

Evidence Linking Stunting to Economic Outcomes in the SAARC Region: a Systematic Review

Minnat Seema Nasser (✉ minnatnasser@hotmail.com)

Institute of Business Management <https://orcid.org/0000-0001-7428-477X>

Ather Akhlaq

Institute of Business Management

Hijaz Ali

Institute of Business Management

Dawood Nasser

Ziauddin Medical college

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Abstract

Background

At present, South Asian Association for Regional Cooperation (SAARC) countries have tremendous pressure on child stunting along with the impact it is making on economic growth. World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF) and The World Bank (WB) have emphasized for this region to reduce stunting by 40%. The objective of this paper is to analyze the impact of stunting on economic outcomes in SAARC countries so that to scale up policies and programs aiming to reduce child stunting.

Methods

The systematic review has assessed five international databases; PubMed, JSTOR, Cochrane Library, Web of Science and CINAHL Plus for published, unpublished, and on-going research till the year 2020. Grey literature is searched using Google Scholar and Google search engines. The systematic review registration number in PROSPERO is CRD42021230279.

Result

Thirty-three studies matched the criteria. Most quantitative studies link stunting with economic repercussions. Three investigations found no or a weak link between the two. Nutritional intervention synthesis predicts a 12 percent return, a 5:1-6:1 benefit-cost ratio, and a 14mm height gain. A 1 cm increase in height increases pay by 4% for men and 6% for women. Stunting caused a 5%-7% income penalty and lower lifetime pay. Studies show that a 10% increase in agricultural growth reduces stunting by 9.6%, while a 10% increase in non-agricultural growth reduces stunting by 8.4%.

Conclusion

To reduce stunting prevalence, policies should be scaled up, as well as targeted and structural interventions are needed.

1- Introduction

According to the WHO (1), globally in 2020, 149 million children under the age of five suffered from stunting, which causes them to be too short for their age and more than two standard deviations below the WHO's median (a value of a child's height in the middle of a frequency distribution of observed values of average child height, with an equal probability of falling above or below) (2). South Asia alone accounts for 53.8 million (31.8%) of the total (1). Stunting is caused by poverty, malnutrition, and chronic disease in the mother or child by birth. Stunting has immediate and intermediate causes, as well as underlying factors (3).

Inadequate nutrition and repeated illnesses in the first five years of a child's life result in decreased IQ and physical development, reduced productivity, and poor health in general, which eventually cause chronic diseases including arthritis, asthma, cancer, and diabetes (3). Stunted children are less productive; mentally, physically, and physiologically (4), which results in lower wages and a likely contender for the next generation/s to be stunted. Stunting also reduces immunity, making people more susceptible to illnesses and affecting reproductive health (5, 6). Due to health concerns, stunted children suffer significant mental and physical effects in their early years, resulting in poor performance in school or in vocational training, poor job performance, lower wages and earnings due to lack of education and skills, which causes them to rely on other household members or society to sustain economic burden (5). Stunting has a lifelong impact (7). Height in childhood determines adulthood height (7), and height is an important determinant of wages (5, 8). As reported by (9–11) a child's first 1000 days including ennead months in the mother's womb impacts the future height. It is difficult to catch up on height later in adolescence due to a malnourished skeleton that takes time to grow taller than the usual non-stunted child (12, 13).

Malnutrition is rampant in South Asia, as adequate food is out of reach for many poor people. They also lack the knowledge or education to make healthy food choices (14). According to World Bank's report, 62 million children out of 155 million are considered stunted, meaning they are too small for their age (15). According to the WHO, what sets South Asia apart from other developing countries where stunting is a problem is the persistence of chronic malnutrition notwithstanding rapid economic growth (16–22). This is due to poor transition mechanisms and weak supply side by countries in terms of inadequate and non-nutritious food, dirty water, poor sanitation, insufficient healthcare, to name a few examples. Due to poverty and its related reasons, the demand side is also weak; underinvesting in healthy food, education, old and traditional belief systems (like gender-based discrimination and the waste of colostrum), are a few of them.

2- Method

This study assessed the economic consequences of stunting in SAARC, considering the impact of childhood stunting on adult economic outcomes. Terms like malnutrition, under-nutrition, and other such categories are used in this study as substitutes for stunting. The PICO questions were used to construct the protocol for this systematic review.

2.1 Eligibility Criteria (PICO)

Eligible population

Stunted children five or under five years of age

Eligible interventions

Malnutrition in mother and child, height is to wage, GDP, income

Eligible comparator

Stunted vs non-stunted children.

Outcomes

Primary Outcomes

impact of stunting on income and economic growth.

Secondary outcome

causal relationship between economic growth and stunting.

(Detail of the PICO criteria is available in Appendix I)

This systematic review searched all published, unpublished, and working papers on stunting and its economic consequences up to May 2020. Studies on Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, India, Pakistan, and Sri Lanka are chosen. We used CINAHL Plus, Cochrane Library, JSTOR, PubMed, and Web of Science to find articles. We used Google Scholar and Chrome to find grey literature and used the top 100 results. The PRISMA guidelines are followed.

