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Multi-sectoral Impacts of the COVID-19 Pandemic on Nutrition Outcomes

An Analytical Framework

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Introduction

The COVID-19 pandemic threatens to derail progress made towards achieving the maternal, infant and young child nutrition targets endorsed by the World Health Assembly (WHA),[i] particularly the targets for stunting, wasting, anaemia in women of reproductive age and exclusive breastfeeding (see Box 1). The prospects for achieving the WHA targets by 2025 were already low before the COVID-19 crisis, and the many disruptions to international, national and subnational structures and systems caused by the pandemic are threatening the progress made in recent years. For example, UNICEF reported that low- and middle-income countries experienced a 30 per cent reduction in the coverage of essential nutrition services in 2020.[ii] These services, including school feeding, micronutrient supplementation and nutrition promotion programmes, are a critical part of the integrated approaches needed to make progress towards the WHA targets.

The Agile Core Team for Nutrition Monitoring (ACT-NM) was set up in June 2020 to collaborate on key products and monitoring challenges to respond to the ongoing needs of the nutrition community. The founding members — the United Nations Children's Fund (UNICEF), the United States Agency for International Development (USAID), the World Health Organization (WHO) and USAID Advancing Nutrition — felt that an "agile working group" would provide a consolidated voice on nutrition monitoring during the ongoing COVID-19 pandemic. There was an early consensus to prioritize the development of a comprehensive nutrition and COVID-19 analytical framework. The members of ACT-NM agreed that the framework should focus on the public health pathways connecting the COVID-19 pandemic to nutrition outcomes in children and adults in low-, middle- and high-income countries, rather than the clinical or biomedical pathways through which the COVID-19 infectious disease may affect nutritional status. ACT-NM decided to focus the analytical framework on the six maternal, infant and young children nutrition targets endorsed by the WHA, since they guide national commitments towards the elimination of malnutrition in all its forms, one of the Sustainable Development Goal targets.[iii]

Box 1. WHA Targets

In 2012, World Health Assembly Resolution 65.6 endorsed a comprehensive plan on maternal, infant and young child nutrition, which specified a set of six global nutrition targets that, by 2025, aim to:

- Achieve a 40 per cent reduction in the number of children under 5 who are stunted
- Achieve a 50 per cent reduction in anaemia in women of reproductive age
- Achieve a 30 per cent reduction in low birthweight
- Ensure no increase in childhood overweight
- Increase the rate of exclusive breastfeeding in the first six months of life up to at least 50 per cent
- Reduce and maintain childhood wasting to less than 5 per cent.

Primary purposes of the framework include:

- Helping policymakers and implementers better identify and assess potential pathways for tracking the intersection between the COVID-19 pandemic and nutrition
- Providing a useful tool for planning policies, programmes and interventions
- Identifying data needs and gaps

A secondary purpose of the framework is to provide a structure for modelling efforts through the use of different pathways, including more in-depth examination of the model parameters and definitions.

The framework has the potential to support an integrated, systems approach to nutrition challenges caused, increased or intensified by the COVID-19 pandemic and future pandemics/crises.

Background

The analytical framework was developed in three phases: 1) conceptualization; 2) literature review; and 3) design.

1. Conceptualization: This phase used a set of guiding questions and a combination of existing frameworks that served as a foundation for building the analytical framework (see Box 2). The conceptualization phase was an iterative process that used evolving drafts of the framework to inform discussion.

2. Literature review: ACT-NM utilized a pragmatic strategy for the literature review between December 2020 and January 2021 to scan the current evidence on COVID-19 and nutrition linkages relevant to the selected outcomes. First, a search was carried out using the major medical databases, namely MEDLINE/PubMed, Scopus, EMBASE/Elsevier and Google Scholar, but also the grey literature (e.g., Google Search). The following key terms were used: "COVID-19" AND ("nutrition", "nutrition conceptual model"/framework", "malnutrition conceptual model"/framework"). The results of this literature review captured scientific journals, institutional reports, advocacy briefs and publicly available presentations, some of which led to other relevant materials. Additional literature was obtained directly from partner agency experts (e.g., UNICEF, USAID, WHO, USAID Advancing Nutrition) during several rounds of internal reviews and a global workshop organized by UNICEF in June 2021. The inclusion criteria were: literature from both the pre-COVID-19 and COVID-19 pandemic eras; original model or framework; primary or secondary research; available in print or downloadable form; and available in English. Literature on the direct biomedical pathways and clinical outcomes of COVID-19 infection or disease on nutritional status was excluded.

A specific goal of the literature review was to identify existing models that could inform the structure of the new framework. Ultimately, the review identified three models that influenced the development of the analytical framework: 1) the UNICEF Conceptual Framework on the Determinants of Maternal and Child Nutrition;[iv] 2) the UNICEF Systems Approach to Nutrition;[v] and 3) Risk Factors for Undernutrition in the Context of COVID-19.[vi] These three models were aligned with ACT-NM's objectives and had a level of clarity and simplicity that illustrated the proximal and distal factors associated with COVID-19 and nutrition.

3. Design: In this phase, ACT-NM made several key decisions related to the scope of the analytical framework. First, a decision was made to take a more streamlined or focused approach that prioritized utility and practicality rather than comprehensiveness. This approach allows users to easily chart pathways to help identify and understand problems (real and potential), as well as opportunities to address or avert those problems. The approach also ensures that the framework is applicable in various contexts, with the flexibility to adjust for factors such as the nature of the epidemic, the type of response, demographics and resource availability.

Second, ACT-NM decided to limit the outcomes included in the framework to the six WHA targets for maternal, infant and young child nutrition. The group also made a parallel decision to focus on categories and factors with the strongest links to these six outcomes. However, the group acknowledged that other outcomes could be added to the framework by users looking at specific issues in their national and/or subnational contexts. For example, the target on overweight in the list of six WHA targets focuses on children, but the framework could also be used to look at adult overweight and obesity issues. Similarly, it could be adapted to look at the intersection of nutrition, non-communicable diseases (NCDs) and the COVID-19 pandemic.

Lastly, ACT-NM decided to group related factors in different categories and sub-categories to facilitate the use of the framework. For example, public health and social measures, such as stringent movement restrictions, are identified as a key factor in the overarching category of 'enabling determinants' and the sub-category of 'governance'. Public health and social measures besides stringent movement restrictions include physical distancing policies and public mobility related issues.[vii] The decision to group related factors simplifies the framework, extends its versatility, and demonstrates its adaptability.

During the design phase, draft frameworks were shared with relevant experts to seek their input. This included experts at UNICEF, WHO, the USAID Bureaus of Global Health, Humanitarian Assistance, and Resilience and Food Security, and the USAID Advancing Nutrition project.

Overview of the analytical framework

The analytical framework groups various factors into different categories and sub-categories relevant to the intersection between COVID-19 and nutrition. Figure 1 shows the simplified organizing structure of the framework with its five overarching categories, including a series of determinants (enabling, underlying and immediate) leading to outcomes and impact. In each category of determinants, there are sub-categories of relevant factors: contextual (enabling determinants), systemic (underlying determinants) and behavioural and nutritional status (immediate determinants). The design of the framework also acknowledges the overall environmental context and the wide-ranging effects of the COVID-19 pandemic on the different categories and sub-categories. In addition, the framework recognizes the importance of deepening inequality and its influence on all components of the analytical framework.

