


Analysis of the effects of child malnutrition on school outcomes, cognitive development, and gross domestic product (GDP): A systematic review

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Abstract

Background: The nutritional status of children is an indicator of a country's health status. Malnutrition, especially child undernutrition, is a major health issue affecting the development of children in many developing countries. As a result, it is the leading cause of ill-health, premature mortality, morbidity, economic loss, poor school outcomes, and cognitive development among children. **Purpose:** The purpose of the present study was to examine the effects of child malnutrition on GDP, school outcomes, and cognitive development. **Methodology:** The systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines published in 2009. Searches were conducted in the ScienceDirect, Scopus, and Google Scholar databases for studies included in this review. These searches were then saved in Mendeley Desktop for review and reference. **Results:** We retrieved 1580 articles after removing duplicates from the databases, of which 20 met our inclusion criteria. The results of the study indicate that child malnutrition negatively impacts school outcomes, cognitive development, and GDP. **Conclusion:** Since nutrition affects life outcomes and society's ability to advance, the government must ensure that school-based feeding programs are more effective and educate the community about nutrition and health

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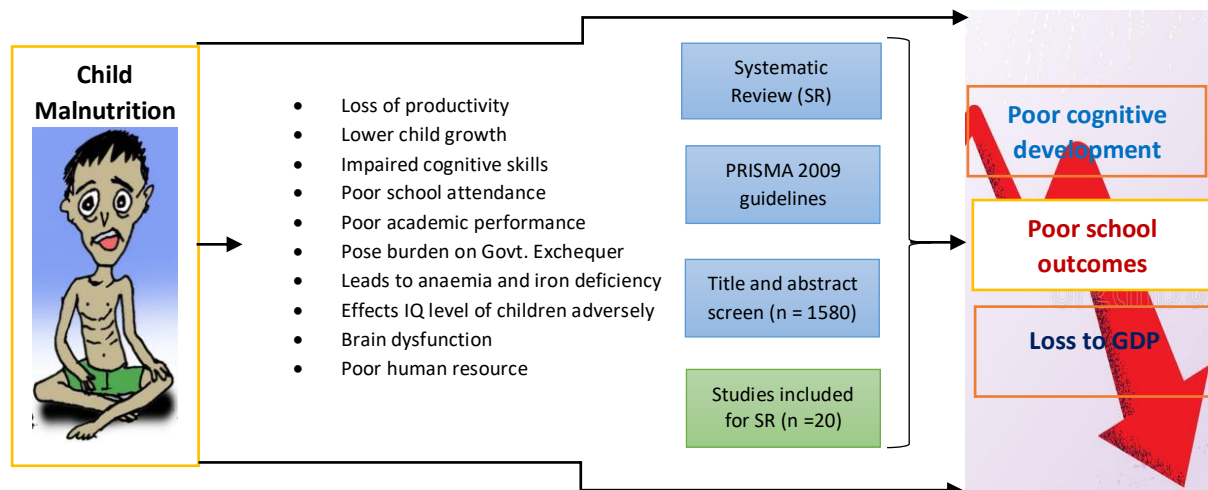
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by explicitly linking nutritional targets, interventions, and indicators with health, education, social development, and other related policy areas.

Keywords: child malnutrition, school attendance, academic performance, cognitive development, GDP, systematic review.

Graphical Abstract



Abbreviations:

CIAF - composite index of anthropometric failure; GDP - gross domestic production; ICDS - integrated child development scheme; IQ - intelligence quotient; ISCA - international save, the children alliance; MDM - mid-day meal; NFHS - national family health survey; WHO - world health organisation

1. Background and motivation

Children who are malnourished are at risk for mortality, morbidity, and low performance ¹. In 2017, more than 1 in 5 children have not reached growth potential and are at risk of associated long-term cognitive impairment, more than 1 in 14 children worldwide were wasted and 45% of all child deaths caused by malnutrition ². Early childhood malnutrition has a detrimental impact on children's growth and development ³. Herophilus (335-280 or 255 BC) was a Greek physician deemed to be the first anatomist once said, “When health is absent, wisdom cannot reveal itself, art cannot manifest, strength cannot fight, wealth becomes useless, and intelligence cannot be applied” ⁴. Health is therefore the ultimate wealth. Good health has a direct relationship to productivity and wellbeing, which in turn facilitate the development process ⁵.

