Prevalence and Predictors of Stunting in Children Under Five Years of Age

Saadia Rafique and Saira Afzal

Department of Community Medicine, King Edward Medical University, Lahore, Pakistan

ABSTRACT

Stunting in children under five years of age is a significant health problem in many middle and low-income countries worldwide. The study aimed to analyse the prevalence and predictors of stunting in children under five years of age. Preferred reporting items for Systematic Reviews and Meta-Analyses (PRISMA Checklist 2020) were used for data reporting and analysis. Medline, PubMed, Google Scholar, PakMedinet, and direct websites of local journals were searched for relevant publications from 1996 to March 2022.

A random-effect model was employed to generate a pooled prevalence and was presented as a percent and 95% confidence interval (CI). A total of thirty-three studies were selected for systematic review. Out of these, nine studies were selected from the last five years to estimate pooled prevalence in children under five years of age. The overall pooled prevalence was 39.11% (95% CI: 33.017 to 45.394). A significant heterogeneity with I2 = 99.39%, p <0.0001, was found among the studies. The remaining twenty-four studies with the prevalence of stunting under five years of age were also divided into two groups based on the age range, either <2 years or 2-5 years of age. The pooled prevalence was 39.11%. Mother's education was the most frequent predictor (85%), followed by socioeconomic status (64 %), breastfeeding (55%), and the weight of the child at birth (40%).

Key Words: *Prevalence, Predictors, Stunting, Children under five years, Systematic review.*

INTRODUCTION

Childhood is a critical growth period because future development depends on it. Restricted growth badly affects the quality of life of many children.[1] Stunting in children under five years of age reflects chronic under nutrition and poor linear growth. Stunting is the percentage of children aged 0 to 59 months, whose height for age is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO child growth standards.[2] Hampered growth in childhood results in harmful health effects, including reduced cognitive development and performance, poor intelligent quotients, delayed psychomotor development, poorer school attendance, the emergence of chronic diseases like Diabetes mellitus, hypertension and ultimately leads to a loss in economic growth and social development of the country.[1,3] Seventy percent of the arrested growth occurs within the Critical window- 1000 days of life from conception to the first two years of life (0-23 months). Nutritional deficiencies, including breastfeeding, complementary feeding, and infections may cause severe irreversible physical changes and neurocognitive damage.[4,5]

Restricted growth in childhood is a significant public health problem,[6] with a prevalence of 36% in Africa and 27% in Asia.[7] Globally, 60 million children under five years of age are moderately and 13 million are severely malnourished.[8] If this challenge is not addressed correctly, it could be predicted that by the year 2020, around one million children will have to survive with physical impairments and reduced mental health. The disease burden of arrested growth is about 3.1 million globally, apart from diseases and disabilities, 45% of child death per annum.[9]

Pakistan has a high burden of regional growth and is positioned third in the world, having 12 million stunted children under five years of age.[10] In Pakistan, 43.7% of under-five children, are stunted,[11] with males predominance (48% *vs.* 42% females).[10] Risk factors for growth retardation under five years of age are described in different levels, including individual (maternal and child factors), household (water, sanitation, hygiene WASH, socioeconomic), and community factors.[12,13] The global Nutrition Target of the World Health Organization (WHO) to lower the number of growth restrictions for children under five by 2025 by 40%.[14] The aim of this research was to analyse the prevalence and predictors of stunting in children under five years of age.

METHODOLOGY

A literature search for studies published between 1996 and March 2022 was done using databases PubMed, Medline, Google Scholar, and PakMedinet. Various synonymic keywords in each database using Boolean operators and a combination of medical subject heading (MeSH) terms were utilised including a large number of relevant articles. In examining child's restricted

growth determinants worldwide, the author used the term "Prevalence of stunting in children under five years of age AND predictors AND determinants AND factors." Eligibility was evaluated, and two authors removed duplicates of the articles. Disagreements between the two authors were resolved. After the full-text assessment, thirty-three papers were found to be eligible and included in the final systematic review.

Inclusion criteria for the study's eligibility include studies conducted in African and Asian regions of the world. Observational studies include cross-sectional articles, surveys, and case-control studies. Retarded growth in children under five years of age and studies published in the English language referred to any causal or contextual factors of restricted growth as recognised by the WHO context. Exclusion criteria include children under five years of age with congenital anomalies, chronic diseases causing loss of appetite, and eating disorders were excluded.

The following information from the selected 33 studies was extracted: author's name, publication year, study setting and design, sample size, child's age, mother's education, the baby's weight at birth, breastfeeding, socioeconomic status, and prevalence of arrested growth. Any discrepancies raised during data extraction will be resolved.

For data analysis, MedCalc Meta-Analysis Software Package version 20.009 was used. A random-effect model was employed to generate a pooled prevalence and was presented as percentage and 95% confidence interval (CI). Twelve heterogeneity statistics were used and reported as a percentage (%) to assess the heterogeneity and the extent of variations between the included studies. Forest Plot was used to present the result of the meta-analysis schematically. The Cochran Q test and I2 statistics test were used for assessing the heterogeneity in pooled prevalence estimates.

RESULTS

The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 Checklist was used. The total number of articles with relevant titles and abstracts found in the database was 615. After studying these articles, duplicate titles and abstracts were removed, and 387 articles were obtained. In the next phase, remaining full-text articles were assessed in more depth, and only fifty-seven articles remained and were further screened. Out of these articles, 24 articles were excluded because they did not meet the inclusion criteria, and in the last, 33 studies met the criteria (Figure 1).

