



## Determinants of stunting in children under five: a systematic review

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### ABSTRAK

**Latar Belakang:** Stunting pada anak balita merupakan masalah kesehatan masyarakat yang berdampak pada pertumbuhan dan perkembangan, yang sering kali diakibatkan oleh kondisi gizi dan kesehatan yang tidak memadai pada masa kanak-kanak.

**Tujuan:** Studi ini secara sistematis meninjau faktor-faktor yang terkait dengan stunting, dengan fokus pada faktor penentu langsung dan tidak langsung di berbagai wilayah.

**Metode:** Pencarian literatur yang komprehensif menggunakan lima basis data berkualitas tinggi: ScienceDirect, Taylor & Francis, ProQuest, Wiley Online Library, dan PubMed. Kata kunci yang selaras dengan istilah MeSH digunakan, dan artikel dari tahun 2017 dan seterusnya dalam bahasa Inggris. Pencarian menghasilkan 1.988 artikel, yang disaring mengikuti pedoman PRISMA.

**Hasil:** Kajian ini menganalisis 21 penelitian, yang sebagian besar berfokus pada anak-anak berusia 0-5 tahun (90,5%). Penelitian ini menggunakan desain cross-sectional (57%) dan terkonsentrasi di Asia (62%) dan Afrika (33%). Faktor-faktor langsung yang secara konsisten terkait dengan stunting termasuk jenis kelamin laki-laki dan masalah kesehatan seperti diare dan infeksi saluran pernapasan atas. Faktor tidak langsung yang disoroti termasuk status pendapatan yang rendah, pendidikan ibu yang rendah, dan praktik menyusui yang buruk. Kondisi ekonomi dan pendidikan ibu yang tidak memadai muncul sebagai kontributor signifikan terhadap stunting.

**Kesimpulan:** Penelitian ini menggarisbawahi interaksi kompleks antara faktor langsung dan tidak langsung yang berkontribusi terhadap stunting. Jenis kelamin laki-laki dan penyakit yang sering diderita memperburuk risiko, sementara kondisi ekonomi dan pendidikan semakin memperparah masalah ini. Untuk memerangi stunting secara efektif, intervensi yang ditargetkan untuk memenuhi kebutuhan spesifik gender, meningkatkan akses layanan kesehatan, serta meningkatkan pendidikan ibu dan kondisi ekonomi sangatlah penting. Penelitian di masa depan harus berfokus pada wilayah geografis yang beragam dan pendekatan metodologis untuk lebih memahami dan mengatasi sifat stunting yang beragam.

**KATA KUNCI:** stunting; nutrisi anak; faktor risiko; review sistematis



## ABSTRACT

**Background:** Stunting in children under five is a critical public health issue that impacts growth and development. It often results from inadequate nutrition and health conditions during early childhood.

**Objectives:** This study systematically reviews factors associated with stunting, focusing on direct and indirect determinants across various regions..

**Methods:** A comprehensive literature search used five high-quality databases: ScienceDirect, Taylor & Francis, ProQuest, Wiley Online Library, and PubMed. Keywords aligned with MeSH terms were used, and articles from 2017 onward in English were included. The search yielded 1,988 articles, which were screened following PRISMA guidelines..

**Results:** The review analyzed 21 studies, predominantly focusing on children aged 0-5 years (90.5%). The research employed mainly cross-sectional designs (57%) and was concentrated in Asia (62%) and Africa (33%). Direct factors consistently linked to stunting included male gender and health issues such as diarrhea and upper respiratory infections. Indirect factors highlighted included low income status, low maternal education, and poor breastfeeding practices. Economic disadvantage and inadequate maternal education emerged as significant contributors to stunting.

**Conclusions:** The study underscores the complex interplay of direct and indirect factors contributing to stunting. Male gender and frequent illnesses exacerbate the risk, while economic and educational disadvantages further compound the issue. To effectively combat stunting, targeted interventions addressing gender-specific needs, improving healthcare access, and enhancing maternal education and economic conditions are essential. Future research should focus on diverse geographic regions and methodological approaches to better understand and address the multifaceted nature of stunting.

**KEYWORD:** stunting; child nutrition; risk factors; systematic review

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## INTRODUCTION

Nutritional intake determines children under five's future growth and development (1). Malnutrition in children and stunting are interrelated conditions (2). Stunting in children under five is the impact of insufficient nutrients during the first thousand days of a toddler's life (3). The effect of stunting is delayed motor development and retardation of mental growth in children (4). Disorders of growth and development in children due to malnutrition, if they do not get Intervention from an early age, will continue until the child becomes an adult (5).

Factors that can influence the incidence of stunting include direct and indirect factors. The direct factors are the child's characteristics, such as gender, consumption of low-protein foods, children's health status, low birth weight (LBW), upper respiration infection (URI), and diarrhea (6). Indirect factors include exclusive breastfeeding

(EB), parental knowledge, immunization status, parental work, parental education, and family economic status (7). The availability of clean water and suitable toilet facilities will reduce severe and moderate malnutrition (8). Mothers who do not give EB will increase the risk of stunting in children (9).

Various determinant variables are also associated with the incidence of stunting (10). Factors affecting stunting are caused by one factor and several factors, such as family characteristics, socioeconomic characteristics, characteristics of children under five, characteristics of health services, characteristics of sanitation, and history of maternal and child illness (11). This study focuses on children under five years, a critical age group where stunting can have long-term detrimental effects on growth and development. By narrowing the scope to this vulnerable

population, the findings become highly relevant and actionable for those working to address stunting in early childhood. The study synthesizes existing research through a systematic review, providing an in-depth understanding of the various factors associated with stunting. The novelty of this approach lies in its ability to compile and analyze diverse factors across different contexts, potentially revealing patterns and trends that individual studies may need to capture. By examining a broad spectrum of socioeconomic, nutritional, and environmental factors, this review offers a holistic perspective on the causes of stunting, which can lead to more effective interventions.