A study ⁶ analysed data from the NFHS-2 (1998-99) for India with a sample of 24396 children below the age of three years and classified the children with anthropometric failure into seven sub-groups

and constructed a Composite Index of Anthropometric Failure (CIAF). A higher prevalence of undernutrition is evident on the CIAF with 60% of children exhibiting anthropometric deficiency. Further investigation found that efforts to reduce undernutrition morbidity and mortality depend on reducing poverty and increasing people's living standards by improving the quality of homes and increasing access to clean water and adequate sanitation. Such interventions have a positive effect on health, and their implementation also contributes to fulfilling people's rights to basic human dignity. There is widespread agreement that improving health in poor countries will ultimately lead to significant economic gains ⁷. People who are healthy are assets to themselves, to their families, and to the community ⁸. In contrast, a sick person is a burden to all, and a danger to future generations as heredity plays a significant role in this regard. A poor health standard reduces both labour productivity and the relative size of the workforce, thus reducing GDP per capita ^{9,10}. When people talk about health, they usually refer to the condition of the body. However, health does not merely mean being free from physical pain or the symptoms of the disease. Good health, according to the World Health Organization (WHO), is more than simply the absence of disease, but also a reflection of a community's psychological and social attitudes.

Most people do not realize the importance of good health, and even if they do, they may disregard it. As per the WHO, in order to do our duties properly, regardless of whether we work at home or in an office, we need to be in good health. The necessity of good health is not limited to a particular religion, caste, creed, or gender. Thus, it is critical for every individual to always maintain a healthy body and a clear and calm mind. According to WHO's report, although many people do not have material problems, they may be unhappy or agitated on a psychological level. They may feel depressed, irritable, or aimless, or suffer from insomnia caused by stress. All these are the result of an unbalanced mind which is a situation of bad health ¹¹. Children's undernutrition is a wide-spread public health problem, especially because good nutrition is an essential determinant for their well-being, as well as a contributor to productivity, economic development, and poverty reduction by improving physical ability, cognitive development, academic achievement, and health. ¹². In most countries worldwide, child undernutrition remained a most serious public health problem and the biggest contributor to child mortality ⁶. Nearly, one-third of the children in developing countries are undernourished ².

The consequences of child malnutrition for morbidity and mortality are enormous. Children who are undernourished have substantially lower chances of survival than children who are well-nourished ⁶.

Undernourished children are much more likely to suffer from serious infections and to die from common childhood illnesses such as diarrhoea, pneumonia, and measles. More than a third of all deaths in children aged five years or younger can be attributable to undernutrition ¹². The consequences of malnutrition are diverse, severe, and long-lasting. Malnutrition is associated with psychological, physiological, immunological and has a strong impact on mortality, morbidity, and quality of life ¹³. A body of literature has been reviewed in this section in the context of economic literature to link the nutrition to cognitive development, educational attainment, and school attendance. Freedom from undernutrition can make a nation rich both in terms of human resource formation and generating income. There is therefore a need for more research in this field to determine the extent and nature of the malnutritional problem among children.

2. Research questions

There is surprisingly little research to know the impacts of nutritional status on school outcomes, cognitive development, and GDP, as most of the studies had stressed on the incidences of nutritional status of pre-school children located in urban centres. Malnutrition can also harm cognitive development ¹⁴, school outcomes ¹⁵, and lower GDP ¹⁶, making it equally important to understand how it affects these aspects. Perhaps this research vacuum or lack of quantity of literature reflects a need to investigate the impacts of nutritional status on school outcomes, cognitive development, and GDP. The purpose of this research was to investigate the effects of malnutrition on cognitive development, school outcomes of children, and GDP. Based on an analysis of the existing studies, researchers sought answers to the following research questions.

- a) **First, what impact does malnutrition have on school outcomes of the children?**
- b) **Second, what are the impacts of malnutrition on cognitive development of the children?**
- c) **Third, what are the impacts of malnutrition on gross domestic product of the country?**

3. Objectives

To answer the above research questions, the present study was carried out with the following objectives:

- a) To know the impacts of malnutrition on school outcomes of the students.
- b) Understanding the effects of malnutrition on child's cognitive development.

