

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



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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assessed five international databases; PubMed, JSTOR, Cochrane Library, Web of Science, and CINAHL Plus for published, unpublished, and ongoing research till the year 2020.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.

**Results:** Thirty-three (33) 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 pays 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.

**Keywords:** Economic outcomes, poverty, review, SAARC countries, stunting.

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### Introduction

According to the WHO globally in 2020, 149 million children under the age of five years suffered from stunting (1), 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 stunting population (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). Stunting has long-term consequences, including children entering school late, performing less well in school, and earning lower grades than non-stunted children due to their diminished cognitive ability, and some are altogether less likely to enroll in school. After reaching adulthood, a person who was stunted as a child is less productive in one or more of the three dimensions, namely, mentally, physically, and physiologically (4). These stunted children frequently earn less money because of their impaired motor skills and/or poor

health and are a likely contender for the next generations to be stunted (5). A child who is not severely stunted has a 5.5 percent higher chance of reaching the age of five than a child who is severely stunted (6).

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). Stunting also reduces immunity, making people more susceptible to illnesses and affecting reproductive health (6, 7). Due to health concerns, stunted children suffer significant mental and physical effects in their early years, resulting in poor performance in school or 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 (7). Stunting has a lifelong impact (8). Height in childhood determines adulthood height (8), also height is an important determinant of wages (7, 9). As reported in literature (10-12) 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 (13, 14).

Malnutrition is rampant in South Asia, as adequate food is out of reach for many poor people. Sometimes, the stunting prevailing populations also lack the knowledge or education to make healthy food choices (15). According to the World Bank's report of 2018, 62 million children out of 155 million are considered stunted, meaning they are too small for their age (16). According to the WHO (2014), what sets South Asia apart from other developing countries where stunting is a problem is the persistence of chronic malnutrition (2), notwithstanding rapid economic growth (17-23). Despite high economic growth, there is a high prevalence of stunted population in South Asia (24). This is due to poor transition mechanisms of economic growth by such countries along with inadequacies in supplying nutritious food items, clean water, hygienic sanitation, and insufficient healthcare to the people where the prevalence of stunting is dense. Due to poverty and its related reasons, the demand side is also weak; underinvesting in healthy food, education, and old and traditional belief systems (like gender-based discrimination and the waste of colostrum), are a few of them.

The diets of South Asians also lack essential nutrients that are necessary for human development and growth (25). Despite largely agrarian dependent economies, most of the rural and urban families in the SAARC regions live below the poverty line (26). Global Hunger Index (2019), reports that SAARC countries' hunger is one of the biggest reasons for stunting (27). Pakistan ranked 94 of 117 states of the world in the world hunger index; India ranked 103, while Bangladesh, Sri Lanka, and Nepal ranked 88, 66, and 73 respectively. Most of the SAARC countries could not make it into the top bracket of the 60 best-performing countries in reducing hunger. Afghanistan is the worst performer at 108th rank in SAARC countries on the list of hunger ranking of 2018 (27).

## Methodology

This study assessed the economic consequences of stunting in SAARC, considering the impact of childhood stunting on adult economic outcomes. The rationale behind taking multiple study designs in our systematic review is to yield varying results having many facets of stunting prevalence and to avoid uncertainty in the synthesis of the result. Including multiple studies also make us attain a comprehensive review of the SAARC region where there is a high stunting prevalence which is hampering the economic growth but literature regarding the issue is scarce. Multiple 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.

### 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: the causal relationship between economic growth and stunting.

(Detail of the PICO criteria is available in Appendix 1)

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.

### Inclusion/Exclusion criteria

The study included all journals, articles, or books on stunting or terms associated with stunting concerning the economy, adulthood income, and GDP. We did not include studies directly on stunting that has 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.

### Search strategy

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

### 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, the total number of observations, location of study, study design, duration of the 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.