The systematic review may reveal several critical gaps in the existing literature on stunting. Geographically, specific regions or countries where stunting is prevalent may be underrepresented, highlighting the need for more research in these specific areas. Temporally, a lack of recent studies might indicate that much of the current literature is outdated, underscoring the importance of contemporary research that reflects current socioeconomic and environmental conditions. Methodologically, the review could uncover a reliance on cross-sectional data, which limits the ability to establish causality, suggesting a need for more longitudinal studies or experimental designs. Additionally, the review may identify a gap in understanding context-specific factors, such as cultural practices or local dietary habits, emphasizing the importance of localized studies considering unique regional or cultural contexts. Finally, while factors associated with stunting may be identified, there could be a lack of research evaluating the effectiveness of interventions, indicating the need for more intervention-based studies to determine the most effective strategies for reducing stunting across different contexts. This study systematically reviews and synthesizes the existing literature on the factors associated with stunting in children under five years of age.

The research aims to identify and analyze the key socioeconomic, nutritional, environmental, and cultural factors contributing to stunting in this vulnerable population by examining a broad range of studies. The study seeks to provide a comprehensive understanding of these factors

across different contexts, highlighting gaps in the current knowledge and informing the development of more effective interventions and policies to reduce the prevalence of stunting in young children globally.

## **MATERIALS AND METHODS**

The literature search for this review utilized five databases with high and medium-quality criteria: ScienceDirect, Taylor & Francis, ProQuest, Wiley Online Library, and PubMed. The keywords for the search were aligned with the Medical Subject Headings (MeSH), comprising terms such as ((factors) OR (risk factor) OR (factored) AND (influenced) OR (influence) OR (affect) OR (actuate) AND (children stunting) OR (children's stunted) AND (determinant) OR (determination)). The inclusion criteria followed the PICOS format: Population/problem—children with stunting; Intervention—no treatment; Comparison—none; Outcome—factors influencing stunting; Study design and publication type—all study designs were considered. The review focused on publications from 2017 onward and included only articles in English. The initial search yielded 1,988 articles, which will be screened using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (**Figure 1**).