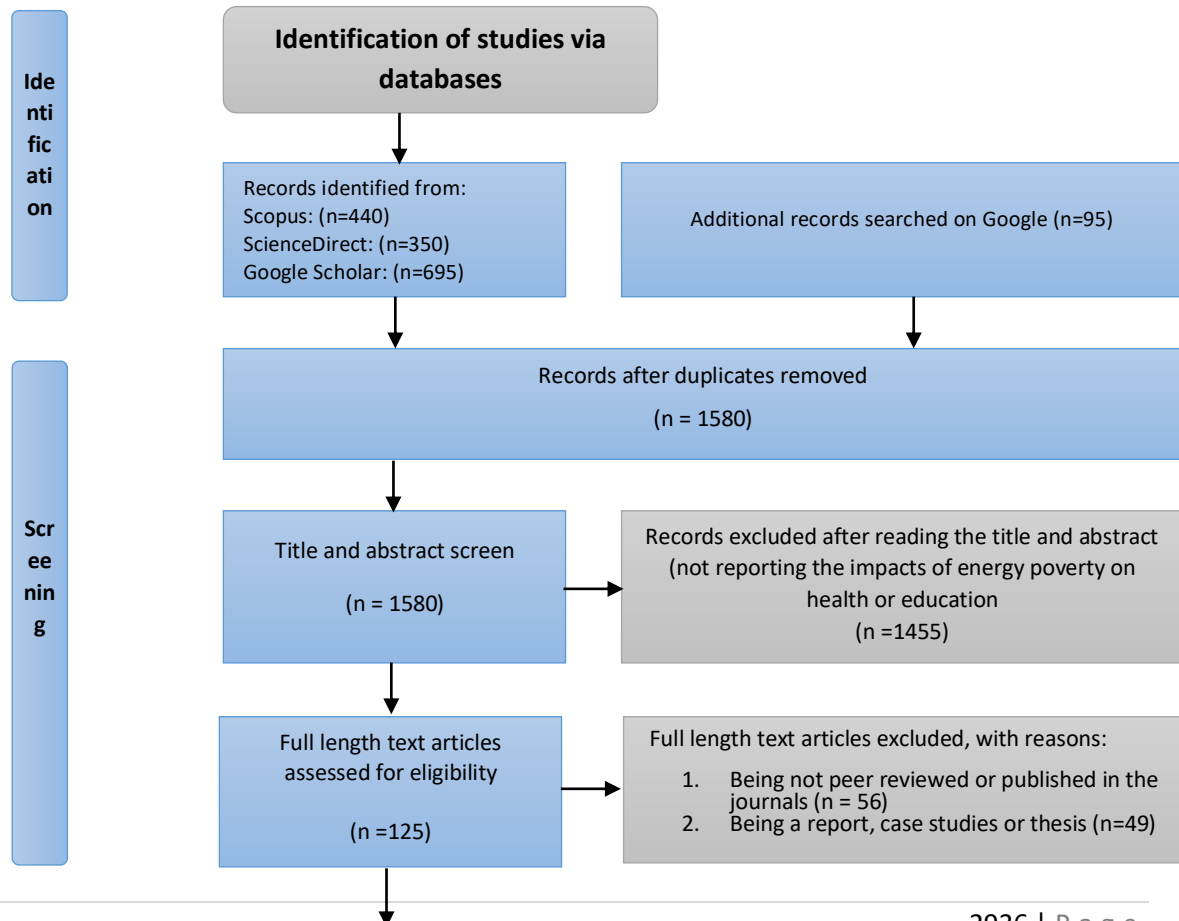
- c) To determine whether malnutrition is associated with a loss in GDP.

4. Methodology

For the current systematic review, we aim to identify studies that explore the effects of malnutrition on school outcomes, cognitive development, and gross domestic product (GDP). Four independent reviewers (*Katoch, Sehgal, Parihar & Nawaz*) have screened the titles, abstracts and full-text documents and independently extract relevant data for analysis. Study quality was assessed using a modified Newcastle- Ottawa Scale ¹⁷. The study is an in-depth review of published literature, so ethical approval was not required. We plan to publish our results in nutrition, health and education related journals, present our findings at conferences focused on nutrition related themes, and communicate our findings to policymakers.

4.1 Systematic Review Protocol

This systematic review study was conducted using the 2009 Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines ¹⁸ Fig 1.



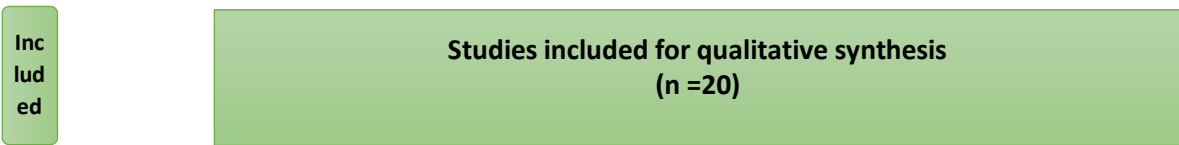


Fig.1 Flow chart for the selection of studies based on PRISMA 2009 guidelines¹⁸

4.2 Searching Databases and Search Strategy

Three databases were used for searching the evidences. We conducted systematic searches on Scopus, ScienceDirect and Google Scholar following the PRISMA 2009¹⁸ flow diagram (Fig. 1). Using Google Search, we identified additional relevant studies. The article which is not available as full-text, the concern author was requested to provide the same. A list of combinations of keywords/search terms was prepared for searching the studies. The search terms that were used included: (Malnutrition OR nutritional status OR cognitive development OR school performance and/OR malnutrition OR Effects of malnutrition on academic performance/cognitive development/GDP OR undernutrition OR relationship between undernutrition, cognitive development, and GDP).

