The potential impacts of the COVID-19 crisis on maternal and child undernutrition in low and middle income countries

Saskia Osendarp (saskia.osendarp@micronutrientforum.org)
Micronutrient Forum https://orcid.org/0000-0002-3847-5584
Jonathan Akuoku
World Bank
Robert Black
Johns Hopkins Bloomberg School of Public Health https://orcid.org/0000-0001-9926-7984
Derek Headey
International Food Policy Research Institute https://orcid.org/0000-0003-2476-5131
Marie Ruel
International Food Policy Research Institute https://orcid.org/0000-0002-9506-348X
Nick Scott
Burnet Institute
Meera Shekar
World Bank
Neff Walker
Johns Hopkins Bloomberg School of Public Health
Augustin Flory
Results 4 Development
Lawrence Haddad
Global Alliance for Improved Nutrition
David Laborde
IFPRI
Angela Stegmuller
Johns Hopkins University Bloomberg School of Public Health
Milan Thomas
George Town University
Rebecca Heidkamp
Johns Hopkins University Bloomberg School pf Public Health

Article

Keywords: Economic Crisis, Food Disruption, Health-system Disruption, MIRAGRODEP, Lives Saved Tool, Optima Nutrition Tool, Child Stunting, Child Mortality

DOI: https://doi.org/10.21203/rs.3.rs-123716/v1

Abstract

The COVID-19-related economic crisis and food- and health-system disruptions threaten to exacerbate undernutrition in low- and middle-income countries (LMIC). We used three modelling tools (MIRAGRODEP, Lives Saved Tool, and Optima Nutrition Tool) to estimate impacts on child stunting, wasting, and mortality, maternal anemia, children born to low BMI women, and future productivity losses for three scenarios across 2020–2022 (n = 118 LMICs). We also estimated the additional cost of mitigation for six nutrition interventions to maximize non-stunted and alive children. By 2022 COVID-19 could result in an additional 9.3 million wasted and 2.6 million stunted children, 168,000 additional child-deaths 2.1 million maternal anemia cases, 2.1 million children born to low BMI women and US$29.7 billion future productivity losses due to excess stunting and child mortality. An additional $1.2 billion per year is needed to mitigate these effects. Governments and donors must maintain nutrition as a priority, continue to support resilient systems, and ensure efficient use of new and existing resources.

Introduction

Before COVID-19, the world was already off-track to achieve the Sustainable Development Goal 2 to eliminate hunger and all forms of malnutrition by 2030.[1] The COVID-19 pandemic and related global economic recession are a severe setback to already insufficient progress towards the global nutrition targets for stunting, wasting, maternal anemia, and breastfeeding by 2025.[1] Pandemic-related economic contractions and food and health systems disruptions now threaten to exacerbate maternal and child undernutrition across low- and middle-income countries (LMIC).[2]

Measuring the effects of the COVID-19 disruptions on delivery of essential health and nutrition interventions has proven challenging as resilient real time information systems were not well established in many countries prior to the crisis. The World Health Organization (WHO) Pulse Survey reported health service disruptions between March and June 2020 in 90% of the 105 countries surveyed across five regions. More than half of the surveyed countries documented disruptions in antenatal care, sick child services, and management of malnutrition and 70% of countries reported disruptions in routine immunization.[3] Experience from previous pandemics suggests that health system recovery could be slow; after the 2014 Ebola outbreak in West Africa it took more than one year for health care services to fully recover.[4]

Evidence on the economic and food insecurity impacts of COVID-19 is also emerging. Global estimates from mid 2020 – prior to further deteriorations in economic growth forecasts – suggested that economic contractions and food supply chain disruptions have contributed to increased household food insecurity and 95 million people falling into severe poverty.[5,6] Updated projections suggests 150 million people will become poor in 2020.[7] Evidence from targeted phone surveys in Asia and Africa also points to disturbingly large increases in poverty and food insecurity throughout 2020.[8,9,10,11] Disruptions in supply chains for perishable nutrient-rich foods such as fruits and vegetables and animal source foods have been reported at local levels, especially during lockdowns, leading to price volatility and declining consumption of these foods.[6,12] As a coping strategy poor households facing income losses tend to shift to cheap sources of calories including starchy staples, cereals, oils, and/or non-perishable ultra-processed foods and reduce consumption of nutrient-rich fruit and vegetables and animal source foods such as dairy, meat, and fish.[13,14,11] These dietary changes likely lead to poorer quality diets, which in turn can increase the risks of undernutrition, and especially micronutrient deficiencies. Social protection programs, including cash and food transfers and school meals were disrupted early in the pandemic[15] and, although many countries have adapted, modified, or scaled up their programs,[16,17] they are likely to fall short of needs.

Early insights on the disruptions to economic, food and health systems suggest a range of potential implications for nutrition. There have been separate estimates of the impacts of health system shocks on child wasting and maternal and child mortality[18,19] and of the economic shocks on poverty in the early stages of the pandemic.[9,10,11,12] However, to date there is no comprehensive assessment of the combined effects of economic, food and health systems disruptions on multiple forms of maternal and child undernutrition.

We have aimed to fill this gap by using several modelling tools to present a multi-year picture of the potential consequences of the economic, food and health systems crises triggered by COVID-19 for maternal and child undernutrition in 118 LMICs. We estimated the potential impacts for 2020-2022 of the crisis on: 1) child stunting, wasting, and mortality, maternal anemia and children born to women with low body mass index (BMI); and 2) associated human productivity losses. Mitigating the impact of these disruptions requires extra financial resources, and so we also estimated the effects of COVID-19 on the domestic and donor financing landscape for nutrition, the additional costs of interventions to mitigate the rise in maternal and child undernutrition, and the effects of optimizing budget allocations for nutrition.

Results

Maternal and child undernutrition and child mortality

Child wasting: Compared to projections without COVID-19, the moderate scenario estimates an additional 9.3 million children under five with wasting (WHZ<-2 SD) from 2020 to 2022, based on predicted GNI declines in the 118 countries (6.4 million in optimistic; 13.6 million in

pessimistic) (Table 2). Two-thirds of these additional wasted children in the moderate scenario would be in South Asia (6.2 million) and 1.9 million in sub-Saharan Africa.

Child stunting: Under the moderate scenario, an estimated 2.6 million additional children will be stunted in 2022 compared to 2019 due to interruptions in nutrition services and declines in household poverty status. (1.5 million in optimistic; 3.6 million in pessimistic) (Table 2). Almost 1.2 million would be in Sub-Saharan Africa and 790,00 in South Asia (Web Annex 1).

Under 5 mortality: Under the moderate scenario, there will be an estimated 168,000 additional under 5 deaths in the 118 countries over the three years due to predicted increases in child wasting and declines in nutrition intervention coverage (47.000 in optimistic; 283,000 in pessimistic) (Table 2). Consistent with wasting, most of these additional deaths are in South Asia and Sub-Saharan Africa (Web Annex 1). However, under the optimistic scenario, a 10% increase in the treatment of moderate acute malnutrition in 2022 relative to 2019, would contribute to 61,000 "lives saved" in 2022 and reduced net 47,000 deaths over the three years (Table 2).

Maternal anemia and low BMI: The moderate scenario estimates an additional 2.1 million pregnant women with any anemia in the 118 countries in 2020-2022 compared to 2019 (1.0 million in optimistic; 4.8 million in pessimistic) (Table 2). Also an additional 2.1 million children would be born to women with low BMI in 2020-2022 (1.4 million in optimistic; 3.0 million in pessimistic scenario) (Web Annex).