Majority of the included studies in this systematic review were from Asian and African region (Table I). These studies were published from 1996 to March 2022 (last 26 years) and were conducted in the rural and urban communities and hospitals. Minimum sample size was 60 and maximum was 76,165 [mean=7360.4, median=324, and interquartile Range (IQR)=3764]. The study design of almost all studies was cross-sectional. Children under five years were included which were split into two categories, under two years of age and second from

two to five years of age. Mother's education, one of the variables in the study was divided into two categories, education less than primary or more than primary standard. Baby's birth weight was divided into two categories, less than 2.5 Kg or more than 2.5 Kg. Breastfeeding was divided into two, depending upon the duration, less than one year or more than one year. Socioeconomic status was divided into the lower, middle, and upper class and lastly, stunting prevalence in children under five and its range in these studies was from 4.48% to 70.7%. Out of these thirty-three studies, 9 studies from the last five years were used to assess the pooled prevalence of stunting as a lot of work including systematic reviews and meta-analysis on stunting have already been done in the last two decades.
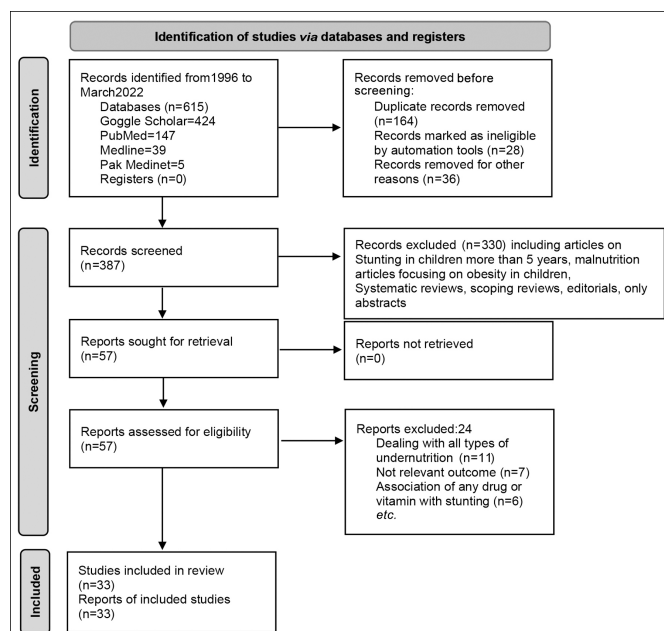

Figure 1: Flow diagram of literature search and study selection.

Nine latest studies from the last five years with total study participants (n=98226) reported growth retardation under five years of age were included, and a meta-analysis was performed (Table II).

The overall pooled prevalence of total stunting in children under five years of age was 39.11% (95% CI: 33.017 to 45.394). A significant heterogeneity with I^2 = 99.39%, p <0.0001 was found among the studies (Figure 2).

Out of 24 studies, seven studies were conducted in Ethiopia. The majority of children were more than 24 months (60%), and mothers were either illiterate (12%-64%) or below primary standard (21.8%-97.8%). Above 90% of children were breastfed for more than a year, the majority of the population study was of a low socioeconomic status (75%), and the prevalence of stunting was 4.48%-55.1%.[15,16,19,33,38,40,47]

Two studies in Pakistan showed that the children under 24 months of age were 52% and 38%. Regarding mothers' education, 52% - 88% of mothers were illiterate, 44% - 50% had low socioeconomic status, having arrested growth prevalence from 37% - 52.32%.[18,44]

Table I: Characteristics of the studies included in the meta-analysis.