Figure 1. Organizing structure of the analytical framework

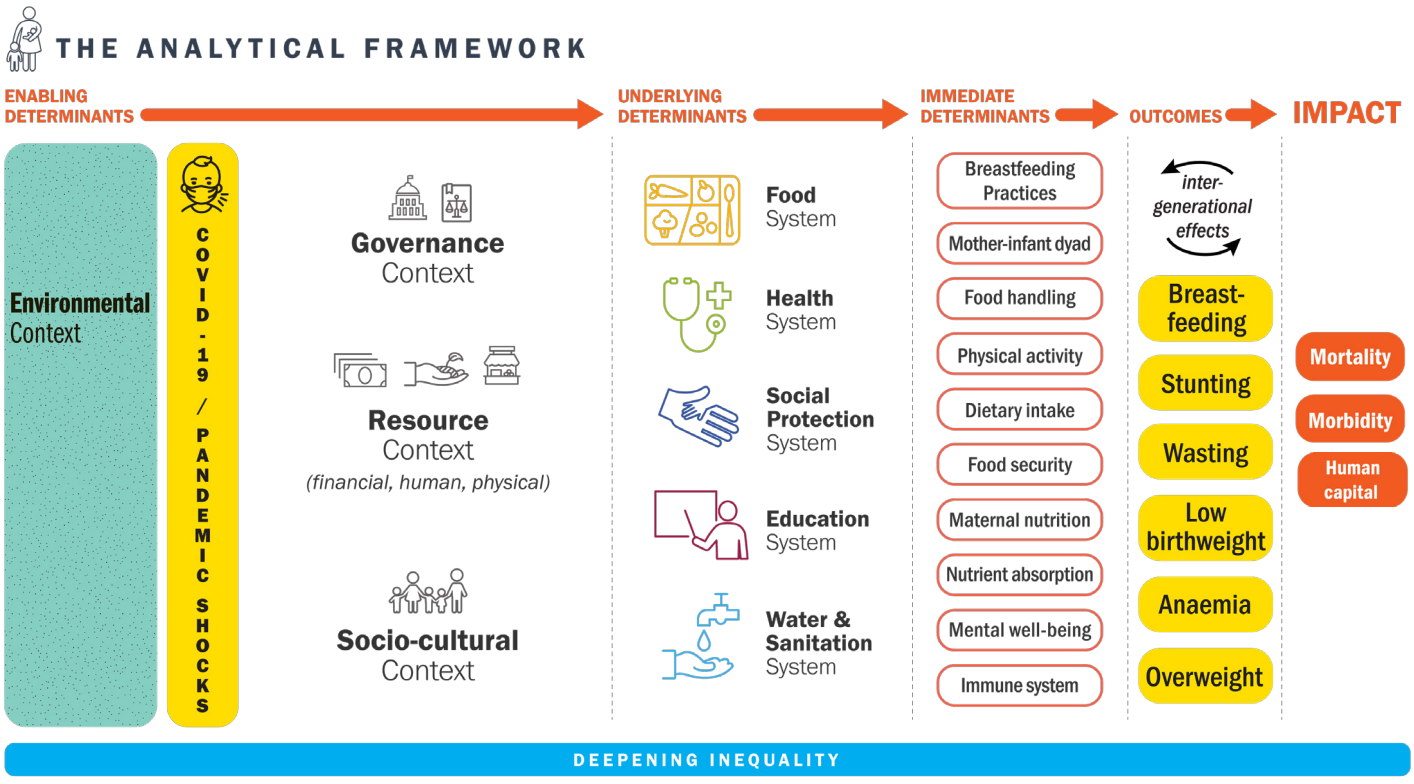
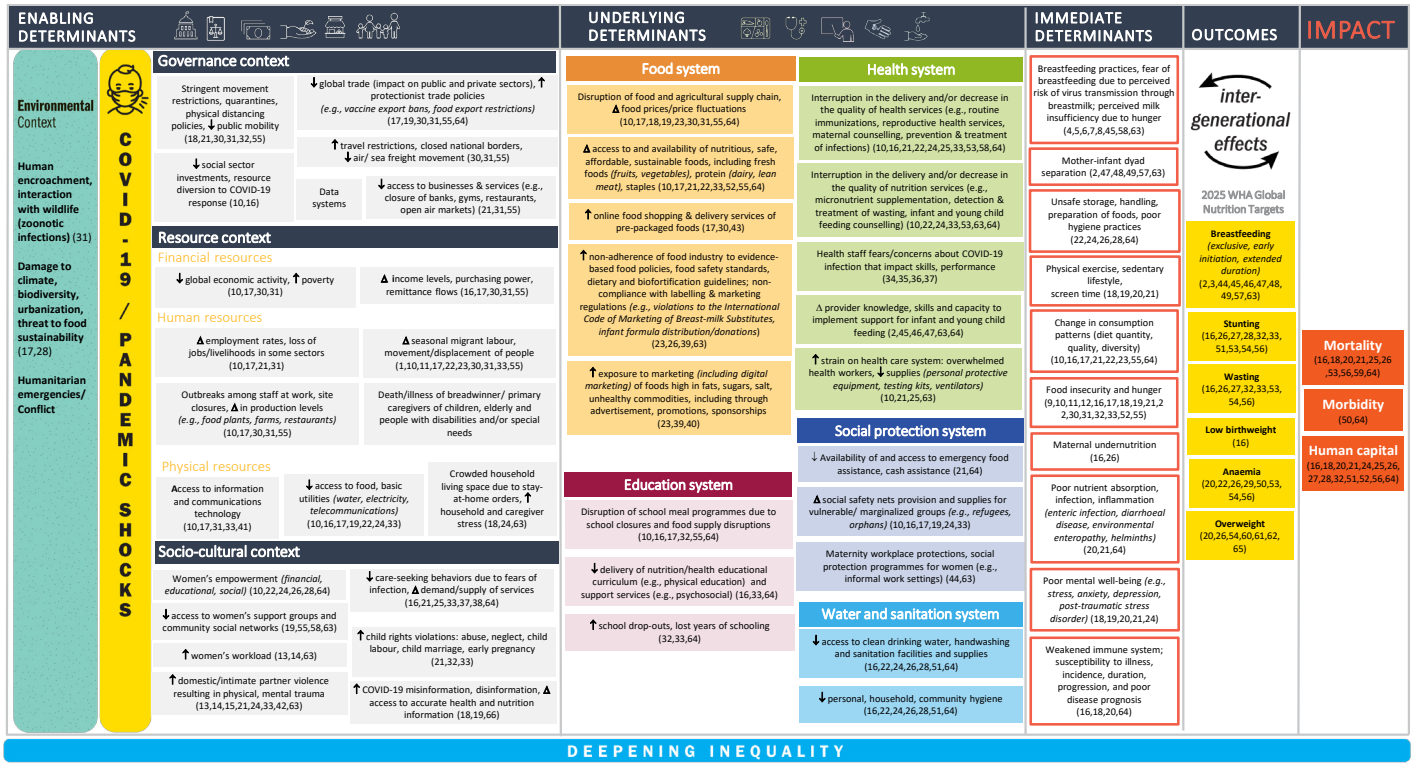


Figure 2 illustrates the full scope of the framework, including the specific contextual, systemic, behavioural and nutritional factors that can be used to plot potential impact pathways that identify intervention opportunities, including policies, programmes and activities. The pathways can also be used by modellers to conceptualize and facilitate the quantification of the nutritional impacts of the pandemic and offer early projections of resource needs for targeted decision-making, interventions and advocacy.

Figure 2. Comprehensive analytical framework



* Δ = variable change; ↑ = increase; ↓ = decrease

WHA =World Health Assembly

Individual components of the framework

The organizing structure of the analytical framework is defined by five overarching categories, which are used to track the connections between COVID-19 and nutrition. The five categories are: 1) **enabling determinants**; 2) **underlying determinants**; 3) **immediate determinants**; 4) **outcomes**; and 5) **impact** (see Figure 3).The serial links connecting these five categories on a left-to-right axis are a critical aspect of the framework because they highlight the relationships between individual factors in and across the categories and their ultimate connection to outcomes and impact.

Figure 3. Overarching categories and serial links in the COVID-Nutrition analytical framework

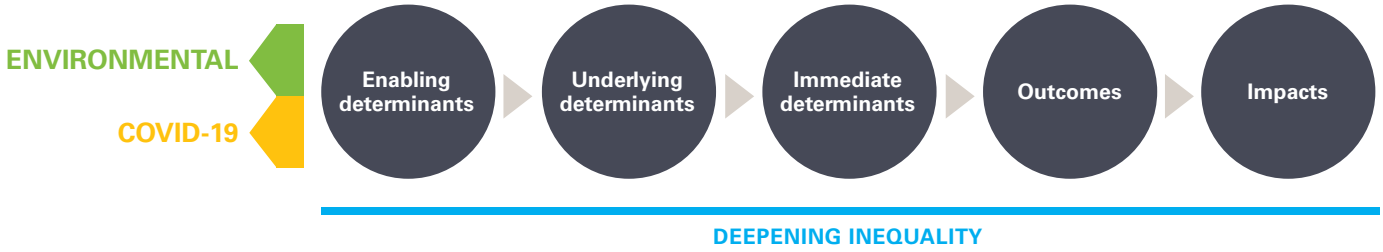
Within each of the five categories is a set of critical factors relevant to the nexus of COVID-19 pandemic and nutrition. Specifically, the different categories include factors related to **context**, **systems** and **behavioural and nutritional status** that are also linked to malnutrition. However, before reviewing the factors within each of the five categories, it is important to identify two significant and overarching determinants that define the overall framework. The first is the environmental context that contributed to the rise of COVID-19 pandemic and the second is COVID-19 pandemic itself.

The environmental context (see Figure 4) includes various factors that increase the risk of the emergence and spread of zoonotic diseases; for example, human encroachment on economically undeveloped or underdeveloped land that leads to more interaction between people and wildlife (31). Other factors in the environmental context that affect the many interconnected issues and activities in the framework include, but are not limited to, climate shocks (e.g., drought, storms, flooding and fires), threats to food production (e.g., soil erosion, infestations, water shortages) and increased urbanization (e.g., air and water pollution, spread of infectious diseases) (17,28). Humanitarian emergencies and conflict are also included in the environmental context because of their ability to also have far-reaching effects on the issues and activities in the framework (e.g., conflict causes disruptions and displacements that can contribute to increased malnutrition and the spread of infectious diseases).

Figure 4. Context: Environmental and COVID-19

The COVID-19 crisis generated a staggering array of pandemic-related shocks that affected nearly all aspects of human life in countries around the world. For nutrition, these shocks – from epidemiologic to economic, from micro to macro, from personal to planetary – directly affected billions of people and created unprecedented challenges for the full range of stakeholders in nutrition programmes and activities, from policymakers to programme implementers. These pandemic shocks play out across the analytical framework, affecting all factors – context, system and behavioural and nutritional status – in one way or another.

Figure 5. Context: Deepening inequality



The framework also acknowledges the deepening inequality linked to the pandemic (see Figure 5). The inequality takes many different forms, ranging from gendered burdens (e.g., disproportionate burden of care falling on women) to greater economic disparities across and within countries and communities.

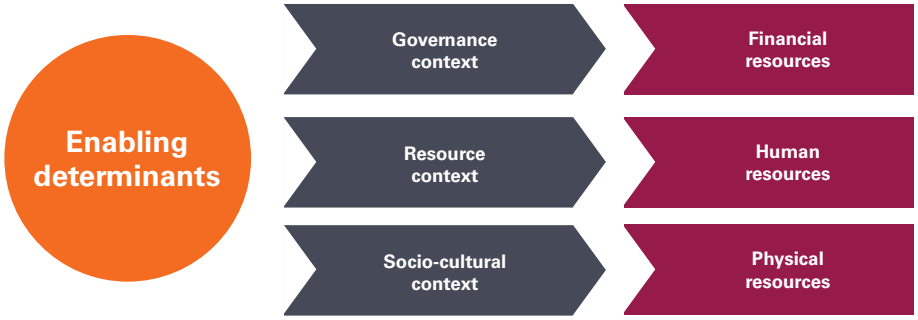
Enabling determinants

Broad contextual factors are included in the category of *Enabling determinants*. These factors cover three specific context areas: 1) **governance**; 2) **resources**; and 3) **socio-cultural**. Resources are separated into financial resources, human resources and physical resources.

