Pediatric Issues in Times of Pandemia:
From Infection to Nutritional Strategies

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Tackling Protein-Calorie Malnutrition during World Crises

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Key Messages

• COVID-19 has affected the food system and industry, which has contributed to increased food prices and increased rate of unemployment.
• Among individuals with malnutrition, COVID-19 exacerbates the condition and increases the risk of morbidity and mortality.
• Government, donors, and developmental partners have taken several steps to reduce the economical and health burden of people.
• Direct and indirect interventions among pregnant women and children can also be implemented to reduce the burden of malnutrition during COVID-19.

Keywords
COVID-19 · Pandemic · Malnutrition · Protein-calorie malnutrition

Abstract

Undernutrition is still highly prevalent in developing countries and leads to a multitude of problems as it weakens the immune system, which leads to increased risk of infections and diet-related diseases. COVID-19 has worsened the existing situation and has resulted in unprecedented health, social, and economic disruptions across the world. Before COVID-19, about 54% children under 5 years were moderately or seriously main nourished, and after the COVID-19 pandemic, early estimates suggest that an additional 2.6 million children were stunted; 9.3 million were wasted, with an addition of 2.1 million maternal anemia cases; 168,000 child deaths; and USD 29.7 billion in productivity losses. This review is mainly focused on the health and nutrition sectors and highlights the impact of COVID-19 on malnutrition, food system and industry, and it also discusses the various measures implemented across the world to cater the burden of maternal and child malnutrition. Movement restrictions and lockdowns within and across the countries/borders have imposed an unprecedented stress and shock on the food supply chain, affecting harvest, food processing, supply, logistics, food demand, shortages, and cost. Many countries have implemented interventions such as cash transfers, food ration distribution, insurance plans, utility subsidy, and tax exemptions to assist the population to cope with the financial and health issues caused due to the outbreak. Other than these measures, evidence recommends some essential direct and indirect interventions which could help in reducing malnutrition during COVID-19. The COVID-19 pandemic has re-demonstrated the connection between food systems, nutrition, health, and prosperity and the need for a more holistic approach.

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Epidemiology of Global Malnutrition

Malnutrition is a major public health concern, which targets the most vulnerable populations including poverty-stricken and people with a compromised immune system [1]. Malnutrition includes overnutrition (overweight and obesity), undernutrition (underweight, stunting, and wasting), and micronutrient excess or deficiencies [2]. In the year 2020, globally, 1.9 billion adults were overweight or obese, while 462 million were underweight [3]. While in the most vulnerable population of children under the age of 5 years, about 45 million were estimated to be wasted, 149 million were stunted, and 38.9 million were estimated to be overweight or obese [3]. Also, around 45% of the deaths under the age of 5 years were linked to undernutrition, of which most of the deaths occurred in low- and middle-income countries (LMICs) (Fig. 1) [3, 4].

Malnutrition affects the global burden of disease economically, socially, developmentally, and therapeutically, by affecting people, their communities, children, and families with long lasting and serious health consequences [3]. Children born as low birth weight (LBW) are unable to reach their full growth potential and are susceptible to illness, infections, and mortality in early life [2]. Young children with compromised immune systems affected by malnutrition are also more susceptible to infectious diseases and are prone to long-term intellectual and psychological development defects and cognitive development delays with compromised mental and physical development [5, 6].

A recent study from 62 LMICs reported an overall prevalence of stunting, wasting, and underweight among children 0–59 months of age from years 2006–2018 to be 29.1%, 6.3%, and 13.7%, respectively [7]. The regional level data in the study from Western Africa, Southern Asia, and Southeastern Asia indicated a relatively increased estimated prevalence of undernutrition as compared to the global estimates [7]. A comparative analysis of the prevalence of malnutrition at a subregional and country level illustrated prevalence of wasting in Asia to be three percentage points greater than that of Africa and 7–8 percentage points greater than that of Europe, the Americas, and Oceania, whereas at the subregional level, substantial variations in the burden of wasting existed [7]. The researchers further suggested that the regional-, subregional-, and country-level disparities in undernutrition do exist, and it is essential to bridge this gap to end malnutrition by 2030 [7].

Malnutrition should be catered in the first two years of life among children or even during the pre-pregnancy or pregnancy period before the symptoms begin to appear [8]. Coinciding with the growth and mental development in children, protein energy malnutrition is a major problem, and this early window period is considered essential to prevent and manage acute and chronic malnutrition symptoms [8, 9].

Malnutrition, being a preventable public health issue, necessitates a multi-sectoral strategic approach which should be wisely implemented to eliminate stunting, wasting, and overweight [10]. This situation further calls for an increased financial investment, alongside concerted efforts to be directed by the government organizations, policymakers, program managers, and relevant industry to eliminate the menace [11]. The United Nations (UN) Decade of Action on Nutrition 2016–2025 and the Agenda for Sustainable Development by 2030 primarily hint at eliminating all forms of malnutrition. The World Health Organization (WHO) has also set an international target to reduce wasting to <5% by 2025 [12].

