REVIEW ARTICLE

Determinants Associated With Stunting Among Children Under Two Years Old In Asia: A Scoping Review

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ABSTRACT

About 18.9 million stunted children were reported in 2022 in Asia. Although there was a reduction in prevalence, the numbers were still high. This review aimed to identify the determinants associated with stunting among children under two years old in Asia. A systematic search of English-language articles published between 2013 and 2023 was conducted using PubMed and Scopus. Only 32 articles were deemed eligible. The included studies indicated several main predictors of child stunting: 1) community and societal factors, 2) household and family factors, 3) inadequate complementary feeding, 4) breastfeeding, and 5) infection. A diverse range of contributing factors is, to varying degrees, associated with stunting, demonstrating the importance of considering how those predictors interact with nutrition. Integrated health promotion, prevention, and interventions by healthcare providers and communities are needed to address this issue.
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INTRODUCTION

Stunting is impaired growth and development that children experience due to poor nutrition, repeated infections, and inadequate psychosocial stimulation. Children are defined as stunted if their height-for-age is less than -2 standard deviations from the WHO Child Growth Standards median (1). In 2022, Asia took a third ranking higher on the prevalence of childhood stunting among other continents. The highest prevalence was in Oceania (44.0%), excluding Australia and New Zealand, followed by Africa (30.0%). From 2012 to 2022, there was a notable reduction in the prevalence of stunting in Asia, declining from 28.2% to 22.3%, a value similar to the global prevalence (2). However, nearly all affected children lived in Asia (52 percent of the global share) and Africa (43 percent of the global share). According to the National Health and Morbidity Survey (2022), the prevalence of stunting among children under five years of age in Malaysia was reported to be 21.2% (Institute for Public Health (3), This represents a 1.7% increase from the 19.5% recorded in 2000 (4), indicating a worsening trend in child malnutrition over the past two decades. The value has exceeded the target and is far from 11.0% to be achieved by 2025 under National Plan of Action for Nutrition of Malaysia III 2016- 2025 (NPAMN III) and the 2022-2030 National Strategic Plan to Address the Problem of Stunting in Children (5).

Stunting usually occurs in the first 1000 days from conception and becomes irreversible after two years of age if not treated. Stunting will cause poor cognition and educational performance, low adult wages, lost productivity, and an increased risk of nutrition-related chronic diseases in adult life (1). Stunting is frequently linked to poor socioeconomic conditions, inadequate maternal health and nutrition, recurrent illness, and/or inadequate nourishment and care of infants and young children during their early years (4). Additionally, poor sanitation and hygiene contribute to poor growth during childhood by causing infections that lead to the loss of essential nutrients. In 2015, it was reported that over 600 million people practiced open defecation in South Asia, and handwashing practices were far from optimal (6). Three sub-regions- South Eastern Asia, Western Asia, and South Asia- are still 'off track" from the annual average rate of reduction (AARR) target but have made progress toward the 2023 child stunting target (2).

Despite the various studies and approaches to overcoming childhood stunting, the prevalence remains high. Therefore, this scoping review aims to identify the

determinants associated with stunting among children under age two years old in Asia.

MATERIAL AND METHODS

Identifying Relevant Research

This scoping review was conducted by carrying out an initial search to develop and refine the search strategy for the scientific literature. Subsequent searches were conducted by two authors using the following databases: PubMed and Scopus. The searches employed both controlled vocabularies, using relevant Medical Subject Headings (MeSH), and keywords representing concepts such as (Determinants or Factors) AND (Children or Infants) AND (Stunting or Growth Disorder) AND (Asia or Asian).

Selection of the studies

Types of study

All types of study including cross-sectional, randomized or quasi-randomized, case control and cohort were included.

Year of publication

From 2013 to 2023 (10 years)

Types of participants

Mothers and children aged to 24 months old. Any family members involved in the study who are important as factors determining stunting were included. This study was targeted at Asian populations.

Article Access type

Free full-access articles

Outcome measure

All the articles found were screened, reviewed, and extracted according to inclusion and exclusion criteria (Table I). To test the authors' agreement on eligibility criteria, two authors (MRS and NF) independently reviewed a random selection of sources of scientific evidence (n=5). A standardized data chart was summarized by one author (NF) and reviewed by the study team for relevance and appropriateness. The charting data were pilot tested by two reviewers (MRS and NF) using a random sample of 5 sources of evidence to ensure all relevant data were captured. Only data relevant to stunting were charted, consistent with the a-priori objectives of the review. Data extracted on the same determinants described in multiple articles were combined in the charting table. As the goal of this review was to provide an overview of the existing literature regardless of quality, a formal appraisal of the methodological quality of the sources of evidence included in the review was not performed. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram for scoping reviews illustrates the process from the articles search to the final selections, as shown in Figure 1.

Table I: Study selection: inclusion and exclusion criteria

Inclusion criteria	Exclusion Criteria
1. Cross-sectional, randomized or quasi-randomized, case control and cohort	1. Preprints which are not peer-reviewed
2. Published after 1 January 2013	2. Abstract-only papers like proceeding papers, conference, editorial, author response, theses and books
3. Available in full text in English or Malay language	3. Review articles
4. Targeted to Asian countries or populations	4. Children aged up to 2 years old
5. Evaluated or described the associated determinants of stunting	

All articles were screened for full-text and assessed for eligibility.