### 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 (28) Mixed Method Assessment Tool (MMAT) to measure quality. Many systematic reviews employ this tool (29, 30). The whole text of the recovered and synthesized papers is tabulated 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.

### Study registration

A registration of the study is available at: [http://www.crd.york.ac.uk/PROSPERO/display\\_record.asp?ID=CRD42021230279](http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42021230279).

**Results**

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 a 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 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: Quality appraisal**

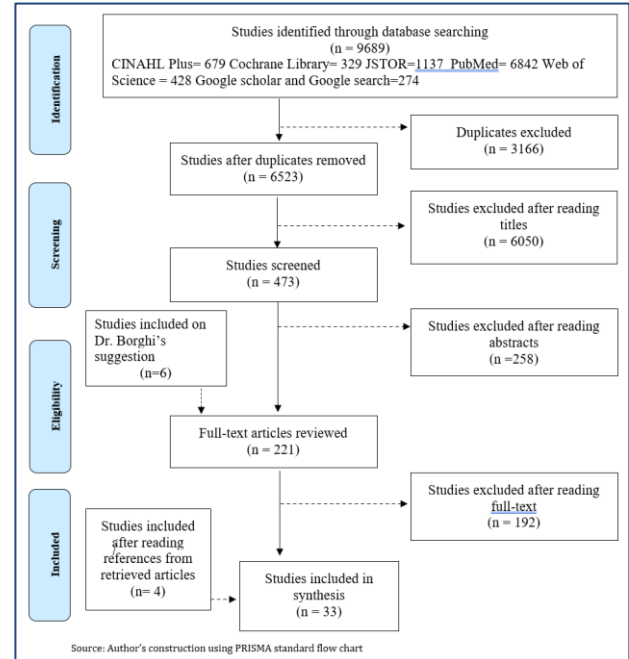
Study design	Number of studies and methods used to collect data			
Study design	25% (*)	50% (**)	75% (***)	100% (****)
Quantitative		2	7	6
Qualitative	1	2	4	4
Mixed Methods	1	2	3	1

*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, and 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.

**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 (12, 31). It also causes persistent damage that hinders an individual's economic growth (12, 31). This harm impacts the next generation, both physically and financially (12, 31). Paternal stimulation was also found to be a factor in a child's physical and mental development (32). 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 (33). 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 (34). 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 (35).



**Figure 1. PRISMA flow chart**

Stunting and poverty are inextricably linked (36). Evidence-based research shows that poverty puts 65 percent of South Asian children at risk of stunting. Harvard University research states that stunting can cost developing countries like South Asia over \$177 billion in lifetime earnings. According to an Indian study on stunting and height (7) 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 (7). According to the Global Panel report (2016), stunting and micronutrient deficiencies cost low-income nations, particularly South Asia, 3% of their GDP (37). Economic shocks have a pro-cyclical influence on health in Asia (38). Part of the current workforce was stunted in childhood (9, 39), resulting in a loss of national economic productivity (40) 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 (13). A study (20) discovered that economic growth had little impact on stunting because of poor government strategies, an unfavorable environment (41), ineffective interventions (42), and a lack of integrated and structural policies (23).

**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.

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.
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.



**Evidence from intervention studies and natural experiments:**

Table 3. shows two intervention studies. One study by Galasso and Wagstaff, (2019) in 34 developing countries (9) and another by Kinra et al. (2008) from India showed better performance in height when given balanced protein-calorie supplementation to pregnant women and children under 6 years (43). The intervention group was 14 mm taller than the control group, with a low p-value 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, complimentary food education, and treatment of severe acute malnutrition, gave a cost-benefit ratio of 1:5-1:6 in Hyderabad, India (9).