Global Burden of COVID-19

COVID-19 has resulted in unprecedented health, social, and economic disruptions across the world [13]. Despite the continued and mixed use of masks, social distancing, lockdowns, and rollout of vaccines in many countries, so far, nearly five million people have lost their lives due to COVID-19, and about 250 million cases of COVID-19 have been reported worldwide [14]. Based on the available stats, the majority of the coronavirus cases have been reported in the United States of America (USA) (45,220,057 cases), India (34,127,450), Brazil (21,680,488), the United Kingdom (UK) (8,630,076), and Russia (7,969,960), whereas the majority of the COVID-19-related deaths have also been reported in the USA (731,271), Brazil (604,228), India (452,811), Mexico (285,347), and Russia (222,320) (Fig. 2) [14, 15].

Impressive progress has been made with respect to COVID-19 vaccinations in many high-income countries (HICs);
however, inequitable distribution of vaccinations across the world, especially in LMICs, remains a main challenge [16]. According to the data, about 36.3% of the world population is fully vaccinated, and about 87.3% population of the United Arab Emirates (UAE), 85.5% population of Portugal, 84.6% population of Malta, and 82.1% population of Singapore are fully vaccination [14]. In contrast, only 0.3% of the population is fully vaccinated for COVID-19 in South Sudan, 1.1% in Afghanistan, 8.0% in Iraq, 16.1% in Pakistan, and 20.6% in India [14]. These numbers clearly state the low coverage of COVID-19 vaccine in LMICs [16].

Impact of COVID-19 on Malnutrition

Millions of people are impacted by the COVID-19 pandemic, especially those who live below the poverty line, particularly in countries of Asia and Africa [17]. This is not because of the crowded conditions and challenge of handwashing and social distancing but majorly because of malnutrition as it increases the risks of getting ill and dying among the individuals [17–19]. It weakens the immune system and leads to many diet-related diseases, and accompanied with these existing issues, COVID-19 worsens the situation and exacerbates malnutrition, infections, and chances of mortality [18]. A Lives Saved Tool analysis suggests that COVID-19 disruptions with restrained access to healthcare and food systems could lead to significant increase in child mortality, and malnutrition could be a significant contributor to this increase in child mortality [20].

During COVID-19, diversion of limited resources for intermediate medical needs, disrupted supply chain, devastated economy, weakened social safety nets, suspension of school feeding programs, increased political instability, increased cost of localized food, and disruptions in food and health systems have exacerbated maternal and child undernutrition across LMICs [21]. Evidence from household surveys in Asia and Africa also reports large increases in poverty and food insecurity throughout 2020 [22–26]. To cope with this, families have shifted to less expensive sources of energy, including cereals, starchy staples, and/or nonperishable ultra-processed foods, with reduced consumption of nutrient-rich vegetables, fruits, and animal-sourced foods, such as fish, meat, and dairy [27, 28]. These shifts have led to less nutritious

![Fig. 2. Cases of COVID-19 across the world.](image-url)
and poorer quality diets, which in turn has increased the risks of undernutrition, especially micronutrient deficiencies (hidden hunger) [27] which has affected both high- and low-income countries [29]. In HICs, hidden hunger coexisted with obesity due to increased intake of macronutrients (i.e., carbohydrates and fats) [30]. Due to the COVID-19 surge, three billion people lacked access to nutritious diet, two billion people suffered from micronutrient deficiencies, one in three women of reproductive age suffered anemia, one in three people were either overweight or obese, and one-tenth of the worlds’ population was undernourished [29].

Before COVID-19, about 54% children under 5 years were moderately or seriously malnourished, of which most of them dwelled in Sub-Saharan Africa and Southern Asia [31]. Estimates using the Modelling International Relations under Applied General Equilibrium model, the Lives Saved Tool, and Optima Nutrition tool for 118 LMIC countries suggest that by 2022, disruptions due to COVID-19 could result in an additional 2.6 million stunted and 9.3 million wasted children, with an addition of 2.1 million maternal anemia cases, 168,000 child deaths, and USD 29.7 billion in productivity losses due to excess stunting and child mortality [32]. Kurtz et al. (2021) [19] reported that malnourished children under 5 years old (with a history of malnutrition) have increased odds of having severe COVID-19 as compared to teenagers. Similarly, there is an increased odds of severe COVID-19 among malnourished adults (with a history of malnutrition) between 18 and 78 years [19].