Adverse birth outcomes: Two maternal nutrition interventions introduced in the optimistic scenario in 2022 have a positive impact on small-for-gestational-age (SGA) and preterm births and stillbirths: MMS in place of IFA, and balanced energy protein supplementation for malnourished pregnant women. An increase to 10% coverage in 2022 would prevent an estimated 400,000 cases of SGA, 296,000 preterm births and 7,600 stillbirths across the 118 countries.

Future productivity losses

The estimated additional burden of childhood stunting and child mortality would result in future productivity losses between the ages of 18 and 65 years (using country-specific life expectancy) of $14.9 billion, $29.7 billion, and $44.3 billion under the optimistic, moderate, and pessimistic scenarios, respectively. Additional cases of anemia during pregnancy would result in $79 million in lost productivity between 2020-2022 ($36 for optimistic -$177 million for pessimistic) (Figure 1). Across the three outcomes, these losses represent between 0.1% and 0.3% of current GNI in the sample of 118 countries.

Financing landscape for nutrition

Since 2002, ODA to nutrition-specific and nutrition-sensitive sectors has on average trended with donor country economic cycles, but with a lag. We ran regressions with GDP growth lags of up to five years, but only the two-year lag is ever statistically significant (always with an elasticity slightly greater than 1). Therefore, like Stuckler et al. (2011), our results are reported with lags of up to two years. For every percentage point increase in national growth there is typically a 1.6 percentage point increase in ODA two years later. For domestic financing, for each one percentage point increase in growth there is a 1.5 percentage point increase in domestic health expenditure, with no time lag. Using the MIRAGRODEP moderate scenario, our dynamic model implies that ODA to nutrition will decline slightly through 2021 before the lagged effect fully manifests in 2022 with a decline of 8.9%. In this scenario ODA does not recover to pre-crisis levels until 2028. Domestic financing for health (including nutrition-specific financing) is projected to fall by 7.2% in 2020, 4.2% in 2021, and 2.2% in 2022, not recovering to pre-crisis levels until the end of the decade unless there is strong recovery in economic growth in LMICs. Relative to no-COVID projections all three disruption scenarios project a significant ODA shortfall to nutrition-relevant sectors through 2030 (19% in pessimistic; 14% in moderate; 9% in optimistic), accompanied by a similar decrease in domestic health budget (Web-Annex).

Additional financing needs and optimizing existing financing

Based on the projected increases in stunting, wasting, and anemia during pregnancy under the moderate scenario, we estimate an additional $1.2 billion per annum ($763 million in optimistic; $1.7 billion in pessimistic) will be needed to mitigate the impacts of COVID-19 on maternal and child undernutrition (Table 3). Scaling up nutrition interventions with direct and indirect effects on child mortality will also avert additional child deaths.

Improvements in allocative efficiency of six nutrition interventions (Figure 2) could avert some of the indirect effects of COVID-19 on nutrition. Our multi-country analysis suggests that realigning financing from provision of complementary foods towards a more targeted and balanced mix of interventions could lead to as many as 8.2 million (4.9%) fewer stunted children under five in 2022 and 339,000 (2.2%) under-five deaths averted in 2020-2022 compared to a scenario without optimization (Figure 2). The illustrative intervention mix includes an expansion of SAM treatment and infant and young child feeding (IYCF) counselling for children 6-23 months of age in food-secure populations, combined with provision of complementary foods in food-insecure populations, increases in vitamin A supplementation, breastfeeding promotion and balanced energy-protein supplementation to women with a low BMI.

Discussion

Our projections demonstrate that, regardless of the scenario, the COVID-19 crisis is expected to have dramatic effects on maternal and child undernutrition and child mortality in the current generation, with massive long-term negative consequences on productivity. The impacts of COVID-19 on health and food systems disruptions, and especially the global economic recession it has triggered, will likely continue at least until the end of 2022 and will jeopardize the efforts of both LMICs and donors to achieve the global nutrition targets and SDGs 2 and 3.

If we focus on the moderate scenario used in our analyses, the changes in GNI per capita due to the COVID-19 crisis could result in an additional 9.3 million wasted children between 2020-2022, a large increase relative to the 47 million wasted children reported in 2019.[20] Reductions in coverage of nutrition services and increases in household food insecurity could add 2.6 million stunted children by 2022 to the estimated 144 million stunted children in 2019. After two decades of global decline in stunting, this would effectively reverse the last year or two of progress. Together these increases in child undernutrition and drops in coverage of essential nutrition services could lead to an estimated 168,000 additional deaths in children under five by 2022. Future productivity losses attributable to increased child stunting and mortality are US$ 29.7 billion, thereby impacting national economies.

Our estimates for increased stunting may be conservative. The first reason is that we only estimated stunting for children under 5 years of age for the final year (2022) of our projections in order to avoid double counting due to the progressive and cumulative nature of child stunting. Our estimates, therefore, exclude additional stunting cases that developed in 2020-22, but were older than 5 years of age in 2022. Second, the projected increases in maternal anemia (2.1 million cases by 2022) and children born to low BMI women (3 million by 2022) suggest that our estimates for increased stunting may further increase beyond 2022, as poor maternal nutritional status is a major risk factor for adverse birth outcomes and subsequent child malnutrition.[21]

The projected deterioration in nutritional status, child mortality, and lost productivity is sobering and demands immediate cross-sector action. The optimistic scenario signals the potential for the health sector to mitigate short- and long-term negative impacts by focusing on rapidly recovering and even modestly expanding coverage of essential maternal and child nutrition services, including the management and treatment of MAM. The optimistic scenario further suggests that this crisis could be used as an opportunity to accelerate introduction and scale-up of two maternal nutrition interventions - multiple micronutrient supplements (MMS) in place of IFA and balanced energy-protein supplements for low BMI women. UN agencies have specifically called for provision of MMS to pregnant women to ensure adequate micronutrient intakes during the COVID-19 crisis.[22] We have an example of using a crisis to scale-up a “new” intervention in the introduction of Multiple Micronutrient Powder (MNP) during the Tsunami response in Aceh, Indonesia in 2006.[23] Similarly, with promising evidence that small-quantity lipid nutrient supplements may improve growth[24] and reduce the risk of child mortality[25], countries could consider introducing these supplements as part of COVID-19 response strategies.

Our costing and optimisation estimates illustrate that allocative efficiency gains can be achieved using existing resources. It is notable that breastfeeding promotion (which reduces mortality) and complementary feeding (which reduces stunting) could also act as double duty actions to also reduce obesity and micronutrient deficiencies.[26] Further improvements may be possible through technical efficiency gains, such as reducing the cost of SAM treatment or, as noted previously, switching from IFA to MMS during pregnancy. However, our findings should not be interpreted as prescriptive at the country level. The optimal results and allocative efficiency gains will vary across countries depending on demographics, epidemiological factors, baseline intervention coverages, and context-specific costs, priority targets, delivery platforms and other constraints. Countries need customised analyses to help decide how to deliver more nutrition for the money available.

To mitigate the effects of COVID-19 on child stunting, child wasting and maternal anemia alone, we estimated that at least an additional $762 million to $1.7 billion per annum will be needed to achieve the global nutrition targets on top of the additional $7 billion per annum estimated in 2017. Previous evidence shows that prior to COVID-19, ODA flows towards nutrition-specific and nutrition-sensitive sectors were already significantly below recommended levels of donor financing.[1] Our results offer only a conservative estimate given that they are restricted to child wasting and stunting and maternal anemia, and cover only six nutrition-specific interventions using pre-COVID-19 cost assumptions. Critically, policies and interventions that address the economic and food systems drivers of nutrition are just as important as those that address health determinants.[27,28] Panel 1 proposes a set of critical actions across health, food and social protection systems that countries should prioritize to mitigate the potentially devastating impacts of the COVID-19 pandemic on maternal and child nutrition.