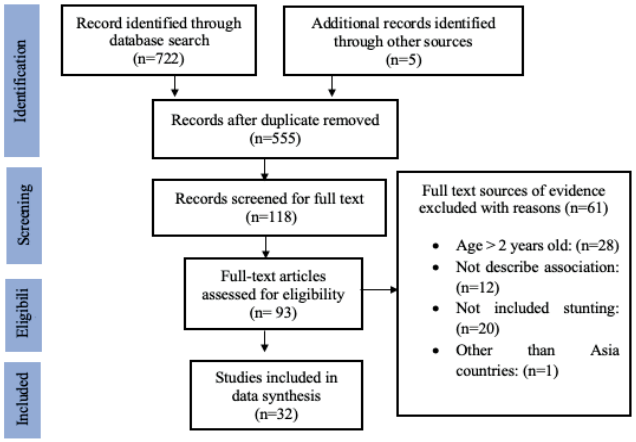

Figure 1: PRISMA flowchart illustrating the selection process of articles for the review. The original database search results in 722 articles (Scopus and PubMed) and 5 articles from other sources. All articles were screened for full-text and assessed for eligibility. Sixty-one articles were excluded with reasons. The eligible articles were included in the review (n=32).

RESULTS

The searches from the two electronic databases hit a total of 722 records (PubMed: 516, Scopus: 206), leading to a total of 555 titles and abstracts that were screened after the removal of duplicates. We retrieved a total of 93 full-text articles. Sixty articles were excluded after full-text assessment for the reasons mentioned in the flowchart (Figure 2). The full-text screening stage led to the inclusion of 32 articles in this review. The studies on the determinants of stunting among children under two years old in Asia are recent, and the number has considerably increased in the last few years. Among the included studies, more than half (56.3%) were published in the last five years (2018–2023), and approximately 43.8% have been published in the past decade (2013–2023). The majority of the sources were from Bangladesh (n=10) and India (n=10), while the rest were from other Asian countries. The study design included a cross-sectional study (n=19), cohort study (n=9), case-control study (n=2), quasi-experimental (n=1) and longitudinal study (n=1), and The findings are presented in Table II.

Table II: Determinants of Stunting Among Children Under 2 In Asia

Author, Year	Objective of study	Country	Study Design	Results: Determinants/Factors
Aguayo et al, 2016 (7)	To identify the most significant predictors of stunting in children 0–23 months old	Maharashtra, India	Cross-sectional Population: 2561 children aged 0 to 23 months old	Associated factors: - Low birthweight (OR 2.49; 95%CI 1.96–3.27) - Children 6–23 months old who not taking a minimum number of times/day of meal and low intake of eggs had a 63% (OR 1.63; 95% CI 1.24–2.14) and two-fold increased odds (OR 2.07; 95% CI 1.19–3.61) - Mother's height <145 cm (OR 2.04; 95% CI 1.46–2.81) - Households without access to improved sanitation had 88% higher odds being stunted
Alam et al, 2017 (8)	To determine factors associated with stunting among children aged 6 to 24 months in a slum of Dhaka, Bangladesh	Dhaka, Bangladesh	Case-control Population: Cases 389 children control 300 children aged 6 to 24 months old	Associated factors: - Child's age >12 to 17 months (AOR 3.13, 95% CI: 2.08, 4.70) and 18 to 24 months (AOR 4.21, 95% CI:2.69, 6.61) - Mother's BMI <18.5 (AOR 3.55, 95% CI: 2.34, 5.38) - Mother's education <5 years (AOR1.53, 95% CI: 1.04, 2.23) - Consumption of untreated drinking water (AOR 1.51, 95% CI: 1.03, 2.21) - Monthly family income <100 USD (AOR 1.98, 95% CI: 1.38, 2.84)
Aguayo et al, 2015 (9)	To identify the factors that are most significantly associated with stunting in Bhutanese children aged 0–23 months old	Bhutan	Cross-sectional Population: 2085 children aged 0 to 23 months old	Associated factors: - Children aged 12–23 months old (OR 3.11; 95% CI 2.45–3.94) - Boys had a 42% higher odds of being severely stunted (OR 1.42; 95% CI 1.04– 1.94) - Low socioeconomic status (OR 1.37; 95% CI 1.01–1.87) - Low antenatal care visits (OR 1.31; 95% CI 1.01–1.69) - Mothers delivered at home/not in a facility (OR 1.54; 95% CI 1.02–2.32) - Not breastfeeding within 1 hour of birth (OR 0.76; 95% CI 0.60–0.95), not exclusively breastfeeding and not continuing breastfeed after 6 months old (OR 0.54; 95% CI 0.36–0.82) - Not appropriately complementary feed for age (OR 1.81; 95% CI 1.23–2.66)
Beal et al, 2019 (10)	To improve understanding of the determinants of child stunting in Vietnam nationally and among vulnerable subpopulations by assessing associations of hypothesized child, maternal, household and environment level determinants of stunting in children 6–59 months using nationally representative data from the 2015 Vietnam Nutrition Surveillance System	Vietnam	Cross-sectional Population: 30771 children with aged 6 to 23 months old	Associated factors: - An increase in child age of 1 year (RR 2.49; 95% CI [2.26, 2.73]) - Low birth weight (RR 1.75; 95% CI [1.55, 1.98]) - Maternal factors: height (< 145 cm) (RR 2.04; 95% CI [1.85, 2.26]), no education (RR 1.77; 95% CI [1.44, 2.16]) or only primary education (RR 1.77; 95% CI [1.48, 2.11]) and BMI (< 18.5) (RR 1.20; 95% CI [1.12, 1.30] - Not currently breastfeeding (RR 1.44; 95% CI [1.14, 1.82]), male sex (RR 1.35; 95% CI [1.27, 1.43]) and ethnic minority (RR 1.31; 95% CI [1.19, 1.44])
Campbell et al, 2018 (11)	To investigate infant, young and child feeding (IYCF) practices and their associations with the nutritional status of infants and young children (<24 months) in Bhutan.	Bhutan	Cross-sectional Population: 441 children aged <24 months old	Not associated: - Infant, young and child feeding practices (IYCF)
Chandrasekhar et al, 2017 (12)	To contribute to the literature investigating the relationship between household food security and children's diet diversity and anthropometry by exploring evidence from India, home to a large number of undernourished children	India	Cross-sectional Population: 2650 children with aged 0 to 23 months old	Associated factor: - Severely food insecure households (AOR 1.528; 95% CI 1.142–2.045) Not associated factor: Dietary diversity and children's diet
Persson, 2017 (13)	To evaluate how select neonatal, maternal, and postnatal factors, which represent different hierarchical levels depicted in the UNICEF malnutrition framework contribute to low length-for-age in the first 2 years of life	Bangladesh, Brazil, India, Nepal, Peru, South Africa, Tanzania	Longitudinal study Population: 1197 children with aged 17 days to 24 months old	Associated factors: At risk or stunted at first 24 months - Lower enrolment weight (OR 1.82, 95% CI 1.49–2.23) - Shorter maternal height (OR 2.38, 95% CI 1.89–3.01) - Higher number of non-diarrheal entero- pathogens detected (OR 1.36, 1.07–1.73) - Lower socio-economic status (OR 1.75, 1.20–2.55) Lower percent of energy from protein (OR 1.39, 1.13–1.72)