2.2 Inclusion/Exclusion criteria

The study included all journals, articles, or books on stunting or terms associated with stunting in relation to the economy, adulthood income, and GDP. We did not include studies directly on stunting that have an economic impact due to education, cognition, test scores, health, socioeconomic position, micronutrient deficiencies, and fetal development. We also included research on the causal relationship between GDP and socioeconomic growth via interventions and policy instruments in health education and socioeconomic relevance.

2.3 Search strategy

The terms were searched using Boolean methodology. Appendix A. details the search approach for databases.

2.4 Study selection

MSN and HA separately incorporated the retrieved studies. The studies were de-duplicated and stored in EndNote. The writers included papers that reported evidence of economic growth and stunting. Studies that did not cover the SAARC region or that sought other outcomes than economic growth were also omitted. The articles were moved to an EndNote library to be searched for duplicates. Author, year of publication, total number of observations, location of study, study design, duration of study, gender, nutritional status, types of nutrition/nutrients supplement, exposure group, result and focus view, economic outcomes (tables vary with headings according to the study design requirement). Fig. 1 shows the article selection procedure in detail.

2.5 Risk of bias (quality) assessment

The authors independently screened all titles, abstracts, and full-text papers included in the review. Any arguments were discussed with third team member Ather Akhlaq (AA) and resolved amicably. The authors utilized (23)'s Mixed Method Assessment Tool (MMAT) to measure quality. Many systematic reviews employ this tool (24, 25). The whole text of the recovered and synthesized papers is tabulated as in Appendix B, C, D, E, F, G. Each study is given a methodological rating of 0, 25, 50, 75, or 100 (100 being the greatest quality). With the MMAT, we rated each method separately. When process evaluation was built into the study design, the overall study quality was assessed.

2.6 Study registration:

A registration of the study is available at: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42021230279.

3- Result

The five databases plus Google Scholar retrieved 9689 articles. 6523 articles remained after 3166 publications were de-duplicated. 6050 items were filtered. 258 publications were omitted from the remaining 473 abstracts. Professors; Borghi, Aguayo and Zulfiqar Ali Bhutta were all provided with the reference list for their expert advice. Dr. Elaine Borghi contributed nine publications, including editorials and research, six were included in our references. Dr. Zivai Murira responded on Dr. Aguayo's behalf and offered one article. Dr. Bhutta did not respond to our second and third soft reminder emails, 10 days apart. We evaluated the remaining 221 publications closely after adding Dr. Borgi's six articles. 29 items qualified. 4 articles were added after reading references from retrieved articles. Figure 1 displays the results of the search of the selected publications' bibliographies.

The link between child stunting and economic outcomes was studied despite the lack of data. We took 19 global studies where one or more SAARC countries were a part of them. Our review includes news, journal, and report articles. Our research found seven papers on India and two news reports on Pakistan. One interview, one cover story, and one study on stunting in D/LMIC countries are included in this review. We found 15 quantitative, 11 qualitative, and 7 mixed-method studies.

Quality appraisal Overall, the studies that were included were of high quality. 25 of the 33 full research papers evaluated received a quality score of equal to or greater than 75%. Quantitative studies had the best quality score of all sorts of methodologies, followed by qualitative studies and mixed methods research (see Table 1).

Table 1

Study design	Number of studies and methods used to collect data			
Study design	25%(*)	50%(**)	75%(***)	100%(****)
Quantitative		2	7	6
Qualitative	1	2	4	4
Mixed Methods	1	2	3	1

Synthesis of results The themes of study types indicating the link between child stunting and economic outcomes in the SAARC region were intervention studies, natural experiments, prospective studies, quasi-experiments, and linear regression estimations. Evidence identified under these study types is presented in Tables 3, 4, 5, 6, 7. In addition to the study types, the link between stunting and economic outcomes is also mentioned, with supporting key background papers as presented in Table 2.

3.1 Reasons for stunting and its Economic outcomes:

Table 2. includes the twenty background articles that outline the reasons for stunting and its economic consequences in the SAARC Region. Stunting in the first two years of life or the first 1000 days leads to poorer human capital (11, 26). It also causes persistent damage that hinders an individual's economic growth (11, 26). This harm impacts the next generation, both physically and financially (11, 26). Paternal stimulation was also found to be a factor in a child's physical and mental development (27). Rudra and Kurian (2017) evaluated the impact of stunting and malnutrition on India's workforce and found that stunted children earn 20% less than non-stunted children in adulthood, which impacts the national income and causes irreversible damage (28). A study in Bangladesh, India, Nepal, Pakistan, Sri Lanka, Bhutan, and 85 other LMICs indicated that stunting has a long-term influence on human development (29). Stunting reduces output and is validated by UNFP (2017). The paper states that stunting, anemia, and iodine deficiency affect more than two-thirds of Pakistani children, resulting in mental and physical development deficits, lower school performance, fatigue and increased mortality. The cost to the economy due to this reason is around UD \$657 million annually in industry, agriculture, and other physical jobs (30).