It is reassuring to see that governments have indeed begun to implement various mitigation and adaptation measures to ensure safe delivery of essential nutrition services, to maintain adequate food supply, and to offset losses in income and widespread food insecurity. Examples of strategies that countries have adopted to prevent interruption of essential health and nutrition services include use of digital health technologies, mobile medical teams or campaigns (e.g. vaccination campaigns), task shifting and additional training of staff, home delivery of food and supplements, transport/financial support to patients, and strengthening of community outreach networks, among others[3,29]. To maintain an adequate food supply, countries are exploring interventions to improve short to medium term agricultural production[30,31] while programs working with small and medium enterprises (SMEs) have supported the adaptation of marketing, sales and distribution strategies as a result of

disruptions in value chains.[29] To mitigate the impacts of the economic crisis on income losses and food insecurity, governments have implemented, adapted, or scaled up social safety net programs including cash and food transfers in more than 200 countries.[16,32,33] However, little information is available on the efficiency and effectiveness of mitigation measures in health, food, and social protection systems. Moreover, it is likely that they these interventions stretch government budgets, fail to meet the overwhelming need for these interventions given the devastating impact of COVID-19 on poverty levels, and leave many of the most vulnerable behind, including women, migrant or refugee populations, and the ultra-poor, to name a few.[34]

Our analyses have some limitations. First, uncertainty is present in all modelling exercises. Pessimistic and optimistic scenarios were developed to reflect this, but the models do not account for the different trajectories that national and subnational economic, health and food systems may take depending on differences between countries in current and new waves of infection and/or mitigation efforts. Second, the paucity of pre-COVID baseline data across LMICs on dietary intake, micronutrient status and obesity precluded modelling the effects on the pandemic on all forms of malnutrition. However, the reported disruptions in supply chains for perishable nutrient-rich foods and related drops in availability, affordability, and consumption[35] suggest potentially large impacts on micronutrient deficiencies and rising obesity.[36]

In conclusion, the COVID-19 pandemic has created a nutritional crisis in LMICs. Without swift and strategic responses by subnational, national, regional, and international actors, COVID-19 will reverse years of progress and exacerbate disparities in disease, malnutrition, and mortality, and jeopardize human capital development and economic growth for the next generation.[37] We must act now to strengthen the delivery of policies and direct and indirect nutrition interventions across health- food- and social protection systems, both in the immediate and longer-term. Additional ODA and domestic funding, as well as better use of existing resources, will be critical to mitigate the damage from COVID-19 and reinvigorate efforts to achieve global targets and safeguard good nutrition for all, now and in the future.

Methods

Estimating effects on maternal and child undernutrition and child mortality

In order to estimate the overall indirect effects of COVID-19 on maternal and child undernutrition and child mortality and explore possible mitigation strategies we used a five-step process across three assumption scenarios (pessimistic, moderate, optimistic) (Table 1).

In the first step, we estimated changes in gross national income (GNI) per capita and poverty (% population<$1.90 per day) due to COVID-19 disruptions across 2020, 2021 and 2022 in 118 LMICs, using three different economic recovery scenarios. Second, we translated these different projections for GNI per capita into country-specific changes in the prevalence of different levels of child wasting and maternal low BMI status using a recent statistical analysis that linked growth shocks to wasting and low BMI risks. Third, we inputted the estimates of poverty and wasting, along with assumptions about levels of disruption of health and nutrition services, into the Lives Saved Tool (LiST) to estimate changes in under-five mortality, stunting and maternal anemia. Finally, we used the Optima-Nutrition model to explore possible strategies to mitigate the predicted increases in undernutrition and child mortality. The methods and inputs for each of these steps are detailed below.

For the first step we used MIRAGRODEP, a global computable general equilibrium model linked to country-specific household survey data, to predict the effects of COVID-19 disruptions on GNI per capita, household incomes and $1.90/day poverty rates between 2020-2022.[38] MIRAGRODEP inputs include international trade and financial disruptions, as well as projected country estimates of COVID-19 cases and associated prevention measures (e.g. lockdowns). The economic channels of disruption included changes in labor force participation and labor productivity due to lockdown policies, increased morbidity and mortality, reduced efficiency of domestic and international transportation of goods, reduced consumer demand for in-person services (e.g. restaurants), and international shocks to trade and financial flows (e.g. reduced demand for oil). For 2020, we modelled a single GNI scenario, as there is less uncertainty on the extent of economic disruption. (MIRAGRODEP results for 2020 were compared to the most recent economic forecasts from a range of international agencies.) However, we opted to model three different scenarios for economic recovery from the pandemic in 2021 and 2022. The optimistic scenario assumed a fast V-shaped economic recovery with economic activity accelerating quickly from 2021 onwards. The moderate scenario assumed a second infection wave into 2021 results in a “stop-start” W-shaped recovery. The pessimistic scenarios assumed a protracted U-shaped recovery with continued economic disruptions in 2021 and most countries not returning to pre-COVID-19 per capita income levels by 2022 (Table 1). For this analysis, the magnitude of macroeconomic disruption for the three scenarios is measured as the percentage difference between GNI per capita with and without COVID-19, while impacts on poverty – which are also used as a proxy for food insecurity (see below) – are measured as the difference in $1.90/day poverty rates with and without COVID-19.

Second, we used elasticities from a recent study[39] that linked economic growth (GNI) shocks to child wasting and maternal low BMI risks to generate predicted changes in wasting and low BMI prevalence. Specifically, that study linked 177 Demographic Health Surveys from 52 LMICs to national level GNI growth shocks, and uncovered statistically significant negative relationships between changes in GNI per capita and: 1) changes in the prevalence of any (<-1SD WHZ), moderate/severe (<-2SD WHZ), and severe (<-3SD WHZ) wasting among children 0-59 months old and 2) prevalence of low Body Mass Index (BMI, <18.5 kg/m2) among mothers 15-49 years old. The corresponding elasticities from that

study were then applied to country-specific GNI growth projections from MIRAGRODEP, population projections and baseline undernutrition estimates from LiST to estimate increases in the number of children with wasting and number of women with low BMI as a result of the COVID-19 crisis.

LiST includes country-specific population projections and other baseline assumptions from publicly available data sources.[40] This analysis included 118 LMIC with sufficient coverage data (Web Annex 4); together these countries include over 95% of both global under-five deaths and stunted children. Mean annual coverage reduction assumptions for five preventive interventions across the three scenarios are consistent with the analyses by Roberton et al[18] and in line with disruptions reported elsewhere in 2020. (Table 1) We also included treatment of severe acute malnutrition (SAM) with similar coverage reduction assumptions but did not assume changes in coverage of treatment of moderate acute malnutrition (MAM), except in the optimistic scenario for 2022. For household food insecurity assumptions, which influence the type of complementary feeding intervention applied (public provision of complementary foods in food insecure households versus only nutrition counseling in food secure households), we used the annualized MIRAGRODEP < $1.90/day poverty projections.