In each contextual area, there are different and specific actions that influence the COVID-19 and nutrition nexus. A compelling example is stringent movement restrictions, which are included in the governance context (18,21,30,31,32,55). These restrictions dramatically limited people's movements as well as the number and types of institutions allowed to be open. As a widely used measure to prevent the spread of SARS-CoV-2 virus, stringent movement restrictions also had a cascade effect on other factors that collectively affected nutrition. See pages 22-27 for examples of impact pathways for COVID-19 and nutrition using stringent movement restrictions as the main enabling determinant.

Tables 1, 2 and 3 provide additional information on the actions in each of the contextual areas: governance, resources and socio-cultural.

Figure 6. Enabling determinants – Contextual factors



Governance. The framework highlights a number of enabling determinants in the governance context that played out in multiple countries. Decisions by government at national and subnational levels had widespread effects on the various factors linked to malnutrition. As mentioned above, stringent movement restrictions are a compelling example of a government action that had broad implications for nutrition.

Table 1. Enabling determinants: Governance context

Public health and safety measures: Stringent movement restrictions, quarantines, physical distancing policies, ↓ public mobility (18,21,30,31,32,55)	Stringent restrictions on people's movement and access have been widely used tools by governments for limiting the spread of SARS-CoV-2 virus and the impact of the COVID-19 pandemic. Other movement restrictions include quarantines, stay-at-home orders and curfews. Similarly, policies on physical distancing (e.g., the recommended two-metre/six-foot distance between people; occupancy controls) and public mobility (e.g., recommended self-isolation, limits on travel, reductions in transport services).
↓ global trade (impact on public and private sectors), ↑ protectionist trade policies (*e.g., vaccine export bans, food export restrictions*) (17,19,30,31,55,64)	Governments also had to address a range of trade issues, including general and focused constraints on both import and export operations (e.g., reduced/heightened demand for certain products) as well as the positive and negative implications of protectionist trade policies (e.g., ensuring domestic markets have sufficient supply of products).
↓ social sector investments, resource diversion to COVID-19 response (10,16)	Government investments in the social sector were also affected, with many programmes facing spending declines as resources were reallocated to the COVID-19 response. However, social sector funding by government did increase in many places as a way to mitigate the impact of COVID-19 pandemic, including housing support, food programmes and counselling services.
↑ travel restrictions, closed national borders, ↓ air/ sea freight movement (30,31,55)	Travel restrictions are another widely-used tool by government at national and subnational levels to limit the spread of COVID-19. These restrictions have affected the movement of people and goods, as land, sea and air access has been controlled for inbound and outbound traffic.
Data systems	The pandemic limited the ability of governments, civil society and the private sector to collect and analyse data, including data relevant to COVID-19. This includes routine, surveillance and survey systems and tools used with health and nutrition data.
↓ access to businesses and services (*e.g., closure of banks, gyms, restaurants, open air markets*) (21,31,55)	Government decisions on access to essential and non-essential businesses and services, including determining what are considered essential and non-essential businesses/services, have been continually adjusted as the pandemic has evolved.

Resources. The framework focuses on three types of resources – financial, human and physical – that are closely linked to COVID-19 and nutrition, including nutrition outcomes. Within each of those resource areas, the framework then focuses on several higher profile factors; for example, the variable effect of the COVID-19 pandemic on employment rates and job opportunities.

Table 2. Enabling determinants: Resource context (financial, human, physical)

Financial resources	
↓ global economic activity, ↑ poverty (10,17,30,31)	COVID-19 pandemic has influenced global economic activity in many different ways, depending on when and how the pandemic affected the region, country and/or subnational area. For example, movement restrictions generally contributed to significant contractions in industry, services and trade, including well-documented shortages of products and labour. Conversely, short-term and/or targeted lifting of restrictions often led to improvements in economic performance. In addition, government programmes (e.g., unemployment payments; subsidized loan schemes for companies) also maintained or stimulated economic activity.
Δ income levels, purchasing power, remittance flows (16,17,30,31,55)	Changes in economic activity at the global level also affect individual finances, including fluctuating and differential income levels (e.g., improvements for some people, declines for others), purchasing power (e.g., greater for some people, lower for others) and remittance flows (e.g., higher for some people, lower for others).
Human resources	
Δ employment rates, loss of jobs/livelihoods in some sectors (10,17,21,31)	Employment rates and temporary/permanent job losses have been affected by COVID-19 pandemic to different degrees, depending largely on the extent, duration and response to the pandemic in different regions, countries and/or subnational areas.
Δ seasonal migrant labour, movement/displacement of people (1,10,11,17,22,23,30,31,33,55)	Travel restrictions have had a direct effect on human resources, particularly the availability of and opportunities for seasonal labour by migrant populations. In some areas, these same populations have seen their general movements restricted by the pandemic while also facing the prospect or reality of displacement.
Outbreaks among staff at work, site closures, Δ in production levels (*e.g., food plants, farms, restaurants*) (10,17,30,31,55)	Workplace outbreaks of COVID-19 infection have varying effects on employees and employers. For individuals who are infected in an outbreak, the effects can range from serious health problems to lost jobs or income. For other employees, outbreaks can also have significant effects on their jobs, including temporary facility closures, reduced hours and less pay.
Death/illness of breadwinner/ primary caregivers of children, elderly and people with disabilities and/or special needs	One of the most critical effects of COVID-19 infection has been the illness and/or death of key breadwinners and primary caregivers. The cascade effect on finances, housing, food, education, etc. has been significant for affected children, families and communities.
Physical resources	
Access to information and communications technology (10,17,31,33,41)	The COVID-19 pandemic has highlighted the importance and value of digital connectivity, including the associated problems of ensuring communities have access to the necessary technologies. The pandemic has also highlighted the problems of differential access due to factors such as location and income.
↓ access to food, basic utilities (*water, electricity, telecommunications*) (10,16,17,19,22,24,33)	The COVID-19 pandemic has simultaneously created and exacerbated poverty and inequity. As a result, people have lost or limited access to essentials, including food, housing, water, electricity and telecommunications.
Crowded household living space due to stay-at-home orders, ↑ household and caregiver stress (18,24,63)	Domestic movement restrictions (e.g., stay-at-home orders) contributed to more consistently and constantly crowded and stressful living spaces. Crowding was particularly challenging for multigenerational families or multi-family households that were already sharing limited living space.

Socio-cultural. The scope of socio-cultural determinants varies by country/community, but the factors included in the framework are relevant in many settings. Issues related to women and their many family and community responsibilities and contributions feature prominently.

Table 3. Enabling determinants: Socio-cultural context

Women's empowerment (*financial, educational, social*) (10,22,24,26,28,64)	The pandemic underscored the many essential roles that women play in day-to-day activities as well as in crisis situations. In turn, this highlighted the importance of addressing the empowerment needed for them to effectively fill those roles, particularly at a time when their efforts are so needed.
↓ access to women's support groups and community social networks (19,55,58,63)	Domestic movement restrictions limited the ability of women to access the various groups and networks that provide them with different types of support (e.g., financial, psychosocial, education, employment). In some communities, mobile phone technologies (e.g., group text messaging apps) were able to partly replace more traditional support mechanisms.
↑ women's workload (13,14,63)	The importance of women's empowerment and the value of support groups/networks was amplified by the increased workload many women faced as they dealt with the wide-ranging effects of COVID-19 pandemic on their families and communities.
↑ domestic/intimate-partner violence resulting in physical, mental trauma (13,14,15,21,24,33,42,63)	Extended periods of enforced proximity (e.g., stringent movement restrictions, quarantines, stay-at-home orders) can contribute to increases in domestic and intimate-partner violence, with the resulting trauma suffered by primary and secondary victims. Pandemic-related limits on policing and the availability of social services amplify the effects of this type of violence.
↓ care-seeking behaviours due to fear of infection, Δ demand/supply of services (16,21,25,33,37,38,64)	Limited and/or incorrect knowledge about the spread of SARS-CoV-2 virus can affect people's willingness to seek care (e.g., fear of COVID-19 infection outweighs the imperative to visit a doctor or clinic). There can also be an increased demand for some types of care (e.g., psychosocial support) to help cope with the varied effects of the pandemic; the supply of these services may not always match the demand.
↑ child rights violations: abuse, neglect, child labour, child marriage, early pregnancy (21,32,33)	The dynamics of the pandemic, ranging from stringent movement restrictions to economic hardship, raise the spectre of increases in the violation of children's rights, including abuse, neglect, child labour, child marriage and early pregnancy. Similar to the situation with domestic and intimate-partner violence, these violations are also negatively affected by pandemic-related limits on policing and the availability of social services.
↑ COVID-19 misinformation, disinformation, Δ access to accurate health and nutrition information (18,19,66)	Limited information about COVID-19 disease as well as both misinformation and disinformation have negatively affected the response to the pandemic, including prevention, testing, treatment and vaccination efforts. The pandemic has also negatively affected access to useful information about health and nutrition; for example, restrictions on outreach programmes conducted by community health workers have limited their ability to share information with their constituents.

Underlying determinants

Systemic factors are included in the category of Underlying determinants. These factors include both nutrition-specific and nutrition-sensitive systems. They cover five different systems, each of which are linked to nutrition outcomes: 1) food; 2) health; 3) social protection; 4) education; and 5) water and sanitation.

Figure 7. Underlying determinants – Systemic factors

For example, in international, national and subnational food systems, the COVID-19 pandemic caused serious disruptions in the food and agriculture supply chains that affected the availability of products at the wholesale and retail levels (10,17,18,19,23,30,31,55,64). In health systems, COVID-19 pandemic interrupted the delivery of both health and nutrition goods and services (10,16,21,22,24,25,33,53,58,64). In the education system, school closures led to the suspension of school-based feeding programmes (10,16,17,32,55,64).