Stunting and poverty are inextricably linked (31). Evidence-based research shows that poverty puts 65 percent of South Asian children at risk of stunting. According to Harvard research, stunting can cost developing countries like South Asia over \$177 billion in lifetime earnings. According to an Indian study on stunting and height (5) a 1 cm increase in height results in a 4% increase in male wage and a 6% increase in female wage. Stunting can be reduced by improving children's nutrition, addressing gender gaps and enhancing women's status, improving sanitation, and lowering poverty and unfairness. Stunting or short stature in childhood is frequently linked to low adult economic performance (5). According to (32), stunting and micronutrient deficiencies cost low-income nations, particularly South Asia, 3% of their GDP. Economic shocks have a pro-cyclical influence on health in Asia (33). Part of the current workforce was stunted in childhood (8, 34), resulting in a loss to national economic productivity (35) In the cases of India, Pakistan, and Bangladesh, despite being among the world's most populous countries, economic growth has been uneven in the last 15-20 years due to low labor productivity (12). A study (19) discovered that economic growth had little impact on stunting because of poor government strategies, an unfavorable environment (36), ineffective interventions (37), and a lack of integrated and structural policies (22).

Table 2
Reasons for stunting and its Economic outcomes

Author's Name	Publication	Year of publication	Studied Country/ies Prevailing Circumstances	Outcomes	Effect on Economic growth	Focus View
Cesar G Victora et al.	Lancet	2008	Brazil, Guatemala, India, the Philippines, and South Africa. Undernutrition of mother and child	School delays, lower income and scarce assets, low birth weight, lower body mass, higher glucose concentration and blood pressure	Adverse	The damage happened in early life due to stunting leads to permanent damage thus affecting economic growth, and might also affect future generations.
Lim et al.	Lancet	2018	195 countries, including SAARC Countries; India, Pakistan, and Bangladesh. Human capital investment	Higher education, training and better health	Expansion in economic growth	Three countries; India, Pakistan, and Bangladesh came in 10 top countries out of 195 countries having the highest human capital but with marked variation in GDP from a developed country.
Dewey K.G. & Begum K.	Maternal and child nutrition	2011	Brazil, India, Philippines and South Africa (in addition to the Guatemala trial). Stunting	Impaired health and education	Impaired economic growth	Summarizes the review on the long term impact of stunting in later life.
Emanuela Galasso & Adam Wagstaff	Economics and Human Biology; Elsevier	2019	1-Stunting 2-Nutritional intervention	1-lesser years of school and lower cognitive skills 2-more schooling and better cognition	1-lower wages & lower country's per capita 2-multiplied rate of return	Lower capita in present due to the fraction of the workforce stunted in childhood in developing countries that includes SAARC countries too.
Emma Batha	Reuters	2016	34 developing countries including SAARC countries; Afghanistan, Bangladesh, India, Nepal, Pakistan Poverty, less investment in early child development, nutrition, sanitation and inadequate simulation	Higher health investment in later life, frequent infections and low cognition	More poverty, lower earnings and low future economic growth	Evidence-based study shows that there is strong evidence linking child stunting and poverty. 65% of the children in South Asian states are at risk of stunting due to poverty. Harvard study says that developing countries including south Asia can lose more than \$177 billion in the lifetime earning of its people due to stunting.
F. H. G. Ferreira & N. Schady	World Bank	2008	India along with other developing countries and developed countries. Microeconomic crises, drought and reduced investment in child human capital	Lesser school years, lower health and tension between income and substitution effect	Transmitted poverty to next generation, pro-cyclical mortality rate, decrease in school enrollment and fall in nutrition level	Economic shocks have a pro-cyclical effect on health in Asia
Fink G. et al	American Journal of Clinical Nutrition	2016	Nepal, Bhutan, Bangladesh included in 38 LMICs Early growth faltering	Loss in education attainment	Loss in economic growth	Human capital losses are largest in South Asia due to stunting
TGP	The Global Panel on Agriculture and Food Systems for Nutrition	2016	Pakistan, India and Bangladesh were mentioned particularly when the report writes on Asian countries. Investment in human capital, actions for better maternal and child nutrition	Forgone economic growth both of individual and country	Decline in global economy	Stunting, vitamin and mineral deficiencies together result in losses of up to 3% of GDP in low-income developing countries including South Asian countries.
Jessica Fanzo	Journal of International Affairs	2014	Asian Country including India. Long-term insufficient nutrients intake and frequent infections before 2 years of age	Delayed motor development, impaired cognition and poor school performance	Poverty	SDG's goal of reducing stunting depends on the government strategy and favorable environment.