As detailed in Table 1 we assumed that service disruptions would continue after initial lockdowns but would become less severe over time and in all three scenarios would recover to half of the 2020 drop in 2021. Possible sources of ongoing disruptions include 1) health workers becoming infected and/or are diverted to care with new virus waves, 2) reduced use of available services by the population due to perceived risk of exposure and 3) reduced financing over time due to economic impacts. For 2022, coverage levels in the pessimistic scenario remained lower than pre-COVID-19 baselines, while they returned to 2019 levels in the moderate scenario. For the optimistic scenario in 2022: (1) coverage for the majority of interventions was increased by 5% relative to 2019; (2) for treatment of MAM in children 6-59 months coverage increased to 10%; (3) multiple micronutrient supplements (MMS) replaced IFA during pregnancy; and (4) balanced protein-energy supplementation for pregnant women with low BMI was added at 10% coverage. We estimated the impacts of these last three interventions added in 2022 on adverse birth outcomes and under 5 child deaths.

Effects on long-term productivity

We used the Human Capital Approach to estimate lost productivity from the nutrition-related impacts of the COVID-19 pandemic. This approach calculates the present value of future productivity based on potential wages and potential time in the workforce.[41] This approach is similar to that adopted for estimating the benefits of scaling up nutrition interventions in Shekar et al.[42] For this study, we used GNI per capita as a measure of average future wages. Estimates of lost productivity were calculated separately for outcomes of stunting, nutrition-related child mortality, and maternal anemia. Total excess cases of each outcome were based on the results of the LiST modelling previously described.

For each child death, years of potential productivity were calculated as the difference between age 18 and the country-specific life expectancy or age 65, whichever is lower. The total number of children with potential lost productivity due to premature mortality was adjusted by the probability of death between age 5 and 18. Each year of productivity was valued using GNI per capita (current US$) adjusted for annual GNI growth, percent lifetime earnings that can be realized[43] and labor share of income. Future lost productivity was discounted at 3% per year.[44,45] For total lost productivity in each country, the lost productivity from each death is summed across all years of lost productivity and multiplied by the adjusted number of deaths.

The estimates of lost productivity for additional stunting cases used a similar approach as that described for child deaths. However, since stunting is expected to reduce future productive capacity for each child and not prevent future labor force participation, only this reduced productive capacity would be considered as potential lost productivity. Previous research estimated that decreased cognitive development due to early childhood malnutrition marked by stunting could lead to 21 percent reduction in adult earnings.[46] Therefore, the approach described for estimating lost productivity due to premature deaths were applied to the additional number of stunting cases and multiplied by 21 percent to derive an estimate for the productivity lost attributable to these additional stunting cases.

Excess cases of anemia in pregnant women were translated into lost earnings due to decreased labor productivity based on the methods described in Horton and Ross (2003)[46]. The level of productivity lost due to anemia differs depending on whether employment is in heavy manual labor, light manual labor, or service industry, with attributed productivity reductions of 17%, 5%, and 4% respectively. For each country, the distribution of types of labor engaged in by women was derived from the World Development Indicators (WDI) database. The proportion of women employed in agriculture, industry, and services were categorized as heavy manual labor, light manual labor, and service labor, respectively. Lost productivity was calculated separately for each category of employment as a product of per capita GNI, number of additional cases of maternal anemia in each year, percent of female employment in the specific category, and the associated reduction in productivity in that category due to anemia. These estimates were adjusted for female labor force participation and labor share of income. Total lost productivity for each country was the sum of estimated productivity lost across the three employment categories and the three years (2020-2022) modelled, discounted at 3% per year.

Effects on the financing landscape for nutrition

To project how available donor and domestic resources for nutrition are expected to change across the three disruption scenarios, we developed a modelling approach based on Stuckler et al[47]. First, using Creditor Reporting System (CRS) data on official development assistance (ODA) from 2002-2018[48], we ran a panel regression to estimate the elasticity of aid to nutrition-specific and nutrition-sensitive sectors with respect to donor countries' economic growth. Then, we multiplied that elasticity by the MIRAGRODEP GNI growth projections to estimate the expected levels of aid to those sectors between 2020 and 2030. We conducted an analogous procedure to project the effect of domestic economic growth on domestic government health spending, using National Health Accounts panel data from WHO's Global Health Observatory[49] for the 118 countries used in the Optima Nutrition model.

Estimating additional intervention costs and optimized nutrition budget allocations

The *Investment Framework for Nutrition* estimated that approximately $7 billion per annum was needed to reach the WHA targets for stunting, wasting, maternal anemia, and breastfeeding by 2025.[42] Given the disruptions caused by the COVID-19 pandemic, we anticipate that more resources will be needed to address the increased burden of malnutrition. We estimated the additional resource needs to address the expected increased in stunting, wasting, and maternal anemia as the product of additional burden of each outcome estimated from the LiST modelling and the cost per case of stunting or anemia averted or case of severe wasting treated.

We used the Optima Nutrition model[50] to illustrate how 2021-2022 financing could be optimally allocated across six nutrition interventions to maximize the number of "alive and non-stunted" children. Optima Nutrition is a cohort model that tracks children until five years of age, categorised according to their mother's breastfeeding practices, family economic status, height-for-age (stunting) status and weight-for-height (wasting) status. Children in the model can die from a range of age-specific causes, with the relative risks of dying from each cause related to the child's breastfeeding, stunting and wasting status. Interventions can improve nutritional outcomes directly or indirectly by reducing risk factors including birth outcomes and diarrhoea incidence. The model includes an optimisation algorithm, which can be used to incrementally shift a fixed amount of funding between interventions until it achieves a budget allocation that maximizes (or minimizes) a given objective. For this analysis the objective of maximizing alive and non-stunted children was selected to identify a priority mix of interventions to both reduce mortality from severe wasting and reduce stunting.

For each of the 118 LMICs, the total expenditure on the six nutrition interventions in 2019 and 2020 was estimated by multiplying coverage estimates from LiST from the moderate scenario (Table 1) by country-specific unit costs (Web Annex). Given evidence for a lagged decline in ODA starting in 2022 (Web Annex), we assumed total available financing for the nutrition interventions in 2021 and 2022 would equal total 2019 expenditure. The model was projected for 2020-2022 inclusive. The pre-optimization epidemiological projections and intervention coverages were aligned with the moderate scenario (Table 1) and were compared to outcomes when the funding was optimized to determine the maximum number of stunting cases and child deaths that could be averted through allocative efficiency.

Data availability statement:

Data that supported the final findings of this study have been deposited here:
https://drive.google.com/drive/folders/1AVqEF7gYTGmJENlya3UbUxO6A2fKBQm6?usp=sharing

Code availability statement:

All software (modelling tools) used in the analyses of this study have been referenced before and are available here: (1)MIRAGRODEP: https://www.ifpri.org/publication/miragrodep-model; (2) The Lives Saved Tool (LiST): https://www.livessavedtool.org/resources ; (3) The Optima Nutrition model: https://optimamodel.com/nutrition/ .

Declarations

The Standing Together for Nutrition Consortium:

The Standing Together for Nutrition (STfN) consortium is a multidisciplinary consortium of nutrition, economics, food and health system experts, currently consisting of 51 individuals from 32 organisations in HIC and LMIC, working to address the scale and reach of COVID-related nutrition challenges (See Web Annex 3).

The authors contributions were as follows:

Writing and modelling group responsible for conceptualization, design of the study, primary analyses and the main paper writing and editing JKA, REB, DH, RH, SO, MR, NS, MS, NW.

Contributors involved in conceptualization, analyses of sub-section, writing of panels or sub-sections: AF, LH, DL, AS, MT.