## **RESULTS AND DISCUSSIONS**

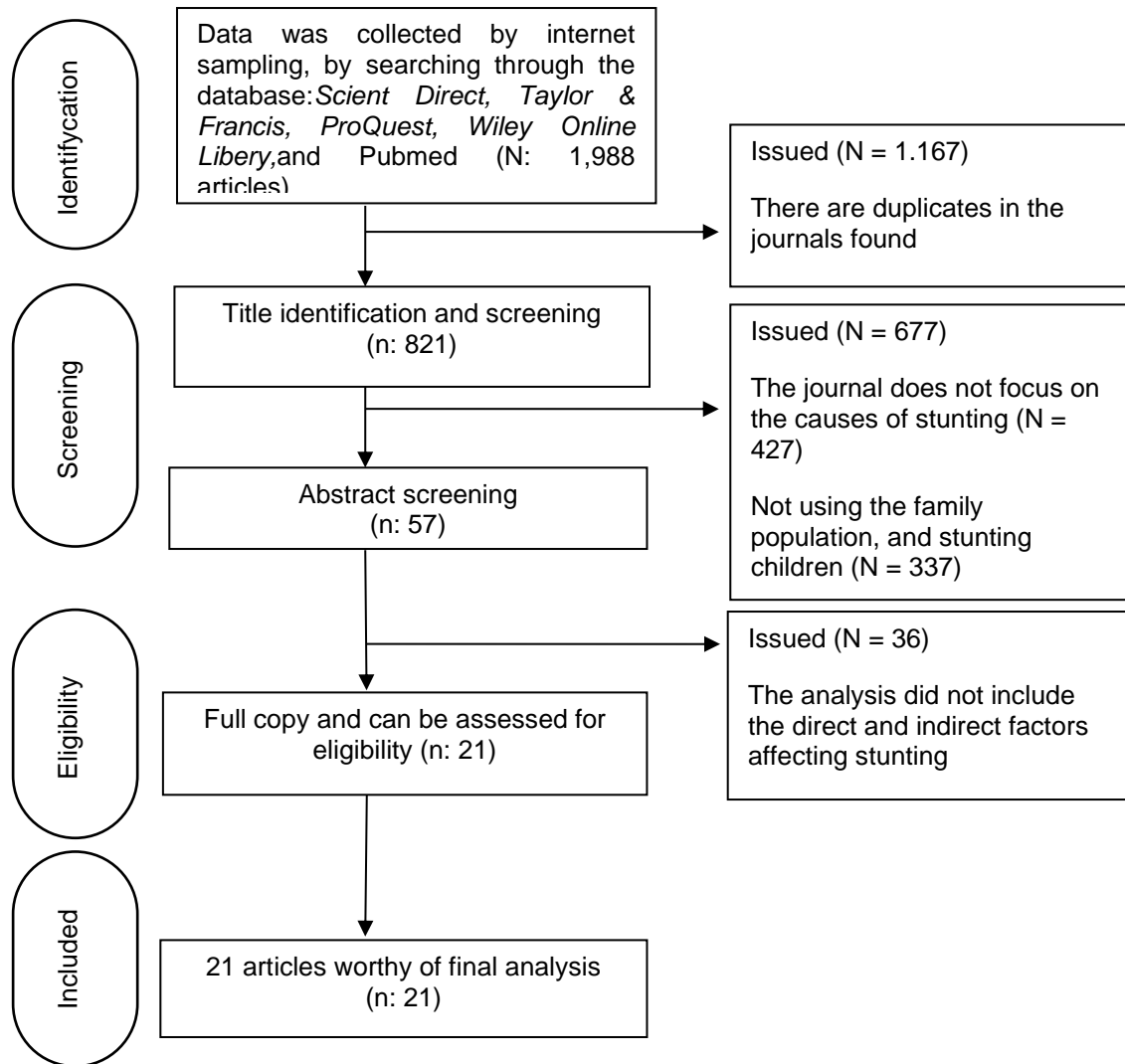
### **Characteristics of Respondents**

The authors analyzed respondent characteristics across 21 international journals, focusing on three key aspects. First, they examined age groups, specifically children aged 0-5 years and those over six years. Second, they reviewed the research designs employed in these studies, which included cross-sectional, case-control, and randomized studies. Lastly, they considered the geographic regions where the research was conducted, covering studies from Asia, Africa, and the Americas.

**Table 1.** found that the respondent characteristics of 21 international journals provided valuable insights into the focus and distribution of stunting research. A significant majority of the studies (90.5%) concentrated on children aged 0-5 years, emphasizing the critical importance of early childhood in understanding

and addressing stunting. In contrast, only 9.5% of the studies examined children over six years, indicating a predominant research interest in the

developmental stages most vulnerable to stunting and its long-term effects.



**Figure 1. Flow Diagram**

Regarding research design, cross-sectional studies were the most frequently employed, comprising 57% of the total, followed by randomized studies at 24% and case-control studies at 19%. This preference for cross-sectional methods suggests a focus on capturing a snapshot of the factors associated with stunting at a particular point in time, which is efficient but may limit causal inferences. Additionally, the

research was predominantly conducted in Asia (62%) and Africa (33%), regions where stunting is a significant public health issue, while the Americas were underrepresented, accounting for only 5% of the studies. These findings underscore the regional focus on areas with higher stunting prevalence and the need for a more diversified research approach, both geographically and methodologically.

**Table 1. Characteristics Responden (N = 21)**

Characteristics	Frequency (n)	Percentage (%)
Children's Age		
0-5 years	19	90.5
> 6 years	2	9.5
Research design		
Cross-sectional	12	57
Case-control study	4	19
Randomized	5	24
Research Area		
Asia	13	62
Africa	7	33
America	1	5

The analysis of respondent characteristics across the 21 international journals reveals a clear emphasis on early childhood, with 90.5% of the studies focusing on children aged 0-5. This focus is justified, as this developmental stage is crucial for growth and development, and stunting during this period can have long-term implications for physical and cognitive development (12). The overwhelming interest in this age group underscores the importance of addressing stunting early to prevent its long-lasting effects (13).

The predominance of cross-sectional studies (57%) in the research highlights a methodological trend toward capturing a snapshot of associations between various factors and stunting at a single point in time. While cross-sectional studies are valuable for identifying correlations and generating hypotheses, they are limited in their ability to establish causal relationships. The reliance on this design suggests a need for more longitudinal and experimental studies that can provide insights into the causal pathways leading to stunting and assess the effectiveness of interventions over time.

Geographically, the concentration of research in Asia (62%) and Africa (33%) aligns with the higher prevalence of stunting in these regions compared to the Americas (5%). This regional focus reflects the urgent need to address stunting where it is most prevalent. However, the

relatively low representation of studies from the Americas indicates a gap in understanding stunting dynamics in these regions, where different socioeconomic and cultural factors may also play a role (14).

Overall, the findings suggest that while significant research focuses on early childhood and regions with high stunting prevalence, there is an opportunity to enhance the robustness of the evidence base through diverse methodological approaches and broader geographic coverage. Addressing these gaps could lead to more effective global strategies and policies to combat stunting.

#### **Direct Factors Causing Stunting**

The data from the eight studies across various countries in Africa and Asia indicate a consistent pattern of factors associated with stunting in children under five years of age. A notable finding is the repeated identification of male gender as a significant risk factor for stunting, with adjusted odds ratios (AOR) and odds ratios (OR) ranging from 1.31 to 2.2 across studies from Ethiopia, Bangladesh, Indonesia, Uganda, India, and Ghana. For instance, in Ethiopia, Bahailu et al. (2020) found that male children were 1.51 times more likely to be stunted (AOR 1.51; 95% CI 1.16-1.96). Similarly, S. Das et al. (2020) in India reported an AOR of 1.33 (95% CI 1.14-1.54) for male children.

**Table 2. Direct factors causing stunting in children**

Article no/country	Author	Geographic region/continent	Causative factor
2 / Ethiopia	Bahailu, et. al. (2020)	Africa	Male (AOR 1.51; 95% CI 1.16-1.96)
8 / Bangladesh	R. Akram, et.al (2018)	Asia	Male (OR 1.31; 95% CI 1.12-1.53) Diarrhea (OR 1.85; 95% CI 1.41-2.42)
11 / Ethiopia	B. Batiro, et.al. (2017)	Africa	URI (AOR 3.04, 95% CI 1.04-13.35)
14 / Indonesia	H. Torlesse, et.al (2016)	Asia	Male (AOR 1.45; 95% CI 1.11-1.90)
15 / Indonesia	C. Titaley, et.al (2019)	Asia	Male (AOR 1.33; 95% CI 1.22-1.45)
17 / Uganda	J. Bukusuba, et.al (2017)	Africa	Male (OR 2.2; 95% CI 1.1-4.2) Children who reported being sick (OR 1.4; 95% CI 0.7-2.9) URI (OR 1.5; 95% CI 0.7- 3.0) Diarrhea (OR 1.1; 95% CI 0.4-3.2)
19 / India	S. Das et al. (2020)	Asia	Male (AOR 1.33; 95% CI 1.14-1.54)
20 / Ghana	Z. Ali et al. (2017)	Africa	Male (AOR 1.99; 95% CI 1.26–3.13)