See Tables 4–8 for additional information on the different factors affected in each system.

Food system. The integrated network of international, national and subnational food systems was heavily affected at all levels by the pandemic, ranging from production to consumption. The five factors included in the framework are indicative of what food systems faced in multiple settings and contexts.

Table 4. Underlying determinants: Food system

Disruption of food and agricultural supply chain, Δ food prices/price fluctuations (10,17,18,19,23,30,31,55,64)	COVID-19 pandemic created multiple problems in the food and agricultural supply chain, including disruptions at different points (e.g., production delays and/or shortfalls, local and long-distance transport, shifting import and export regulations) and fluctuating cost and price structures affecting producers through to consumers.
Δ access to and availability of nutritious, safe, affordable, sustainable foods, including fresh foods (fruits, vegetables) protein (dairy, lean meat), staples (10,17,21,22,33,52,55,64)	A significant consequence of issues in the food and agricultural supply chain was the availability of a range of healthy and affordable foods in the consumer market (e.g., fresh fruits and vegetables, dairy products, meat, fish, staples). Availability of these foods also affected the ability of consumers to access them. For example, in some cases, certain food products were available and accessible, but other foods necessary for a balanced diet were not. In other cases, availability and accessibility were limited across all categories of food products.
↑ online food shopping and delivery services of pre-packaged foods (17,30,43)	Efforts by people to limit their exposure to the SARS-CoV-2 virus drove a large expansion in the online food shopping and delivery business, including both fresh and prepared foods. In some settings, this expansion was also affected by restrictions on out-of-home eating (e.g., the mandated closure of restaurants and street-vending enterprises).

↑ non-adherence of food industry to evidence-based food policies, food safety standards, dietary and biofortification guidelines; non-compliance with labelling and marketing regulations (e.g., violations to the International Code of Marketing of Breast-milk Substitutes, such as infant formula distribution/donations) (23,26,39,63)	Compliance with food-related policies and regulations by the food industry declined during the pandemic. Reasons for the decline included a reduced ability by authorities to track and enforce compliance due to various COVID-19-related restrictions (e.g., stringent movement restrictions, organization closures) and a willingness by some suppliers/sellers to disregard or circumvent policies and regulations.
↑ exposure to marketing (including digital marketing) of foods high in fats, sugars, salt, unhealthy commodities, including through advertisement, promotions and sponsorships (23,39,40)	Food companies took advantage of captive audiences due to movement restrictions to increase their product marketing and advertising campaigns, including campaigns for highly processed foods that appeal to people because of their fat, salt and/or sugar content.

Health system. Being the front line of the COVID-19 crisis response had a profound effect on health systems. Intense pressures on systems due to the pandemic overwhelmed health workers and also interrupted the ability of the systems and workers to provide other services vital to the health and well-being of individuals and communities. While systemic factors varied by setting and context, the framework includes five that were recurrent in different locations.

Table 5. Underlying determinants: Health system

Interruption in the delivery and/or decrease in the quality of health services (*e.g., routine immunizations, reproductive health services, maternal counselling, prevention & treatment of infections*) (10,16,21,22,24,25,33,53,58,64)	The need to reorient staff and facilities to deal with COVID-19 cases led to significant interruptions in the provision of normal and/or routine health services for all patients. For many patients, these interruptions had negative effects on their health and well-being. Decreased demand for non-COVID-19 health services — due partly to patient reluctance to seek care because of the pandemic — also contributed to the interruption of services. The large backlog of cases and a pent-up demand for health services have led to continued interruptions, even when the burden of COVID-19 declined.
Interruption in the delivery and/or decrease in the quality of nutrition services (*e.g., micronutrient supplementation, detection & treatment of wasting, IYCF/BF counselling*) (10,22,24,33,53,63,64)	Nutrition services also faced significant interruptions as available resources (e.g., financial, human) were repurposed to attend to COVID-19 cases. In addition, decreased demand due to patient concerns about the pandemic further limited the availability of nutrition services. For many patients, interruptions in nutrition services had negative effects on their health and well-being.
Health staff fears/concerns about COVID-19 infection that impact skills and performance (34,35,36,37)	Concerns about contracting COVID-19 infection in the workplace affected the performance of health care workers. Also, heightened safety protocols to address staff fears and concerns made it more difficult to carry out the various tasks required to provide care to patients.
Δ provider knowledge, skills and capacity to implement support for infant and young child feeding (2,45,46,47,63,64)	Support for evidence-based interventions (e.g., extended breastfeeding, kangaroo mother care) was reduced or discontinued in some settings due to limitations in provider knowledge, skills and capacity caused by COVID-19 disease.
↑ strain on health care system: overwhelmed health workers, ↓ supplies (such as personal protective equipment (PPE), testing kits, ventilators) (10,21,25,63)	The demands of dealing with COVID-19 cases put tremendous pressure on health care systems. The workload required to deal with the surge of patients and the challenges of caring for them was overwhelming for many health care workers, particularly when combined with shortages in PPE to protect themselves from infection as well as critical supplies for patient care (e.g., ventilators, oxygen).

Education system. Schools at all levels of a country's education system faced many logistical and pedagogical challenges because of the COVID-19 pandemic. The analytical framework highlights four that had nutrition implications, including three with very direct implications and one with significant indirect implications.

Table 6. Underlying determinants: Education system

Disruption of school meal programmes due to school closures and food supply disruptions (10,16,17,32,55,64)	School meal programmes meet vital nutrition needs for millions of students. In many settings, when schools closed or there were disruptions to the food supply, meal programmes were reduced or discontinued, which had a direct effect on the students who rely on them.
↓ delivery of nutrition/health educational curriculum (e.g., physical education) and support services (e.g., psychosocial support) (16,33,64)	Schools are a source of nutrition and health instruction that contribute to children's – and in many cases, their parents' –understanding of the importance of these issues to their well-being. Schools also provide students with opportunities to actively participate in nutrition and health activities (e.g., physical education) and receive related support services (e.g., counselling and psychosocial support). Closures and/or reduced schedules limited the ability of schools to effectively reach children with instruction, activities and support services.
↑ school drop-outs, lost years of schooling (32,33,64)	The COVID-19 pandemic led to students dropping out of school for a range of academic, psychological and socio-economic reasons. While the link to nutrition is indirect, dropping out of school can be the result or driver of nutrition challenges. For example, if a family is struggling to afford food, having a child work instead of going to school can be seen as a necessity; conversely, the loss of structure provided by school – especially school meal programmes – can negatively affect the nutrition status of a child. In addition, there are broader socio-economic implications of an increase in school drop-out rates as well as lost years of schooling due to closures and/or poor-quality replacement programmes (e.g., online coursework).

Social protection system. The widespread disruptions caused by the pandemic placed intense demands on social protection systems. Not only were more people seeking help and support from these systems, but the scale and scope of the needs by individual, family and community also increased. Three factors related to social protection systems are included in the framework.

Table 7. Underlying determinants: Social protection system

↓ availability of and access to emergency food and cash assistance (21,64)	Emergency food and cash assistance programmes experienced a surge in demand in many countries. The response to this increased demand ranged from large-scale assistance provided by international and multilateral organizations to local food banks operated by community organizations.
Δ social safety nets provision and supplies for vulnerable/ marginalized groups (*e.g., refugees, orphans*) (10,16,17,19,24,33)	Long-term social safety nets (e.g., cash, in-kind transfers, social pensions, public works, and school feeding programmes) provided much-needed support to vulnerable and marginalized populations affected by the COVID-19 crisis. In many cases, social safety nets were expanded because of the pandemic, but they were not always able to meet the full demand and/or need for support.
Maternity workplace protections, social protection programmes for women (*e.g., informal work settings*) (44,63)	Pregnant women faced multiple challenges in formal and informal workplaces during the pandemic, including feeling unsafe at work due to inadequate or non-existent COVID-19 disease prevention practices and inadequate or limited risk assessments of workplace conditions for pregnant women.

Water and sanitation system. Functioning water and sanitation systems were a valuable asset during the pandemic, with implications for prevention, monitoring and treatment of COVID-19 infection as well as their regular role in contributing to the health and well-being of households and communities. Two of these systemic factors are included in the framework.

Table 8. Underlying determinants: Water and sanitation system

↓ access to clean drinking water, handwashing and sanitation facilities and supplies (16,22,24,26,28,51,64)	Reduced access to sufficient clean water for drinking, handwashing and food preparation as well as reduced access to functioning sanitation facilities affected the ability of individuals, families and communities to protect their health during the pandemic.
↓ personal, household, community hygiene (16,22,24,26,28,51,64)	Systemic stresses from the pandemic undermined hygiene practices at multiple levels, including personal, household and community. Systemic stresses included limited availability of alternatives to soap and water for handwashing (e.g., safe and effective hand sanitizer) and lack of structures/ reinforcements to build good behaviours (e.g., school programmes on the importance of personal hygiene).

Immediate determinants

Multiple factors linked to behavioural and nutritional status are included in the category of *immediate determinants* (Table 9). These factors are logical progressions of the pathways defined by the contextual and systemic factors in the preceding categories of *enabling* and *underlying* determinants.