Contributors involved in conceptualization and review of final paper: see web annex.

All authors were involved in the conceptualization and reviewed and approved the final version of the manuscript.

Affiliations:

Micronutrient Forum, Washington, DC 20005-3915, USA (SO); World Bank Washington DC, USA (JKA, MS); Johns Hopkins Bloomberg School of Public Health, Baltimore MD, USA (REB, NW, RH, AS); International Food Policy Research Institute (IFPRI), Washington, DC, USA (DH, MR, NC, DL, PM); Burnet Institute, Melbourne, VIC, Australia (NS); Wageningen University & Research, Wageningen, NL (IB); World Food Programme, Rome, IT (SDP); Results for Development (R4D), Washington, DC, USA (AF); Global Alliance for Improved Nutrition (GAIN), Geneva, CH (LH); City, University of London, London, UK (CH); independent (AH); Asian Development Bank (MT); and University of Washington, Seattle, WA, USA (CL)

Declaration of Interest:

SO, DH, MR, LH and AF have received financial support from the Children's Investment Fund Foundation in support for this research. The funders had no role in the analysis and interpretation of the evidence or in writing the paper and the decision to submit for publication. The other authors declare that they have no conflicts of interest. As corresponding author Saskia Osendarp states that she has full access to all data and final responsibility for the decision to submit for publication.

Acknowledgements

The authors thank Anouk de Vries and Catrin Kissick for their support in manuscript preparation and Inge Brouwer, Namukolo Covic, Saskia de Pee, Corinna Hawkes, Anna Herforth, Carol Levin and Purnima Menon for their critical review of the final paper and for providing input in previous versions of the manuscript. REB, NW, RH, A, JKA and MS have received financial support from the Bill & Melinda Gates Foundation (BMGF) for their contributions to this research. Some of the underlying modelling used in this work has received indirect financial support from the United States Agency for International Development, but the views and opinions expressed in this paper do not necessarily represent the views and opinions of BMGF or USAID.

Funding

The work on this study was supported by a grant from the Children's Investment Fund Foundation (CIFF). The funders were not involved in the writing of this manuscript and agreed on having this paper published as "free to access".

References

1. Development Initiatives. 2020 Global Nutrition Report: Action on equity to end malnutrition [Internet]. The Global Nutrition Report's Independent Expert Group. 2020. Available from: https://globalnutritionreport.org/documents/566/2020_Global_Nutrition_Report_2hrssKo.pdf
2. Headey D, Heidkamp R, Osendarp S, Ruel M, Scott N, Black R, et al. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. Lancet. 2020;
3. World Health Organisation. World Health Organization. (2020). Pulse survey on continuity of essential health services during the COVID-19 pandemic: interim report, 27 August 2020. World Health Organization [Internet]. 2020 [cited 2020 Dec 6]. Available from:

https://apps.who.int/iris/bitstream/handle/10665/334048/WHO-2019-nCoV-EHS_continuity-survey-2020.1-eng.pdf?sequence=1&isAllowed=y

4. Barden-O'Fallon J, Barry MA, Brodish P, Hazerjian J. Rapid Assessment of Ebola-Related Implications for Reproductive, Maternal, Newborn and Child Health Service Delivery and Utilization in Guinea. PloS Curr. 2015;7.
5. Laborde D, Martin W, Swinnen J, Vos R. COVID-19 risks to global food security. Science (80-) [Internet]. 2020 Jul 31;369(6503):500 LP – 502. Available from: http://science.sciencemag.org/content/369/6503/500.abstract
6. Laborde D, Smaller C. What Would it Cost to Avert the COVID-19 Hunger Crisis? [Internet]. 2020 [cited 2020 Oct 25]. Available from: https://ecommons.cornell.edu/handle/1813/70172
7. World Bank Group. REVERSALS OF FORTUNE [Internet]. 2020 [cited 2020 Dec 6]. Available from: https://openknowledge.worldbank.org/bitstream/handle/10986/34496/9781464816024.pdf
8. 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 Glob Heal [Internet]. 2020;8(11):e1380–9. Available from: http://www.sciencedirect.com/science/article/pii/S2214109X20303661
9. Headey D, Goudet S, Lambrecht I, Oo Z, Maffioli EM, Toth R. Poverty and Food Insecurity during COVID-19: Telephone survey evidence from mothers in rural and urban Myanmar.
10. Amare M, Abay K, Tiberti L, Chamberlin J. Impacts of Covid-19 on Food Security: Panel Data Evidence from Nigeria. SSRN Electron J. 2020;
11. Kansiime 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;
12. Wolle A, Hirvonen K, de Brauw A, Baye K, Abate GT. Household food consumption patterns in Addis Ababa, Ethiopia. Strategy Support Program [Internet]. 2020. (Strategy Support Program - Working Paper 139). Available from: https://www.ifpri.org/publication/household-food-consumption-patterns-addis-ababa-ethiopia%0AAccessed: 2020-11-03%0A
13. Ammar A, Brach M, Trabelsi K, Chtourou H, Boukhris O, Masmoudi L, et al. Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 international online survey. Nutrients. 2020;
14. Harris J, Depenbusch L, Pal AA, Nair RM, Ramasamy S. Food system disruption: initial livelihood and dietary effects of COVID-19 on vegetable producers in India. Food Secur. 2020;
15. UNESCO. Prioritize health and well-being now and when schools reopen [Internet]. 2020. Available from: https://en.unesco.org/news/prioritize-health-and-well-being-now-and-when-schools-reopen
16. Gentilini U, Almenfi M, Orton I, Dale P. Social Protection and Jobs Responses to COVID-19 : A Real-Time Review of Country Measures [Internet]. Social Protection and Jobs Global Practice. 2020. Available from: http://hdl.handle.net/10986/33635
17. Nishtar S. Ehsaas Emergency Cash : A digital solution to protect the vulnerable in Pakistan during the COVID-19 crisis. 2020;0–37.
18. Roberton T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam Y, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. Lancet Glob Heal [Internet]. 2020 Jul 1 [cited 2020 Aug 17];8(7):901–9. Available from: www.thelancet.com/lancetgh
19. KC A, Gurung R, Kinney M V., Sunny AK, Moinuddin M, Basnet O, et al. Effect of the COVID-19 pandemic response on intrapartum care, stillbirth, and neonatal mortality outcomes in Nepal: a prospective observational study. Lancet Glob Heal [Internet]. 2020 Oct 1 [cited 2020 Oct 25];8(10):e1273–81. Available from: www.thelancet.com/lancetgh
20. Fore HH, Dongyu Q, Beasley DM, Ghebreyesus TA. Child malnutrition and COVID-19: the time to act is now. Lancet [Internet]. 2020 Jul [cited 2020 Aug 17];0(0). Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673620316482
21. Black RE, Alderman H, Bhutta ZA, Gillespie S, Haddad L, Horton S, et al. Maternal and child nutrition: Building momentum for impact. The Lancet. 2013.
22. WFP, UNICEF, Global Nutrition Cluster G. Protecting Maternal Diets and Nutrition Services and Practices in the Context of COVID-19 [Internet]. 2020 [cited 2020 Nov 1]. Available from: https://fr.en-net.org/forum/31.aspx
23. de Pee S, Moench-Pfanner R, Martini E, Zlotkin SH, Darnton-Hill I, Bloem MW. Home fortification in emergency response and transition programming: Experiences in Aceh and Nias, Indonesia. Food Nutr Bull. 2007;
24. Das JK, Salam RA, Hadi YB, Sheikh SS, Bhutta AZ, Prinzo ZW, et al. Preventive lipid-based nutrient supplements given with complementary foods to infants and young children 6 to 23 months of age for health, nutrition, and developmental outcomes. Cochrane Database of Systematic Reviews. 2019.
25. Stewart CP, Wessells KR, Arnold CD, Huybregts L, Ashorn P, Becquey E, et al. Lipid-based nutrient supplements and all-cause mortality in children 6-24 months of age: A meta-analysis of randomized controlled trials. Am J Clin Nutr. 2020;