Sr.#	Author	Year	Area	*s/s	Study design	Child's age <24m	>24m	Mother's education	>Primary	Weight of baby at birth <2.5kg	>2.5kg	Breast feeding duration <1y	>1y	Socioeconomic status		Stunting prevalence <2y	>2y
1	Beruk Berhanu Desalegn et al.[15]	2016	Ethiopia	312	**C/S	33.7% n=106	66.3% n=206	97.8% n=306	2.2% n=6	--------		7% n=22	93% n=290	--------		4.48% n=14	22.11% n=69
2	Melkamu Beyene Teferi et al.[16]	2016	Ethiopia	324	C/S	65.4% n=212	34.6% n=112	No.31.5% No n=102	=>Prim 68.5% n=222	18.5% n=60	81.5% n=64	13.6% n=44	86.4% n=280	------		22% n=71	10.8% n=35
3	Sunanda Das & Jahida Gulshan[17]	2017	Bangladesh	17,955	****BDHS 2014	Under 5 years		--------		--------		---------		49.6% Poor n=8906		48% n=8618	
4	Gul Nawaz Khan et al.[18]	2016	Pakistan	3964	C/S	52% n=2062	48% n=1902	88% No n=3488	12%=> Primary n=476	------		---------		50% Lower n=1982	42% Upper Middle n=1665	52.32% n=2074	47.68% n=1890
5	Hana Moges et al.[19]	2020	Ethiopia	415	C/S	49.1% n=203	50.9% n=212	36.6% No n=152	=>Primary 63.4% n=263	22.4% n=93	77.6% n=322	7% n=29	93% n=386	34.7% Poor n=144	Lower Middle 65.3% n=271	39.7% n=165	55.1% n=228
6	Febri Wicaksono & Titik Harsanti[20]	2020	Indonesia	76,165	*****IDHS 2013	Under 5 years			>Senior High School 25.8 n=19650	------		--------		--------		36.7% n=27953	
7	Ayu Rosita Dewi et al.[21]	2019	East Java	200	***C/C	2-5 years old			>Sr.High School 69.5% n=139	23.5% n=47	76.5% n=153	54% n=108	46% n=92	-------		12.7% n=25	
8	Angritta Sari et al.[22]	2017	Banjarmasin	190	C/C	2-5 years old		-------------		18.9% n=36	81.1% n=154	27.3% n=52	72.7% n=138	--------------		21.55% n=41	
9	Lenni Silas et al.[23]	2018	Mimika	100	C/S	Under 5 years		36% n=36	64% n=64	12% n=12	88% n=88	--------		39% Poor n=39	61% Upper Middle Class n=61	32.2% n=32	
10	Ashis Talukder et al.[24]	2018	Bangladesh	6965	BDHS 2014 C/S	Under 5 years		=	=	--------		---------		56.3% Poor n=3921	Middle Class >43.7% n=3044	52.37% n=3648	37.2% n=2590
11	Chatianya R Patil et al.[25]	2016	India	200	C/S	49.5% n=99	50.5% n=101	Primary 48% n=96	Middle 52% n=104	--------		--------		55% Lower Middle Class n=110	45% Upper Middle Class n=90	37%Rural n=74	22%Urban n=44
12	Zeritu Dewana et al.[26]	2017	Ethiopia	764	C/S	2-5 years old		47% Illiterate n=359	31.2>Primary n=239	------	------	8.3% n=64	91.7% n=700	--------		52.5% n=402	
13	Muldiasman et al.[27]	2018	Indonesia	2502	National Nutritional Survey 2015	Under 5 years		--------		41.2% n=1031	58.8% n=1471	Early initiation 35.2% n=880	64.8% n=1622	--------		27.5% n=688	
14	Endang Dewi Lestari et al.[28]	2018	Indonesia	60	C/C	2-5 years old		33.3% Low n=20	66.7% High n=40	30% n=18	70% n=42	56.7% Exclusive n=34	43.3% Non-Exclusive n=26	70% Poor n=42	30%Upper Middle Class n=18	56.7% n=34	
15	Marti Rahayu Diah Kusumawati et al.[29]	2019	Indonesia	290	Primary Nutrition Survey2015	Under 5 years		62.4% Low n=181	37.6% High n=109	80.3% n=233	19.7% n=57	--------		64.5% Poor n=187	35.5% Lower Middle n=103	70.7% n=205	
16	Emily Bloss et al.[30]	2004	Kenya	175	C/S	50.68% n=89	49.32% n-86	85% n=145	15% n=26	--------		93% n=163	7% n=12	--------		60% n=105	
17	Lulu Chirande et al.[31]	2015	Tanzania	7324	TDHS 2015 C/S	Under 5 years		26% Illiterate n=1889	6%>Primary n=455	8% n=579	92% n=6725	48% n=3501	52% n=3823	46% Poor n=3370 / 23% Lower Middle n=1685	31% Upper Middle n=2271	16% n=1172	42% n=3076
18	Rajini Peter & Anil Kumar[32]	2014	India	506	C/S	60% n-=303	40% n-203	41.5% Illiterate n=210	58.5% Litterate n=296	13% n=66	87% n=440	48% n=243	52% n=263	23% Poor n=117	77% Middle Class n=389	29.8% n=202	
19	Tesfaye Gobena & Firehiwot Mesfin[33]	2015	Ethiopia	798	C/S	Under 5 years		60% Illiterate n=479	40% Litterate n=319	--------		---------		---------		46% n=368	
20	Judith A Ricic & Stan Backer[34]	1996	Philippines	18544	PDHA 1996 C/S	Under 5 years		--------		48% n=8737	52% n=9643	--------		--------		40% n=7418	
21	El Taguri Adel et al.[35]	2008	Libya	5348	C/S	39% n=2054	61% n=3294	--------		30% n=1604	70% n=3744	--------		35% Poor n=1879	65% Middle Class n=3486	20.7% n=1108	
22	A Mittal et al.[36]	2007	India	482	C/S	34% n=162	66% n=320	67% Illiterate n=323	33% Litterate n=159	--------		--------		--------		46% n=222	
23	Ponam P Dhatrak et al.[37]	2013	India	150	C/S	Under 5 years		48% Illiterate n=72	52% Litterate n=78	14% n=21	86% n=129	22% n=32	78% n=118	38% Poor n=57	62% Middle Class n=93	52% n=78	
24	Man Defro Asfaw et al.[38]	2015	Ethiopia	778	C/S	40% n=312	60% n=466	64% Illiterate n=498	5%>Primary n=36	--------		90.5% n=705	9.5% n=73	--------		47.6% n=371	
25	D Rawali[39]	2011	Nepal	154	C/S	26% n=40	74% n=114	23% Illiterate n=36	50%>Primary n=76	--------		--------		78% Poor n=120	22% Middle Class n=34	37.3% n=58	
26	Mulugeta Gebria Yohanes & Awrajaw Dessie[40]	2022	Ethiopia	554	C/S	42% n=232	58% n=322	58% Illiterate n=322	15%>Primary n=82	--------		80.5% n=446	19.5% n=108	75% Poor n=416	25% Middle Class n=138	39.5% n=219	