Table 9. Immediate determinants

Breastfeeding practices, fear of breastfeeding due to perceived risk of virus transmission through breastmilk and perceived milk insufficiency due to hunger (4,5,6,7,8,45,58,63)	Breastfeeding practices were negatively affected by a combination of factors, many of which are traceable to reductions in antenatal and postnatal care services where fears and misconceptions about breastfeeding could be addressed by trained and experienced facility- and community-based health workers.
Mother-infant dyad separation (2,47,48,49,57,63)	Concerns about infection control in some health care settings led to dyad separation during the pandemic, which negatively affected breastfeeding practices. Shortcomings in the provision of clear guidelines to mothers and health care workers did not make it clear that dyad separation was usually unnecessary, even for COVID-19-positive mothers.
Unsafe storage, handling and preparation of foods and poor hygiene practices (22,24,26,28,64)	Safe and hygienic practices related to food storage, handling and preparation are vital to individual and public health and well-being. Due to various challenges linked to COVID-19 pandemic, proper procedures may not have been followed at one or more points in the chain connecting food producers to individual and institutional consumers.
Physical exercise, sedentary lifestyles and screen time (18,19,20,21)	Multiple pandemic-related factors contributed to declines in physical exercise and increases in sedentary behaviours, including stay-at-home orders and stringent movement restrictions, closures of gyms and recreational facilities, fears of COVID-19 exposure/infection and self-isolation. Sedentary behaviour was also reinforced by an increase in "screen time", as the availability of screens (e.g., television, computers, tablets, consoles, phones) and programming made it an easy way for people to spend time.

Change in consumptions patterns (diet quantity, quality, diversity) (10,16,17,21,22,23,55,64)	Poor diet quantity, quality and diversity linked to the pandemic, including increased consumption of unhealthy food products, had adverse effects on people's general health and well-being. In certain contexts, diet had specific COVID-19-related effects, including a lower resistance to infection and more difficult recovery from COVID-19 infection.
Food insecurity and hunger (9,10, 11,12,16,17,18,19,21,22,30,31,32, 33,52,55)	The pandemic triggered an increase in the number of people facing food insecurity and hunger. Areas already prone to food insecurity and hunger were particularly hard hit, but the pandemic brought these issues to a broad cross section of families and communities that had either never faced them before, or had moved past them in recent years.
Maternal undernutrition (16,26)	Multiple factors identified in the framework could contribute to maternal undernutrition, ranging from increased workload, to limited availability of affordable and nutritious foods, to the interruption of nutrition services in health systems.
Poor nutrient absorption, infection, inflammation (*enteric infection, diarrhoeal disease, environmental enteropathy and helminths*) (20,21,64)	The negative effects of poor nutrient absorption, infection and inflammation were amplified during the pandemic for various reasons, ranging from less healthy diets to reduced access to health and nutrition services.
Poor mental well-being (*e.g., stress, anxiety, depression, post-traumatic stress disorder*) (18,19,20,21,24)	The pandemic introduced new mental health issues and aggravated existing ones among people of all ages and from all walks of life. Factors that affected mental health included isolation due to stringent movement restrictions, changes in diet and exercise patterns, concerns about finances, food security and pre-existing health conditions.
Weakened immune system; susceptibility to illness, incidence, duration, progression and poor disease prognosis (16,18,20,64)	Individuals with weakened immune systems were not only more susceptible to COVID-19 infection, but they also faced more challenges dealing with the infection, including more rapid disease progression, a longer duration of disease and a poorer prognosis. In addition, a weakened immune system can make people more susceptible to a range of different diseases/infections.

Outcomes

The outcomes included in the framework mirror the six global nutrition targets for maternal, infant and young child nutrition endorsed by the WHA (Table 10). These outcomes were selected as a way to focus the analytical framework on a particular subset of nutrition issues and their links to the COVID-19 pandemic. Without this focus, the broad and interdisciplinary nature of nutrition – combined with the wide-ranging effects of COVID-19 pandemic – would lead to an inestimable number of outcomes. However, as mentioned above, it is possible for users to consider other outcomes in the framework and explore how the various factors can be linked to them (e.g., reductions in adult overweight/obesity; prevention and treatment of NCDs).

Intergenerational effects are included under outcomes because malnutrition in one generation can contribute to malnutrition in the next generation. For example, evidence suggests that mothers with stunted growth often deliver babies affected by stunting; there is also a link between malnutrition during pregnancy and low birthweight.

Table 10. Outcomes

Breastfeeding (2,3,44,45,46,47,48,49,57,63)	Breastfeeding practices (early initiation, exclusive breastfeeding in the first six months, extended breastfeeding until 24 months of age)
Stunting (16,26,27,28,32,33,51,53,54,56)	Children under age 5 who are stunted
Wasting (16,26,27,32,33,53,54,56)	Children under age 5 who are wasted
Low birthweight (16)	Babies born with low birthweight
Anaemia (20,22,26,29,50,53,54,56)	Women of reproductive age with anaemia; children and pregnant women with micronutrient deficiencies
Overweight (20,26,54,60,61,62,65)	Children under age 5 who are overweight

Impact

Impact is broken down into three categories: mortality, morbidity and human capital (Table 11). The dynamic nature of the COVID-19 pandemic and the global response creates an opportunity for users of the framework to consider both short-term and long-term impact in each of the three categories. For example, researchers could look at the short-term impact of COVID-19 infection on productivity (e.g., outputs in a specific sector) based on different waves of infections in a country (e.g., pre- and post-vaccination campaigns) or they could look at the long-term impact of COVID-19 infection, including future productivity.

The understanding of COVID-19 comorbidities continues to grow as more is learned about the disease, creating opportunities to consider the connections with nutrition, including obesity and NCDs. In addition, COVID-19 can impact the ability to manage nutrition-related morbidities. For example, the negative impact of the COVID-19 pandemic on food security, nutrition and lifestyle has the potential to increase the incidence of NCDs and to worsen their outcomes.

Table 11. Impact

Mortality (16,18,20,21,25,26,53,56,59,64)	Deaths caused directly from COVID-19 infection as well as the increase in deaths indirectly caused by COVID-19-pandemic-related circumstances and/or events (e.g., reduced access to health services).
Morbidity (50,64)	Direct COVID-19 infection as well as multiple comorbidities associated with COVID-19 and the COVID-19-related circumstances and/or events that contribute to those comorbidities (e.g., increase in hypertension due to changes in food availability and consumption).
Human capital (16,18,20,21,24,25, 26,27,28,32,51,52,56,64)	The knowledge, skills, abilities, experience, intelligence, training and competencies possessed individually and collectively by individuals in a population.

Potential uses of the analytical framework

The analytical framework provides users with the ability to plot a vast number of impact pathways connecting the various factors to nutrition outcomes. To illustrate the range of possibilities, examples of six different pathways are included below. The versatility of the framework enables stakeholders (e.g., policymakers, planners, implementers, modellers and researchers) to look at the nexus of COVID-19 and nutrition from different perspectives, with different priorities and at different levels (e.g., global, national and subnational). Three of the most useful activities are: 1) assessing data needs and availability; 2) modelling; and 3) scenario planning.

Data needs and availability. The process of plotting known and potential pathways can also be used to identify what data are needed and what data are available to understand and address nutrition challenges created and/or intensified by the COVID-19 pandemic. For example, many countries lack baseline data on nutrition vulnerabilities, or subnational data for differential analysis on sub-populations. In other countries, pre-COVID-19 era data sets on critical issues may exist, but applicable post-COVID-19 era data have not been collected or are not yet available. Using impact pathways to help identify data needs and availability could support the development of a core set of national-level data, collected through appropriate approaches (e.g., routine systems, surveys and/or questionnaires) that could be used to track and assess the situation. In addition, using impact pathways to understand data needs and availability is an opportunity to assess and adjust measurement methodologies and re-evaluate existing assumptions about data and data systems. See pages 22-27 for six examples of impact pathways.

As part of the development of the analytical framework, ACT-NM conducted an intensive search to identify data sources relevant to the different factors included in the framework. The search was the first phase of an ongoing initiative to build a regularly updated database of sources that can be used by planners, modellers and researchers when they explore different impact pathways using the framework. The evolving nature of the COVID-19 pandemic and response at national and global levels means that new data sources and new datasets will be available moving forward. It should be noted that this data source database provides neither data nor model parameters definitions. The initial search identified a number of applicable data sources at global and national levels, ranging from data about context and history to data about specific effects linked to COVID-19. For example, the initial search found 183 countries had data related to the enabling determinant covering public health and safety measures, including 'stringent movement restrictions, quarantines, physical distancing policies and public mobility'. In contrast, only eight countries had data on the Underlying Determinant covering 'increased online food shopping and delivery services of pre-packaged foods' and each of these countries had participated in a phone-based survey to collect data on this factor.

It is important to note that the difficulty of collecting data during the pandemic due to capacity and resource constraints has been a serious challenge in countries around the world. For example, national and subnational programmes were forced to use alternative ways of collecting COVID-19-related data (e.g., targeted phone and internet surveys), which tend to generate different and less robust data than traditional systems and instruments.

Modelling. In general, the overall analytical framework, and more specifically, unique pathways, can provide outlines/structure for modelling efforts to assess critical issues related to COVID-19 and nutrition. For example, where actual data or plausible projections are available, the different factors included in an impact pathway could be used to model the effects of programme and policy actions on various outcomes. A model could consider the cascade effects of nationwide stringent movement restrictions to estimate the number of children who could face adverse nutritional outcomes (e.g., stunting and wasting) as a result. Multifactorial modelling efforts using different pathways and/or different outcomes could provide valuable information on how to adjust global and national

priorities and policies to address challenges, strategically allocate resources, and plan for effective programme interventions in country-specific contexts. Pathway-specific model parameters must be developed within the relevant context.

Scenario planning. In most cases, pathways plotted with the factors in the analytical framework are de facto scenarios. Scenarios (i.e., a postulated sequence of events) and scenario planning are powerful tools to help better understand the linkages between COVID-19 and nutrition and explore ways to adjust/improve policies and programmes to better address realities on the ground. Scenario planning can raise important and challenging questions that are likely to have different answers in different contexts. For example: How does the pandemic affect the provision of health and nutrition services and what is the impact on malnutrition in all its forms? What policies should be implemented to limit COVID-19 pandemic effects on malnutrition? What programme adaptations were most effective in mitigating the effects of the pandemic on malnutrition?