Apart from undernutrition, school closures during COVID-19 have also contributed to weight gain among children and adolescents due to decreased physical activity and increased sedentary lifestyle [33, 34]. A study reported an increase in meal frequency and 20.7% increase in intake of sweet and fried food during COVID-19 [33]. During the lockdown, the obesity prevalence in China increased from 10.5% to 12.6% among high-school and college students [35]. Studies from Palestine reported weight gain in 41.7% of the adolescents [36], a study from Spain reported a 25% increase [37], and a study from the USA reported weight gain in 15% of the adolescents during the pandemic [38]. A study in Qatar also reported a 3–6 kg increase in body weight among adults aged ≥18 years [39]. Prior to the pandemic, obesity was considered to be an issue in HICs, but an increase was also observed in LMICs during the pandemic [40]. Obesity also increases the risk of severe illnesses due to COVID-19 [41]. In the USA, children (less than 18 years) with obesity had a 3.07 times higher risk of hospitalization due to coronavirus, and there was a 1.42 times higher risk of severe illness (invasive mechanical ventilation, intensive care unit admission, or death) when hospitalized [41]. Even among adults, high BMI among COVID-19 patients was associated with a 33% increased risk of hospitalization and a 61% increased risk of mortality among adults in the USA [42]. The COVID-19 pandemic is expected to increase the risk of all forms of malnutrition; thus, all children at risk of malnutrition require nutritional care and support to address their nutritional needs [19, 43].

Impact of COVID-19 on the Food System and Industry

Movement restrictions and lockdowns within and across the countries/borders have imposed an unprecedented stress and shock on food supply chain, affecting harvest, food processing, supply, logistics, and food demand [44]. Disrupted local and national food markets have caused steep reduction in the global economy [44, 45]. In developing countries, these disruptions have further worsened the vulnerability of livelihoods and food systems (e.g., agrifood systems) [45].

Looking into the crises in global perspective, observations are quite clearly indicating stability of the physical and technological infrastructure of the food industry unlike health services sector that was overwhelmed in its capacity [46]. Contrarily, the food system failed to respond in its social interface [47]. It would not be wrong to comment that COVID-19-linked food business impositions brought food services and hospitality industry to their knees [47]. Apart of the business aspects, disruption of the food supply chain in food service and hospitality industries severely affected flow of consumer goods from farm to fork [48]. Short-term and long-term suspension of food businesses severely hit businesses of fresh food supplies like fruits and vegetables, fish, and cheese which were replaced with supermarket standard products [49]. Agri-tourism that also provides opportunities to local farmers and food entrepreneurs to diversify their income resources has also been collapsed with suspension of tourism, severely affecting economies which heavily rely on the tourism industry [50]. Unlike small- and medium-size food
businesses, fast-food business operators and beverages industries aggressively marketed ultra-processed foods and beverages whose regular consumption is associated with increased risk of obesity, noncommunicable diseases, and a higher rate of contract with the COVID-19 and associated mortality [51, 52].

According to the Global Food Crises Report 2020, about 135 million people from 55 countries faced a "crisis" level or higher level of acute food insecurity, and about more than 183 million people faced a "stressed" level of acute food insecurity [53]. This situation commends urgent action before blowing into social and economic crisis [53]. A UN report states that about 720–811 million people have gone to bed hungry in the year 2020, and about 118 million people have faced chronic hunger in 2020 compared to 2019 [54]. It further added that about 30% of the world’s population had lack of access to food in the year 2020 [54]. Thus, this pandemic has markedly increased the number of people facing acute food insecurity in 2020–2021 [55].

COVID-19 has a direct and an indirect impact on the food supply chain [21]. Direct impact such as movement restrictions, lockdowns, closure of hotels and restaurants, and restriction on vendors has influenced the urban market [21]. Lockdowns and disrupted trading have also impacted the harvesting and agricultural activities, availability of migrant labor, purchase, and postharvest losses [56, 57]. Some examples of the affected include mango producers in Pakistan, coffee growers in Columbia and Brazil, and livestock in the UK [56]. Indirect impact of COVID-19 includes unemployment and reduced income [21]. Many people working in retails and as casual labors have faced massive job losses, with a major drop in their income [58]. According to the estimates by the International Labour Organization, about 345 million jobs were lost across the globe in the third quarter of 2020 [57, 59]. Loss of job and drop in income have been compounded with food shortages and increased food prices [60]. Disruptions in the supply chain have also led to increased food prices [61]. The economic downturn has affected the affordability of nutritious foods [61]. In Sub-Saharan Africa, the nutritious foods such as fruits and vegetables are ten times more expensive than the staple food [62]. In Syria, the monthly cost of food has increased by 240% with increase in 1.4 million food-insecure people [62]. The wheat cost in South Sudan in the year 2020 has increased by 62%, the price of maize in Kenya has increased by 60% since 2019, while the overall cost of food in Ghana jumped has to 33% in year 2020 [62].

The pandemic also led to suspension of many nutrition focused programs, for example, many school food programs across different countries were suspended due to school closures [63]. A study reported food shortage, poor quality food, decreased meal frequency and portion, and increased child labor due to suspension of school feeding programs during COVID-19 in Ethiopia [63]. However, despite the school closures, some countries like the USA, India, Nigeria, Columbia, Libya, Congo, Cambodia etc. continued their intervention through different strategies and modalities [63–67].

