevalent among children with growth failure in this study. These findings are consistent with literature highlighting that improper feeding practices increase the risk of undernutrition, including stunting, wasting, and underweight [14] However, some studies, such as those from Sri Lanka and Balangan, found no significant link between feeding patterns and growth failure, indicating that knowledge gaps and contextual differences might influence outcomes.. [15,32] In order that, the knowledge gap regarding feeding patterns as well as breastfeeding has also been focused on. [33]

This study also found that inadequate dietary diversity, such as reliance on formula milk without solid foods, contributes to insufficient energy intake and increased

risk of growth faltering. A varied diet that includes carbohydrates, proteins, vegetables, and animal-source foods supports better growth outcomes in children under five, [34] who are among the most nutritionally vulnerable age groups. [35]

The multivariate logistic regression analysis confirmed that complementary feeding was the most dominant risk factor for growth failure, even after adjusting for maternal education and birth weight. Although a birth weight ≥ 2500 grams reflects good intrauterine growth, inappropriate postnatal feeding still places children at risk of growth faltering. Furthermore, maternal education alone does not guarantee correct feeding practices. If household food security is inadequate, even educated mothers may be unable to meet their child's nutritional needs.[36] The coefficient of determination (R^2) indicated that 42.8% of growth failure can be explained by feeding practices, while the remaining 57.2% may be attributed to other factors, including infections, genetic conditions, and chromosomal abnormalities.

In line with previous studies from India, this study found that maternal education was not a significant determinant of child malnutrition. However, this contradicts findings from Bangladesh, where socioeconomic factors (education and income) were significantly associated with child growth outcomes. [24] Education is considered an indirect determinant of maternal behavior in child feeding. While it may influence knowledge and practices, it must be supported by access to resources, health services, and adequate food availability to result in tangible improvements in child nutritional status.[16]

CONCLUSION

This study concludes that the provision of appropriate complementary feeding (MP-ASI) is the most significant factor influencing optimal growth in early childhood. Among the variables analyzed, complementary feeding practices demonstrated a stronger and more consistent association with growth outcomes compared to maternal education level and birth weight status. This finding highlights the critical role of dietary quality and feeding patterns during the first 1,000 days of life in preventing growth failure among children aged 6–23 months.

Research limitations

Research Limitations

Several limitations should be considered in interpreting the findings of this study:

1. Sample Size and Generalizability

The relatively small sample size limits the generalizability of the results to the wider population of children aged 6–23 months. Although the findings offer valuable insights into potential risk factors, further studies involving larger and more diverse populations are recommended to enhance external validity and statistical power.

2. Fluctuations in Growth Status

During the two-month monitoring period, weight gain dynamics were observed among the participants. In the first month, several children did not experience adequate weight gain according to WHO standards, yet in the second month, nearly half of these children showed improvements and gained weight in accordance with growth standards.

This fluctuation created challenges in consistently categorizing case subjects, as the status of growth failure could change over a relatively short time. Consequently, some children could not be definitively classified as cases, which may have influenced the statistical outcomes and reduced the number of eligible subjects for analysis.

Ethics Clearence

This research has received approval with the number 178/EA/KEPK-FKM/2024 from Public Health, Diponegoro University, Semarang.

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Competing interests

No conflict of interest

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request

Author Contribution

Study design: Siti Fatimah Pradigdo

Data gathering: Siti Fatimah Pradigdo

Data analysis: Siti Fatimah Pradigdo, Naintina Lisnawati

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