No.	Author	Year	Country	Sample size	Study	Male	Female	Mother Education					Socioeconomic		Stunting
27	Erni Gustina et al.[41]	2020	Indonesia	729	C/S	35.5% n=259	64.5% n=470	6% Illiterate n=44	94% Litterate n=685	--------	51% n=372	49% n=357	70% Poor n=504	30% Middle Class n=225	37.6% n=275
28	Vestine Uvwiringiiyimana et al.[42]	2022	Rwanda	3593	RDHS 2022 C/S	Under 5 Years		15% Illiterate n=538	12%> Primary n=432	--------	88.7% n=3187	11.3% n=406	46.8% Poor n=1682	53.2% Middle Class n=1911	38% n=1366
29	Desi Nurfita et al.[43]	2022	Indonesia	2621	C/S	Under 5 years		6% Illiterate n=157	94% Litterate n=2464	--------	66% n=1730	34% n=891	56% Poor n=1475	44% Middle Class n=1146	12.66% n=332
30	Asif Khaliq et al.[44]	2021	Pakistan	6168	PDHS 2021 C/S	38% n=2344	62% n=3824	52% Illiterate n=3223 / 33%> Primary n=2046		--------	--------	--------	44% Poor n=2714	66% Middle Class n=3454	30% n=1850
31	Quraish Serwanja et al.[45]	2019	Sierra leone	4045	SLDHS 2019 C/S	38% n=1537	62% n=2508	40% Illiterate n=1618 / 11%> Primary n=445		--------	--------	--------	38% Poor n=1537	62% Middle Class n=2508	29% n=1173
32	Mohaimen Mansoor et al.[46]	2021	Bangladesh	6179	BDHS 2121 C/S	40% n=2468	60% n=3702	16% Illiterate n=987 / 28%> Primary n=1728		--------	--------	--------	31% Poor n=1912	69% Middle Class n=4258	33.6% n=2074
33	Mulat Mossie Menalu et al.[47]	2021	Ethiopia	381	C/S	62% n=239	38% n=146	12% Illiterate n=46	88% literate n=339	--------	64% n=247	36% n=138	76% Poor n=293	24% Middle Class n=92	41% n=158

*S/S Sample Size, **C/S Cross Sectional Study, ***C/C Case Control Study, ****BDHS Bangladesh Demographic Health Survey, ***** IDHS Indonesian Demographic Health Survey, ******TDHS Tanzania Demographic Health Survey, *******PDHS Philippine Demographic Health Survey, ********RDHS Rwanda Demographic Health Survey, *********PDHS Pakistan Demographic Health Survey, *********SLDHS Sierra Leone Demographic Health Survey.
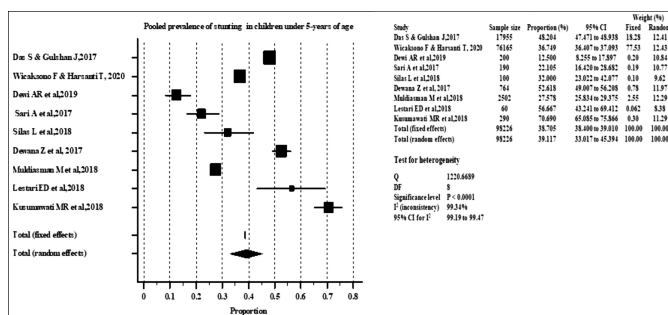

Figure 2: Forest plot of the prevalence of stunting in children under five years of age.

Two studies conducted in Bangladesh showed that 40% of children were below 24 months, 57% of women were below primary, and 16% were illiterate. 56.3% - 31% were poor, and stunting prevalence was 33.6% - 37.2%.[24,46]

Four studies in India showed that stunted children below 24 months were 34%-60%, and illiterate mothers were 41.5%-67%. The baby's birth weight was less than 2500 grams was 13% - 14%. Children who were breastfed for more than one year were 52%-78%. Participants with poor socioeconomic status were 23% -38%, and stunting prevalence was 22%-52%.[25,32,36,37]

One study conducted in Kenya, showed that 50.68% of children under 24 months of age, 85% of mothers' education was below primary, 93% of children were breastfed for less than a year, and 60% were stunting prevalence.[30]

One of the studies conducted in Tanzania showed that 26% of mothers were illiterate, 8% of children had low birth weight, 48% were breastfed for less than a year, 46% were with poor socioeconomic status, and stunting prevalence below two years was 16% and 2-5 years was 42%.[31] A study conducted on children under five years of age in the Philippines showed that 48% of children were below 2500 grams at birth and stunting prevalence was 40%.[34] One of the

studies conducted in Libya showed that 39% of children were below 24 months of age, 30% with low birth weight, 35% had poor socioeconomic status, and stunting prevalence was 20.7%.[35] One of the studies conducted in Nepal, showed that there were 37.3% stunted children. Children under two years of age were 26%, 23% mothers were illiterate, 27% had below-primary education, and 78% belonged to poor socioeconomic class.[39]