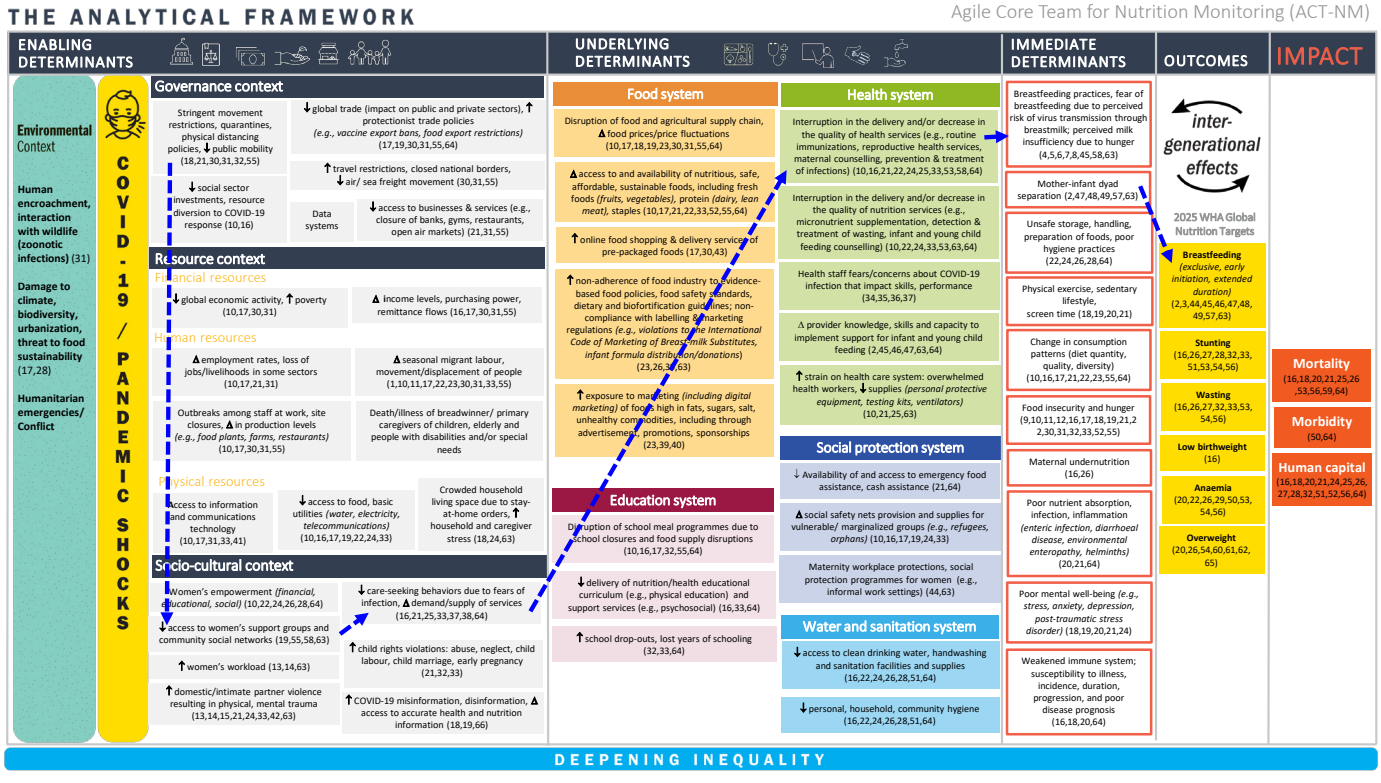
Examples of impact pathways

One of the fundamental uses of the analytical framework is the development of impact pathways to explore the different connections and relationships between the various factors that connect COVID-19 and nutrition. As mentioned above, pathways can provide a structure for productive modelling; they can be used to identify data needs and availability; and they are the basis for practical scenario planning. Six examples – each linked to one of the outcomes included in the framework – have been developed to demonstrate how they can be constructed and used to identify and understand the COVID-19 and nutrition nexus.

Impact pathway:

Breastfeeding

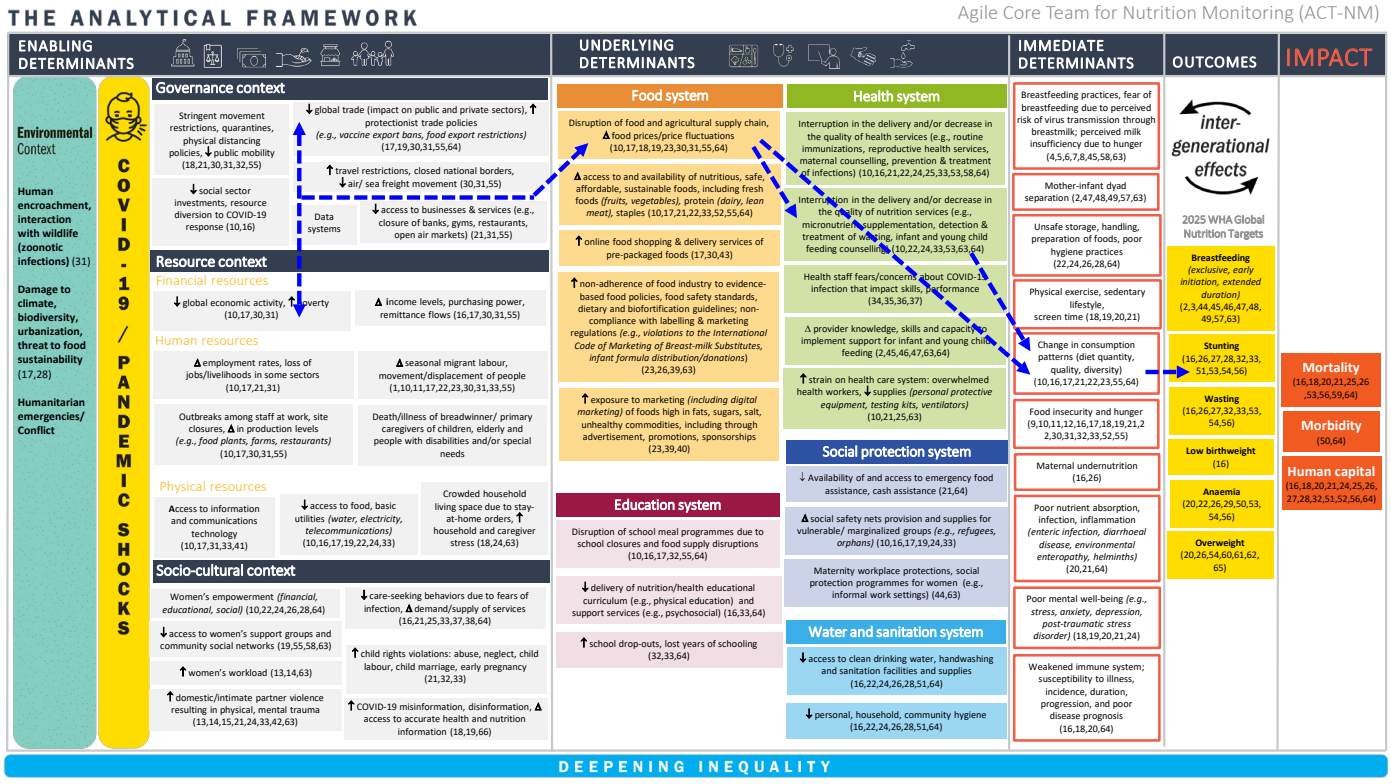
Domestic movement restrictions drastically reduced women's access to support groups and community social networks, which are critical sources of information and encouragement for new and/or young mothers. In many locations, support groups and social networks collapsed after failed attempts to operate via text messaging. The loss of support options – combined with legitimate concerns about COVID-19 infection in various settings – adversely affected the willingness of new mothers to seek health services of any kind, including maternal counselling and counselling on infant feeding. The decline in the willingness to seek care was further complicated by the limited availability of health services and health professionals. As a result, there were widespread fears about SARS-CoV-2 virus transmission through breastmilk. In addition, the rapidly changing nature of the COVID-19 pandemic meant that important messages about COVID-19 infection and breastfeeding (e.g., risks, protocols) were not available or were uncertain. In an area where there had always been low levels of compliance with optimal breastfeeding practices, this interconnected set of factors led many mothers to either stop or reduce breastfeeding of their infants.