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Table II: Determinants of Stunting Among Children Under 2 In Asia (CONT.)

Author, Year	Objective of study	Country	Study Design	Results: Determinants/Factors
Choudhury et al, 2017 (14)	To identify the age-specific risk factors for different categories of undernutrition among Bangladeshi children aged less than 2 years old	Bangladesh	Cross-sectional Population: 10291 children with aged less than 2 years old	Associated factors: Birth to 5 months - Male, thin mothers and education or did not complete primary schooling (p<0.05) 6 to 11 months - Male, increase in age, deprivation of colostrum, consumption of less than four food groups, and mothers who were severely or moderately thin, education below secondary level schooling, or did not receive any postnatal care and households with severe food insecurity (p<0.05) 12 to 23 months Male, increase in age, consumption of less than four food groups, mothers who were severely/moderately or mildly thin, had education below secondary level schooling, or did not receive any postnatal or antenatal care, households with no or non-hygienic latrine facility, severely food insecure households, and most categories of asset index quintile (p<0.05)
Das et al, 2019 (15)	To measure the relative contributions of the most predictive correlates of stunting to mean length-for-age z (LAZ) score difference between stunted and non-stunted children at 24 months of age	Bangladesh	Cohort Study Population: 211 children with aged 0 to 24 months old	Associated factors: Energy intake, gender, maternal height, having a separate room for kitchen, people per room and birth weight with stunting (p<0.05)
Dearden et al, 2017 (16)	To better understand associations between water, sanitation, and child growth	Ethiopia, India, Peru, Vietnam	Cohort Study	Associated factors: - A study found that children aged 1-year-old with access to improved toilets had a low level of stunting risk in Ethiopia, India Peru, and Vietnam (p<0.01) Children aged 1-year-old in Ethiopia, Peru and Vietnam with access to improved water were found less likely to become stunted (p<0.01)
Hasan et al, 2019 (17)	To identify the association between mother's dietary diversity and stunting among children <2 years of age seeking clinical management for diarrhoea in a diarrhoeal disease hospital in Bangladesh	Dhaka, India	Case-control study Population: 148 children for cases and 148 children for controls with aged below 2 years old	Associated factors: - Mothers consumed <5 food groups (AOR 1.72, 95% CI: 1.04–2.87, *p*=0.04). - Short statured mothers (AOR 95% CI: 2.33–9.84, *p*<0.01) Mother's illiteracy, monthly family income of less than 11,480 BDT, absence of bank account, and poor sanitation were found as determinants of stunting (p<0.05)
Hashmi et al, 2019 (18)	To provide a comprehensive understanding of maternal risk factors, infant risk factors and maternal infant feeding practices among refugees and migrants along the Thailand-Myanmar border	Myanmar-Thailand border	Cross-sectional Population: 390 children with aged 2 to 12 months old	Associated factors: - Each 5 cm increase in maternal height had decreased odds of stunting (AOR 0.50, 95% CI: 0.38, 0.66, p<0.001) - Migrants (AOR 2.08, 95% CI: 1.12, 3.84, p=0.020) Small-for-gestational age (AOR 3.42, 95% CI: 1.88, 6.22, p<0.001)
Hossain et al, 2019 (19)	To explore the association between different growth biomarkers and stunting in Bangladeshi children	Bangladesh	Quasi-experimental Population: 50 stunted, 50 control with aged 12 to 18 months old	Associated factors: - Fasting serum leptin (AOR 3.9; 95% CI: 1.3–10.9), leptin–adiponectin ratio (AOR 4.31 Ч 10^{8}; 95% CI: 696–2.67 Ч 10^{14}), insulin-like growth factor-1 (IGF-1) (AOR 1.02; 95% CI: 1.0–1.04), and gamma interferon (IFN-γ) (AOR 0.92; 95% CI: 0.85–0.98). Non associated factors: Gut hormones, adipokines, human growth factors, EED markers, cytokines, or systemic inflammatory markers
Islam et al, 2018 (38)	To identify predictors of stunting among this population between 12 and 24 months of age using repeated longitudinal data in an urban slum context	Bangladesh	Cohort study Population: 265 children with aged 0 to 24 months old	Associated factors: - Male (AOR 1.75, 95% CI: 1.04, 2.95). - One unit increase in LAZ score at birth had 60% lower likelihood (AOR 0.40, 95% CI: 0.26, 0.61) of being stunted between 12 and 24 months of age - Poor households (AOR 2.81, 95% CI: 1.43, 5.52) - Age at 18 months (AOR 2.13, 95% CI: 1.55, 2.92) and 24 months AOR 2.34, 95%CI: 1.56, 3.52) compared to 12 months Non associated factors: Weight-for-age Z (WAZ) score at birth, number of days of exclusive breastfeeding during the first six months of life, average days suffered from diarrhoea per month, proportion of calorie coming from either carbohydrate or protein portion of complementary food and dietary diversity score

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Table II: Determinants of Stunting Among Children Under 2 In Asia (CONT.)