Source: Author's construction

Author's Name	Publication	Year of publication	Studied Country/ies Prevailing Circumstances	Outcomes	Effect on Economic growth	Focus View
J. Hoddinott et al.	Maternal and Child Nutrition, Wiley	2013	Developing countries and India, Pakistan, Bangladesh, Bhutan, Nepal. Stunting, low age at first birth and more pregnancies	Low test scores and nonverbal cognitive disorders, lower household per capita expenditure and higher poverty	Adverse consequences on human, social and economic capital	Summary of repercussions of stunting in the initial 1000 days including enneadic months in mother's womb till the old age and cost-benefit ratios of nutritional interventions to reduce stunting.
PRB	Population Reference Bureau	2012	India and Senegal. 1-Intervention in proper nutrition 2-High income/ economic growth	1-better performance in school, higher lifetime earnings and increased productivity in labor force 2-Wealthier population, higher purchasing power and more essential nutrients	1-effective interventions 2-better health and larger increase in economic growth	There is more to stunting than just economic growth and that is lack of action in interventions and poor strategy by the policymakers
Milman et al.	American Society for Nutritional Sciences	2005	Bangladesh India, Nepal, Pakistan, Sri Lanka, Bhutan 85 countries. Reduced stunting by long-term and specified interventions	Reduced stunting prevalence	Increase in country's economic performance	Child stunting is associated with impact over long-term development and specific interventions needed to curb it
M. Shekar et al.	Maternal & Child Nutrition, Wiley	2016	South Asia including India. 1-Stunting 2-Intervention in nutrition	1-increased mortality, morbidity, decrease cognitive abilities, poor education outcomes and loss in earnings 2-Reduced poverty	1-Loss in national economic productivity 2-High economic growth	Stunting can result in loss of earnings leading to losses to national economic productivity.
Rudra & Kurian	Observer Research Foundation	2017	India. Stunting	Hindrances in physical and mental development high risk of diabetes, obesity and hypertension in future	Reduced earnings	Stunting has permanent and irreversible consequences leading to poor performance in school learning and lesser earnings in adulthood.
Pakistan Scaling Up Nutrition and United Nations World Food Programme	United Nations World Food Programme	2017	Pakistan. Malnutrition	Loss of laborer, higher healthcare expenses and lower productivity	Low GDP	The consequences of poor nutrition – includes lost laborers, increase healthcare expenses and lesser productivity that costs Pakistan US\$7.6 billion, or 3 percent of GDP every year
Shreya Raman	IndiaSpend	2018	India. Childhood stunting	Impaired brain development, lower cognitive and socio-emotional skill, lower attainment of schooling	Lesser earnings by workforce and reduced per-capita income	South Asia is topping the list in the WHO Report on stunting that the present working force is earning 10% lesser because they are stunted in childhood.

Author's Name	Publication	Year of publication	Studied Country/ies Prevailing Circumstances	Outcomes	Effect on Economic growth	Focus View
McGoovern. et al	International Journal of Epidemiology	2017	South Asian Countries and Africa including SAARC countries India. Childhood stunting	Poverty	Reduced economic growth	Summarizes the pathway linking stunting and economic growth. The preferred studies state that 1-cm increase in stature with respect to height is associated with a 4% higher wages in men and a 6% higher wage in women.
Subramanian & Subramanyam	Journal of Korean Medical Science	2015	India. Undernourishment	Poverty	Lack in strategic intervention	Evidence from study on India along with other developing countries shows that economic growth has little to no impact on increasing child's nutritional level.
S.V. Subramanian et al	Maternal & Child Nutrition, Wiley	2016	India. Child growth faltering	Benefits in cognitive and economic development	Macroeconomic growth	Summary of different approaches to reduce stunting from India. Integrated and structural factors policy suggestions.
W. Joe et al.	Maternal & Child Nutrition, Wiley	2016	India. 1-public development expenditure 2-increase in aggregate income poverty level	Failure in reduced child undernutrition	Lack of planning in intervention	Macroeconomic growth didn't translate into maternal and child health and reduction in poverty.
Source: Author's construction						

3.2 Evidence from intervention studies and natural experiment:

Table 3. shows two intervention studies. One study by (8) in 34 developing countries another by (38) from India showed better performance in height when given balanced protein-calorie supplementation to pregnant women and children under 6 years. The intervention group was 14 mm taller than the control group, with a p-value of less than 1%, i.e., $p = 0.007$. The distribution of nutrients of iodized salt, iron foliate, calcium, energy protein, vitamin A, and zinc to pregnant women and toddlers for ten years, along with the promotion of breastfeeding, supplemental feeding, complementary food education, and treatment of severe acute malnutrition, gave a cost-benefit ratio of 1:5-1:6 in Hyderabad, India (8).

A natural experiment in Table 4. by (39) from 86 developing economies, including India, found that both agrarian (agriculture) and non-agrarian (industrial and services) growth reduce stunting prevalence. A 10% increase in agrarian GDP per capita reduces child stunting by 9.6%, and a 10% increase in non-agrarian GDP per capita reduces non-agrarian growth by 8.4%.