A natural experiment in Table 4. by Mary et al. (2019) (5) from 86 developing economies, including India, found that both agrarian (agriculture) and non-agrarian (industrial and services) growth reduce stunting prevalence. Furthermore, 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	Type of nutrition/ nutrient supplements	Exposure	Result
<b>Emanuela Galasso &amp; Adam Wagstaff</b>	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 per-capita income	(i) salt iodization, (ii) multiple micronutrient supplementation in pregnancy including iron-folate, (iii) calcium supplementation in pregnancy, (iv) energy-protein supplementation in pregnancy, (v) vitamin A supplementation in childhood, (vi) zinc supplementation in childhood, (vii) breastfeeding promotion, (viii) complementary feeding education, (ix) complementary food supplementation, and (x) severe acute malnutrition management	Females, neonates, and children under 5 years	Estimation of a rate-of-return of 12%, and a benefit-cost ratio of 5:1-6:1 in 34 developing countries with 90% stunting prevalence including SAARC Countries.
<b>S. Kinra</b>	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	Balanced protein-calorie supplementation (2.51 MJ, 20 g protein) offered daily to pregnant women and preschool children aged under 6 years, coupled with integrated delivery of vertical public health programs.	Undernourished females and children under 6 years of age	The intervention group showed better performance in height.

Source: Author's construction

**Table 4 Evidence from a 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

**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 study (17) 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. Another 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 generations (12). Stunted children are more prone to accidents, have higher absenteeism from school and work (44), and have lower physical energy for farming and industrial labor (45, 46). (8) estimated that birth length is associated with adult height and postnatal growth is associated with an education achieved, which affects 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	Reason	Exposure	Result
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 policy implications	Children up to the age of 6 years and pregnant and lactating mothers and woman of 16-44 years of age	Increase in economic growth does not result in automatic immediate positive reaction on malnutrition alleviation.
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	Adverse	children up to the age of 2 years and pregnant, and lactating mothers and women	In the visit when the cohort's age was between 26 and 32 it was found that damage occurred in early life results in a permanent impairment, and have high potential to affect future generations, the prevention from stunting will probably bring about important health, educational, and economic benefits

Satyanarayan a et al.	1977		India	Prospective	1960-63	Males	Poor	Malnourishment	Accidents and absenteeism	Decrease in economic output	Malnourished in childhood	Accidental cases and rates of absenteeism are reported to be on higher side among malnourished subjects.
Satyanarayan a et al.	1979	1480	India	Prospective	In 1965 it was an ongoing study	Males	Poor	Malnutrition	Reduced physical capacity in farming	Decrease in economic output	Males from 23 villages in rural Hyderabad, India, malnourished in childhood	Malnutrition in childhood is associated with reduced physical work capacity in farming.
K. Satyanarayan a et al.	1984	57	India	Prospective	1977	Males between 20-35	Adequate	Malnutrition	Reduced physical capacity in industry	Decrease in economic output	Males from Hyderabad, India, malnourished in childhood	Malnutrition in childhood is associated with physical work capacity in the industry
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	Decrease in economic activity in adulthood	Preterm, Small for gestation age (SGA), and SGA but the term	Birth length is positively associated with adult height; Postnatal growth was associated with schooling attainment.
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	Reduce child mortality, higher IQ and higher lifetime earnings	Children in an urban slum of Karachi, Pakistan	Home-fortification can give better improvement in clinical outcomes at a reasonable cost, and can be cost-beneficial when lifetime earnings are considered

Source: Author's construction

#### 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 (9). The study projected that better policy implementation (10, 47) can save developing countries between 5% and 7% per capita GDP.

Table 7. shows the wage-height relationship. According to the findings (48, 49) on household survey data in 12 developing countries (including Pakistan and Nepal), consistent income development could lead to a significant decrease in stunting. Research (18, 19, 23) found no link between macroeconomic growth and child stunting, nor did macroeconomic growth lead to a reduction in poverty. According to a study (50), 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. Furthermore, stunting reduces annual per capita GDP by 13.5 percent. A study (51) 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	Notes
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	On average, the per capita income penalty from stunting is between 5–7%.