Author, Year	Objective of study	Country	Study Design	Results: Determinants/Factors
Johri et al, 2016 (20)	To investigate whether maternal health literacy is associated with child undernutrition in 2 resource poor Indian populations	India	Cross-sectional Population: 1116 children in rural area, 657 children in urban area with aged 12 to 23 months old	Associated factors: High health literacy (rural) (AOR 0.50; 95% CI: 0.33, 0.74; p=0.001); (urban) (AOR: 0.58; 95% CI: 0.35, 0.94; p=0.028)
Korpe et al, 2016 (21)	To describe the natural history of Cryptosporidium spp. infection in a birth cohort of children in Bangladesh and evaluate for association with malnutrition	Bangladesh	Cohort study Population: 392 children with aged 0 to 24 months old	Associated factor: - Cryptosporidium spp. Infection (p<0.01) Non associated factor: Number of diarrheal episodes over the first 24 months of life
Laksono et al, 2022 (22)	To analyzes the association between maternal education and stunting among children under two years in Indonesia	Indonesia	Cross-sectional Population: 70,293 children with aged 0 to 24 months old	Associated factors: - Low maternal education level (AOR 1.587; 95% CI 1.576–1.598) - Mothers who live in urban areas (AOR 0.828; 95% CI 0.825–0.831) - Maternal marital status, mothers who were never married (AOR 1.348; 95% CI 1.308–1.389) Boys gender (AOR 1.352; 95% CI 1.347–1.356)
Liu et al, 2021 (23)	To evaluate the prevalence of malnutrition and to investigate the associated factors of stunting among 6–23-month-old infants in poor rural areas of central China	China	Cross-sectional Population: 17193 children with aged 6 to 23 months old	Associated factors: - Increase age (OR 1.05, 95% CI (1.03, 1.07) - Boys gender (p<0.001) - Infants who not met the requirements for minimum diversity diet (MDD) (p<0.001) - Infants of minorities mothers had a lower prevalence of stunting than those with a mother of Han nationality (OR 0.63, 95% CI (0.44, 0.90) - Low maternal educational level (p<0.001) Mothers working in agriculture (OR 1.42, 95% CI (1.07, 1.89) were at lower odds of stunting than homemakers
Menon et al, 2015 (24)	To examine the associations between age-appropriate IYCF practices and child nutrition outcome in India using data from ~18 463 children of 0–23.9 months old from India's National Family Health Survey, 2005–06-3	India	Cross-sectional Population: 18463 with age 0 to 23.9 months old	Associated factor: Poor minimum diet diversity (p<0.001)
Milton et al, 2018 (25)	To evaluate the nutritional status of a cohort of infants living in arsenic contaminated areas in Bangladesh	Bangladesh	Cohort study Population: 120 children with aged 0 to 9 months old	Associated factor: Household drinking water arsenic exposure ≥50 µg/L at age of 9 months (p=0.009)
Mya, 2019 (26)	To explore the relationship between IYCF practices and nutritional status of children age 6–23 months, using the 2015–16 Myanmar DHS data	Myanmar	Cross-sectional Population: 1222 children with aged 6 to 23 months old	Associated factors: - No breastfed child (AOR 0.51; 95%CI 0.29, 0.88) - Female children were less likely to be stunted than male children (AOR 0.46; 95%CI 0.30, 0.71). - Less than average perceived birth (AOR 2.38; 95%CI 1.44, 3.92) - Working mothers (AOR 1.97; 95%CI 1.32, 2.94) - Short stature mothers with height less than 150 cm (p<0.001) - Living at rural areas (AOR 2.08; 95%CI 1.15, 3.77) Non associated factors: - Other IYCF indicator (consumption of iron rich foods, minimum meal frequency, minimum dietary diversity and minimum acceptable diet)
Rah et al, 2015 (27)	To determine the association between household access to water, sanitation and personal hygiene practices with stunting among children aged 0–23 months in rural India	India	Cross-sectional Children aged 0 to 23 months old	Associated factor: - Household access to toilet facility was associated with a 16% lower odds of being stunted (OR 0.84, 95% CI 0.71 to 0.99) Non associated factors: Household access to a piped water source and household sanitation

CONTINUE

Table II: Determinants of Stunting Among Children Under 2 In Asia (CONT.)