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Many countries are striving to support their citizens during this crisis, while some countries are being supported by different nongovernmental organizations and UN agencies to help people survive despite the challenges of COVID-19 [68]. Few initiatives by countries are listed below:

- **Pakistan**: the government introduced a program which provided cash grants of PKR 12,000 per household to the most vulnerable people and who have lost their jobs during the pandemic [69]. The state has also provided support to the farmers by procuring wheat for sustainable supply in the country. An "Agriculture Package" was also introduced which provided financial assistance to farmers on inputs such as pesticides, seeds, fertilizers, and tractors to reduce their cost of production [69]. The Ehsaas Nushonuma Programme was launched in 14 districts which aimed at reducing child stunting. It comprised of cash transfer, healthcare, and immunization for pregnant women and children and provision of specialized nutritious food to pregnant women, new mothers, and children [70].
- **Bangladesh**: the World Bank mobilized USD 87.8 million in cash transfers as a part of “Livestock Dairy Development project” to 407,000 vulnerable poultry and dairy farmers to support their business [55].
- **Kyrgyz Republic**: the World Bank-supported, “GAFSP-funded Agricultural Productivity and Nutrition Improvement Project” which aimed to improve water infrastructure and develop the capacity of water users’ associations [55]. They also distributed USD 1.1 million for procurement of seeds and fertilizer through 30 projects [55].

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• Haiti: the “Resilient Productive Landscape project” helped over 16,000 farmers by mobilizing funds to access fertilizers and seeds to safeguard their production for cropping seasons [55].
• Mozambique: United States Agency for International Development (USAID) in collaboration with the Development Finance Corporation provided loan guarantees to two local banks that helped supply food from rural producers to urban consumers, such as storage providers and transportation [62].

Evidence-Based Interventions

Maintenance of adequate nutrition and rehabilitation has been considered as the most effective intervention to reduce mortality due to malnutrition [71]. Studies have suggested nutrition education as a suitable intervention for mothers to improve growth of their children in the first two years of life [71–73]. While other interventions include exclusive breastfeeding in the first six months of life; deworming; vitamin A supplementation; food fortification; zinc treatment and rehydration salts for diarrhea; folic acid/iron for lactating and pregnant women; and improved access to piped water, hygiene, and sanitation [71–73]. These interventions have shown positive effects on the prevention of malnutrition among children [71–73]. Evidence-based interventions that contribute to improving maternal and child nutrition are a combination of direct (e.g., micronutrient supplementation, delayed cord clamping, breastfeeding promotion, and counseling) and indirect (e.g., water, sanitation and hygiene promotion, poverty alleviation, food security, women empowerment, and malaria prevention) interventions [72].

Evidence on direct interventions shows that maternal multiple micronutrient supplementation improves child growth in LMIC and helps reduce the risk of LBW by 15%, stillbirths by 9%, small-for-gestational age (SGA) babies by 7%, and preterm births by 4% [74]. Provision of food supplements such as balanced energy protein during pregnancy also helps reduce the risk of stillbirth by 61%, LBW by 40%, and SGA births by 29% [75]. Provision of supplementary food with the use of locally produced supplementary and therapeutic food in communities and in food-insecure settings have supported in the management of children with acute malnutrition [72]. Provision of small-quantity lipid-based nutrient supplementation has also shown positive effects on growth among children 6–23 months old [72]. It has shown to reduce the effect of stunting by 18% by 6 months of age, and it has also shown to reduce the risk of SGA births by 6% [72]. Vitamin A supplementation to neonates in the South Asian region has shown to reduce the risk of mortality at 6 months by 13% [76].

Indirect nutrition interventions, such as preconception care, malaria prevention, water, sanitation, and hygiene promotion have also provided significant nutritional benefits [72]. Birth spacing has shown to improve maternal nutrition outcomes and reduce the incidence of stunting by 10–50% among children in different contexts [77]. A review of 17 trials reported that malaria chemoprevention during pregnancy reduces the risk of severe anemia by 40% and LBW by 27% and increases the birth weight by 93 g [27]. These set of interventions, i.e., direct and indirect, can be useful upon implementation in response to COVID-19 to cater malnutrition. However, Keats et al. [72] 2021 recommends a set of key interventions to address malnutrition, which are highlighted in Table 1.

Response to COVID-19 to Cater Malnutrition

Lockdown during the pandemic was a huge shock to the economy of the countries [46]. During this time, the government put initial emphasis to support poor, stabilize food prices, and to expand social protection programs [78]. Some of the interventions implemented by the government, donors, and development partners are mentioned below:

Cash Transfers

Pakistan introduced an “Ehsaas program” which provided direct cash transfers to about 80 million people with a target of 12 million households and a budget of USD 900 million [79]. The coverage was increased to an additional six million families during the pandemic, indicating the coverage of almost half of the Pakistan’s population [79]. The government of Bangladesh also introduced several food and cash transfer programs [79]. The prime minister of Bangladesh also provided one-time cash transfer as a gift of Eid-ul-Fitr worth BDT 2,500 to each of five million poor families, totaling BDT 12.5 billion [79].