Impact pathway:

Stunting

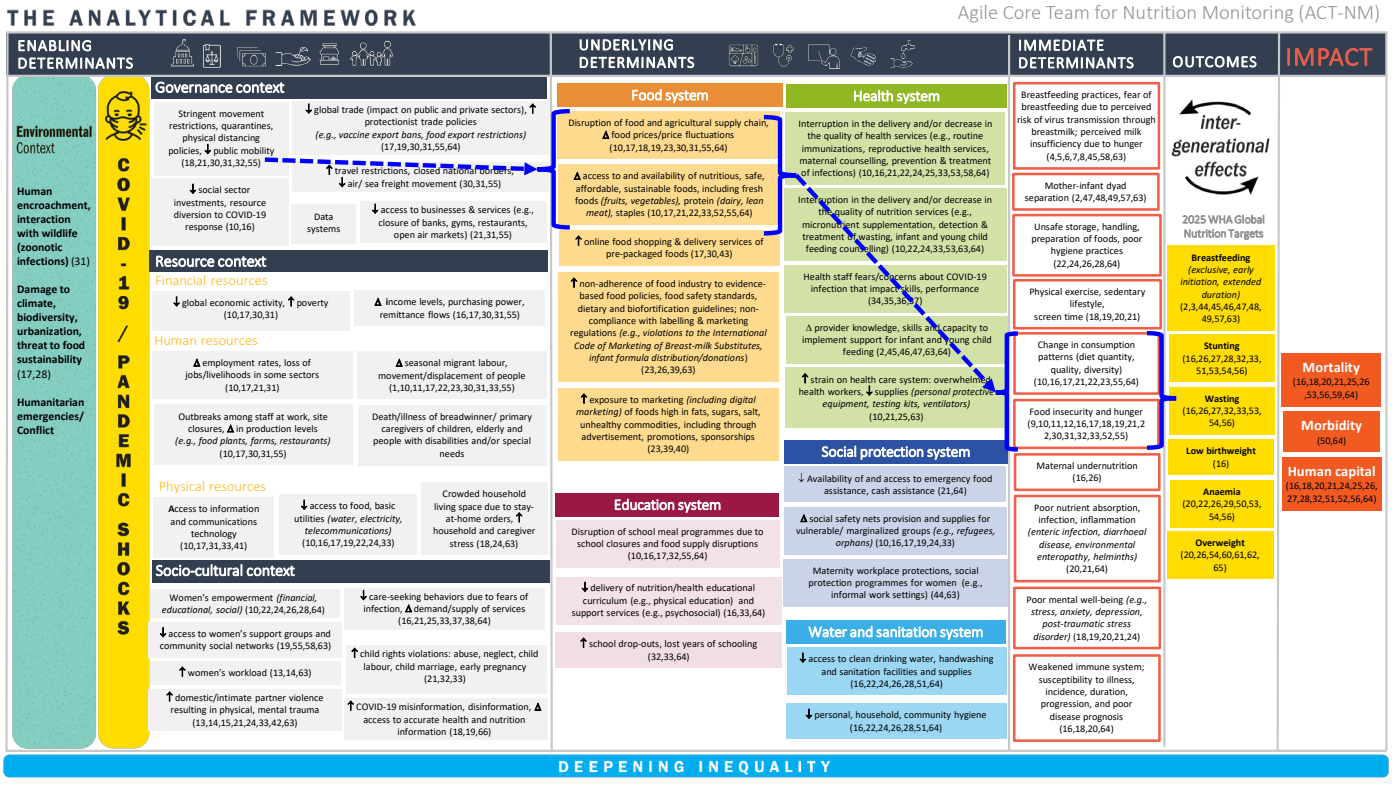
The combined and intertwined effects of interruptions in global trade, shifts in trade priorities and a contraction of economic activity, both internationally and nationally, disrupted the food and agricultural supply chains in the country. This disruption affected the availability of both imported and locally produced foods in the country's wholesale and retail markets; it also created the likelihood that local production of foodstuffs would be lower than normal. In addition, the disruption severely limited the availability of products for nutrition services in the health system; the lack of products – combined with other disruptions and changes affecting the health system – dramatically reduced participation in nutrition programmes. The reduced availability of food products in the marketplace and through the health system contributed to declines in the quantity, quality and diversity of diets for mothers and children, which undermined long-standing programmes to prevent and reduce the impacts of stunting in the country.



Impact pathway:

Wasting

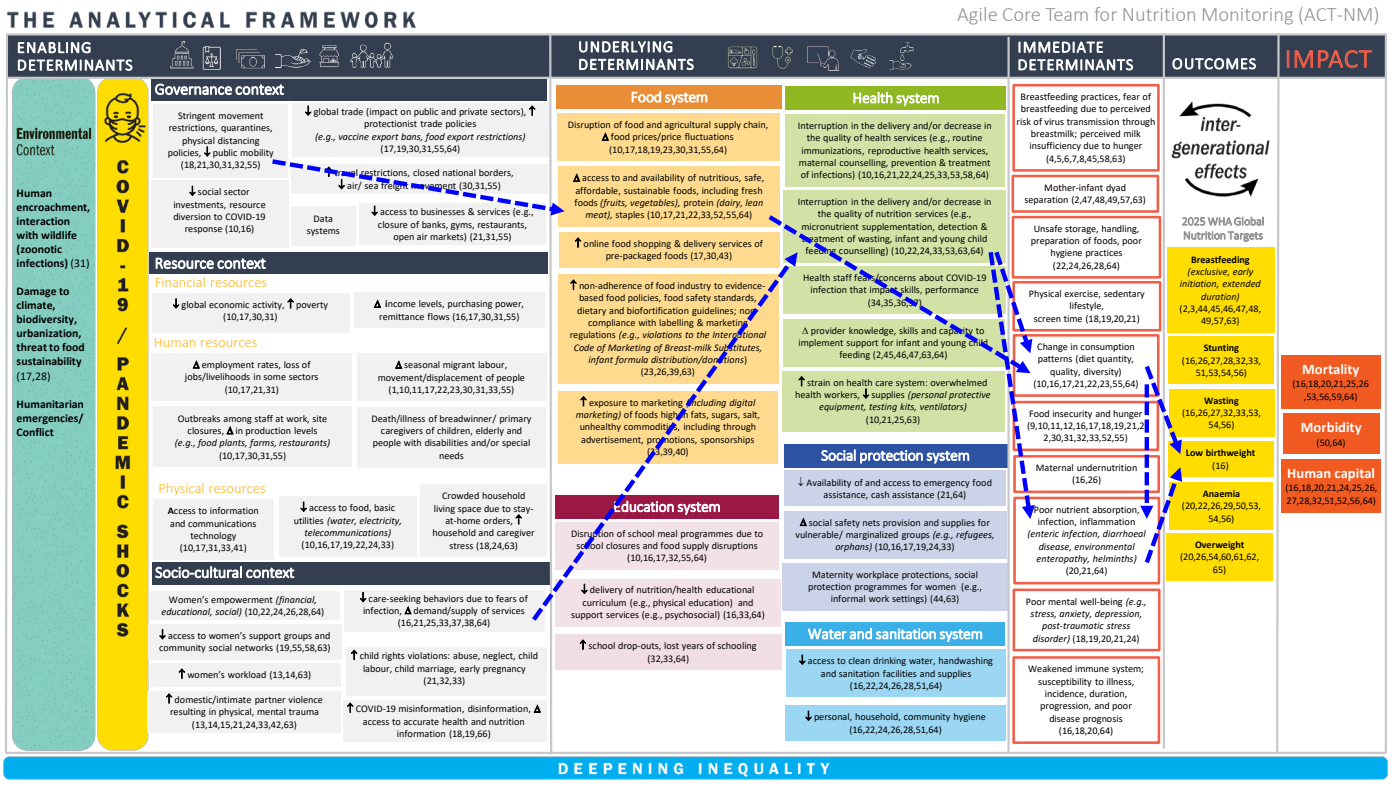
Limitations on people's movements, especially stringent movement restrictions, led to an ongoing disruption in the county's supply chain for food. This disruption also severely reduced the availability of and access to essential and healthy fresh foods across the country, including in urban, suburban and rural communities. The issues with food availability and access had a rapid effect on the quantity, quality and diversity of food that families were able to afford and procure. For many of these families, these new COVID-19-pandemic-related challenges collided with the regular day-to-day challenges of making ends meet, which led to dramatic increases in food insecurity and even hunger. In districts where food insecurity and hunger are chronic and/or recurrent issues, the decline in the quantity of food and the quality of diets was a tipping point that undermined recent improvements in addressing wasting in children under 5 years old. The combination of limitations on movement, cuts in the availability of health services and fears of contracting COVID-19 disease in health facilities also contributed to immediate and future concerns about the prevention and treatment of wasting.



Impact pathway:

Low birthweight

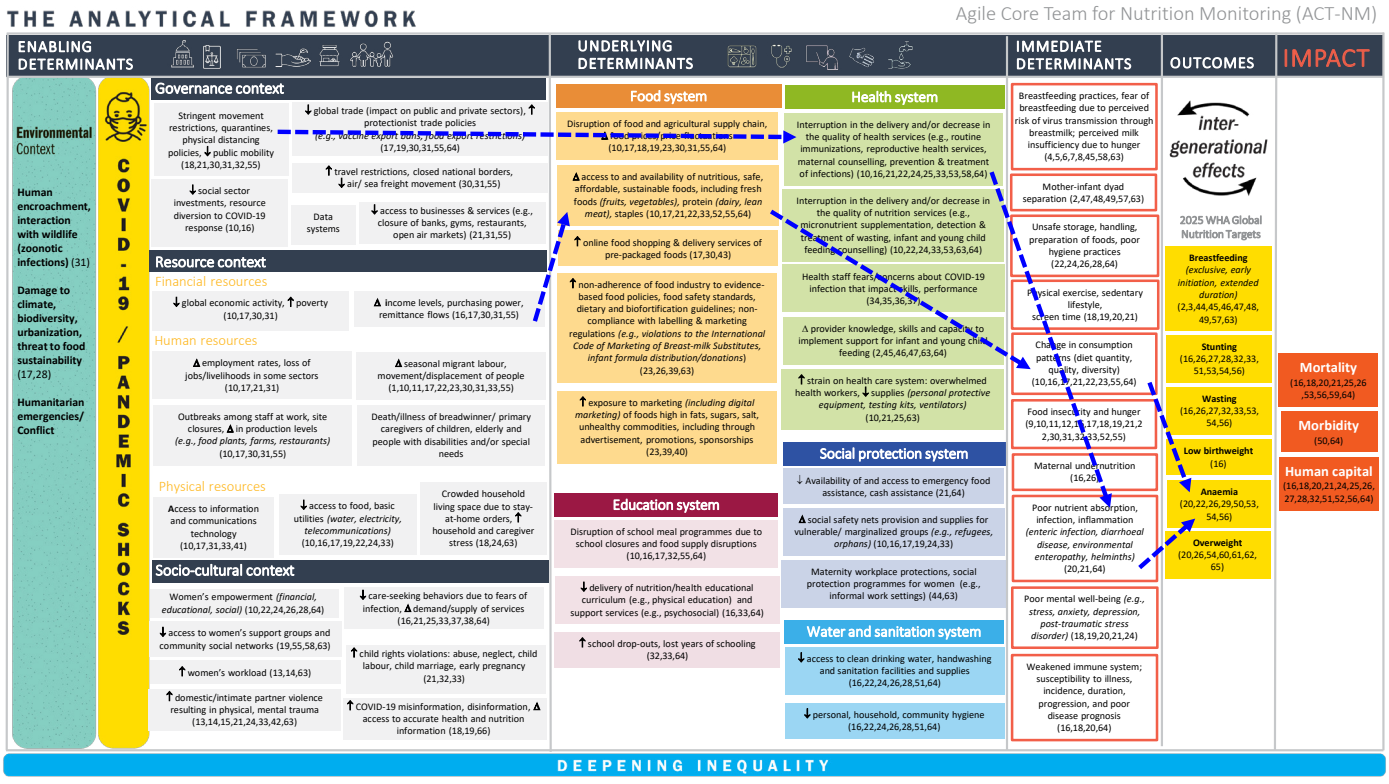
Although food shopping was allowed during periodic pandemic-related stringent movement restrictions, the ability to consistently access a sufficient quantity of nutritious foods at affordable prices was always a challenge, often requiring people to travel some distance at a time when public transport was irregular and infrequent. The stress of food shopping during these periods was even more difficult and taxing for pregnant women. As a result, these women struggled to maintain a diet with the quantity, quality and diversity of food needed to ensure a healthy pregnancy. In addition, psychosocial support was not available when stringent movement restrictions were in place. This ongoing support had helped many pregnant women navigate the various challenges they faced under ordinary circumstances; it would have been even more valuable when the challenges increased significantly. In addition, the suspension of nutrition services at the health centre further undermined the ability of these women to understand and, when necessary, address vital nutrition issues. The combination of a poor, limited diet and the inability to access needed support services increased the likelihood of more low birthweight babies being born.