Author, Year	Objective of study	Country	Study Design	Results: Determinants/Factors
Nisar et al, 2016 (28)	To investigate the effect of antenatal iron-folic acid (IFA) supplementation on child stunting in Nepalese children age <2 years	Nepal	Retrospective Cohort study Population: 5235 children with aged below 2 years old	Associated factors: - Living in either hill rural region or mountain rural areas - Mothers who had no education - Belonging to the poorest pooled household wealth index quintile - Mothers who were smokers - Maternal short stature - Perceived birth size as very small or smaller than average - Multiple births, and infants with more than 4th birth rank and birth interval less than 2 years - Initiated breastfeeding >1 hour - Buddhist or other religion Mothers who had more than 4 times antenatal care visits had significantly lower relative risks of stunting
Raihan et al, 2018 (29)	To explore the relationship between Blood Lead Level (BLL) and stunting among children less than 2 years of age	Bangladesh	Cross-sectional Population: 729 children with aged below 2 years old	Associated factors: - Increase in BLL (p<0.05) - Boys (AOR 2.25, 95% CI: 1.57–3.23; p<0.001) - Severely food insecurity household status (AOR 1.91, 95% CI: 1.07–3.40; p<0.05) Increase in child weight (AOR 0.46, 95% CI: 0.39–0.54; p<0.001) and increased maternal BMI (AOR 0.94, 95% CI: 0.90–0.99; p<0.05)
Sari & Sartika, 2021 (30)	To examined stunting at birth and its associations with physical factors of parents and children in Indonesia	Indonesia	Cross-sectional Population: 765 children with aged 0 months old	Associated factors: - Teenage mothers (age of less than 25 years old) (p<0.01) - Short mother and father (AOR 5.93; 95% CI, 5.53 to 6.36; p<0.001) Infants of parents whose ages were both <20 years old or >35 years old (AOR 2.37; 95% CI, 2.25 to 2.50; p<0.001)
Sinha et al, 2018 (31)	To explore the risk of infant stunting according to different subcategories of maternal stature, that is, less than 145, 145 to 149.9, 150 to 154.9, and ≥155 cm	India	Cohort study Population: 1787 children with aged 0 to 12 months old	Associated factor: LBW infants born to short-stature mothers were found to have two-fold higher odds of stunting compared to those born to mothers with height ≥150 cm, regardless of the age of assessment, that is, at birth, 3, 6, 9, and 12 months of age
Sanin et al, 2018 (32)	To explore the status of micronutrient adequacy among such vulnerable children and establish its association with stunting along with other determinants	Bangladesh	Cohort study Population: 265 children with aged 0 to 24 months old	Associated factors: - Children with a history of LBW (AOR 3.03, 95% CI: 1.69, 5.44) - Male children (AOR 1.98, 95% CI: 1.17, 3.33) - Increasing age, at 18 and 24 months of age (AOR 1.97, 95% CI: 1.49, 2.59 and AOR 2.12, 95% CI: 1.45, 3.11, respectively) compared to 12 months of age Non associated factor: Micronutrient adequacy (Mean adequacy ratio) was not associated with stunting among children ages 12 to 24 months old
Tariq et al, 2018 (33)	To identify the sociodemographic, nutritional, and health-related factors associated with stunting, wasting, and underweight in children under the age of two years in Pakistan	Pakistan	Cross-sectional Population: 984 children with aged 0 to 23 months old	Associated factors: - Children below 1 year old (OR 0.26; 95% CI: 0.20–0.36) - Children having a birth order of fifth or higher (OR 1.60; 95% CI: 1.13–2.21) - Below average size at birth (OR 2.60; 95% CI: 1.26–5.23) - Teenage mothers (13-17 years old) at the time of first birth (OR 3.42; 95% CI: 1.67–7.20) - Mothers with low BMI (OR 3.36; 95% CI: 1.69–6.68) - No intake of haematinics during pregnancy (OR 2.60; 95% CI: 1.90–3.41) - Poor toilet facilities (OR 95% CI: 1.35–2.72) - Uneducated fathers (OR 3.20; 95% CI: 2.02–5.00) and mothers (OR 3.31; 95% CI: 1.94–5.65) - Mothers had no access to information (OR 1.70; 95% CI: 1.26–2.31) - Low socio-economic status (OR 5.60; 95% CI: 3.42–9.10) - Living in rural areas (OR 1.60; 95% CI: 1.20–2.13) - Children born out of consanguinity (OR 1.41; 95% CI: 1.05–1.90) Children having low consumption of vitamin A (OR 1.90; 95% CI: 1.14–3.08) and no consumption of iron (OR 2.10; 95% CI: 1.07–4.10)

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Table II: Determinants of Stunting Among Children Under 2 In Asia (CONT.)

Author, Year	Objective of study	Country	Study Design	Results: Determinants/Factors
Titaley et al, 2019 (34)	To examine the determinants of stunting in children aged 0–2 years in Indonesia using data derived from the 2013 Indonesia Basic Health Survey	Indonesia	Cross-sectional Population: 24657 children with aged 0 to 2 years old	Associated factors: - Children living in households with three or more children under five-years-old (AOR 1.33, 95%CI: 1.03–1.72, p=0.029) - Children from households where five to seven members lived (AOR 1.11; 95%CI: 1.03–1.20, p=0.005) - Lower wealth quintiles (p<0.001) - Mothers attending less than four antenatal care (AOR 1.22, 95%CI: 1.08–1.39, p=0.002) - Boys (AOR 1.33, 95%CI: 1.22–1.45, p<0.001) - Children aged 12–23 months (AOR 1.89; 95%CI: 1.54–2.32, p<0.001) Children who weighed <2500 g (AOR 2.55; 95%CI: 2.05–3.15, p<0.001)
Upadhyay & Srivastava, 2016 (35)	To examine the effect of pregnancy intention and maternal postnatal depressive symptoms on early childhood stunting in India.	India	Cross-sectional Population: 1833 children with aged 5 to 21 years old	Associated factors: - Children born after unintended pregnancy (AOR 1.76; 95 % CI: 1.25– 2.48) - Children of those women who showed symptoms of postnatal depression (AOR 1.53; 95 % CI: 1.21–1.92) - Children of small birth size than average or above birth size (AOR 1.82; 95 % CI: 1.44-2.30) - Preterm birth compared to the term baby (AOR 1.61; 95 % CI: 1.04-2.49) - Lower age of mother at birth of the child (AOR 0.60; 95 % CI: 0.43-0.86) - Lower wealth quintiles (AOR 0.72; 95 % CI: 0.55,0.93) Non associated factor: Social support
Young et al, 2018 (36)	To examine associations between preconception maternal nutritional status and offspring linear growth across the first 1000 days	Vietnam	Cohort study Population: 1409 participant from birth to 2 years old	Associated factors: - Maternal preconception BMI of <18.0 kg/m^2 and <17.5 kg/m^2 (p<0.05) - Preconception weight <43 kg (p<0.01) - Preconception height <150 cm (p<0.001) Non associated factors: - The traditional underweight category of <18.5 kg/m^2 the lowest BMI cut-off of <17.0 kg/m^2
Nargis et al, 2014 (37)	To assess nutritional status of children below 24 months in district of Pekan, Pahang and identify the contributing factors	Malaysia	Cross-sectional Population: 910 participant below 24 months old	Associated factors: - Low socio-economic status (p<0.05) - Illiterate mothers Increase household size (p<0.05)

Thirty-two studies were included in the table. Community and societal factors, household and family factors, inadequate complementary feeding, breastfeeding, infections, and child factors were found to be determinants of stunting among children below 2 years old.