Food Ration Distribution

The state government of India distributed staple food, vegetables, and fruits as take-home rations to poor and marginalized population [80]. The governments of Rwanda, Uganda, and Botswana delivered food from house to house in urban areas, the Madagascar government placed markets where oil and rice were sold at half price, whereas the Sudan government sold food baskets at discounted rates [81]. After the closure of schools in Lesotho and Liberia, school meals were replaced by take-home meals [81]. The Ministry of Education of Libya and Congo, in collaboration with World Food Pro-
gram (WFP), launched “school feeding at home” initiative, which provided take-home rations to the school children [64]. The Ehsaas Nashonuma Programme in Pakistan also provided food to pregnant women and children in the most vulnerable settings with high rates of childhood stunting [70].

**Insurance Plans**

India introduced a support package named “Pradhan Mantri Garib Kalyan Yojana,” which helped to buffer the health and nutrition shocks during COVID-19 [79]. This program provided insurance coverage of Indian Rupees 0.5 million to each health worker suffering from COVID-19. Rwanda revised its community-based health insurance scheme called “mutuelle de santé” by providing easy access to poor to become eligible for healthcare services [82]. However, in Morocco, the households under the noncontributory health insurance (RAMED) received an one-time cash transfer worth USD 80–120 to support households [83].

**Supporting the Unemployed**

The Afghan government received a funding of USD 280 million for “COVID-19 Relief Effort for Afghan Communities and Households Project” [84]. Under the Relief Effort for Afghan Communities and Households project, the program “Dastarkhan-e-Milli” aimed to cover 4.1 million households who had an income of USD 2 or less [84]. The African government introduced a temporary Social Relief of Distress fund support program to assist unemployed people who were not covered by unemployment insurance or any other support program during COVID-19 [85]. Some countries also created

### Table 1. Direct and indirect interventions to cater malnutrition [40]

| Direct interventions | Indirect interventions |
|----------------------|------------------------|
| Healthcare sector nutritional interventions | Other sectoral strategies directly affecting nutrition |
| Maternal and child micronutrient supplementation including home fortification* | Iodized or other micronutrient-fortified salt |
| Maternal and child food supplementation* | Staple food fortification* |
| Support for early immediate breastfeeding initiation* | Biofortification and agronomic fortification* |
| Delayed cord clamping* | Nutritional interventions in schools |
| Promotion and support for exclusive and continued breastfeeding* | Nutrition in emergency programs |
| Promotion of age-appropriate complementary feeding practices* | Mass and social media messaging for improved nutrition |
| Management of moderate acute malnutrition* | Policies to reduce prices or increase access to nutritious foods and diverse diets |
| Treatment of severe acute malnutrition* | Policies to limit marketing of unhealthy foods and breast milk substitutes including labeling |
| Anemia treatment | Promotion of healthy diets and age-appropriate complementary feeding in social protection programs* |
| Promotion of healthy diet and physical activity during childhood and adolescence | Sugar-sweetened beverage taxes |

* Most recommended interventions.
temporary work opportunities for the unemployed adults which included labor intensive public work [81].

Utility Subsidy

The Pakistan government deferred the deadline of payment of utility bills, whereas the African government of 12 countries waived off the utility bills of mainly water and electricity to relieve the partial burden from the shoulders of the poor people [81, 86]. Apart from the above listed interventions, the government of different countries also waived off rents, reduced fuel charges, relieved taxes, exempted VAT charges, and provided interest free loans to the community [55, 69, 81, 84].

Way Forward

COVID-19 fallout has gone far beyond a viral infection. It specifically has affected the lives of the most vulnerable population including children, pregnant and lactating women, and of people with a compromised immune system. Long-term programs that focus on the root causes of malnutrition should be encouraged, and both direct and indirect nutrition interventions across food, health, and social protection systems can be useful in catering malnutrition impacted by COVID-19. However, implementation of these interventions requires adequate coordination and a multi-sectoral approach to strengthen the efficient delivery and resilience of the families. The government should adopt a wholesome strategy targeting sectors beyond health and nutrition including economy, agriculture, education, human rights, etc. The government should also conduct program evaluations to gauge its actual impact on health and nutrition of the population.

Measures taken to slow down the spread of COVID-19 has decreased the spread of virus but has also exposed the world to economic and food crises. Government, NGOs, donors, and UN agencies are working to strategize and prioritize investments for COVID-19, but at the same time, effective execution does require money, political will, great coordination, commitment, multi-sectoral collaboration, and international unity.

Conflict of Interest Statement

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Author Contributions

All the authors equally contributed to the writing of the manuscript.