Impact pathway:

Anaemia

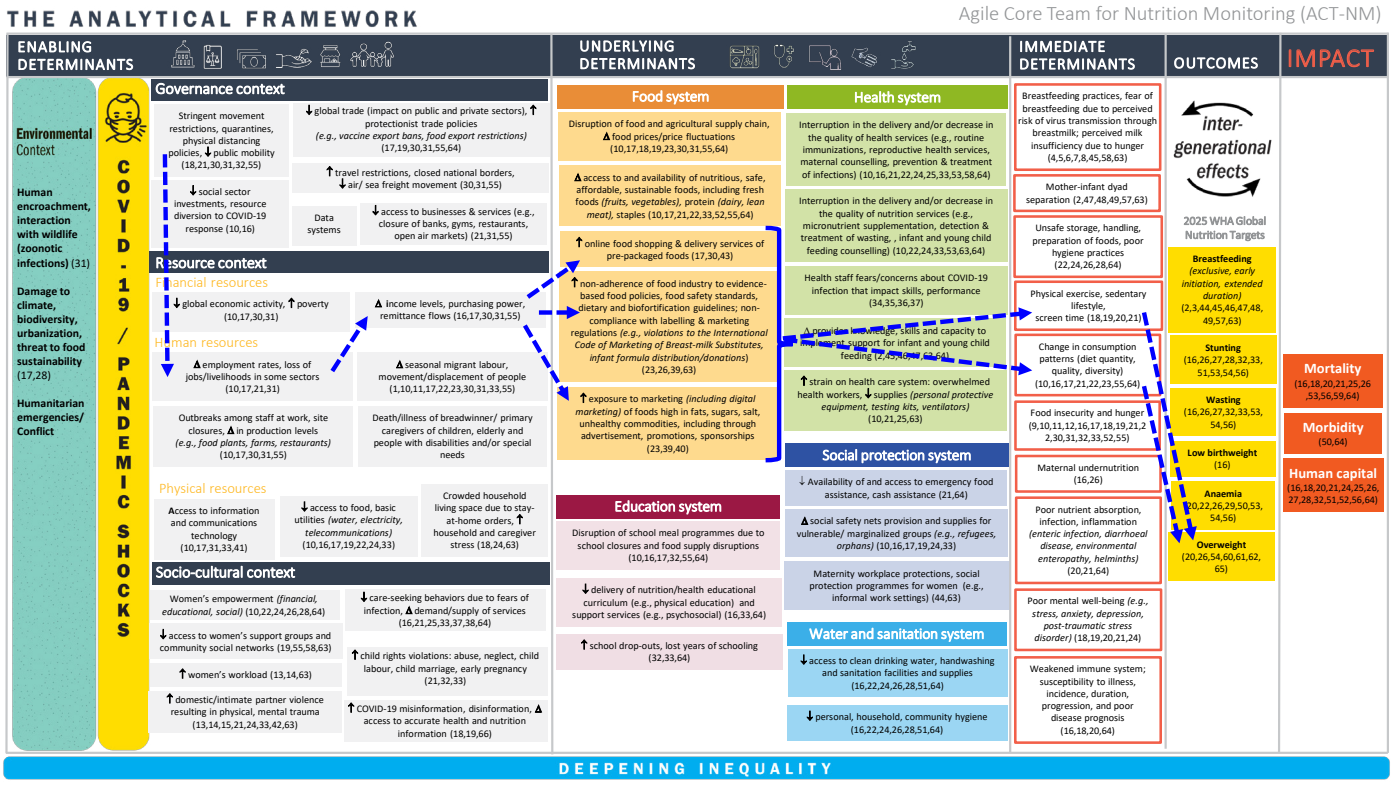
Limited mobility – combined with the prioritization of COVID-19 cases – reduced the ability of women of reproductive age to access regular health services, including the full range of prenatal services. The inability to seek/receive health care has had multiple effects on this group of women that effect their health generally and their reproductive health specifically. On a parallel track, declining income and rising prices have affected access to and the availability of nutritious and affordable foods for these same women. As a result, the quantity, quality and diversity of their diets has declined, which further compromises their overall health and their ability to have a healthy pregnancy, including due to issues with anaemia and related micronutrient deficiencies.



Impact pathway:

Overweight

For workers in many sectors, limitations on people's movements led to a loss of jobs. Regardless of the sector, the job losses quickly affected people's incomes; while some workers were able to secure temporary benefits to partially replace their lost income, there was a clear change in people's purchasing power. This change influenced patterns of food consumption, with more individuals and families shifting to lower-priced foods, many of which are highly processed products with a long shelf-life that are inherently less healthy. While the reliance on these less expensive foods may enable people to maintain a sufficient quantity of food intake, they have a negative effect on the quality and diversity of people's diets. The unhealthy effects of a reliance on highly processed food, which are typically less nutrient-dense products, are further complicated by declines in physical activity and increases in sedentary activities, which are also the result of stringent movement restrictions, including school closures. As a result, children in many settings have gained unhealthy weight due to COVID-19-related decisions and events.



Limitations

The analytical framework is based on findings from an extensive but time-constrained literature review between December 2020 and January 2021, which was done to identify existing models that could shape the organizing structure of the new framework. The same review also helped identify specific factors to fill out the different categories in the structure. The time constraints limited the review to information about existing models and specific factors that was available at that point in the COVID-19 pandemic. It is possible that an additional literature review could yield different and/or additional findings that may be relevant to the structure and content of the framework.

The initial literature review provided an early warning about the extent of data gaps and the limitations of some of the available data. The additional work done to identify global- and national-level data sources reinforced the fact that the widespread lack of quality data available for factors included in the framework was a challenge. Although new data are increasingly available, the data gaps and limitations are likely to continue for the foreseeable future.

While the current version of the framework includes multiple sectors relevant to nutrition (e.g., social protection, education), it has a strong public health perspective. However, different factors can be added under the included sectors and the framework can be adjusted to include additional sectors. By design, the framework does not directly address the clinical or biomedical pathways of COVID-19 infectious disease on nutritional status.

The individual country context and the dynamic nature of the pandemic and its response may affect both the structure and the flow of the framework over time. For example, the full range of interactions between the various factors included in the framework can be difficult to represent, given unique country contexts and shifts in the pandemic and its response.

Conclusion

The analytical framework developed by ACT-NM groups various factors relevant to the intersection between COVID-19 pandemic and nutrition into different categories and sub-categories. The five overarching categories are enabling determinants, underlying determinants, immediate determinants, outcomes and impact. Each of the three categories of determinants has a different sub-category of critical factors: context, system and behavioural and nutritional status. In addition, the framework recognizes the overall environmental context and the wide-ranging effects of COVID-19 pandemic. The framework also acknowledges the cross-cutting causes and consequences of deepening inequality on the intersection of COVID-19 and nutrition.

The straightforward structure and content of the analytical framework makes it a powerful and adaptable tool for users interested in exploring the linkages between the COVID-19 pandemic and nutrition, with broad applicability in different contexts. It provides policymakers and programme staff with the ability to identify and understand the many different pathways and scenarios where COVID-19 and nutrition intersect. Its versatility and flexibility also enable planners and evaluators to assess and adapt existing policies and programmes as well as consider future options and opportunities. A parallel component of this work is the ability of modellers to explore the implications of different decisions, actions and/or factors on the overall framework and/or specific pathways or scenarios. In addition, data experts can use the framework to identify where meaningful data exist and where they need to be collected and analysed to improve decision-making and programme implementation.

The ultimate value of the framework is its ability to provide a systemic but flexible approach to frame and manage future pandemics and shocks by learning how countries – individually and collectively – responded to the multiple crises linked to the COVID-19 pandemic and nutrition.

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