4.3 Inclusion Criteria and Quality Assessment

Studies were included in the systematic review if they (1) conducted on malnutrition/undernutrition/nutritional status; (2) focussed on effects of malnutrition/undernutrition on cognitive development/ school outcomes and/or GDP and; (3) were written in English language only. Using the modified Newcastle-Ottawa Scale¹⁷, as used in Epstein et al. 2018¹⁹, four authors (Katoch, Sehgal, Parihar & Ahmed) independently assessed the quality of the remaining articles.

4.4 Exclusion Criteria

The criteria for excluding a study were: 1) Unrelated research works; 2) studies without sufficient data; 3) duplicate sources; 4) the case studies, books, policy briefs, thesis/dissertations; 5) non-peer-reviewed research articles; 6) articles that their full text was not available.

4.5 Data Extraction

All the studies identified by the search on Scopus, ScienceDirect and Google Scholar were added into the Mendeley Desktop library and duplicates were removed before screening in the first phase. Each reference was screened by four independent reviewers (Katoch, Sehgal, Nawaz & Shrikant) to determine if it should be included or excluded for full text review based on the above eligibility criteria. Disagreements between reviewers were discussed and settled by consensus. In the second phase, all the studies were screened by reading the titles and abstracts and excluded those studies not reporting malnutrition/effects of malnutrition on cognitive development, school outcomes and GDP. The third phase consists of full-length text review and inclusion of peer reviewed articles published in the journals only and exclusion of non-peer-reviewed articles, reports, case studies, theses/dissertations, books, and policy briefs, etc. for the systematic review. In the fourth phase, relevant data were included in the data extraction form which include: a) author [Ref.] & year; b) country/location; c) type and size of sample (n); d) issue addressed; e) main findings; e) Impacts of malnutrition on cognitive development, school outcomes and GDP.

5. Results

This systematic review aims to bring together evidences on the effects of malnutrition on cognitive development, school outcomes and GDP. There were a total of 1580 records identified after the search and removal of duplicates. During the screening of titles and abstracts, 1455 articles were excluded that did not report the impacts of malnutrition on cognitive development, school outcomes and GDP. Only 125 full-text articles were assessed for eligibility. Furthermore, 56 articles were also excluded for being reports, case studies and theses and 48 articles were excluded for being not peer reviewed or published in the journals. Based on the full-length text screening, 20 studies met our inclusion criteria for the current systematic review.

A systematic review of studies identified over time is represented in Figure 1. A total of 20 studies were included in this review. Out of which one study conducted between 1985 to 1990 ²⁰, one between 1991 to 1995 ²¹, three in 1996 to 2000 ^{22, 23, 24} two between 2001 to 2005 ^{15, 25} two during 2006 to 2010 ^{26, 27} seven during 2011 to 2015 ^{14, 28, 29, 30, 31, 32, 33} and five studies were conducted between 2016 to 2020 ^{34, 16, 3, 35}.

Figure 1 Number of studies reviewed, conducted over time.

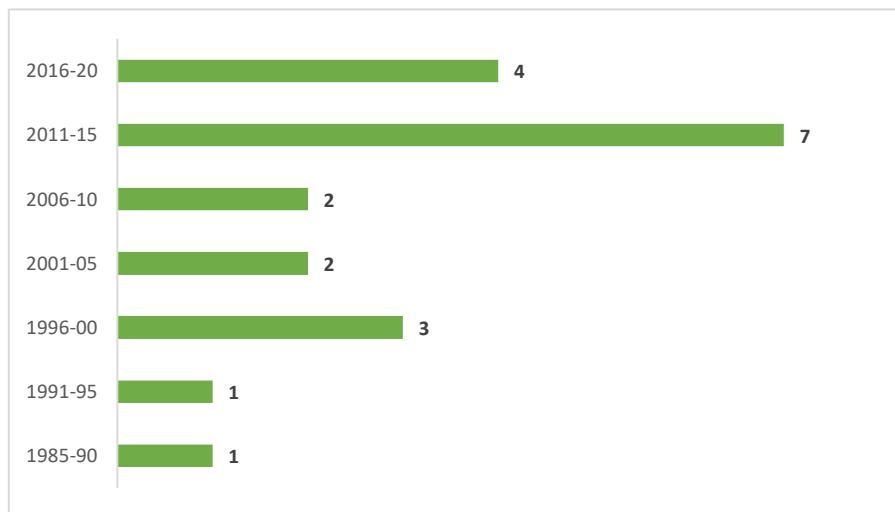


Table 1 Summary of studies showing the impacts of malnutrition on cognitive development, school outcomes and GDP