In addition to gender, health-related factors such as diarrhea and upper respiratory infections (URI) were also commonly associated with stunting. R. Akram et al. (2018) in Bangladesh identified diarrhea as a significant factor with an OR of 1.85 (95% CI 1.41-2.42), while in Uganda, J. Bukusuba et al. (2017) found that children with a history of URI had an OR of 1.5 (95% CI 0.7-3.0). Other health issues, including general illness and a history of previous sickness, were also associated with stunting, although the strength of these associations varied. The consistent finding that male children are at higher risk of stunting across multiple studies suggests a potential biological or socio-cultural vulnerability that warrants further investigation. The higher likelihood of stunting in males could be due to several factors, including differences in growth patterns, nutritional needs, or care practices between genders. The cultural context in some regions might also play a role, where boys may face different dietary practices or healthcare access than girls (15,16).

The consistent finding that male children are at higher risk of stunting across various studies

suggests a complex interplay of factors that merits further investigation. Biological differences between genders may play a role, as boys could have distinct growth patterns and nutritional needs that make them more susceptible to stunting if these needs are not met (17). Additionally, differences in nutritional intake might contribute to the disparity, with boys potentially requiring more calories or specific nutrients at certain growth stages. Socio-cultural factors also come into play, as cultural practices and biases can affect access to food and healthcare, potentially leading to disparities in nutritional care between boys and girls (18,19). Healthcare access and practices might differ by gender as well, with boys sometimes receiving less medical attention for illnesses that could worsen stunting (20). Furthermore, traditional care practices, including breastfeeding and weaning methods, may vary by gender, impacting overall nutritional status. Understanding these multifaceted influences is crucial for developing targeted interventions to address gender-specific risks and improve child health outcomes.

The association between stunting and health-related factors such as diarrhea and upper respiratory infections (URI) highlights the critical role of effective illness prevention and management in combating stunting. Diarrhea is particularly concerning because it can lead to significant nutrient loss through increased stool frequency and fluid loss, which impairs the body's ability to absorb essential nutrients. This malabsorption and loss of nutrients can directly hinder a child's growth and contribute to stunting. Furthermore, frequent episodes of diarrhea can exacerbate existing nutritional deficiencies, creating a vicious cycle of poor growth and persistent illness (21,22).

Upper respiratory infections (URI), including common colds and more severe respiratory conditions, also play a significant role in stunting. Repeated or severe respiratory infections can undermine a child's overall health by increasing metabolic demands and decreasing appetite, compromising nutritional intake. These infections can lead to a higher incidence of malnutrition, as children with frequent URIs may experience reduced growth rates and delayed physical development. Chronic or severe respiratory illnesses can weaken the immune system, making children more vulnerable to other infections and compounding the risk of stunting (23,24). Addressing these health-related factors requires a multifaceted approach. Improving access to clean water and sanitation can help reduce the incidence of diarrhea. Enhancing healthcare infrastructure to ensure prompt infection treatment and promoting vaccination programs can mitigate the impact of respiratory illnesses. Public health initiatives focused on educating caregivers about preventive measures and proper nutrition during illness can also contribute to better health outcomes and reduce the risk of stunting (25,26).

These findings highlight the need for targeted interventions that address both the biological and sociocultural factors contributing to stunting (15,19,23,27,28), particularly among male children and those frequently affected by illness. Health programs should focus on improving access to healthcare, promoting gender equality in nutrition and care, and preventing common childhood diseases to mitigate the risk of stunting in vulnerable populations (29–33).

### **Indirect Factors Cause Stunting**

The analysis of indirect factors contributing to stunting, based on studies from various countries in Asia and Africa, reveals several recurring themes. Low-income status was consistently identified as a significant risk factor for stunting across multiple studies. For instance, in Bangladesh, H. Sarma et al. (2017) reported an odds ratio (OR) of 2.17 (95% CI 1.70-2.76) for children from low-income families. Similarly, in Ethiopia, Bahailu et al. (2020) found that low-income families had an adjusted odds ratio (AOR) of 5.95 (95% CI 2.58-13.69). Across different regions, economic disadvantage appears to be a dominant factor influencing stunting. Maternal education also emerged as a critical factor. Several studies indicated that low or no education among mothers significantly increased the risk of stunting in children. For example, in Bangladesh, R. Akram et al. (2018) found that children of illiterate mothers had an OR of 2.12 (95% CI 1.49-3.02), while S. Khan et al. (2019) in Pakistan reported an AOR of 2.55 (95% CI 1.26–5.17) for low maternal education. This trend was observed across other studies, including in India (S. Das et al., 2020) and a multi-country analysis by Z. Li et al. (2020).

Breastfeeding practices were another significant factor associated with stunting. Studies from Ethiopia highlighted the impact of breastfeeding practices, with late initiation of breastfeeding, bottle-feeding, and lack of exclusive breastfeeding being strongly associated with stunting. For instance, T. Fikadu et al. (2015) reported an AOR of 5.61 (95% CI 1.49-11.08) for children breastfed for less than two years. The consistent identification of low-income status as a significant risk factor for stunting underscores the profound and multifaceted relationship between poverty and child malnutrition (29,34,35). Children from low-income families often face a range of barriers that contribute to poor nutritional outcomes and stunting (23). Economic constraints typically limit their access to essential resources such as sufficient and nutritious food, quality healthcare, and educational opportunities. These limitations directly affect a child's growth and development, as inadequate nutrition can impair physical growth and cognitive development, leading to stunting (28,35,36).