References

1 Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ. 2005;173(3):279–86.
2 Dukhi N. Global prevalence of malnutrition: evidence from literature. In: Imran M, editor. Malnutrition. London: IntechOpen; 2020. p. 1–16.
3 World Health Organization. Malnutrition: factsheet. 2021 [cited 2021 Oct 22]. Available from: https://www.who.int/news-room/fact-sheets/detail/malnutrition.
4 World Health Organization. Malnutrition. 2021 [cited 2021 Oct 22]. Available from: https://data.unicef.org/topic/nutrition/malnutrition/.
5 Black R, Allen L, Bhutta Z, Caulfield LE, De Onis M, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet. 2008;371(9608):243–60.
6 Blossner M, De Onis M, Prüss-Üstün A. Malnutrition: quantifying the health impact at national and local levels: World Health Organization; 2005.
7 Ssentongo P, Ssentongo AE, Ba DM, Ericson JE, Na M, Gao X, et al. Global, regional and national epidemiology and prevalence of child stunting, wasting and underweight in low-and middle-income countries, 2006–2018. Sci Rep. 2021;11(1):5204.
8 Shrimpton R, Victora CG, de Onis M, Lima RC, Blössner M, Clugston G. Worldwide timing of growth faltering: implications for nutritional interventions. Pediatrics. 2001;107(5):e75.
9 Benson TD. Improving nutrition as a development priority: addressing undernutrition within national policy processes in Sub-Saharan Africa. International Food Policy Research Institute; 2008. Vol. 156.
10 World Health Organization. Reducing stunting in children: equity considerations for achieving the global nutrition targets 2025. 2018.
11 Ntambara J, Chu M. The risk to child nutrition during and after COVID-19 pandemic: what to expect and how to respond. Public Health Nutr. 2021;24(11):3530–6.
12 World Health Organization. Global nutrition targets 2025: wasting policy brief. 2014 [cited 2021 Oct 23]. Available from: http://www.who.int/nutrition/publications/globaltargets2025_policybrief_wasting/en/.
13 Weiss MA, Jackson JK, Schwarzenberg AB, Nelson RM, Sutter KM, Sutherland MD, et al. Global economic effects of COVID-19. Congressional Research Service. 2020.

14 Zhang W, Sack DA. Progress and hurdles in the development of vaccines against enterotoxigenic *Escherichia coli* in humans. Expert Rev Vaccines. 2012;11(6):677–94.

15 Worldometer. Countries where COVID-19 has spread; 2021 [cited 2021 Oct 21]. Available from: https://www.worldometers.info/coronavirus/countries-where-coronavirus-has-spread/.

16 Hussmann K, Cuadrado DC, Kirya M. Global access to COVID-19 vaccines: lifting the veil of opacity. 2021.

17 Nutrition International. COVID-19 has unleashed a malnutrition crisis. 2021 [cited 2021 Oct 15]. Available from: https://www.nutritionintl.org/our-work/how-we-help/covid-19/.

18 Huizar MI, Arena R, Laddu DR. The global food syndemic: the impact of food insecurity, malnutrition and obesity on the health-span amid the COVID-19 pandemic. Prog Cardiovasc Dis. 2021 Jan–Feb; 64:105.

19 Kurtz A, Grant K, Marano R, Arrieta A, Grant K Jr, Feaster W, et al. Long-term effects of malnutrition on severity of COVID-19. Sci Rep. 2021;11(1):14974.

20 Roberton T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam M, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and childhood mortality in low-income and middle-income countries: a modelling study. Lancet Global Health. 2020;8(7):e901–e908.

21 Aksener N, Kandru G, Keats EC, Bhutta ZA. COVID-19 pandemic and mitigation strategies: implications for maternal and child health and nutrition. Am J Clin Nutr. 2020;112(2):251–6.

22 Amare M, Abay KA, Tiberti L, Chamberlin J. Impacts of COVID-19 on food security: panel data evidence from Nigeria. Washington, DC: International Food Policy Research Institute; 2020.

23 Egger D, Miguel E, Warren SS, Shenoy A, Collins E, Karlan D, et al. Falling living standards during the COVID-19 crisis: quantitative evidence from nine developing countries. Sci Adv. 2021;7(6):eabe0997.

24 Hamadani JD, Hasan MI, Baldi AJ, Hossain SJ, Shiraji S, Bhuiyan MSA, et al. Immediate impact of stay-at-home orders to control COVID-19 transmission on socioeconomic conditions, food insecurity, mental health, and intimate partner violence in Bangladeshi women and their families: an interrupted time series. Lancet Global Health. 2020;8(11):e1380–e1389.

25 Headey DD, Goudet S, Lambrecht I, Oo TZ, Maffioli EM, Toth R. Poverty and food insecurity during COVID-19: telephone survey evidence from mothers in rural and urban Myanmar. Washington (DC): International Food Policy Research Institute. 2020.

26 Kansimie MK, Tambo JA, Mugambi I, Bundi M, Kara A, Owuor C. COVID-19 implications on household income and food security in Kenya and Uganda: findings from a rapid assessment. World Dev. 2021;137:105199.

27 Radeva-Petrova D, Kayentao K, Ter Kuile FO, Sinclair D, Garner P. Drugs for preventing malaria in pregnant women in endemic areas: any drug regimen versus placebo or no treatment. Cochrane Database of Syst Rev. 2014;2014(10):CD000169.

28 United Nations Children’s Fund. Young children’s diets show no improvement in last decade, “could get much worse” under COVID-19 – UNICEF, 2021 [cited 2022 Jan 6]. Available from: https://www.unicef.org/eap/press-releases/young-childrens-diets-show-no-improvement-last-decade.