Ref.[author] Year	Country/location	Type and size of sample (n)	Issue addressed	Main findings	Impacts of malnutrition on		
					cognitive development	school outcome	GDP
Sharma & Katoch, 2018 ³⁴	India/J&K	School-going children n=360	Impact of Nutritional Status on School Attendance of Children	There is a positive relationship between the nutritional status and the level of school attendance.	---	Negative [-]	---
Mukudi, 2003 ¹⁵	Kenya	middle school pupils n = 851	Nutrition status, education participation, and school achievement among Kenyan middle-school children	The association between attendance rate and nutrition status is a function of socioeconomic status. Additionally, it was found that school attendance, a function of nutritional status, had the greatest influence on the achievement of students involved in the study.	---	Negative [-]	---
Laxmaiah, A et al., 1999 ²⁴	India/ Karnataka	A total of 2,694 school children (MDM -1361; Non-MDM-1333)	Impact of mid-day meal program on educational and nutritional status of school children in Karnataka	MDM improved the nutritional status of the children, which led to a higher school attendance rate for the children	---	Negative [-]	---
Sood, 2010 ²⁶	India	---	Malnourishment Among Children in India	Children's poor nutrition and health status is recognised as a significant factor for school enrolment, participation, and achievement. The loss of productivity due to malnutrition costs the nation more than 1% of GDP in India.	---	Negative [-]	Negative [-]
Galasso & Wagstaff, 2019 ¹⁶	Peru, Ethiopia, India, Vietnam, Philippines, Tanzania, Brazil	Sample ranges from 714 in Peru to 5914 in Brazil	Economic costs of childhood stunting	Manufacturing garments and food are the industries most affected by childhood stunting, accounting for 0.01% to 1.2% of the national GDP losses.	---	---	Negative [-]
Alderman et al., 2006 ²⁷	Tanzania	915 households	Reducing child malnutrition in Tanzania	Better nutrition increases income, thereby contributing towards GDP	---	---	Negative [-]
Scrimshaw, 1998 ²³	Japan	Review study	Malnutrition, brain development, learning, and behaviour	A lack of nutrients could negatively affect cognitive development in the elderly, as adequate protein, and calories during the first two years of life enhance the cognitive performance of undernourished children.	Negative [-]	---	---
Paul & Singh, 2020 ³	India	42,152 individuals across India	early childhood adversities, physical, cognitive and language development	Malnutrition was found to be one of the major biological and social risk factors that affected the cognitive and language development of Indian children.	Negative [-]	---	---
Ampaabeng & Tan, 2013 ¹⁴	Ghana	3582 respondents with	cognitive consequences of early childhood malnutrition	There is a direct and negative impact of early childhood malnutrition on cognitive development among famine survivors in Ghana.	Negative [-]	---	---

Alamy & Bengelloun, 2012 ²⁸	---	Review study	Malnutrition and brain development	Malnutrition contributes to impaired cognitive skills, which lead to poor attendance and academic performance in children in the school.	Negative [-]	---	---
Kerac et al., 2014 ²⁹	Africa	Review study	Malnutrition and Neurologic Disability in Africa	Malnutrition is a major public health problem that adversely affects cognitive function in children. Malnutrition can also cause perinatal problems, such as birth asphyxia, a major cause of neurological damage and cerebral palsy.	Negative [-]	---	---
Morgane et al., 1993 ²¹	---	Review study	Prenatal malnutrition and development of the brain	Various minimal brain dysfunctions result from malnutrition, which can lead to difficulties with attention processes and cognition	Negative [-]	---	---
Schoenmaker et al., 2015 ³⁰	Global	190 internationally adopted children	Cognitive and health-related outcomes after exposure to early malnutrition	A child's IQ in middle childhood and young adulthood is adversely impacted by early malnutrition, resulting in poor cognitive development	Negative [-]	---	---
Berkman et al., 2002 ²⁵	Peru	followed up from birth to 2 years, 239	Effects of stunting, diarrhoeal disease, and parasitic infection during infancy on cognition in late childhood	Young children who are malnourished have stunting and are potentially unable to function cognitively by the age of nine. In lower-income communities throughout the developing world, interventions designed to combat malnutrition early in life could lead to significant improvements in cognitive function of children.	Negative [-]	---	---
Fagerström et al., 2011 ³¹	Sweden	1402 individuals (60–96 years of age)	Malnutrition and cognitive impairment	No matter where they live or what they do, people with moderate to severe cognitive impairments are at risk for malnutrition.	Negative [-]	---	---
Tooley et al., 2016 ³⁵	United States	Review study	Nutritional status and implications for cognitive and behavioural development	Foster children are more likely to suffer from anaemia and iron deficiency anaemia, which is linked to poor physical, cognitive, and behavioural outcomes	Negative [-]	---	---
Gordon, 1997 ²²	United Kingdom	502 low birth weight infants	Nutrition and cognitive function	The cognition and visual function can be improved by providing better nutrition, such as breast feeding	Negative [-]	---	---
Khanam et al., 2011 ³²	Bangladesh	5541 individuals	Impact of child malnutrition on schooling	School attendance is lower and more likely to be missed when a child is malnourished	Negative [-]	Negative [-]	---
Muiru et al., 2014 ³³	Embu County	150 pupils, 50 teachers and 50 parents	Malnutrition: its Impact on Attendance	Malnutrition adversely affects learning due to increased infections, diminished cognitive abilities, and low school attendance.	Negative [-]	Negative [-]	---
Jamison, 1986 ²⁰	China	3,000 children	Child malnutrition and school performance in China	The nutritional status of children negatively affects their attendance at school	Negative [-]	Negative [-]	---