Table 3
Evidence from intervention studies

Author's Name	Publication & Year of publication	N	Location	Study design	Duration	Gender	Nutritional status	Impact	Outcomes	Effect on Economic growth
Emanuela Galasso & Adam Wagstaff	2019; Economics and Human Biology; Elsevier	34 developing countries	34 developing countries	Intervention	10 years	Females, and children from both gender	Poor	Stunting	Lesser schooling and lower cognition	Lower economic growth
S. Kinra	2008; BMJ	1165	29 villages (15 intervention, 14 control) Near Hyderabad, South India	Intervention	15 years' follow-up of participants born within an earlier controlled, community trial of nutritional supplementation integrated with other public health programs	Both	Poor	Integrated nutritional supplement along with parallel public health programs	Taller controlled group	Better economic performance

Source: Author's construction

Table 4
Evidence from natural experiment

Author's Name	Publication & Year of publication	N	Location	Study design	Duration	Impact	Outcomes	Effect on Economic growth	Gender	Result
Mary et al	2019; Wiley; Development Policy Review	367	86 developing countries	Natural IV	1984-2014	Growth in agrarian and non-agrarian sectors	Food security	Reduced child stunting	Both	Both agrarian and non-agrarian growth decrease stunting, agrarian growth is significantly superior to non-agrarian growth in this regard. The estimated impacts is decrease in 9.6% in stunting due to 10% increase GDP for agrarian (as opposed to 8.4% for non-agrarian)

Source: Author's construction

3.3 Evidence from prospective studies:

Table 5. shows data from prospective studies. One prospective cohort study (a cohort study is a study where participants are enrolled before developing the outcome of the researcher's interest) was conducted on malnutrition and economic expansion in two economically resurgent states, Bihar and Gujarat. Gujarat improved its record in combating malnutrition, reducing undernutrition from 73.04 percent in 2007 to 25.09 percent in 2013, as the state's economy grew.

While Bihar's economy grew by 8% in 2012, undernutrition remained at 82%. This 10-yearlong study reveals that substantial economic growth does not alleviate malnutrition. Four of the seven prospective studies were conducted in India only. Two were undertaken in various underdeveloped nations, with India included in the SAARC cohort. One (16) was conducted in Pakistan for 55 years, giving evidence that the sprinkles receiving group had a greater income than those in the placebo receiving group after 4 months of getting homemade food rich in zinc and iron. Other study reveals that harm in the first two years of a child's life can lead to persistent handicap and that this child can potentially affect future generation/s (11). Stunted children are more prone to accidents, have higher absenteeism from school and work (40), and have lower physical energy for farming and industrial labor (41, 42). (7) estimated that birth length is associated with adult height and postnatal growth is associated with education achieved, which effects income.

Table 5
Evidence from prospective studies

Author's Name	Publication & Year of publication	N	Location	Study design	Duration	Gender	Nutritional status	Impacts	Economic Outcomes	Reas
Ruia et al.	2018, Indian Journal of Community Medicine, Wolters Kluwer	2 States from India	Bihar, India & Gujarat, India	Prospective cohort. An exploratory study	10 years	Females and children	Poor	Integrated child development scheme	No evidence of excessive growth	Poor impli
C. G. Victora, L. Adair, C. Fall, P. C. Hallal, R. Martorell, L. Richter, H. S. Sachdev	2008, Lancet	8181 for India	Brazil, Guatemala, India, the Philippines, and South Africa	prospective cohort	Recruited between 1969-72	Females and children	Average	Mother and child under-nutrition	School delays, lower income and scarce assets, low birth weight, lower body mass, higher glucose concentration and blood pressure	Adve
Satyanarayana et al.	1977		India	Prospective	1960-63	Males	Poor	Malnourishment	Accidents and absenteeism	Decre econi output
Satyanarayana et al.	1979	1480	India	Prospective	In 1965 it was an ongoing study	Males	Poor	Malnutrition	Reduced physical capacity in farming	Decre econi output
K. Satyanarayana et al.	1984	57	India	Prospective	1977	Males between 20-35	Adequate	Malnutrition	Reduced physical capacity in industry	Decre econi output
Stein et al.	2013; The Journal of pediatrics	4518	Brazil, Guatemala, India, the Philippines, and South Africa	Prospective Cohort	15-18 years in different countries	Both		Preterm or small for gestation age birth	Persistent deficit in height and schooling	Decre econi activi adult

Source: Author's construction

Author's Name	Publication & Year of publication	N	Location	Study design	Duration	Gender	Nutritional status	Impacts	Economic Outcomes	Reas
W. Sharieff, S. H., Zlotkin, M. D. Krahn et al.	2008	5000	Karachi, Pakistan	Retrospective cohort to see a cost-benefit analysis	4 months and followed for 55 years in a Markov process of time cycles.	Both	Poor	Intervention through zinc and iron in home-made foods	Reduction in diarrhea, improved hemoglobin level	Redu child mort; highe and r lifetir earni

Source: Author's construction

3.4 Evidence from adult height and age by quasi-experiment and linear regression:

As tabulated in Table 6. one quasi-experiment was found, that involved five SAARC countries: Afghanistan, Bangladesh, India, Nepal, and Pakistan. The study used a backward-looking accounting framework to estimate how much a country's per capita income is lower today because some of its workforce was stunted as a child, and a forward-looking accounting framework to estimate the net present values of the costs and benefits of a package of interventions aimed at reducing childhood stunting (8). The study projected that implementing the study by (9, 43) could save developing countries between 5% and 7% per capita GDP.