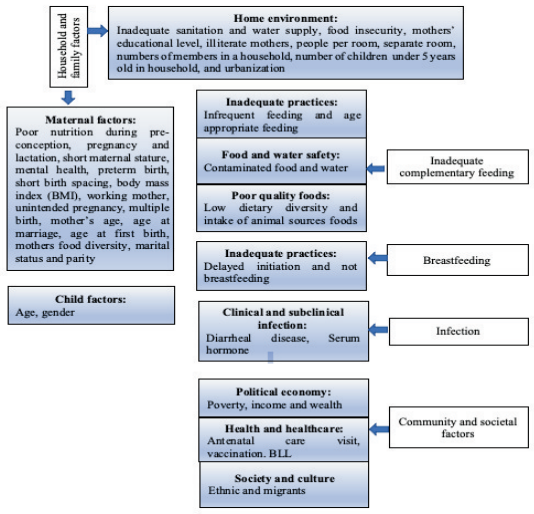

Figure 2: Determinants of stunting among children under age 2 in Asian countries according to WHO categories. Five categories were found to be associated factors with childhood stunting which were community and societal factors, household and family factors, inadequate complementary feeding, breastfeeding, and infections. Another factor found is the child factor.

Child factors

According to the findings, child factors were associated with stunting such as children's age (8-10,14,23,32,34,36) and gender (7,12-13,20-21,24,27,30,32,36). These findings found that boys were associated with an increased risk of stunting. Stunting rates also were higher in children age range between 6 to 24 months old. Low birth weight infants (7,10,15,28,31,33,35) and higher birth rank (28,33) also contributed to childhood stunting.

Community and societal factors

Based on the results, eleven studies found that children from poorer families and households with low income were associated with an increased risk of stunting (8-9,13-14,17,28,33-35,37,38). From these findings, two articles found family income less than 100 USD associated with an increased risk of stunting with AOR value of 1.98, 95% CI =1.38 - 2.84, and p<0.05 respectively. Next, four studies found children or mothers living in rural regions were associated with an increased risk of stunting (20,26,28,33). The review

results showed that migrants (18) and ethnicity (10,23) were associated with an increased risk of stunting. A study found migrants had limited access to food sources and poor WASH which had potential impacts on child nutrition and health (18). Meanwhile, antenatal care (ANC) was found to be associated with stunting (9, 14, 28, 34). Mothers attending antenatal care less than four times or not attending at all during pregnancy or postnatal were more likely associated with an increased risk of child stunting compared to mothers who visited antenatal care more than four times during pregnancy. A study found that elevated blood lead level (BLL) in children was a statistically significant and independent predictor of stunting (29).

Household and family factors

In household and family factors, maternal factors were associated with stunting such as poor maternal dietary diversity (17), short-statured mothers with height less than 150 CM (7,10,13,15,17-18,26,28,30-31,36), low BMI levels (8,10,29,33,36), poor mental health (35), adolescent pregnancy (30,33,35), multiple births and short birth spacing with less than 2 years (28), and preterm birth (35). Instead of mothers, short fathers also had significantly associated with stunting (30). A study found infants with birth weights less than 2500 grams were associated with stunting (OR=2.49, CI 95% = 1.96- 3.27) (7).

For the home environment, results found poor maternal educational levels (n=7) and illiterate mothers (n=3) act as determinants of stunting. These studies found that mothers with below secondary level were more likely to have stunted children under 2 years old (9,17,25). In this review results, three studies found that severe food insecurity has a significant association with stunting (12,14,29). Households with severe food insecurity have 53% higher odds of having stunted children (AOR =1.528, 95% CI=1.142–2.045, p = 0.004) (12). Children who lived with five to seven members in a household and children living in households with three or more children under five years old were associated with increased odds of stunting (34,37). In a study by Titaley et, al (2019), it was found that children who live with a minimum of three children under five years old in households were significantly increased odds of stunting (AOR = 1.33, 95%CI= 1.03–1.72, p = 0.029) (34). Six studies found households with access to improved water and sanitation facilities were associated with reduced risks of childhood stunting.

Inadequate complementary feeding

Children not given any complementary food by the age of 6 months to 23 months old and not appropriately fed for age were associated with higher odds of being stunted (7,9). In this review, one study found that children who consumed less than four food groups (14) were identified as being at an increased risk of stunting. In contrast, three studies found that children who achieved a minimum intake of dietary diversity decreased odds of stunted (12,23,24) while one study did not find an association with stunting (26). Low protein, energy sources, and low vitamin A intake were associated with an increased risk of stunting (13,15,33,). The consumption of untreated drinking water (8) and household drinking water arsenic exposure ≥50 µg/L (25) were associated with an increased risk for stunting.
Breastfeeding

Inadequate breastfeeding practices such as delayed initiation (9,28), non-exclusively breastfeeding (9), and not continuing breastfeeding until the age of two years old (9-10,24) were associated with childhood stunting. In Bangladesh, deprivation of colostrum was associated with stunting in six to eleven months old (14).

Infection and Others

Exposure to infectious diseases has a more severe effect on growth faltering in normal children. One study (13) found a higher number of non-diarrheal enteropathogens associated with stunting. Stunting also was associated with increased infections (21). One study (19) found that hormones 1) Fasting serum leptin, 2) leptin–adiponectin ratio, 3) insulin-like growth factor-1, and 4) gamma interferon was associated with stunting, but no significant associations between gut hormones, adipokines, human growth factors, EED markers, cytokines, or systemic inflammatory markers with child stunting status.