MDM-mid day meal, GDP-gross domestic product, Negative [-] - shows negative impact of malnutrition

6. Discussions

Continually inadequate diets lead to chronic undernutrition, which directly impacts many aspects of children's development. Specifically, it inhibits physical and cognitive development of children, lessening their ability to learn in schools ³⁶, undermines educational attainment and negatively impacts productivity, with adverse effects on income and growth ³⁷. The cycle of poverty and malnutrition is perpetuated by poor nutritional status in three important ways - direct productivity losses associated with poor physical health and disease-related impairments; indirect productivity losses associated with poor schooling and cognitive development; and increased health care expenses ¹². The economic costs of malnutrition are very high- several billion dollars a year are lost in terms of GDP ³⁸. Malnutrition affects GDP, school outcomes, and cognitive development mainly in the following ways.

6.1 Effects of malnutrition on cognitive development

The development of children's cognitive skills is recognized as a pre-requisite for their overall well-being ³⁹. It is widely recognized that ill health and poor nutrition affect the mental and cognitive development in infancy and early childhood adversely ^{22,37,39}. Investing in education and community development would be more beneficial as it improves the mental and physical health of underprivileged populations and reduces the risk of malnutrition ³. Malnourished children may enter school at a disadvantage, and results into poor physical growth, cognitive development, and poor academic performance ⁵. Severe malnutrition in early childhood has a long-term effect on the development of the children. For example, a study in Jamaica found that children who had suffered from severe malnutrition between the ages 6 and 24 months were found to lag behind from adequately nourished children at ages 7, 8, 9 and 14 years in an intelligence quotient (IQ) test. At 14 years they were substantially delayed in overall IQ, vocabulary, and tests of educational achievement (Matthew Jukes, 2006).

A study ³⁷ conducted in Egypt found that the children consisted of toddlers, aged 18-30 months, and school going children, aged 6 - 9 years, have a significant influence on their cognitive ability from the current and long-term nutrition. It further revealed that investing in nutrition is desirable, because nutrition may have a direct effect on the productivity of labour and an indirect effect on educational achievement. Also, the adequate nutrition is essential for the proper growth and development of individuals and partly determines the quality of life and well-being of the individuals. Therefore,

malnutrition is a major public health problem that adversely affects cognitive function in children [3,14,23,28,29](#) Table. 1.

6.2 Effects of malnutrition on school outcomes

School outcomes are adversely impacted by malnutrition, and the consequences are diverse, severe, and long-term. It can be assessed by using various indicators of performance, such as marks or grades obtained in the annual examination based on the curriculum [40,41](#), percentage of attendance in the school i.e, number of days the child attended the school in a year (Hancock et al., 2013; Naik et al., 2015), and marks obtained by the student in a test conducted by some agencies - universities, colleges, and recruiting boards etc for admission purposes [45](#) or providing employment, a combination of school attendance and grade achievement [5,44](#).

6.2.1 Effects on Academic Performance

In a well-established body of research, it has been demonstrated that nutrition during the early years of life is crucial to future health, education, and employment outcomes [44,46,47](#). Poor nutrition can negatively affect the learning and performance of school-age children [48](#). To ensure the prosperity of any nation, it is necessary to continuously increase the incomes of the average people. The productivity of the average people is determined by the level of education they have obtained. For example, a study entitled "A well-educated workforce leads to state prosperity" conducted by the United States indicates that investing in education is essential to making a nation's economy more productive and increasing its population's well-being [49](#). In this way, it is very important to know the linkage between the nutritional status of the child and the educational attainment. Based on longitudinal data from rural Zimbabwe, a study [50](#) found that better pre-school nutrition is associated with greater attained height, higher grades of schooling completed, and earlier start to schooling ages of the child. They established that the determinants of pre-school height include shocks - such as war and drought and that these temporary events have long-lasting impacts on the nutritional status of the children. The study also found that losses in life earnings could range from 7% to 12% depending on the magnitude. Children suffering from anaemia are more likely to perform poorly in the classroom, restricting their ability to develop their human capital, therefore perpetuating poverty [51](#).