Table 7. shows the wage-height relationship. According to the findings of (44, 45) on household survey data in 12 developing countries (including Pakistan and Nepal), consistent income development could lead to a significant decrease in stunting. Research by (17, 18, 22) found no link between macroeconomic growth and child stunting, nor did macroeconomic growth lead to a reduction in poverty. According to (46), a 10% rise in GDP reduces child stunting prevalence by 2.7%, while a percentage point increase in child stunting results in a 0.4% loss in GDP per capita. According to (46), stunting reduces annual per capita GDP by 13.5 percent. A study by (47) identified a link between \$1/day poverty and a 0.62 prevalence of stunting.

Table 6
Evidence from adult height and age by quasi-experiment

Author's Name	Publication & Year of publication	N	Location	Data	Study design	Age	Impact	Outcomes	Economic effects	Gender
Emanuela Galasso & Adam Wagstaff	2019; Economics and Human Biology; Elsevier	34 developing countries, including SAARC Countries	34 developing countries	World Development Indicators (WDI)	Development accounting approach	Backward-looking exercise of the workforce who are 50 at the time of study	Nutrition intervention	Increase in schooling years and cognitive development	Increase in GDP	Both

Source: Author's construction

Table 7
Evidence from adult height and age by linear regression

Author's Name	Publication & Year of publication	N	Location	Data	Study design	Age	Economic Impact	Outcomes
Haddad et al	2002, Economic Development and Cultural Change	179	63 developing countries	World Health Organization, ACC/SCN, World Bank, Food and Agriculture Organization (FAO), UNESCO	OLS	1970–96. Woman and children under 5 years of age	Increase in per-capita income	Improved child nutritic level
Smith & Haddad	2003, Oxford University Press	12 developing countries, 61 developing economies for cross country estimations	12 countries including Pakistan and Nepal	WHO, ACC/SCN, World Bank	OLS & IV	Household survey	Increase in household income due to increase in national income	Reduction in malnutrition
Subramanyam et al.	2011, Economic Growth and Child Undernutrition	28,066, 26,121, and 23,139 respectively with corresponding dates.	Cross-section waves 1992–93, 1998–99, and 2005–06, India	NFHS was conducted in India. The NFHS is part of the Demographic and Health Surveys (DHS), Reserve Bank of India	OLS	Children under 5 years of age	Increase in per-capita income	Reduction in child under-nutrition
Rasmus Heltberg	2009; Health Economics, Wiley	Developing countries	Developing countries	World Development Indicators.	OLS		Economic growth	Very small decrease in child malnutrition
Sebastien Mary	2018, MDPI, Economies	74 developing countries observed between 1984 and 2014	74 developing countries	Political Risk Services (PRS), World Health Organization, World Bank database, Climate Research Unit (CRU) and the Tyndall Centre for Climate Change Research (TYN)	OLS	Children under 5 years of age born between 1984-2014	Economic growth	Reduced child stunting

Source: Author's construction

Author's Name	Publication & Year of publication	N	Location	Data	Study design	Age	Economic Impact	Outcomes
Vollmer et al.	2014; Lancet Global Health	462, 854	36 developing countries	Demographic and Health Surveys. Penn World Tables 8.0	OLS	0–35 months,	Macroeconomics growth	Early childhood malnutrition
William Joe, Ramaprasad Rajaram and S. V. Subramanian	2016, Wiley, Maternal & Child Nutrition		India	National Family Health Surveys (NFHS) of India, UNICEF, Central Statistical Organization of the Ministry of Statistics and Program Implementation, Government of India, Reserve Bank of India	OLS & Alternative model specifications	State-wise prevalence of developmental indicators, Indian States 1992–1993 and 2005–2006	1-public development expenditure 2-increase in aggregate income poverty level	Failure in reduced child undernutrition

Source: Author's construction

4- Discussion

4.1 Summary of the evidence linking childhood stunting to economic outcomes in SAARC region

Several studies have discovered an inverse relationship between SAARC economic growth and child stunting. Nutritional deficiencies (maternal and child), stunting genes, lack of education (including literacy and maternal health during pregnancy and nursing), wrong eating habits, poor hygiene conditions, frequent infections in children, the role of paternal stimulus, poverty, macroeconomic shocks, and lack of government expenditure or moderate pro-poor policies are variables that contributed to the region's child stunting (17–20, 22, 29, 36, 37). Stunting negatively affects a child's academic, physical, mental, and motor abilities, lowering income, employment, and wages (11, 12, 19, 28–30, 35)

Studies comparing height and wages demonstrate a link. Studies conducted in other countries (no studies were found on SAARC), validate our claim that taller people earn more. Four studies partly on height and wage India, were found. In one study, providing pregnant women with a balanced protein calorie supplement raised their baby's height by 14 mm (38). A 1-cm increase in stature relative to height leads to a 4% rise in male and a 6% increase in female earnings (5). In both agriculture and industry, shorter workers produced poor output (40–42). An established relationship between birth length, adult height, and schooling (7) was found.