DISCUSSION

In this scoping review, we summarized the determinants associated with stunting in Asian countries. Community and societal factors, household and family factors, complementary feeding, breastfeeding, and infections were found to be associated with stunting. In addition, children's age and gender were also associated with an increased risk of stunting. Understanding these determinants will help reduce gaps in future nutrition interventions aimed at preventing stunting.

This review found that increasing age was associated with stunting. As children get older, their energy intake requirements increase to meet their needs for healthy growth and development (38). Children aged 6-59 months are more likely to experience stunting because, after the age of 6 months, exclusive breastfeeding is sometimes not continued until two years, and complementary feeding is sometimes inappropriately given, while their nutritional needs increase (39).

Stunting among children was found to be higher in males compared to females, similar to findings in East Africa across all age groups (0 to 59 months old). Male children require approximately 300 more calories per day than females for growth and development, especially in the early years of life (40). They may exhibit greater susceptibility to undernutrition and resultant stunting

when confronted with the increased energy demands due to disease or food insufficiency resulting from drought or crop failures. In addition, there is an observed elevation in inflammatory responses among males, as evidenced by elevated levels of cytokines, NK cells, and IgE. Differences in morbidity and immune function may increase the risk of childhood stunting in males (41).

Community and societal factors

Other factors contributing to stunting include community and societal factors such as poverty and ethnic minority status. Globally, 181 million children under five years old experience child food poverty (42). Children from low-income families may not be able to consume highly nutritious food, as their economic condition directly impacts their purchasing power. Meanwhile, households with affluent socioeconomic status possess superior access to high-quality food compared to households of lower socioeconomic status (43). Additionally, ethnic minority status is associated with a high risk of stunting. Surveys in thirteen Latin American countries on ethnic inequalities in child stunting showed most Indigenous children come from poorer families. In terms of dietary patterns, children often receive breastmilk with low-quality complementary foods during the breastfeeding period, which alone is inadequate to fulfill their nutritional needs for optimal growth (44). Furthermore, certain beliefs and traditions related to maternal nutritional childcare such as the discarding of colostrum and early weaning, contribute to the risk (45).

Stunting was reduced in households with improved sanitation and water facilities. According to the National Health and Morbidity Survey (NHMS) 2016, households with unsanitary waste disposal had 1.42 times the risk of stunting in children under five (p=0.001). Unsanitary waste disposal can lead to household fecal cross-contamination and environmental enteropathy (46). Twenty-five percent of stunted 24-month-olds had five or more diarrhea episodes in their first 1000 days (47). Improving water, sanitation, and hygiene (WASH) can minimize the risk of diarrhea (48).

Household and family factors

Next, the factors influencing childhood stunting in Asia are household and family factors. This review found that maternal mental health was associated with stunting (35). As an intermediary factor, it affects a mother's ability to provide quality care for her children, which in turn influences child nutrition, resulting in inadequate feeding and health care. In addition, depressed mothers usually stopped exclusive breastfeeding earlier than non-depressed mothers (49). This can contribute to stunting, as stress interferes with breastmilk production, making feeding difficult.

ANC was also significantly associated with childhood stunting. Children born to mothers who had fewer than three antenatal visits, did not receive antenatal care from a doctor, nurse, or midwife, did not deliver in a health facility, or were not attended by a doctor, nurse, or midwife, had a higher prevalence of stunting (9). Nutrition, breastfeeding, family planning, and birth spacing programs provided during ANC visits are widely used to improve mother and child health. Mehta et al found that children born to mothers who participated in antenatal intervention were less likely to be stunted compared to those born to non-participating mothers (50).

Furthermore, 23.3% of the studies found that infants with low birth weight (<2500g) were associated with stunting, similar to recent findings in Sub-Saharan Africa (51). Low birth weight (PT/LBW) infants are more likely to have respiratory problems, feeding issues, malnutrition, and infections due to their underdeveloped immune systems (52).

Three studies found that parenteral age was associated with stunting. Mothers' age at birth and first birth between 14 to 24 years old were associated with stunting. Another study found that infants born to mothers aged below 18 years old had a higher risk of low birth weight (53). These infants also have worse mortality, self-rated health, height, obesity, and diagnosed conditions compared to those born to mothers aged 25 to 34 years (54). Similar to previous review, stunting was found to be higher among children born to mothers under 20 years old (55). The energy needs and nutritional intake of pregnant adolescents increase for both the mother and the fetus, leading to competition for nutrients. This competition can result in nutritional deficiencies, which can cause low birth weight and other potentially significant health issues in the future (56). However, one study in this review reported no association between mothers' age at first birth and stunting (8).

Furthermore, one study found birth spacing of less than 24 months was associated with a greater risk of childhood stunting. A 2023 meta-analysis of 46 studies involving 898,860 children found that a birth spacing of 24 months or more was associated with a 61.0% decrease in stunting risk, suggesting that birth spacing between 38 to 48 months may be optimal for reducing poor nutritional outcomes (57). Birth spacing allows mothers to properly care for their older children, including continuing breastfeeding until 2 years old, and reduces the risk of undernutrition in the next pregnancy, as mothers have high nutritional needs during the postnatal period.

The review also found a significant association between stunting and low maternal BMI and height (less than 150 cm). These determinants result in adverse pregnancy outcomes, including preterm birth and a small gestation age, leading to breastfeeding difficulties, health problems, and developmental delays (58). Short-statured mothers may restrict fetal growth due to reduced

protein and energy supply, smaller reproductive organ sizes, and less space for fetal development. Child linear growth is closely linked to the mother's height, which reflects preconception nutritional status. While genetics and maternal nutrition in the first 1000 days are crucial to child development, strong nutrition during growth may improve a child's growth and development even if genetics cannot be changed (59). During pregnancy, insulin-like growth factor 2 (IGF-2) is important for supporting fetal and placental development. Maternal undernutrition can lead to a decrease in IGF-2 expression, resulting in reduced placental weight in early gestation, which impairs nutrient delivery and contributes to fetal growth restriction. Previous studies indicated that children classified as SGA exhibited reduced expression of IGF2 in comparison to infants appropriate for gestational age (AGA) (60). During infantile stage, growth and development were influenced by child nutrition (including breastfeeding and complementary feeding), parental behaviors, parenting practices, social and cultural factors, and the surrounding environment (61).