26. Hawkes C, Ruel MT, Salm L, Sinclair B, Branca F. Double-duty actions: seizing programme and policy opportunities to address malnutrition in all its forms. Lancet. 2019;395(10218):142–55.
27. Bhutta ZA, Akseer N, Keats EC, Vaivada T, Baker S, Horton SE, et al. How countries can reduce child stunting at scale: lessons from exemplar countries. Am J Clin Nutr [Internet]. 2020 Jul 21 [cited 2020 Nov 1];112(2):894S-904S. Available from: https://academic.oup.com/ajcn/.
28. Gillespie S, van den Bold M. Stories of Change in nutrition: An overview. Glob Food Sec [Internet]. 2017 Jun 1 [cited 2020 Nov 3];13:1–11. Available from: https://www.sciencedirect.com/science/article/pii/S2211912416301006
29. BIFAD. BIFAD - Covid-19 and Nutrition -Impacts Field Innovations and the Way Forward September 142020. In 2020. Available from: https://www.usaid.gov/sites/default/files/documents/BIFAD_-_Covid_19_and_Nutrition_-_Impacts_Field_Innovations_and_the_Way_Forward_September_14_2020.pdf
30. Amjath-Babu TS, Krupnik TJ, Thilsted SH, McDonald AJ. Key indicators for monitoring food system disruptions caused by the COVID-19 pandemic: Insights from Bangladesh towards effective response. Food Secur. 2020;
31. Adhikari J, Timsina J, Khadka SR, Ghale Y, Ojha H. COVID-19 impacts on agriculture and food systems in Nepal: Implications for SDGs. Agric Syst. 2021;
32. Purnima Menon, Rasmi Avula, Shweta Khandelwal SR. COVID-19 and nutrition in India: The challenges of preserving progress through a period of crisis. Nat Food. 2021; *(submitted to Nature Food)*
33. Namukolo Covic and Inge D. Brouwer. COVID-19 and maternal and child undernutrition: the emerging Ethiopian experience. Nat Food. 2021; *(submitted to Nature Food)*
34. Abdoul-Azize HT, El Gamil R. Social Protection as a Key Tool in Crisis Management: Learnt Lessons from the COVID-19 Pandemic. Glob Soc Welf. 2020;
35. David Laborde, Anna Herforth, Derek Headey S de P. COVID-19 pandemic leads to greater depth of unaffordability of healthy and nutrient adequate diets in low and middle income countries. Nat Food. 2021; *(submitted to Nature Food)*
36. Hawkes C. Plausible impacts of the COVID-19 crisis on obesity and diet-related NCDs. Nat Food. 2021; *(submitted to Nature Food)*
37. Martorell R. Improved nutrition in the first 1000 days and adult human capital and health. Am J Hum Biol [Internet]. 2017 Mar 1 [cited 2020 Nov 1];29(2). Available from: https://pubmed.ncbi.nlm.nih.gov/28117514/
38. Laborde Debucquet D, Martin W. Implications of the global growth slowdown for rural poverty. Agric Econ (United Kingdom). 2018;
39. Headey D, Ruel M. Economic Shocks and Child Wasting [Internet]. Washington D.C.:; 2020. Report No.: IFPRI Discussion paper No 01941. Available from: http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/133786/filename/133994.pdf
40. LIST: Lives Saved Tool [Internet]. Available from: https://www.livessavedtool.org/country-data-pack
41. Cost–benefit analysis and the human capital approach. In: Cost–Benefit Analysis and Health Care Evaluations,. Second Edi. Edward Elgar Publishing; 2014. p. 313–39.
42. Shekar M, Kakietek J, Dayton Eberwein J, Walters D. An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting. An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting. 2017.
43. Hoddinott J, Alderman H, Behrman JR, Haddad L, Horton S. The Economic Rationale for Investing in Stunting Reduction. Matern Child Nutr. 2013;9(suppl 2):69–82.
44. M.R. Gold, J.E Siegel, L.B. Russell and, M.C. Weinstein. Cost-effectiveness in Health and Medicine. New York: Oxford University Press: Oxford University Press; 1996.
45. Neumann PJ, Ganiats TG, Russell LB, Sanders GD SJ. Cost-Effectiveness in Health and Medicine. Oxford and New York: Oxford University Press: Oxford University Press; 2016.
46. Horton S, Ross J. The Economics of Iron Deficiency. Food Policy. 2003;28(1):51–75.
47. Stuckler D, Basu S, Wang SW, McKee M. Does recession reduce global health aid? Evidence from 15 high-income countries, 1975–2007. Bull World Health Organ. 2011;
48. OECD. OECD Stat [Internet]. [cited 2020 Aug 1]. Available from: https://stats.oecd.org/
49. WHO Global Health Observatory [Internet]. [cited 2020 Nov 1]. Available from: https://www.who.int/data/gho
50. Pearson R, Killedar M, Petravic J, Kakietek JJ, Scott N, Grantham KL, et al. Optima Nutrition: An allocative efficiency tool to reduce childhood stunting by better targeting of nutrition-related interventions. BMC Public Health. 2018;

Tables

Table 1. Disruption scenarios reflecting effects of the Covid-19 Crisis on Gross National Income (GNI) and Nutritional Intervention Coverage in LMIC[#]									
Year	2020			2021			2022		
Scenario	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic	Pessimistic	Moderate	Optimistic
Change in GNI per Capita (mean)	▼6.1%	▼6.1%	▼6.1%	▼5.4%	▼3.4%	▼0.47%	▼2.9%	▼0.73%	▼0.45%
Nutrition Interventions	***Coverage reduction relative to country-specific baseline (pre-COVD)***								
Breastfeeding promotion	▼42.3%	▼22.8%	▼14.3%	▼21.2%	▼11.4%	▼7.2%	▼10.6%	0%	▲ 5.0%
Complementary feeding SBCC (food secure)	▼42.3%	▼22.8%	▼14.3%	▼21.2%	▼11.4%	▼7.2%	▼10.6%	0%	▲ 5.0%
Public Provision of complementary foods (food insecure)	▼42.3%	▼22.8%	▼14.3%	▼21.2%	▼11.4%	▼7.2%	▼10.6%	0%	▲ 5.0%
Vitamin A supplementation	▼42.3%	▼22.8%	▼14.3%	▼21.2%	▼11.4%	▼7.2%	▼10.6%	0%	▲5.0%
Treatment of severe acute malnutrition	▼50.0%	▼25.0%	▼15.0%	▼25.0%	▼12.5%	▼7.5%	▼12.5%	0%	▲ 5.0%
Iron and folic acid in pregnancy	▼51.9%	▼26.9%	▼18.5%	▼25.9%	▼13.4%	▼9.2%	▼13.0%	0%	0% [##]
Multiple micronutrients in pregnancy	-	-	-	-	-	-	-	-	▲ 5.0% [##]
Balanced protein-energy supplementation in pregnancy	-	-	-	-	-	-	-	-	▲10.0%
Treatment of moderate acute malnutrition[###]	-	-	-	-	-	-	-	-	▲10.0%

Table notes

[#] Justification for the magnitude of the reduction are provided in the methods narrative.