Hunger, undernutrition, and poverty during pregnancy or in the first 1000 days affect adult income. A nutritious diet has a cost-benefit ratio of 1.5–1.6 in low-income countries (8). A study of 8181 people indicated that hunger can affect a child's life, from schooling to adulthood income (11). A lack of nutrition hampers individual output in the industrial and agricultural sectors (40–42). Malnutrition costs Pakistan \$7.6 billion per year (3% of GDP) (30). India's workforce earns 10% less due to the fact that they were stunted in childhood (34).

4.2 Interpreting the findings of Stunting to Economic Growth

A country's human capital is priceless and is measured by health and education. Human capital that is healthier and more efficient grows the economy faster. Similarly, unhealthier and less skilled human capital is more likely to become a burden. This inefficient productivity issue impacts a country's economy. Stunting, if it occurs in childhood, affects a person's health and productivity in adulthood. Expenses for diminished immunity, chronic illness, health drift to the next generation, and other variables might further harm a person's financial situation.

However, while the SAARC region's human capital ranks among the top 10 out of 195 countries, there remains a wide range of differences in human productivity level (21). Stunting, vitamin and mineral deficiencies cost low-income developing countries, particularly in South Asia, up to 3% of their GDP (30). Stunting causes the highest human capital losses in this region and can have irrevocable, lasting implications that can limit economic growth, resulting in the decrease of the country's GDP. Stunting reduces per capita income by 5–7% (8). Childhood stunting has been linked to reduced school attendance. This might be attributed to poor motor and cognitive skills, frequent infections and illnesses, chronic illness, and other stunting-related difficulties. Adults with less education and health difficulties have a harder time finding work in a competitive economy. If they do get jobs, they are more likely to be injured and have inferior physical work capacity (11, 40–42). OLS estimation shows that a 1% increase in stunting reduces GDP by 0.4%, which has a 13.5% impact on developing countries' GDP (46).

4.3 Interpreting the findings of Economic Growth to Stunting

As evidenced by industrialized countries, faster economic growth reduces stunting. Economists attribute this to increasing GDP per capita. Macroeconomic shocks affect incomes, which affect generations, and so on. In natural trials, a 10% rise in agricultural GDP reduces stunting prevalence by 9.6%, while a similar increase in non-agricultural GDP reduces it by 8.4% (39). Increasing national GDP improves child nutrition, and a 10% rise in GDP reduces stunting by 2.7% (39, 46, 47). While many studies demonstrate that an increase in GDP reduces stunting, few shows that it has no or just a minor impact. The authors claim that a rise in GDP has little or no influence due to a gap in the government or policymakers' transition mechanisms (17, 18, 20). Institutions trying to reduce stunting prevalence must enhance strategies and interventions, so that growth in GDP or national income should not have any or limited influence. Moreover, policies must target a larger number of poor people.

4.4 Strengths and weaknesses of this review

Our systematic review's methodical approach is its strength. We couldn't find any other reviews like it, so it's a unique addition to the literature. The lack of research on SAARC and policymakers' lack of understanding of the difficulties occurring in this region, which are distinct from other geographic areas where stunting is common. This assessment has focused on the SAARC region and can help policymakers plan policies and initiatives to minimize stunting prevalence. This review used a comprehensive search approach that covered five worldwide databases, including all study and intervention categories. We utilized methodological appraisal scores to assess each study's quality. The review followed PRISMA guidelines. Our review was assessed using the Mixed Method Assessment Tool (MMAT) to reduce bias.

The review has limitations. Our exploratory evaluation did not exclude papers based on low quality scores. To find more relevant content, we could have searched other worldwide academic databases and search engines, but we were time-constrained. It's also possible that some discoveries have become obsolete. Studies in other languages are excluded, causing language bias. Therefore, we utilized Google Scholar and Chrome to reduce bias in our search. There has been little research undertaken on emerging countries' having one or more SAARC members along with other developing countries. This review used such studies to draw conclusions. So it was difficult to draw general conclusions based just on SAARC outcomes.

4.5 Implications for countries with high stunting prevalence

Children's health is often improved by increased per capita national affluence. Policymakers must examine how state policies affect policy effectiveness and child nutrition. Despite the fact that stunting is common in some areas, there is little understanding of how it affects adulthood and future earnings. Growing wealth disparities have impeded economic growth, causing problems for current and future generations. To decrease stunting, we need to have improved knowledge of prenatal and postnatal growth constraints. Improvements in child nutrition and health require equitable economic growth, not growth equality. Investing in pro-poor programmes and making food affordable. Primary care programmes are critical in times of economic crisis or food shortages and should be addressed quickly. Due to a lack of spillover effects, the transition channel through which macroeconomic growth is expected to positively influence poverty has proven unsuccessful. Inclusionary macroeconomic growth with active transition channels is required to reduce stunting.