An empirical study⁵² conducted in Mysuru, India among high school children for a period of three months to determine the impact of malnutrition on scholastic performance found a significant relationship between nutritional status and school performance. In addition, it was revealed that majority of the students were malnourished, and it was recommended that educational institutions must identify students with anaemia and malnutrition, and educate them along with their parents about healthy eating habits and nutritional supplementation programs. Another study⁵³ examined the impact and mechanism that transmits malnutrition and found that lack of nutrients during pregnancy and infancy adversely impacts not only the health of the infant and mother but also that of the individual throughout their lives. It is also disclosed that the presence of iron deficiency in a pregnant woman increases maternal mortality, prenatal loss, and perinatal loss of the infant. As an example, if a mother is iron deficient, her child is born with poor iron reserves and is at greater risk of morbidity and mortality during infancy, which inhibits growth, impairs immunity, and increases infection rates in children. A study⁵⁴ conducted to determine the effects of health and nutrition status on educational outcomes for rural Tanzanian children found that malnutrition and poor health experienced during early childhood had long-term consequences on their human capital development. Additionally, the study revealed that improving child health status can result in an additional 28% probability of completing primary education.

Having a healthy diet, including a balanced diet, improves brain capacity, maximizes cognitive capabilities, and improves academic performance in school-age children⁴⁰. Having too much junk food and unhealthy diet negatively impacts academic performance because information reaching the brain is limited⁵⁵. In another study⁵⁶, tribal and non-tribal students were compared, and tribal students had lower BMI values, possibly due to differences in their diets, which adversely affected their academic performance.

Throughout the lifespan, nutrition is crucial to a child's performance academically and for their employment status as well as to their long-term health, well-being, and brain development⁵⁷. Students with good nutrition can maximize their full potential throughout their lifetimes, allowing them to maximize their cognitive and intellectual development. Having proper nutrition is crucial to students achieving their academic potential. Monitoring at the school level and educating parents and children about malnutrition and healthy eating can be the possible solution. The study thus,

concludes that malnutrition has a definite and negative relationship with the academic performances of the children ^{44,58-60}.

6.2.2 Effects on school attendance

It is believed that without regular attendance at school, a child cannot become literate or achieve the right aims and objectives of the true education. Academic performance of the students also depends upon the percentage of school attendance ^{34,61}. As an indicator of students' performance in school, we can calculate the percentage of school attendance by dividing the number of school days the student attends each year by the total number of working school days in the same year ⁴². Very few studies have investigated the relationship between nutrition and school attendance. A study ⁶² found that stunting and anaemia are associated with poor attendance of primary schools and both conditions are prevalent in younger children. The study also revealed that the school feeding programs can improve the attendance in the schools. The nutrition is very important for school readiness, which means the children must possess certain cognitive skills such as language abilities and numeracy, and level of physical and motor development, and appropriate socio-economic development to make entry into the school. Lack of school readiness at the age of school entry may lead to poor achievement, which in turn leads to drop out and class repetition and deficits become compounded.

Research shows that school attendance has a significant impact on a child's achievement in education. As an example, research conducted at the University of Western Australia ⁴² titled "Students Attendance and Educational Outcomes: Every Day Counts" with the primary aim to assess how absence from school affected students' academic achievement found that average academic achievement declined with each absence from school and continued to decline as absence rates increased. Further, the study suggests that frequent absences from school disadvantage the child's academic achievement, which can persist not only in the current year, but also in future years. If a child misses more than half a day of school on a weekly basis, the school considers their education at risk.

Using anthropometric measurements, including weight-for-age, height-for-age, and weight-for-height, a study ¹⁵ titled "nutrition status, educational participation and school achievement among Kenyan middle school children" found that school attendance rates, which is influenced by nutritional status, had the greatest influence on the achievement of students in the school. An

analysis of the Mid-Day Meal (MDM) program in Karnataka on school attendance and nutritional status of primary school children has indicated that the program is associated with improved educational and nutritional outcomes for school children²⁴. Further, the study found that students with Mid-Day Meal (MDM) programs had better school attendance, which had a considerable positive impact on their academic performance.

Therefore, malnutrition is one of the factors that influence the status of attendance at school on the one hand, while on the other hand, it affects students' academic performance. In order to attain the goals and objectives of true education, a child must attend school regularly. Hence, we can say that a student can attend school properly if he is in good health-which depends on nutrition. School absence and low attendance have various causes, and malnutrition is one of them. In order to improve the educational outcomes of the students, one way might be to improve the nutritional status of the students.