Stunting is correlated with family size and food security. A meta-analysis of nine articles showed that children with numerous family members had a 1.43 times higher risk of stunting. However, stunting is less prevalent in high-income families due to their adequate nutritional intake, while in low-income families, the nutritional intake for one child may need to be distributed among other children (62). Lack of access to healthy food is a critical component of food insecurity, which can lead to malnutrition in both children and adults (63). This review had similar findings to two other systematic reviews, which found that poor household food security increases stunting among children under 5 years old (64-65).

Mother literacy and education were also associated with stunting. Most childcare responsibilities fall on mothers, who also have a significant influence on decisions pertaining to their children's health and nutrition. Similar to the findings of a meta-analysis in Africa, higher levels of maternal education were associated with a reduced risk of stunting among children (62).

This review found that living in rural areas was associated with stunting, similar to findings in the Ecuadorian highlands. In rural areas, determinants of stunting were maternal height, diarrhea prevalence, socioeconomic status, and child age (1). Other studies indicated that children living in rural areas had poor food diversity and low intake of vegetables, and protein sources (57-58).

Complementary feeding

Next, nine studies found an association between complementary feeding and stunting. Inadequate practices and poor quality of complementary feeding were associated with higher odds of being stunted. This review also found that poor food diversity intake among children increased the risk of stunting. In addition, another study found that stunting was 3.28 times higher in 6–12-month-olds who did not meet the minimum meal frequency (66). During the period of complementary feeding, children are at high risk of undernutrition if complementary foods are often of inadequate nutritional quality, given too early or too late, in too small amounts, or not frequently enough (67). If complementary food is more energy-diluted than breastmilk, total energy intake will reduce, resulting in stunting (68). Children who achieved a minimum dietary had a 1.15 (95%CI: 1.07–1.24) times higher chance of experiencing normal nutritional status. Eating a diversified meal is associated with a reduction in undernutrition among children aged 6 to 23 months (69). However, six studies revealed no association between infant and young child feeding practices and stunting, presumably due to low anthropometric failure rates and small sample sizes.

Breastfeeding

The study review shows that early initiation of breastfeeding, exclusively breastfeeding and continuing breastfeeding until the age of have a significant effect on reducing stunting among children below 2 years old. Breastfeeding is one of the most effective methods for ensuring the health and survival of children. Mother's milk is an ideal source of energy and nutrients for children aged 6 to 23 months. It may meet half or more of a child's energy needs between 6 and 12 months and one-third between 12 and 24 months (68). Two studies found that exclusive breastfeeding and its duration did not cause stunting. A cross-sectional study in Indonesia found that wealthier children under 2 who were not exclusively breastfed were 40% less likely to be stunted due to better food access. Children under 2 years old are sometimes fed other foods by mothers due to hunger, fussiness, or an inability to breastfeed (70). Similar findings in Zambia showed that breastfeeding duration was negatively associated with HAZ, but the magnitude was smaller to be clinically significant (71).

Infection and Others

Exposure to infectious diseases has a more severe effect on growth faltering in otherwise normal children. One study found a higher number of non-diarrheal enteropathogens associated with stunting. Stunting also was associated with an increased risk of infections. According to a recent study, early onset stunting during infancy is linked to impaired immunological function, which increases the likelihood of mortality in children under the age of five. Globally, stunting impacts 20% of children under five, with 40% of these cases resulting in mortality (72). Infection in the intestinal tract can develop symptoms such as diarrhea among children (48). Diarrhea results in low appetite, lower food intake, loss of nutrients, and malabsorption which contribute to stunting (73). All these symptoms make it challenging for children to obtain sufficient nutrients from food.

Fasting serum leptin, leptin–adiponectin ratio, insulin-like growth factor-1 (IGF-1), and gamma interferon were associated with stunting. Growth Hormone (GH), Thyroid Stimulating Hormone (TSH), Luteinizing Hormone (LH), and Adrenocorticotropic Hormone (ACTH) are involved in regulating IGF-1 production. However, when thyroid hormone activity is diminished, the secretion of these hormones decreases, leading to a reduction in IGF-1 levels, which may contribute to malnutrition. IGF-1 plays a crucial role in energy, protein, and carbohydrate metabolism and promotes their absorption into circulation. A 2018 study conducted in India reported decreased T3, T4, and TSH levels in malnourished children (74). Similar to a previous literature review of five articles identified an association between thyroid dysfunction and stunted growth in children (75).

This review assesses the factors associated with stunting among children under 2 years old. However, it has a few limitations. It focuses solely on factors associated with stunting and might appear too descriptive. This review includes only open-access and English-language articles, thus some relevant studies may be missing. In addition, fewer published studies from continents other than Asia were presented including Europe, Latin America, Africa, Northern America, Australia, and New Zealand, which limits the ability to compare political and sociological differences. No meta-analyses were conducted, which may affect the generalizability of the study findings.

CONCLUSION

The results of this review show that there is a diverse range of determinants of stunting among Asian children under two years of age. The current evidence in Asian countries largely aligns with common proximate factors found in broader literature, such as low birth weight, age, short maternal stature, low maternal BMI, lower maternal education, decreased antenatal care visits, large family size, lower wealth quintiles, severe food insecurity, non-exclusive breastfeeding, and poor dietary diversity, all of which are significantly associated with childhood stunting. These findings highlight the need for developing nutrition education and intervention focused on these factors. Additionally, the review suggests that stunting prevention programs or interventions, such as maternal nutrition education can be effectively initiated as early as the pre-conception phase and during the first 1000 days of life to reduce stunting rates effectively.

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