5- Conclusion

The majority of quantitative evidence supports our hypothesis that stunting and economic outcomes are inversely correlated. Economic growth should have a spillover effect. Children who are healthy and have no history of stunting do better in school and earn more than their stunted peers. Not much can be attained in outcomes through nutritional, fortification, and micronutrient interventions unless tailored activities are done, therefore, better transition mechanism is needed. Direct health interventions have dramatically reduced stunting. Improving maternal health and interventions is also important in lowering stunting.

From conception to two years of age, children must be fed a balanced, healthy diet. For such children, better health will allow them to keep their average origin height (according to the WHO, average height varies by location and origin; for example, Chinese people are shorter than Pakistanis and Indians). The review reveals that schooling and skills attainment are better in children who are not stunted at an early age. Stunted children are more chronically ill, prone to infections, injuries, and accidents. Their absenteeism is higher, resulting in low productivity.

Stunting is usually a rural phenomenon, and agricultural prosperity raises rural living conditions. Macroeconomic shocks impact child stunting as it impact food nutrition, health and education. A stunted population have a pro-cyclical effect in the economic drift.

Abbreviations

GDP Gross Domestic Product

LMICs Lower Middle-Income Countries

MMAT Mixed Method Assessment Tool

OLS Ordinary Least Square

PICO Patient/Population, Intervention, Comparison and Outcomes

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SAARC South Asian Association for Regional Cooperation

SDG Sustainable Development Goals

UNFP United Nations Population Fund

UNICEF The United Nations Children's Fund

WB The World Bank

WHO World Health Organization

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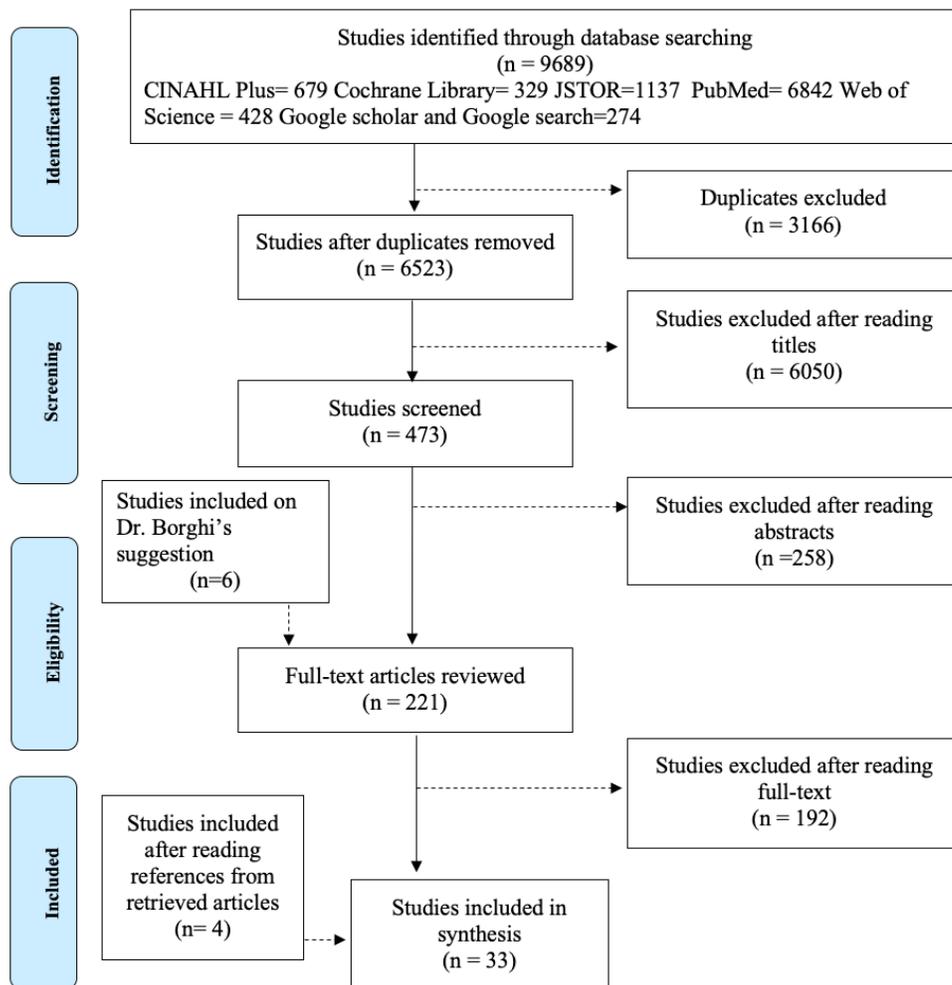
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Figures



Source: Author's construction using PRISMA standard flow chart

Figure 1

PRISMA flow chart

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