6.3 Effects of malnutrition on gross domestic product (GDP)

Economic growth is a necessary but insufficient condition for reducing malnutrition⁶³. It is necessary because there is no example of a low-income country making significant progress in reducing malnutrition without rapid economic growth, but it is insufficient because there are several instances where rapid economic growth has produced little or no reduction in malnutrition⁶⁴. In 2010, World Bank estimated that it would cost an additional US \$10.3 billion of public investment by countries and external funding agencies to scale up a set of proven undernutrition - specific interventions to 100% coverage in 36 countries where most of the world's undernourished children less than 5 years live. It was further estimated that such an investment would save 1.1 million lives, avert 30 million cases of stunting, and save 30 million disability-adjusted life years annually⁶⁵. As per the International Save, the Children Alliance (ISCA) undernutrition kills more than three million children every year and prevents hundreds of millions from achieving their full potential. At the national level, undernutrition can reduce GDP by as much as 6% a year. Globally, the direct cost of child undernutrition is estimated at \$20 to \$30 billion. ISCA established that investing in and improving the nutrition of children can accelerate economic development and poverty reduction⁶⁶.

The impact of malnutrition on economic growth is recognized in principle. The economic cost of micronutrient malnutrition in India amounts to 0.8% to 2.5% of the GDP⁶⁷, in Cambodia it is 2.5% of

GDP, and in Albania the burden on national economy due to malnutrition was about 0.7% of GDP⁶⁸. In developing countries, the average cost of stunting is 5% to 7% of per capita income²⁶. Research conducted by United Nations Economic Commission for Africa and the World Food Program (WFP) to estimate the cost of hunger in Ethiopia found that the cost associated with child undernutrition is estimated at 16.5% of Ethiopia's GDP in 2009. The study strongly suggested that in order for the country to achieve sustainable human and economic growth, special attention must be given to the early stages of life as the foundation of human capital⁶⁹.

GDP loss due to micronutrient malnutrition in India is 1% of the GDP which in absolute term is Rs. 77.6 crores as compared to budget of Rs. 3315 crores for Integrated Child Development Scheme (ICDS) expenses⁷⁰. According to a study⁷¹, there is a close link between improved nutrition, higher income, and productivity. As higher income is associated with improved sanitation and health, and well-nourished individuals are more productive in physical labour. The study projected that in developing countries the productivity losses began to diminish in individual countries but the progress is not visible at the level of the region until the run of the 21st century when improvements in Latin America become evident. Their projection shows that the improvements in Asia become evident as of 2020, and significant improvements are visible in both Latin America and Asia by 2050. The study further revealed that no improvement is visible in Africa even by 2050. Poor nutrition affects economic productivity both directly (*since undernourished adults are less able to perform work*), and indirectly (*through poorer cognition and school achievement*). The main productivity losses associated with malnutrition worldwide during the 20th century was 8% of GDP, and despite the various interventional programs initiated; it is projected that economic losses attributable to undernutrition will remain 6% of GDP over the first half of the twenty-first century. The losses are largely associated with impaired cognition which directly reduces productivity, with reduced educational attainment, as well as lower productivity of undernourished adults in manual works⁶⁵.

Therefore, the impact of child malnutrition on GDP has been acknowledged. In almost all developing countries Fig. 2, the cost of malnutrition is estimated to be much higher than the cost of interventional programs. It is thus imperative for the government to invest in nutritional intervention programmes if it is to eradicate malnutrition.

Fig.2 Effects of malnutrition on cognitive development, school outcomes and GDP



7. Conclusions and policy implications

Health is something most people overlook, but no matter what our line of work may be, we must be in good health in order to perform our duties properly. In order to always maintain a healthy body and a clear and calm mind, it is essential for anyone to maintain a healthy body and a healthy mind. Despite not having material problems, many people are unhappy or agitated on a psychological level. An unbalanced mind is the result of a bad health situation, such as feeling depressed, irritable, or aimless, as well as insomnia due to stress. Undernutrition in children is a widespread problem, especially because good nutrition positively affects physical ability, cognitive development, academic achievement, and health, and contributes to productivity, economic development, and poverty reduction. The biggest contributor to child mortality in most countries around the world is child undernutrition. In summary, malnutrition adversely impacts cognitive development, academic performance, school outcomes, and GDP. It contributes to the mortality and morbidity of children by causing diverse, severe, long-term consequences. To eradicate malnutrition, we must therefore combine health initiatives, nutrition interventions such as midday day meals scheme at school, and the creation of extra income, particularly for those whose families are hungry because they don't work, in order to break the vicious circle of chronic undernutrition. Policy implications of the study are as follows:

- a) The government needs to increase public spending to ensure that school-based feeding programs are implemented/strengthened effectively, in order to improve the nutritional status, enrolment rates, and student attendance.
- b) Efforts should be made to eliminate malnutrition through explicit links between nutritional targets, interventions, and indicators in the areas of health, education, social development, and other related policy areas.

- c) Educating community members about health and nutrition is important, especially caregivers, lactating women, and expecting mothers, so that their hygiene levels can be improved and they can adopt better dietary habits.

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