Two studies conducted in Indonesia on children under five years of age showed that 6% of mothers were illiterate, and 94% were literate. Mothers breastfed children for more than one year were 34%-49%, poor were 56%-70%, and the stunting prevalence was 12.66%-37.6%.[41,43] One study conducted in Rwanda under five years of age showed that 15% of mothers were illiterate, and 73% were below primary, 88.7% of children were breastfed for less than one year, 46.8% had poor socioeconomic status, and 38% was the stunting prevalence.[42] In a study conducted in Sierra Leone, 38% of children were under two years of age, 40% of mothers were illiterate, 49% were below primary, 38% belonged to poor socioeconomic status, and 29% was the stunting prevalence.[45]

DISCUSSION

Growth retardation is the most prevalent manifestation of childhood malnutrition. Globally, one in four children under five years of age suffers from it.[3] This research was conducted to describe its frequency and predictors in children under five years of age. The pooled prevalence of growth restriction was 39.11%. The results are almost similar to one of the studies conducted in Ethiopia, which showed 38.3% retarded growth in under five year children.[48] This similarity could be that these studies were conducted in the African and Asian regions, which already have a high prevalence because of the common issues.

Table II: Meta-analysis of the pooled prevalence of stunting in children under five years of age.

Study	Sample size	Proportion (%)	95% CI	Weight (%)	
				Fixed	Random
Das S & Gulshan J,2017	17955	48.204	47.471 to 48.938	18.28	12.41
Wicaksono F & Harsanti T, 2020	76165	36.749	36.407 to 37.093	77.53	12.43
Dewi AR *et al.*, 2019	200	12.500	8.255 to 17.897	0.20	10.84
Sari A *et al.*, 2017	190	22.105	16.420 to 28.682	0.19	10.77
Silas L *et al.*, 2018	100	32.000	23.022 to 42.077	0.10	9.62
Dewana Z *et al.*, 2017	764	52.618	49.007 to 56.208	0.78	11.97
Muldiasman M *et al.*, 2018	2502	27.578	25.834 to 29.375	2.55	12.29
Lestari ED *et al.*, 2018	60	56.667	43.241 to 69.412	0.062	8.38
Kusumawati MR *et al.*, 2018	290	70.690	65.085 to 75.866	0.30	11.29
Total (fixed effects)	98226	38.705	38.400 to 39.010	100.00	100.00
Total (random effects)	98226	39.117	33.017 to 45.394	100.00	100.00

In this systematic review, 28 out of 33 studies (85%) showed that a mother's education is a highly prevalent predictor related to the inhibited growth in under five children, and it has been concluded that the prior studies regarding the critical relevance of children's growth retardation and mother's education. One of the studies conducted in Indonesia showed the importance of a mother's education and also as one of the determinants of the incidence of impeded growth in children with the OR value of 1.9, which means 1.9 times greater risk of stunted growth in children of a mother with low education compared to children of parents with higher education.[49] Maternal education enhances the horizon of the mother's knowledge regarding food, nutrition, childcare, feeding practices, and ultimately the child's good health.

Another essential predictor in 40% of the studies in the systematic review is the baby's weight at birth. Weight of the baby <2500 grams is considered a low birth weight (LBW), and it is one of the leading factors in determining the growth pattern after birth. LBW is related to preterm delivery, intrauterine growth retardation (IUGR), or both. One of the studies conducted in Indonesia showed that its prevalence among Indonesian toddlers is 40.4%, and infants born with less birth weight <2500 grams are 1.74 times more likely to be stunted than those born with average weight.[50]

Studies have shown that different factors contribute to a child's restricted growth, including breastfeeding. Most studies show that almost 55% of mothers have breastfed their children for more than one year but not exclusive breastfeeding for the first six months. One of the studies conducted in Mexico showed that one hundred eighty-nine children were evaluated; 59.3% were breastfed, and 40.7% were not. The proportion of not breastfed children with impeded growth (27.5%) was almost twice that of breastfed children (12.0%). Most of the mothers did not meet the WHO recommendations regarding feeding practices of the children.[51] Another study in Indonesia showed that exclusively breastfed children were 20% less likely to be stunted than non-breastfed. Exclusive breastfeeding is a protective factor against stunting.[52]

Socioeconomic status, one of the crucial predictors in the study with 64%, showed that the poor and the lower middle class have a high prevalence of retarded growth in children under 5 years of age. One of the studies conducted in Nairobi, Kenya, showed that 68% of stunted children under five years of age lived in the poorest household compared to 57% of children living in poor households. Childhood arrested growth is an indicator of chronic deprivation of nutrition.[53] In this regard, socioeconomic status plays an important role.

The risk of information bias might have increased due to different sample sizes, methods of sampling, and different tools for the outcome measures in these studies. Literature shows that stunted growth results from the interaction of multiple factors ranging from poor maternal physical health before and during pregnancy, short stature, anaemia, and other co-morbidities, child's nutrition, weaning, and safe drinking water, sanitation, and socioeconomic status.[54,55] Therefore, further studies shall investigate these factors to prevent and control childhood growth restriction.

The prevalence and predictors in this study can be used to implement preventive and control measures to address this issue effectively. New community-based nutrition programs need to be established and the up-gradation of already existing nutrition plans to handle this problem at the community level. Parents need to be educated and counselled regarding appropriate feeding practices for their children.[56]

CONCLUSION

In this systematic review, the pooled prevalence of stunting in children under-five was 39.11%. Regarding predictors, the mother's education was one of the most frequent predictors (85%), followed by socioeconomic status (64%), breastfeeding (55%), and weight of the baby at birth (40%).