[##] In 2022 small scenario IFA is replaced by Multiple Micronutrient Supplementation and coverage increased relative to IFA baseline.

[###] For MAM treatment no change of coverage was assumed, the 10% increase of coverage in 2022 was assumed for all 118 countries while currently, treatment is going on in 36 countries.

▼ indicates percent decrease; ▲indicates percent increase

Table 2: Modelled changes in undernutrition and mortality in children under 5 and anemia during pregnancy across 118 LMICs by scenario (in thousands)

	Pessimistic				Moderate				Optimistic			
	2020	2021	2022	3-year impact	2020	2021	2022	3-year impact	2020	2021	2022	3-year impact
Additional cases of wasted children (0-59m)	▲5,780	▲5,200	▲2,630	▲13,620	▲5,780	▲2,980	▲530	▲9,300	▲5,780	▲310	▲350	▲6,440
Additional cases of stunted children* (0-59m)	–	–	▲3,550	▲3,550	–	–	▲2,620	▲2,620	–	–	▲1,540	▲1,540
Additional deaths in children under 5 years of age	▲127	▲114	▲43	▲283	▲108	▲54	▲6	▲168	▲96	▲12	▼61	▲47
Additional cases of anemic pregnant women (15-49y)	▲2,700	▲1,400	▲700	▲4,800	▲1,400	▲*700*	–	▲2,100	▲100	▲500	▼400	▲1,000
Additional number of children born to low BMI women	▲1,300	▲1,100	▲600	▲3,000	▲1,300	▲700	▲100	▲2,100	▲1,300	▲100	▼100	▲1,400

*To avoid double counting stunted children, given the cumulative nature of the outcome, we have only reported the number of children 6-59 months who were stunted at the end of the three-year period. ▲indicates relative increase in cases; ▼ indicates relative decrease in cases

Table 3: Additional per annum cost of intervention to mitigate increased malnutrition outcomes under various modelled scenarios (in '000 USD)

Outcome	Pessimistic	Moderate	Optimistic
Stunting (0-59m)	1,258,000	930,000	545,000
Wasting (0-59m)	454,000	310,000	215,000
Maternal anemia (15-49 y)	14,000	6,000	3,000
TOTAL	**1,726,000**	**1,246,000**	**763,000**

Panel

Panel 1: Health System, Social Protection and Food System Policies and Interventions to Mitigate the Nutrition Impacts of COVID-19

Mitigating the losses for nutrition caused by the COVID-19 crisis and accelerating progress towards achieving SDG 2 requires concerted actions across sectors and more efficient use of available resources. The allocative efficiency analyses presented in this paper include seven health sector interventions. Data on coverage, impact and cost effectiveness of social protection programs and food system interventions in LMICs were not sufficient to carry out similar analyses for these sectors.

However, recent evidence from countries that have achieved notable improvements in childhood stunting reinforce the hypothesis that in order to achieve global nutrition targets, policies and interventions addressing economic and food systems drivers of nutrition are as important as those through health systems.[1,2,3] In addition, actions to prioritize the production, access and affordability of nutritious foods and reduce the appeal and availability of high fat, sugar, sodium (HFSS) food and snack products have "double-duty" potential; they can be designed to tackle both undernutrition and obesity.[4]

Here we recommend actions across sectors for LMIC to consider prioritizing in their COVID-19 response:

Health systems: build resilience, adapt, innovate, and strengthen coordination and monitoring systems

- Restore and aim to further scale up essential maternal and child nutrition services including those modeled in our paper (IYCF interventions across 0-23 months, Vitamin A supplementation, screening and treatment of SAM. Ensure that interventions are 'double-duty' wherever possible (i.e. IYCF interventions)
- Consider whether this is an appropriate opportunity for the context-specific introduction of efficacious ready-to-scale interventions including MMS and BEP during pregnancy, SQ-LNS for complementary feeding supplementation and MAM treatment among children 6-59 months.
- Strengthen health systems and access to care more generally and improve resilience for future shocks: ensure recommended COVID-19 infection control protocols and supplies (i.e. protective equipment) are in place to avoid interruptions in face-to-face services at health posts and clinics, stock outs of essential drugs and supplies and human resources shortages.
- Invest in robust rapid monitoring systems to track changes in utilization of interventions and the prevalence of malnutrition even during crisis.

Social protection programs: minimize disruptions and expand more robust programs to enhance both income and dietary quality to tackle malnutrition in all its forms

- Orient food baskets, food subsidies, voucher schemes and cash transfers towards enhancing the affordability and appeal of nutritious foods and limit the appeal of foods that are high in sodium, sugar, saturated and trans fatty acids.
- Expand cash transfers and include conditionalities related to participation in well-designed and delivered behaviour change communication interventions focused on healthy diets, physical activity, and preventive use of health services.[3,5]
- Promote healthy school food. School meal programs can alleviate hunger, reduce micronutrient deficiency, prevent overweight/ obesity, improve girl's school attendance and serve as a social protection approach for families.[3,5] Take-home rations, vouchers and cash transfers are being used to reach children affected by COVID-19 school closures.[6] Developing and enforcing guidelines around quality of school meals can help address both undernutrition and obesity.

Food systems: protect vulnerable and marginalized households, support more diverse and resilient distribution systems, and build robust processing, storage and marketing systems for nutritious foods.

- Strengthen value chains for nutritious foods to enhance their availability, access, and affordability especially for the poor, and implement interventions to prevent disruption of food markets and retail.
- Subsidize retail of nutritious food (e.g., fair price outlets, ration stores, vouchers, cooperatives, community kitchens, feeding centres) and consider zoning and operations rules and regulations for food markets and retail that increase market opportunities for small producers and low income consumers.
- Boost local production of nutritious foods through homestead food production and urban and peri-urban agriculture, focusing on women's empowerment and livelihoods
- Scale-up large-scale food fortification and biofortification in specific contexts, as they are critical to support micronutrient nutrition, particularly for population groups with high needs, and in contexts where the required dietary shifts are not available or accessible.
- Promote trade policies that favour nutritious foods and disfavour unhealthy food, such as import duty waivers to favour nutritious food and/or ingredient imports (e.g., fortification premix). Implement specific interventions and policies to enhance women's empowerment and address all forms of inequality.