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	Caveat	Gender	Notes
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 nutrition level	Sustainable economic growth	Woman and children under 5 years of age	The increases in per capita national income have strong signs that it leads to improvements in child nutritional status. 9 percentage-point reduction in child undernutrition over 1970–95 was brought through increases in national food availabilities by approx. 45% and women's education roughly 30%.
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	Balanced strategies and direct intervention	both	When Pakistan's per capita GDP was \$480 in 1997 the malnutrition rate was 45.7% and in 1991 when Nepal's per capita GDP was \$210 its malnutrition was 48.1%. Hence GDP does impact on 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	Inappropriate interventions	Both	No consistent evidence was found between economic growth leading to a reduction in childhood undernutrition in India.

Rasmus Heltberg	2009; Health Economics, Wiley	Developing countries	Developing countries	World Development Indicators.	OLS		Economic growth	Very small decrease in child malnutrition	Non-focused interventions	Both	The cross-country correlation between \$1/day poverty and stunting is 0.62.
Sebastien Mary	2018, MDPI, Economics	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	Further increase in economic growth	Both	A 10% increase in GDP per capita reduces child stunting prevalence by 2.7%. A percentage point increase in child stunting prevalence results in a 0.4% decrease in GDP per capita. The stunting costs on average about 13.5% of GDP per capita in developing countries.
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	Direct health investment	Both	Minimal association from very small to the null was found between increases in per-head GDP with decrease in early childhood undernutrition.
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	Lack of planning in intervention	Mother and child	Study results confirm that macroeconomic growth in two Indian states did not necessarily translate into increased public development or a substantial reduction in poverty between 1992 and 2005. A quantum leap in developmental spending and 'inclusive' macroeconomic growth is necessary to achieve a positive impact on stunting in India.

Source: Author's construction

## Discussion

While numerous studies have been conducted globally to establish a link between child stunting and economic outcomes, few have been conducted specifically for the SAARC countries. Numerous studies conducted globally demonstrate an inverse relationship between childhood stunting and economic growth (51, 52), although a few studies also demonstrate a null or inconsistent relationship between the two variables (18, 19). According to the literature, stunting is typically caused by poverty and malnutrition, which impairs growth trajectory, cognition, schooling, and frequent bouts of infection (health). Poverty has a variety of consequences, including economic consequences. Poor nutrition perpetuates the cycle of poverty and malnutrition in three ways: (a) Direct losses in productivity and functioning below optimal levels as a result of poor physical health and short height in adulthood due to malnutrition and disease, and (b) Indirect losses in productivity and functioning below optimal levels as a result of poor physical health and short height in adulthood due to malnutrition and disease. (b) Indirect costs are associated with poor cognitive development and decreased school attendance; and (c) Increased healthcare costs associated with infectious and chronic diseases, as well as other adverse outcomes in later life. Fogel et al. (1982) (53) state in their study of the industrial sector performance in the United States and several European states between 1820 and 1860 that "the deleterious effect of industrialization on workers was visible in their physical stature."

A higher level of education correlates with higher earnings and, consequently, with a faster rate of real GDP growth (54, 55) as more developed human capital is critical to national income. Earnings increases correlate positively with additional years of education (56, 57). Between education spending and economic growth, there is a positive and significant correlation (58). Lin (2003) (59) found that economic growth, education, and technological progress all have a positive effect on each other.

A generalized health deficit can result in economic devastation, whether for a household or a country. According to DALYs (disability-adjusted life years), chronic disease accounts for 54% of all lost healthy life years (60). Numerous studies indicate that disease burden, in general, is expected to affect economic growth, and chronic illness reduces the supply of workers due to morbidity, mortality, and early retirement (61-63), thereby reducing an individual's productivity (64, 65). To calculate the indirect cost of disease, taking into account lost work time due to illness, which affects the household's ability to earn income (66). Sukrcke et al. (2006) (67) discovered that the caregiver's indirect costs of illness are 1.42 days per month when devoted to the patient during the illness, and 5.30 days when the illness has an effect on labor supply. Adult height data from the twentieth century shows that adult stunting led to an 8% drop in GDP (68). Child stunting has a clear economic impact, and we know from the literature that the SAARC region has a sizable stunted population.