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
SR: Substantial contributions to the conception, acquisition, and analysis of work drafting the work.
SA: Critically revising for important intellectual content and final approval of the version to be published.
All the authors have approved the final version of the manuscript to be published.

REFERENCES

1. Mediani HS. Predictors of stunting among children under five year of age in Indonesia: A scoping review. *Global J Health Sci* 2020; **12(8)**:83. doi:10.5539/gjhs.v12n8p83

2. Kejo D, Mosha TC, Petrucka P, Martin H, Kimanya ME. Prevalence and predictors of undernutrition among underfive children in Arusha District, Tanzania. *Food Sci Nutr* 2018; **6(8)**:2264-72. doi: 10.1002/fsn3.798.

3. Vilcins D, Sly PD, Jagals P. Environmental risk factors associated with child stunting: A systematic review of the literature. *Annals Global Health* 2018; **84(4)**:551. doi: 10.9204/aogh.2361.

4. Guyatt H, Muiruri F, Mburu P, Robins A. Prevalence and predictors of underweight and stunting among children under 2 years of age in Eastern Kenya. *Public Health Nutr* 2020; **23(9)**:1599-608. doi: 10.1017/S1368980019003793.

5. Akombi BJ, Agho KE, Hall JJ, Merom D, Astell-Burt T, Renzaho AM. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. *BMC Pediatr* 2017; **17(1)**:15 doi: 10.1186/s12887-016-0770-z.

6. De Onis M, Branca F. Childhood stunting: A global perspective. *Maternal Child Nutr* 2016; **12(Suppl 1)**:12-26. doi: 10.1111/mcn.12231.

7. Amare D, Negesse A, Tsegaye B, Assefa B, Ayenie B. Prevalence of undernutrition and its associated factors among children below five years of age in Bure Town, West Gojjam Zone, Amhara National Regional State, Northwest Ethiopia. *Adv Public Health* 2016; Article ID 7145708 http://doi.org/10.1155/2016/7145708

8. Darsene H, Geleto A, Gebeyehu A, Meseret S. Magnitude and predictors of undernutrition among children aged six to fifty nine months in Ethiopia: a cross sectional study. *Arch Public Health* 2017; **75**:29. doi: 10.1186/s13690-017-0198-4. eCollection 2017..

9. Chowdhury TR, Chakrabarty S, Rakib M, Afrin S, Saltmarsh S, Winn S. Factors associated with stunting and wasting in children under 2 years in Bangladesh. *Heliyon* 2020; **6(9)**: e04849. doi: 10.1016/j.heliyon.2020.e04849.

10. 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. *Pak J Med Sci* 2020; **36(3)**:581-85 doi: 10.12669/pjms.36.3.1370.

11. Babar M, Khan R, Ullah A. Nutritional status and associated factors among nomad children under five years of age in district Faisalabad. *Pak J Public Health* 2017; **7(3)**:163-8

12. Dorsey JL, Manohar S, Neupane S, Shrestha B, Klemm RD, West KP. Individual, household, and community level risk factors of stunting in children younger than 5 years: Findings from a national surveillance system in Nepal. *Mater Child Nutr* 2018; **14(1)**: e12434. doi: 10.1111/mcn.12434.

13. Mengesha HG, Vatanparast H, Feng C, Petrucka P. Modeling the predictors of stunting in Ethiopia: analysis of 2016 Ethiopian demographic health survey data (EDHS). *BMC. Nutr.* 2020 ;6:52. doi: 10.1186/s40795-020-00378-z.

14. Rabaoarisoa CR, Rakotoarison R, Rakotonirainy NH, Mangahasimbola RT, Randrianarisoa AB, Jambou R, *et al*. The importance of public health, poverty reduction programs and women's empowerment in the reduction of child stunting in rural areas of Moramanga and Morondava, Madagascar. *PLoS One* 2017; **12(10)**: e0186493. doi: 10.1371/journal.pone.0186493.

15. Desalegn BB, Kinfe E, Fikre K, Bosha T. Stunting and its associated factors in under five years old children: The case of Hawassa University Technology villages, Southern Ethiopia. *J Environm Sci Toxicol Food Technol* 2016; **10(11)**: 25-31.doi: 10.9790/2402-1011022531

16. Teferi MB, Hassen HY, Kebede A, Adugnaw E, Gebrekrstos G, Guesh M. Prevalence of stunting and associated factors among children aged 06–59 months in Southwest Ethiopia: A cross-sectional study. *J Nutritional Health Food Sci* 2016; **2016**: **4(6):** 1-6. doi:dx.doi.org/10.15226/jnhfs.2016.00180

17. Das S, Gulshan J. Different forms of malnutrition among under five children in Bangladesh: A cross sectional study on prevalence and determinants. *BMC Nutri* 2017; **3(1)**:1-2. doi.org/10.1186/s40795-016-0122-2

18. Khan GN, Turab A, Khan MI, Rizvi A, Shaheen F, Ullah A, *et al*. Prevalence and associated factors of malnutrition among children under-five years in Sindh, Pakistan: A cross-sectional study. *BMC Nutrition* 2016; **2(1)**:1-7. doi.org/10.1186/s40795-016-0112-4

19. Moges H, Alemayehu D, Redi H, Gebeyehu Y, Dires A, Gedamu S. Prevalence and associated factors of stunting among children aged six month-five year in Ataye Town, Northeast Ethiopia. *Int J Nutrition Food Sci* 2019; **8(6)**: 86-92. doi: 10.11648/j.ijnfs.20190806.12

20. Wicaksono F, Harsanti T. Determinants of stunted children in Indonesia: A multilevel analysis at the individual, household, and community levels. Kesmas: Jurnal Kesehatan *Masyarakat Nasional (National Public Health J)* 2020; **15(1)**:48-53. doi.org/10.21109/kesmas.v15i1.2771

21. Dewi AR, Dewi YL, Murti B. Life course factors associated with stunting in children aged 2-5 years: A path analysis. *J Maternal Child Health* 2019; **4(5)**:348-57. e-ISSN: 2549-0257.