29 Micronutrient Forum. Global hidden hunger; 2022 [cited 2022 Jan 6]. Available from: https://micronutrientforum.org/the-global-challenge/.

30 Guralnik JM, Eisenstaedt RS, Ferrucci L, Klein HG, Woodman RC. Prevalence of anemia in persons 65 years and older in the United States: evidence for a high rate of unexplained anemia. Blood. 2004;104(8):2263–8.

31 Save the Children. The impact of COVID-19 on child malnutrition; 2020.

32 Osendarp S, Akouku JK, Black RE, Headey D, Ruel M, Scott N, et al. The COVID-19 crisis will exacerbate maternal and child under-nutrition and child mortality in low- and middle-income countries. Nature Food. 2021;2(7):476–84.

33 Stavridou A, Kapsali E, Panagouli E, Thriossios A, Polychronis K, Baco-poulou F, et al. Obesity in children and adolescents during COVID-19 pandemic. Children. 2021;8(2):135.

34 Ruiz-Roso MB, de Carvalho Padilha P, Mantilla-Escalante DC, Ullona N, Brun P, Acevedo-Correa D, et al. COVID-19 confinement and changes of adolescent’s dietary trends in Italy, Spain, Chile, Colombia and Brazil. Nutrients. 2020;12(6):1807.

35 Jia P, Zhang L, Yu W, Yu B, Liu M, Zhang D, et al. Impact of COVID-19 lockdown on activity patterns and weight status among youths in China: the COVID-19 impact on lifestyle change survey (COINLICS). Int J Obes. 2021;45(3):695–9.

36 Allabadi H, Dabis J, Aghabekian V, Khader A, Khammass U. Impact of COVID-19 lockdown on dietary and lifestyle behaviours among adolescents in Palestine. Dynam Human Health. 2020;7:2170.

37 Fernandez-Rio J, Cecchini JA, Mendez-Gimenez A, Carriedo A. Weight changes during the COVID-19 home confinement. Effects on psychosocial variables. Obes Res Clin Pract. 2020;14(4):383–5.

38 Dutta M. COVID-19 and impact of school closures on the children of the United States: a point of view with an empirical analysis; 2020.

39 Alah MA, Abdeen S, Kehiyayan V, Bougniza I. Impact of staying at home measures during COVID-19 pandemic on the lifestyle of Qatar’s population: Perceived changes in diet, physical activity, and body weight. Prev Med Rep. 2021;24:101545.

40 World Health Organization. Obesity and overweight; 2021 [cited 2022 Jan 6]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

41 Kompaniyets L, Agathis NT, Nelson JM, Preston LE, Ko JY, Belay J. Underlying medical conditions associated with severe COVID-19 illness among children. JAMA Netw Open. 2021;4(6):e2111182.

42 Kuehn BM. More severe obesity leads to more severe COVID-19 in study. JAMA. 2021;325(16):1603.

43 Zemrani B, Gehri M, Masserey E, Knob C, Pellaton R. A hidden side of the COVID-19 pandemic in children: the double burden of undernutrition and overnutrition. Int J Equity Health. 2021;20(1):44.
44 Deconinck K, Avery E, Jackson LA. Food supply chains and COVID-19: impacts and policy lessons. *EuroChoices*. 2020;19(3):34–9.

45 World Health Organisation. Revised WHO drinking-water guidelines to help prevent water-related outbreaks and disease. *Can Commun Dis Rep*. 2004; 30(40):194–5.

46 Shafi M, Liu J, Ren W. Impact of COVID-19 pandemic on micro, small, and medium-sized enterprises operating in Pakistan. *Res Globalization*. 2020; 2:100018.

47 Lee AJ, Cullerton K, Herron LM. Achieving food system transformation: insights from a retrospective review of nutrition policy (in) action in high-income countries. *Int J Health Policy Manag*. 2020.

48 FAOSTAT. *Suite of food security indicators*. [cited 2021 Oct 23]. Available from: http://www.fao.org/faostat/en/#data/FS.

49 World Health Organisation. *Global spending on health: a world in transition*. World Health Organization; 2019. Available from: https://www.who.int/health_financing/documents/health-expenditure-report-2019.pdf?ua%20=%20en.

50 Marrón-Ponce JA, Flores M, Cediel G, Monteiro CA, Batis C. Achieving food system transformation: insights from a retrospective review of nutrition policy (in) action in high-income countries. *Int J Health Policy Manag*. 2020.

51 Arru B, Furesi R, Madau FA, Pulina P. Economic performance of agroitivism: an analysis of farms located in a less favoured area in Italy. *Agric Food Econ*. 2021;9(1):1–21.

52 White M, Nieto C, Barquera S. Good deeds and cheap marketing—The food industry in the times of COVID-19. *Obesity*. 2020; 28(9): 1578–9.

53 Taylor DN, Cárdenas V, Perez J, Puga R, Svennerholm AM. Safety, immunogenicity, and lot stability of the whole cell/recombinant B subunit (WC/rCTB) cholera vaccine in Peruvian adults and children. *Am J Trop Med Hyg*. 1999;61(6):869.