**Table 3. Indirect factors causing stunting**

Article no/country	Author	Geographic region/continent	Causative factor
1 / Bangladesh	H. Sarma, et al., (2017)	Asia	Low-income families (OR 2.17; 95% CI 1.70-2.76) Poorer (OR 1.79; 95% CI 1.43-2.23) Lack of mass media exposure (OR 1.20; 95% CI 1.06-1.36)
2 / Ethiopia	Bahailu, et al. (2020)	Africa	Low-income families (AOR 5.95; 95% CI 2.58-13.69) Mothers with low education (AOR 0.18; 95% CI 0.05- 0.71)
7 / Bangladesh	P. Svefors, et.al., (2016)	Asia	Mother without education (OR 1.74; 95% CI 1.17– 2.81)
8 / Bangladesh	R. Akram, et.al (2018)	Asia	Illiterate mother (OR 2.12; 95% CI 1.49-3.02) Poor (OR 2.34; 95% CI 1.71-3.2)
10 / Ethiopia	T. Fikadu, et.al., (2015)	Africa	Children who were bottle-fed (AOR 3.30; 95% CI 1.33-8.17) Exclusive breastfeeding for <6 months (AOR 3.27; 95% CI 1.21- 8.82) Breastfeeding children <2 years (AOR 5.61, 95% CI 1.49-11.08)
11 / Ethiopia	B. Batiro, et.al. (2017)	Africa	Late initiation of breastfeeding after one hour after birth (AOR 5.16; 95% CI 2.24-15.90)
12 / Ethiopia	B. Bogale, et al. (2020)	Africa	Low-income families (AOR 2.87; 95% CI 1.72–4.81) No breastfeeding (AOR 1.55; 95% CI 1.07–2.24)
14 / Indonesia	H. Torlesse, et.al (2016)	Asia	Low-income families (AOR 2.30; 95% CI 1.43-3.68)
15 / Indonesia	C. Titaley, et.al (2019)	Asia	Poor ANC (AOR 1.22; 95% CI 1.08–1.39)
17 / Uganda	J. Bukusuba, et.al (2017)	Africa	Poor (OR 1.5; 95% CI 0.6-3.5)
18 / Pakistan	S. Khan, et al. (2019)	Asia	ANC> 3 times during pregnancy (AOR 0.61; 95% CI 0.38-0.98) Low maternal education (AOR 2.55; 95% CI 1.26–5.17)
19 / India	S. Das et al. (2020)	Asia	Low maternal education (AOR 0.59; 95% CI 0.42- 0.82)
21/35 low and middle-income countries	Z. Li, et al. (2020)	Asia, Africa	Lack of maternal education (OR 1.9; 95% CI 1.8-2.0) Poor (OR 1.7; 95% CI 1.6-1.8)

Educational deficits among parents, particularly mothers, also contribute to the cycle of poverty and stunting. Low-income families may have lower levels of education, which can affect

their knowledge of nutrition and childcare practices. This lack of awareness can result in suboptimal feeding practices and inadequate care during illness, increasing the risk of stunting (39–



41). Addressing these issues requires a comprehensive approach that includes improving access to nutritious food, expanding healthcare services, and enhancing educational opportunities. Social and economic policies aimed at reducing poverty, such as income support programs, food assistance, and investments in education and healthcare, could play a crucial role in breaking the cycle of poverty and stunting, leading to improved outcomes for children in low- and middle-income countries (42,43). Maternal education plays a crucial role in child health, as evidenced by the strong association between low maternal education and increased stunting risk. Educated mothers are more likely to be aware of proper nutrition, healthcare practices, and the importance of early childhood development, which can significantly impact a child's growth (14, 37, (14,37,44). Therefore, improving educational opportunities for women, particularly in regions with high stunting prevalence, could substantially reduce stunting (30, (30,39). Breastfeeding practices are crucial to addressing stunting, particularly in African contexts where inadequate breastfeeding is closely linked to higher rates of stunting. Breastfeeding provides essential nutrients and antibodies for a child's growth and immune system development. In many regions, poor breastfeeding practices, such as delayed initiation, inadequate duration, or insufficient exclusivity, can significantly contribute to nutritional deficiencies and increased stunting rates (25,36).

Early breastfeeding initiation is critical as it ensures that infants receive colostrum—this nutrient-rich first milk is high in antibodies and essential for building the newborn's immune system. Delayed initiation, often due to lack of awareness or medical complications, can deprive infants of these crucial benefits, impacting their growth. Exclusive breastfeeding for the first six months is equally essential, as it ensures that infants receive all the necessary nutrients and protection from infections without the interference of potentially contaminated complementary foods (25). Continued breastfeeding for at least two years provides additional nutrients and emotional support while also helping to protect against illnesses. Inadequate duration of breastfeeding can leave children vulnerable to malnutrition and

infections, both of which are linked to stunting. Studies have consistently highlighted that children who are not exclusively breastfed or who are weaned too early are at a higher risk of stunting (28,34).

To address these issues, comprehensive interventions are needed. Public health campaigns should focus on educating mothers about the benefits of early and exclusive breastfeeding, proper breastfeeding techniques, and the importance of continued breastfeeding. Community health worker programs can play a vital role in providing personalized support, guidance, and encouragement to mothers. These programs can help address common barriers to optimal breastfeeding practices, such as lack of knowledge, cultural beliefs, and practical challenges. By promoting best practices in breastfeeding through targeted education and support, it is possible to improve nutritional outcomes and significantly reduce stunting rates in affected communities (14).