22. Sari A, Mambang M, Putri KS, Haryono IA, Lestari YP, Sari MY. Factors affecting the stunting case: A retrospective study on children in Banjarmasin. In2nd Sari Mulia International conference on health and sciences 2017 (SMICHS 2017)–One health to address the problem of tropical infectious diseases in Indonesia 2017 Dec. *Atlantis Press* dx.doi.org/10.2991/smichs-17.2017.3.

23. Silas L, Rantetampang AL, Tingginehe R, Mallongi A. The factors affecting stunting child under five years in sub province Mimika. *Int J Sci Healthcare Res* **3(2)**:99-108

24. Talukder A, Rahman Razu S, Zobayer H. Factors affecting stunting among children under five years of age in Bangladesh. *Fam Med, Prim Care Rev* 2018; 2018; **20(4)**: 356–362 doi.org/10.5114/fmpcr.2018.79348

25. Patil CR, Thakre SS, Khamgaonkar MB, Thakre S. Prevalence of stunting and wasting among Anganwadi school children of rural and urban area of Central India: A cross-sectional study. *Int J Medical Sci Public Health* 2017; **6(2)**:413-7 doi: 10.5455/ijmsph.2017.17082016634

26. Dewana Z, Fikadu T, Facha W, Mekonnen N. Prevalence and predictors of stunting among children of age between 24 to 59 months in Butajira town and surrounding district, Gurage zone, Southern Ethiopia. *Health Sci J* 2017; **11(4)**:518.doi: 10.21767/1791-809X.1000518

27. Muldiasman M, Kusharisupeni K, Laksminingsih E, Besral B. Can early initiation to breastfeeding prevent stunting in 6–59 months old children? *J Health Res* 2018 ; **32(5)** 334-41 doi.org/10.1108/JHR-08-2018-038

28. Lestari ED, Hasanah F, Nugroho NA. Correlation between non-exclusive breastfeeding and low birth weight to stunting in children. *Paediatrica Indonesiana* 2018; **58(3)**:123-7. doi.org/10.14238/pi58.3.2018.123-7

29. Kusumawati MR, Marina R, Wuryaningsih CE. Low birth weight as the predictors of stunting in children under five years in Teluknaga sub district province of Banten 2015. *KnE Life Sci* 2018; 284-93. doi.org/10.18502/kls.v4i10.3731

30. Bloss E, Wainaina F, Bailey RC. Prevalence and predictors of underweight, stunting, and wasting among children aged 5 and under in western Kenya. *J Tropical Pediatrics* 2004; **50(5)**:260-70. doi: 10.1093/tropej/50.5.260.

31. Chirande L, Charwe D, Mbwana H, Victor R, Kimboka S, Issaka AI, Baines SK, Dibley MJ, Agho KE. Determinants of stunting and severe stunting among under-fives in Tanzania: Evidence from the 2010 cross-sectional household survey. *BMC Pediatrics* 2015; **15(1)**:1-3. doi: 10.1186/s12887-015-0482-9.

32. Peter R, Kumar KA. Prevalence and predictors of undernutrition in children aged 0-59 months in the slums of Hyderabad, India. *Int J Res Health Sci* 2014; **2(4)**:987-98

33. Yisak H, Gobena T, Mesfin F. Prevalence and risk factors for under nutrition among children under five at Haramaya district, Eastern Ethiopia. *BMC Pediatrics* 2015; **15(1)**:1-7. doi: 10.1186/s12887-015-0535-0.

34. Ricci JA, Becker S. Risk factors for wasting and stunting among children in Metro Cebu, Philippines. *American J Clinical Nutrition* 1996; **63(6)**:966-75. doi: 10.1093/ajcn/63.6.966.

35. Adel ET, Marie-Françoise RC, Salaheddin M M, Najeeb E, Monem Ahmed A, Ibrahim B, Gerard L. Nutritional status of under-five children in Libya; a national population-based survey. *Libyan J Medicine* 2008; **3(1)**:13-9. doi: 10.4176/071006.

36. Mittal A, Singh J, Ahluwalia SK. Effect of maternal factors on nutritional status of 1-5-year-old children in urban slum population. *Indian J Community Medicine* 2007; **32(4)**: 264-67doi: 10.4103/0970-0218.37691

37. Dhatrak PP, Pitale S, Kasturwar NB, Nayse J, Relwani N. Prevalence and epidemiological determinants of malnutrition among under-fives in an urban Slum, Nagpur. *National J Community Med* 2013; **4(1)**:91 http://njcmindia. com/index.php/file/index

38. Asfaw M, Wondaferash M, Taha M, Dube L. Prevalence of undernutrition and associated factors among children aged between six to fifty nine months in Bule Hora district, South Ethiopia. *BMC Public Health* 2015; **15(1)**:1-9. doi: 10.1186/s12889-015-1370-9.