This literature review's different study designs show there are a lot of factors that lead to child stunting, both directly and indirectly. These factors have an impact on the economic well-being of families and the country as a whole,

which suggests that SAARC's economic growth and child stunting go against each other.

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

Evidence was found that 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 (18-21, 23, 34, 41, 42). Stunting negatively affects a child's academic, physical, mental, and motor abilities, lowering income, employment, and wages (12, 13, 20, 33-35, 40).

Although there are few studies demonstrating the height-wage relationship, studies from other regions of the world corroborate our claim that taller people earn more. The review examined four studies conducted globally on height and wages, one of which included India. The poverty causes people to consume less nutritious food, a lack of nutrient-dense food is one of the reasons for a child's short stature. Pregnant women who received a balanced protein-calorie supplement increased their baby's height by 14 mm, according to the study (43). As established in the literature, greater height is associated with a higher income. A 1-cm increase in stature to height results in a 4% increase in male earnings and a 6% increase in female earnings (7). In agriculture as well as industry, shorter workers resulted in lower output (44-46). There is a well-established relationship between birth length, adult height, and education (8) Hunger, malnutrition, and poverty during pregnancy or the first 1000 days of life all affect adult earnings. In low-income countries, a nutritious diet has a cost-benefit ratio of 1.5–1.6 (9). According to a study of 8181 people, hunger can harm a child's life, from schooling to adulthood income (12). Individual output in the industrial and agricultural sectors is harmed by a lack of nutrition (44-46). Pakistan spends \$7.6 billion per year (3 percent of GDP) on the malnutrition (35). India's workforce earns 10% less because they were stunted in childhood (39).

### Interpreting the findings of Stunting to Economic Growth in the SAARC region

A country's human capital is priceless and is measured by health and education. The 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.

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 (22). Stunting, vitamin and mineral deficiencies cost low-income developing countries, particularly in South Asia, up to 3% of their GDP (35). Stunting causes the highest human capital losses in this region and can have irrevocable, lasting implications that can limit economic growth, resulting in a decrease in the country's GDP. Stunting reduces per capita

income by 5% to 7% (9). Childhood stunting has been linked to reduced school attendance. This might be attributed to a 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 (12, 44-46). OLS estimation shows that a 1% increase in stunting reduces GDP by 0.4%, which has a 13.5% impact on developing countries' GDP (50).

#### **Interpreting the findings of Economic Growth to Stunting**

The evidence from industrialized countries reveals that higher economic growth reduces stunting. Economists attribute this to an increase in 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% (5). Increasing national GDP improves child nutrition, and a 10% rise in GDP reduces stunting by 2.7% (5, 50, 51). While many studies demonstrate that an increase in GDP reduces stunting, few show 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 (18, 19, 21). 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.

#### **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 stunting prevalence and its economic outcomes for the SAARC region, therefore we have taken studies that were conducted globally on stunting prevalence and its economic outcomes where one or more SAARC countries were involved. This helped us with collecting substantial literature review evidence for future studies.

#### **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. Even though 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 programs and making food affordable. Primary care programs 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.

#### **Conclusion**

Statistically, most evidence suggests that economic outcomes and stunting are related. Growth should have a ripple effect. Healthy children outperform their stunted peers in school and earn more. Nutritional, fortification, and micronutrient interventions can only achieve limited outcomes unless they are tailored. Shortages of food and water have reduced stunting. Improving maternal health and interventions helps reduce stunting.

Children must be fed a balanced, healthy diet from conception to age two. Better health will allow these kids to maintain their origin height (according to the WHO, average height varies by location and origin; for example, Chinese people are shorter than Pakistanis and Indians). The high prevalence of stunting affects the economic outcomes of households as well as of the country.

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