References for Panel 1

1. Bhutta ZA, Akseer N, Keats EC, Vaivada T, Baker S, Horton SE, et al. How countries can reduce child stunting at scale: lessons from exemplar countries. Am J Clin Nutr [Internet]. 2020 Jul 21 [cited 2020 Nov 1];112(2):894S-904S. Available from: https://academic.oup.com/ajcn/.
2. Gillespie S, van den Bold M. Stories of Change in nutrition: An overview. Glob Food Sec [Internet]. 2017 Jun 1 [cited 2020 Nov 3];13:1–11. Available from: https://www.sciencedirect.com/science/article/pii/S2211912416301006
3. Headey D, Hoddinott J, Ali D, Tesfaye R, Dereje M. The Other Asian Enigma: Explaining the Rapid Reduction of Undernutrition in Bangladesh. World Dev. 2015;
4. Hawkes C, Ruel MT, Salm L, Sinclair B, Branca F. Double-duty actions: seizing programme and policy opportunities to address malnutrition in all its forms. Lancet. 2019;395(10218):142–55.
5. Durao S, Visser ME, Ramokolo V, Oliveira JM, Schmidt BM, Balakrishna Y, et al. Community-level interventions for improving access to food in low- and middle-income countries. Cochrane Database of Systematic Reviews. 2020.
6. Abebe G. Cash-for-work and food-for-work programmes' role in household resilience to food insecurity in southern Ethiopia. Dev Pract [Internet]. 2020 [cited 2020 Nov 3]; Available from: https://www.tandfonline.com/doi/abs/10.1080/09614524.2020.1747398

Figures

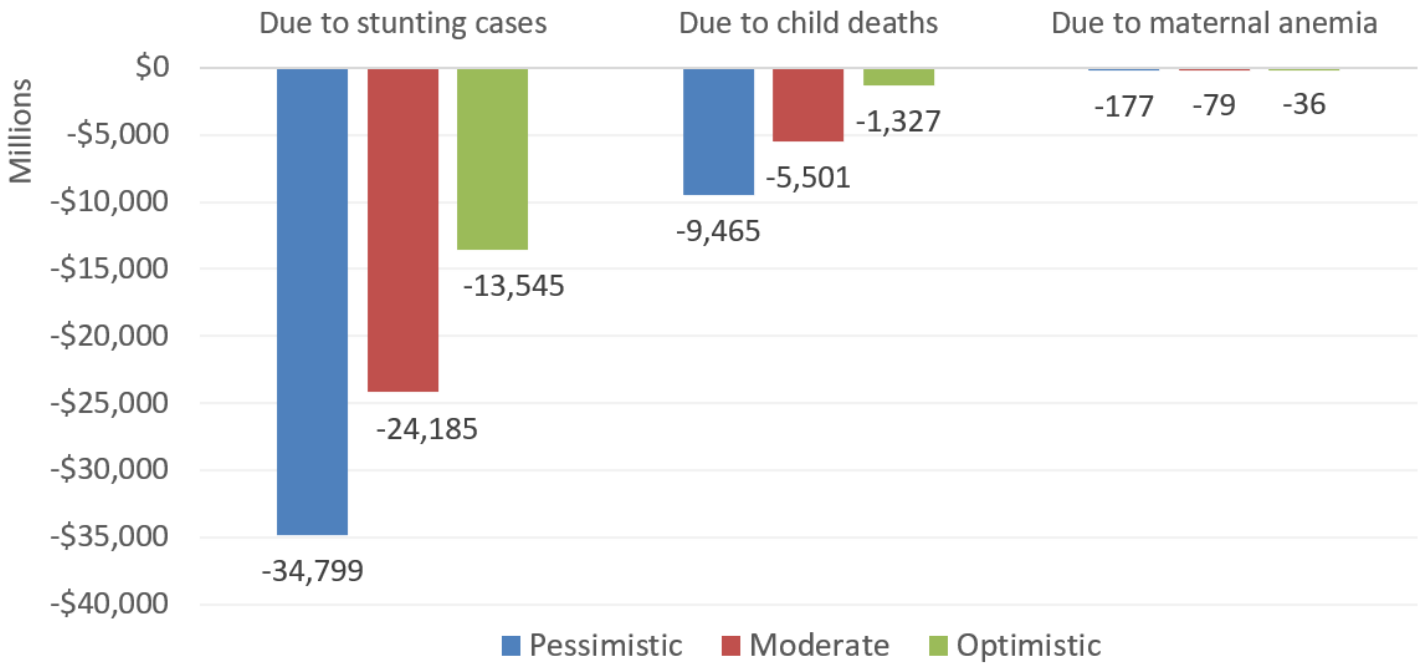

Figure 1

Future productivity losses due to additional cases of child stunting and mortality and maternal anemia

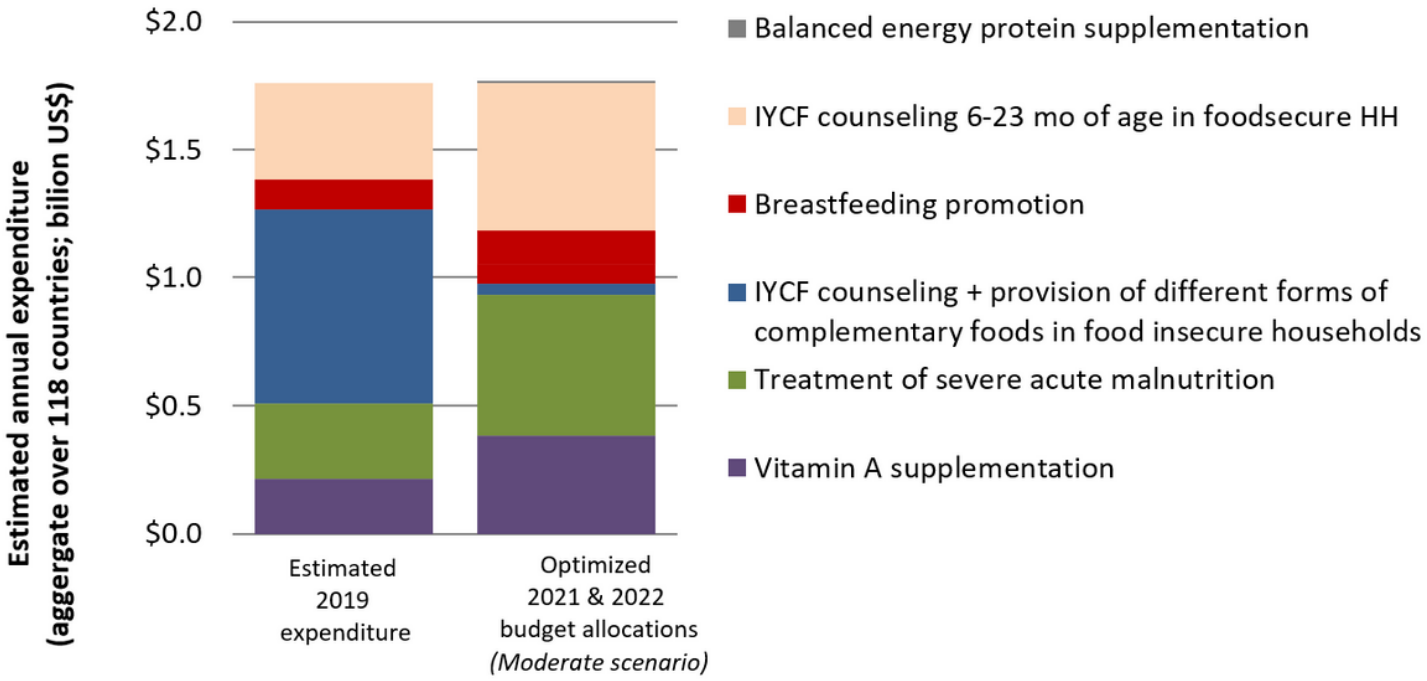

Figure 2

Optimization of interventions to reduce child stunting and child mortality. Notes: Left bar: estimated expenditure on selected nutrition interventions in 2019, calculated by combining coverage estimates (medium scenario) and unit cost estimates. Right bar: optimized budget allocation to maximize alive and non-stunted children, with total funding envelope estimated from ODA projections relative to 2019. Results are aggregated over 118 countries, and variations exist across countries due to demographic, epidemiological and economic factors. Breastfeeding promotion includes both early initiation and exclusive breastfeeding promotion

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- WebAnnex1Table1FINAL.docx
- WebAnnex2.docx
- WebAnnex3STfNauthors.docx
- WebAnnex4listofcountries07122020.pdf