39. Ruwali D. Nutritional status of children under five years of age and factors associated in Padampur VDC, Chitwan. *Health Prospect* 2011; **10**:14-8. doi.org/10.3126/hprospect.v10i0.5639

40. Gebreayohanes M, Dessie A. Prevalence of stunting and its associated factors among children 6–59 months of age in pastoralist community, Northeast Ethiopia: A community-based cross-sectional study. *PLoS One* 2022; **17(2)**: e0256722. doi: 10.1371/journal.pone.0256722.

41. Gustina E, Sofiana L, Ayu SM, Wardani Y, Lasari DI. Good parental feeding style reduces the risk of stunting among under-five children in Yogyakarta, Indonesia. 2020 **8(2)**. http://doi.org/10.15562/phpma.v8i2.306

42. Uwiringiyimana V, Osei F, Amer S, Veldkamp A. Bayesian geostatistical modelling of stunting in Rwanda: Risk factors and spatially explicit residual stunting burden. *BMC Public Health* 2022; **22(1)**:159. doi: 10.1186/s12889-022-12552-y.

43. Nurfita D, Parisudha A, Sugiarto S. Stunting determinants in kulonprogo district, yogyakarta year 2019. *Epidemiol Society Health Review* (ESHR) 2022; **4(1)**:12-20. doi.org/10.26555/eshr.v4i1.4039

44. Khaliq A, Wraith D, Miller Y, Nambiar-Mann S. Prevalence, trends, and socioeconomic determinants of coexisting forms of malnutrition amongst children under five years of age in Pakistan. *Nutrients* 2021; **13(12)**:4566. doi: 10.3390/nu13124566.

45. Sserwanja Q, Kamara K, Mutisya LM, Musaba MW, Ziaei S. Rural and urban correlates of stunting among under-five children in Sierra Leone: A 2019 Nationwide cross-sectional survey. *Nutr Metab Insights* 2021; **14**:11786388211047056. doi: 10.1177/11786388211047056.

46. Mansur M, Afiaz A, Hossain MS. Sociodemographic risk factors of under-five stunting in Bangladesh: Assessing the role of interactions using a machine learning method. *PLoS One* 2021; **16(8)**:e0256729. doi: 10.1371/journal.pone.0256729.

47. Menalu MM, Bayleyegn AD, Tizazu MA, Amare NS. Assessment of prevalence and factors associated with malnutrition among under-five children in Debre Berhan town, Ethiopia. *Int J General Med* 2021; **14**:1683. doi: 10.2147/IJGM.S307026.

48. Kassa ZY, Behailu T, Mekonnen A, Teshome M, Yeshitila S. Malnutrition and associated factors among under five children (6-59 Months) at Shashemene Referral Hospital, West Arsi Zone, Oromia, Ethiopia. Current Pediatric Research. 2017.

49. Handayani F, Siagian A, Aritonang EY. Mother's education as a determinant of stunting among children of age 24 to 59 months in North Sumatera province of Indonesia. *IOSR J. Humanit Soc Sci* 2017; **22**:58-64

50. Aryastami NK, Shankar A, Kusumawardani N, Besral B, Jahari AB, Achadi E. Low birth weight was the most dominant predictor associated with stunting among children aged 12–23 months in Indonesia. *BMC Nutr* 2017; **3(1)**:1-6. doi.org/10.1186/s40795-017-0130-x

51. Zaragoza-Cortes J, Trejo-Osti LE, Ocampo-Torres M, Maldonado-Vargas L, Ortiz-Gress AA. Poor breastfeeding, complementary feeding and dietary diversity in children and their relationship with stunting in rural communities. *Nutrición Hospitalaria* 2018; **35(2)**:271-8. doi: 10.20960/nh.1352.

52. Hadi H, Fatimatasari F, Irwanti W, Kusuma C, Alfiana RD, Asshiddiqi MI, Nugroho S, Lewis EC, Gittelsohn J. Exclusive breastfeeding protects young children from stunting in a low-income population: A study from Eastern Indo-

nesia. *Nutri* 2021; **13(12)**:4264. doi.org/10.3390/nu1312 4264

53. Faye CM, Fonn S, Levin J. Factors associated with recovery from stunting among under-five children in two Nairobi informal settlements. *Plos One* 2019; **14(4)**:e0215488. doi: 10.1371/journal.pone.0215488.

54. Nkurunziza S, Meessen B, Van Geertruyden JP, Korachais C. Determinants of stunting and severe stunting among Burundian children aged 6-23 months: Evidence from a national cross-sectional household survey, 2014. *BMC Pediatr* 2017; **17(1)**:176. doi: 10.1186/s12887-017-0929-2.

55. Dake SK, Solomon FB, Bobe TM, Tekle HA, Tufa EG. Predictors of stunting among children 6-59 months of age in Sodo Zuria District, South Ethiopia: A community based cross-sectional study. *BMC Nutr* 2019; **5(1)**:1-7. doi: 10.1186/s40795-019-0287-6.

56. Juarez M, Dionicio C, Sacuj N, Lopez W, Miller AC, Rohloff P. Community-based interventions to reduce child stunting in rural guatemala: A quality improvement model. *In J Environ Res Public Health* 2021; **18(2)**:773. doi: 10.3390/ijerph180 20773.

• • • • • • • • • •