These findings highlight the need for multifaceted interventions that simultaneously address economic, educational, and health-related factors to combat stunting effectively. Targeted policies that improve maternal education, economic conditions, and healthcare access, along with promoting proper breastfeeding practices, could significantly reduce the burden of stunting in vulnerable populations across Asia and Africa.

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#### **CONCLUSIONS AND RECOMMENDATIONS**

The study underscores the complex interplay of direct and indirect factors contributing to stunting in children, with clear patterns emerging across diverse geographic regions. Direct factors such as male gender and health issues like diarrhea and upper respiratory infections are consistently linked to an increased risk of stunting. The data reveal that male children are particularly vulnerable to stunting, and frequent illnesses exacerbate nutritional deficiencies, compounding the risk. Indirect factors, including economic disadvantage

and low maternal education, further compound this issue. Low-income status is a prevalent risk factor across studies from Asia and Africa, while inadequate maternal education is also a critical contributor to higher stunting rates. Additionally, poor breastfeeding practices, including late initiation and inadequate duration, are strongly associated with stunting, as highlighted in studies from Ethiopia. To address these challenges, targeted gender-specific interventions are essential. Developing and implementing nutrition and health programs tailored to higher-risk male children can help mitigate this disparity. Such programs should include health education and support strategies to meet specific nutritional needs and address health risks associated with male children. This approach aims to reduce the gender-based disparities in stunting rates and ensure that both boys and girls receive equitable health support.

Furthermore, enhancing healthcare access is crucial for addressing the common health issues contributing to stunting. Improving access to healthcare services, including effective treatment for diarrhea and upper respiratory infections, and promoting preventive measures such as vaccination and health education can help reduce the incidence of these conditions. Complementary economic support programs are also necessary to alleviate poverty and improve living conditions for low-income families. This could involve financial aid, food security initiatives, and increased access to essential services. Maternal education programs should be expanded to provide comprehensive education on child care, nutrition, and breastfeeding practices. Encouraging optimal breastfeeding practices through public health campaigns and support groups can significantly impact stunting rates, ensuring children receive the nutritional foundation for healthy growth and development.

## REFERENCES

1. Arini HRB, Hadju V, Thomas P, Ferguson M. Nutrient and Food Intake of Indonesian Children Under 5 Years of Age: A Systematic Review. *Asia Pacific Journal of Public Health* [Internet]. 2022 Jan 12;34(1):25–35. Available from:

<http://journals.sagepub.com/doi/10.1177/10105395211041001>

2. Tanaka J, Yoshizawa K, Hirayama K, Karama M, Wanjihia V, Changoma MS, et al. Relationship between dietary patterns and stunting in preschool children: a cohort analysis from Kwale, Kenya. *Public Health* [Internet]. 2019 Aug;173:58–68. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S003335061930160X>
3. Schrijner S, Smits J. Grandparents and Children's stunting in sub-Saharan Africa. *Soc Sci Med* [Internet]. 2018 May;205(October 2017):90–8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0277953618301552>
4. Mustakim MRD, Irwanto, Irawan R, Irmawati M, Setyo boedi B. Impact of Stunting on Development of Children between 1-3 Years of Age. *Ethiopian Journal of Health Sciences* [Internet]. 2022 May;32(3):569–78. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/35813667>
5. Dipasquale V, Cucinotta U, Romano C. Acute Malnutrition in Children: Pathophysiology, Clinical Effects and Treatment. *Nutrients* [Internet]. 2020 Aug 12;12(8):2413. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32806622>
6. Fenta HM, Workie DL, Zike DT, Taye BW, Swain PK. Determinants of stunting among under-five years children in Ethiopia from the 2016 Ethiopia demographic and Health Survey: Application of ordinal logistic regression model using complex sampling designs. *Clinical Epidemiology and Global Health* [Internet]. 2020 Jun;8(2):404–13. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S213398419303823>
7. Mugi anti S, Mulyadi A, Anam AK, Najah ZL. Causes of Stunting Children Age 25-60 Months in Kota Blitar District Sukorejo. *Jurnal Ners dan Kebidanan (Journal Ners Midwifery)* [Internet]. 2018 Dec 28;5(3):268–78. Available from:

- <https://jnk.phb.ac.id/index.php/jnk/article/view/374>
8. Bharti R, Dhillon P, Narzary PK. A spatial analysis of childhood stunting and its contextual correlates in India. *Clinical Epidemiology and Global Health* [Internet]. 2019 Sep;7(3):488–95. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S213398418301702>
  9. Nigatu D, Azage M, Motbainor A. Effect of exclusive breastfeeding cessation time on childhood morbidity and adverse nutritional outcomes in Ethiopia: Analysis of the demographic and health surveys. Ciccozzi M, editor. *PLoS One* [Internet]. 2019 Oct 2;14(10):e0223379. Available from: <https://dx.plos.org/10.1371/journal.pone.0223379>
  10. Purwanti R, Nurfitita D. Review of Literature: Analysis Socio-Demographic Determinants Genesis Stunting In Toddlers in Various Developing Countries. *Bul Penelitian Kesehatan* [Internet]. 2019 Dec 20;47(3):153–64. Available from: <http://ejournal2.litbang.kemkes.go.id/index.php/bpk/article/view/1349>
  11. Igbokwe O, Adimorah G, Ikefuna A, Ibeziako N, Ubesie A, Ekeh C, et al. Socio-demographic determinants of malnutrition among primary school aged children in Enugu, Nigeria. *Pan African Medical Journal* [Internet]. 2017;28:1–5. Available from: <http://www.panafrican-med-journal.com/content/article/28/248/full/>
  12. Mkungudza J, Twabi HS, Manda SOM. Development of a diagnostic predictive model for determining child stunting in Malawi: a comparative analysis of variable selection approaches. *BMC Medical Research Methodology* [Internet]. 2024 Aug 8;24(1):175. Available from: <https://bmcmmedresmethodol.biomedcentral.com/articles/10.1186/s12874-024-02283-6>
  13. De Sanctis V, Soliman A, Alaaraj N, Ahmed S, Alyafei F, Hamed N. Early and Long-term Consequences of Nutritional Stunting: From Childhood to Adulthood. *Acta Biomedica* [Internet]. 2021 Feb 16;92(1):e2021168. Available from:
  14. Vaivada T, Akseer N, Akseer S, Somaskandan A, Stefopoulos M, Bhutta ZA. Stunting in childhood: an overview of global burden, trends, determinants, and drivers of decline. *The American Journal of Clinical Nutrition* [Internet]. 2020 Sep 14;112(Suppl 2):777S-791S. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/33682846>
  15. Thompson AL. Greater male vulnerability to stunting? Evaluating sex differences in growth, pathways and biocultural mechanisms. *Annals of Human Biology* [Internet]. 2021 Aug 18;48(6):466–73. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/35105202>
  16. Thurstans S, Opondo C, Seal A, Wells JC, Khara T, Dolan C, et al. Understanding Sex Differences in Childhood Undernutrition: A Narrative Review. *Nutrients* [Internet]. 2022 Feb 23;14(5):948. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/35267923>
  17. Thurstans S, Opondo C, Seal A, Wells J, Khara T, Dolan C, et al. Boys are more likely to be undernourished than girls: a systematic review and meta-analysis of sex differences in undernutrition. *BMJ Global Health* [Internet]. 2020 Dec 15;5(12):e004030. Available from: <https://gh.bmj.com/lookup/doi/10.1136/bmjgh-2020-004030>
  18. Umallawala T, Puwar T, Pandya A, Bhavsar P, Saha S, Patil MS. Sociocultural Determinants of Nutritional Status Among Children Under Five Years of Age: An Ethnographic Study From Gujarat. *Cureus* [Internet]. 2022 Jul 27;14(7):e27377. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/36046281>
  19. Grzymisławska M, Puch E, Zawada A, Grzymisłowski M. Do nutritional behaviors depend on biological sex and cultural gender? *Advances in Clinical and Experimental Medicine* [Internet]. 2020 Feb 4;29(1):165–72. Available from:

- <http://www.advances.umed.wroc.pl/pdf/2020/29/1/165.pdf>
20. Titaley CR, Ariawan I, Hapsari D, Muasyaroh A, Dibley MJ. Determinants of the Stunting of Children Under Two Years Old in Indonesia: A Multilevel Analysis of the 2013 Indonesia Basic Health Survey. *Nutrients* [Internet]. 2019 May 18;11(5):1106. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/31109058>
  21. Hendrickson SM, Thomas A, Raué H-P, Prongay K, Haertel AJ, Rhoades NS, et al. *Campylobacter* vaccination reduces diarrheal disease and infant growth stunting among rhesus macaques. *Nature Communications* [Internet]. 2023 Jun 26;14(1):3806. Available from: <https://www.nature.com/articles/s41467-023-39433-1>
  22. Gizaw Z, Yalew AW, Bitew BD, Lee J, Bisesi M. Stunting among children aged 24–59 months and associations with sanitation, enteric infections, and environmental enteric dysfunction in rural northwest Ethiopia. *Scientific Reports* [Internet]. 2022 Nov 11;12(1):19293. Available from: <https://www.nature.com/articles/s41598-022-23981-5>
  23. Sturgeon JP, Njunge JM, Bourke CD, Gonzales GB, Robertson RC, Bwakura-Dangarembizi M, et al. Inflammation: the driver of poor outcomes among children with severe acute malnutrition? *Nutrition Reviews* [Internet]. 2023 Nov 10;81(12):1636–52. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/36977352>
  24. Morales F, Montserrat-de la Paz S, Leon MJ, Rivero-Pino F. Effects of Malnutrition on the Immune System and Infection and the Role of Nutritional Strategies Regarding Improvements in Children’s Health Status: A Literature Review. *Nutrients* [Internet]. 2023 Dec 19;16(1):1. Available from: <https://www.mdpi.com/2072-6643/16/1/1>
  25. Ridho FM, Fauzan M, Faisal A, Hanafi H. The Effectiveness of Health Communication in Preventing Stunting. *Jurnal Ilmu Sosial dan Ilmu Politik* [Internet]. 2024 Feb 15;3(2):99–107. Available from:
  26. Ponum M, Khan S, Hasan O, Mahmood MT, Abbas A, Iftikhar M, et al. Stunting diagnostic and awareness: impact assessment study of sociodemographic factors of stunting among school-going children of Pakistan. *BMC Pediatric* [Internet]. 2020 Dec 19;20(1):232. Available from: <https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-020-02139-0>
  27. Jiang Y, Su X, Wang C, Zhang L, Zhang X, Wang L, et al. Child: Prevalence and risk factors for stunting and severe stunting among children under three years old in mid-western rural areas of China. 2014;45–51.
  28. Das S, Chanani S, Shah More N, Osrin D, Pantvaiddya S, Jayaraman A. Determinants of stunting among children under 2 years in urban informal settlements in Mumbai, India: evidence from a household census. *Journal of Health, Population and Nutrition* [Internet]. 2020 Dec 27;39(1):10. Available from: <https://jhpn.biomedcentral.com/articles/10.1186/s41043-020-00222-x>
  29. Ponum M, Khan S, Hasan O, Mahmood MT, Abbas A, Iftikhar M, et al. Stunting diagnostic and awareness: impact assessment study of sociodemographic factors of stunting among school-going children of Pakistan. *BMC Pediatric* [Internet]. 2020 Dec 19;20(1):232. Available from: <https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-020-02139-0>
  30. Njuki J, Eissler S, Malapit H, Meinzen-Dick R, Bryan E, Quisumbing A. A Review of Evidence on Gender Equality, Women’s Empowerment, and Food Systems. In: *Science and Innovations for Food Systems Transformation* [Internet]. Cham: Springer International Publishing; 2023. p. 165–89. Available from: [https://link.springer.com/10.1007/978-3-031-15703-5\\_9](https://link.springer.com/10.1007/978-3-031-15703-5_9)
  31. Mkandawire E, Bisai C, Dyke E, Dressel A, Kantayeni H, Molosoni B, et al. A qualitative assessment of gender roles in child nutrition in Central Malawi. *BMC Public Health* [Internet]. 2022 Dec 20;22(1):1392. Available from:

- <https://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-022-13749-x>
32. Sahiledengle B, Petrucka P, Desta F, Sintayehu Y, Mesfin T, Mwanri L. Childhood undernutrition mediates the relationship between open defecation with anemia among Ethiopian children: a nationally representative cross-sectional study. *BMC Public Health* [Internet]. 2024 Jun 3;24(1):1484. Available from: <https://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-024-18931-x>
  33. Luzingu JK, Stroupe N, Alaofe H, Jacobs E, Ernst K. Risk factors associated with under-five stunting, wasting, and underweight in four provinces of the Democratic Republic of Congo: analysis of the ASSP project baseline data. *BMC Public Health* [Internet]. 2022 Dec 23;22(1):2422. Available from: <https://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-022-14842-x>
  34. Communication S, Fatima S, Manzoor I, Joya AM, Arif S, Qayyum S. Stunting and associated factors in children of less than five years : A hospital-based study. 2020;(April).
  35. Bogale B, Gutema BT, Chisha Y. Prevalence of Stunting and Its Associated Factors among Children of 6 – 59 Months in Arba Minch Health and Demographic Surveillance Site ( HDSS ), Southern Ethiopia : A Community-Based Cross-Sectional Study. 2020;2020.
  36. Kragel EA, Merz A, Flood DMN, Haven KE. Risk Factors for Stunting in Children under the Age of 5 in Rural Guatemalan Highlands. *Annals of Global Health* [Internet]. 2020 Feb 3;86(1):1–5. Available from: <https://annalsofglobalhealth.org/articles/10.5334/aogh.2433/>
  37. Akram R, Sultana M, Ali N, Sheikh N, Sarker AR. Prevalence and Determinants of Stunting Among Preschool Children and Its Urban–Rural Disparities in Bangladesh. *Food and Nutrition Bulletin* [Internet]. 2018 Dec 29;39(4):521–35. Available from: <http://journals.sagepub.com/doi/10.1177/0379572118794770>
  38. Batiro B, Demissie T, Halala Y, Anjulo AA. Determinants of stunting among children aged 6-59 months at Kindo Didaye woreda, Wolaita Zone, Southern Ethiopia: Unmatched case control study. Iturriza-Gómara M, editor. *PLoS One* [Internet]. 2017 Dec 20;12(12):e0189106. Available from: <https://dx.plos.org/10.1371/journal.pone.0189106>
  39. Wassie EG, Tenagashaw MW, Tiruye TY. Women empowerment and childhood stunting: evidence from rural northwest Ethiopia. *BMC Pediatric* [Internet]. 2024 Jan 9;24(1):30. Available from: <https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-023-04500-5>
  40. Rachmawati UA, Pratiwi PS, Yusnita, Abirami KR, Praditya FY. Classification of Stunting Events: Case Study in West Java, Indonesia. In 2024. p. 53–63. Available from: [https://link.springer.com/10.1007/978-3-031-66965-1\\_6](https://link.springer.com/10.1007/978-3-031-66965-1_6)
  41. Dadras O, Suwanbamrung C, Jafari M, Stanikzai MH. Prevalence of stunting and its correlates among children under 5 in Afghanistan: the potential impact of basic and full vaccination. *BMC Pediatric* [Internet]. 2024 Jul 6;24(1):436. Available from: <https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-024-04913-w>
  42. Padigapati VNS, Singh A, Velayudhan PK, Perumal A, Ramalingam S. Examining the Prevalence and Predictors of Stunting in Indian Children: A Spatial and Multilevel Analysis Approach. *Agricultural Research* [Internet]. 2024 Jul 16; Available from: <https://link.springer.com/10.1007/s40003-024-00757-z>
  43. Musheiguza E, Mbegalo T, Mbukwa JN. Bayesian multilevel modelling of the association between socio-economic status and stunting among under-five-year children in Tanzania. *Journal of Health, Population and Nutrition* [Internet]. 2023 Nov 29;42(1):135. Available from: <https://jhpn.biomedcentral.com/articles/10.1186/s41043-023-00474-3>
  44. Li Z, Kim R, Vollmer S, Subramanian S V. Factors Associated With Child Stunting, Wasting, and Underweight in 35 Low- and Middle-Income Countries. *JAMA Netw Open* [Internet]. 2020 Apr 22;3(4):e203386.