54 Li A, Cam PD, Islam D, Minh NB, Huan PT, Rong ZC, et al. Immune responses in Vietnamese children after a single dose of the auxotrophic, live Shigella flexneri Y vaccine strain SFL124. *J Infect*. 1994;28(1):11–23.

55 FAOSTAT. *Suite of food security indicators*. [cited 2021 Oct 23]. Available from: http://www.fao.org/faostat/en/#data/FS.

56 Marrón-Ponce JA, Flores M, Cediel G, Monteiro CA, Batis C. Achieving food system transformation: insights from a retrospective review of nutrition policy (in) action in high-income countries. *Int J Health Policy Manag*. 2020.

57 Van Loon FPL, Clemens JD, Chakraborty J, Rao MR, Kay BA, Sack DA, et al. Field trial of inactivated oral cholera vaccines in Bangladesh: results from 5 years of follow-up. *Vaccine*. 1996;14(2):162–6.

58 Alvi M, Gupta M. Learning in times of lockdown: how Covid-19 is affecting education and food security in India. *Food Secur*. 2020; 12(4):1–4.

59 Moeen MS, Haider Z, Shikoh SH, Rizwan N, Davies S, Rana AW. COVID-19-estimating impact on the economy and poverty in Pakistan: using SAM multiplier model, Pakistan agricultural capacity enhancement program (PACE) International food Policy Research Institute – Pakistan (IFPRI): Pakistan; 2020.

60 Levine MM, Gangarosa EJ, Werner M, Morris GK. Shigellosis in custodial institutions. 3. Prospective clinical and bacteriologic surveillance of children vaccinated with oral attenuated shigella vaccines. *J Pediatr*. 1974;84(6):803–6.

61 Aday S, Aday MS. Impact of COVID-19 on the food supply chain. *Food Qual Saf*. 2020;4(4):167–80.

62 Francis NN, Pegg S. Socially distanced school-based nutrition program under COVID-19 in the rural Niger Delta. *Extr Ind Soc*. 2020;7(2):576–9.

63 United Nations Office for the Coordination of Humanitarian Affairs. *Pakistan humanitarian response plan for COVID-19 pandemic 2021*. 2021.

64 Dunn CG, Kenney E, Fleischacker SE, Bleich SN. Feeding low-income children during the Covid-19 pandemic. *N Engl J Med*. 2020; 382(18):e40.

65 Dunn CG, Kenney E, Fleischacker SE, Bleich SN. Feeding low-income children during the Covid-19 pandemic. *N Engl J Med*. 2020; 382(18):e40.
76 Neonatal Vitamin A Supplementation Evidence Group. Early neo-
natal vitamin A supplementation and infant mortality: an individ-
ual participant data meta-analysis of randomised controlled trials. 
Arch Dis Child. 2019;104(3):217–26.

77 Dewey KG, Cohen RJ. Does birth spacing affect maternal or child 
nutritional status? A systematic literature review. Matern Child 
Nutr. 2007;3(3):151–73.

78 Begum IA, Talukder RK, Kazal MMH, Alam MJ. Landscape of en-
hanced access to social protection, safety nets and increased re-
silience in Bangladesh. Agricultural economics. IntechOpen; 
2021.

79 Kotloff KL, Winickoff JP, Ivanoff B, Clemens JD, Swerdlow DL, 
Sansonetti PJ, et al. Global burden of Shigella infections: implica-
tions for vaccine development and implementation of control 
strategies. Bull World Health Organ. 1999;77(8):651–66.

80 Mangal DK. India’s fight against COVID-19 and malnutrition, in ET 
health world. Economic Times; 2020.

81 Devereux S. Social protection responses to COVID-19 in Africa. 
Global Soc Policy. 2021:14680181211021260.

82 International Monetary Fund (IMF). Policy responses to COVID-19; 
2020 [cited 2021 Oct 23]. Available from: www.imf.org/en/Top-
ics/imf-and-covid19/Policy-Responses-to-COVID-19.

83 Savarino SJ, Hall ER, Bassily S, Brown FM, Youssef F, Wierzba TF, 
et al. Oral, inactivated, whole cell enterotoxigenic Escherichia coli 
plus cholera toxin B subunit vaccine: results of the initial evalua-
tion in children. PRIDE Study Group. J Infect Dis. 1999;179(1):107– 
14.

84 World Bank. Afghanistan: new grants to cushion impact of CO-
VID-19 on poor households and protect food security. Washin-
gton; 2020.

85 Sherwin G, Seventer DV, Arndt C, Davies RJ, Harris L, Robinson S, 
et al. Extraordinary COVID-19 social support programs in South 
Africa yield economic benefits during the pandemic period. Inter-
national Food Policy Research Institute; 2021.

86 Latif A. COVID-19: Pakistan unveils economic relief package; 2021 
cited 2021 Oct 20]. Available from: https://www.aa.com.tr/en/
asia-pacific/covid-19-pakistan-unveils-economic-relief-pack-
age/1777961#.