Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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The impact of COVID-19 on diet quality, food security and nutrition in low and middle income countries: A systematic review of the evidence

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SUMMARY

Background & aims: The current global pandemic of Coronavirus (COVID-19), and measures adopted to reduce its spread, threaten the nutritional status of populations in Low- and middle-income countries (LMICs). Documenting how the COVID-19 affects diets, nutrition and food security can help generating evidence-informed recommendations for mitigating interventions and policies.

Methods: We carried out a systematic literature review. A structured search strategy was applied in MEDLINE (Pubmed®), EMBASE®, Scopus® and Web of Science®. Grey literature was retrieved by screening a pre-set list of institutions involved in monitoring the impact of the COVID-19 pandemic on nutrition and food security. The first search was done on 20th August 2020, and updated in mid-November 2020 and mid-January 2021. All research steps were described as recommended in the PRISMA statement.

Results: Out of the 2085 references identified, thirty-five primary studies were included. In spite of their heterogeneity, studies converge to demonstrate a detrimental effect of COVID-19 pandemic and associated containment measures on diet quality and food insecurity. One of the major direct effects of COVID-19 on food and nutrition outcomes has been through its impact on employment, income generating activities and associated purchasing power. Other channels of impact, such as physical access, availability and affordability of food provided a heterogeneous picture and were assessed via binary and often simplistic questions. The impacts of COVID-19 on food systems and diets manifested with various intensity degrees, duration and in different forms. Factors contributing to these variations between and within countries were: 1) timing, duration and stringency of national COVID-19 restriction measures and policies to mitigate their adverse impacts; 2) context specific food value chain responses to domestic and international containment measures; 3) differentiated impacts of restriction measures on different groups, along lines of gender, age, socio-economic status and employment conditions. Shorter value chains and traditional smallholder farms were somewhat more resilient in the face of COVID-19 pandemic. Additionally, the impact of the pandemic has been particularly adverse on women, individuals with a low socio-economic status, informal workers and young adults that relied on daily wages. Finally, there were heterogeneous government responses to curb the virus and to mitigate the damaging effects of the pandemic. It has been demonstrated that existing and well-functioning social protection programmes and public distribution of food can buffer the adverse effects on food insecurity. But social safety nets cannot be effective on their own and there is a need for broader food systems interventions and investments to support sustainable and inclusive food systems to holistically achieve food and nutrition security.

Conclusion: The current economic and heath crisis impacted diet quality and food security. This raises concerns about long term impacts on access to and affordability of nutrient-rich, healthy diets and their health implications. Women and individuals with a low socio-economic are likely to be the most at risk

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of food insecurity. Social safety nets can be effective to protect them and must be urgently implemented. We advocate for improved data collection to identify vulnerable groups and measure how interventions are successful in protecting them.

1. Introduction

The current global Coronavirus pandemic (COVID-19), and measures adopted to reduce its spread, threaten the nutritional status of populations in Low- and middle-income countries (LMICs) [1]. Disturbance to the food environments may ensue from changes to both external and personal dimensions of food environments [2]. External dimensions include food availability and quality, prices, vendors, markets and regulations, while personal dimensions include geographical access, affordability, convenience and desirability [2].

Children under-5 years and women are expected to be particularly affected by a fall in access to food – particularly for healthy items, such as fruit and vegetables – and by potential disruption of health and nutrition-related programmes and interventions, reducing their access to health care [3]. The World Food Programme (WFP) has estimated that the COVID-19 pandemic will see more than a quarter of a billion people suffering acute hunger by the end of 2020, which represents a doubling of current figures [4]. It was also estimated that even fairly short lockdown measures, combined with severe mobility disruptions and comparatively moderate food systems' disruptions, could result in a 14,3% increase in the prevalence of moderate or severe wasting among children under-5 years across 118 LMICs [5]. Reduced coverage of essential maternal and child health interventions could result in an increase of 9·8–44.7% in under-5 child deaths per month, and an 8.3–38.6% increase in maternal deaths per month, across 118 LMICs [3]. Poorer nutritional status may in turn expose individuals to more severe COVID-19 infections and increase pressure on already vulnerable health systems [3].

Hence, the need to prepare and/or strengthen appropriate interventions to mitigate the effect of the pandemic on nutritional outcomes are urgently needed. A response to the COVID-19 pandemic may likely include support to functional and resilient food systems, sustainable healthy diets and access to public health services for all, and particularly the most vulnerable [1,6–9].

Such interventions should be guided by evidence. Most of the predictions of the impact of the COVID-19 pandemic on diet quality and the nutritional status of populations are based on macro or micro-level simulations [3,5,10,11]. The actual impact of the COVID-19 pandemic is still to be quantified. The aim of this research is to provide a preliminary assessment of the multifaceted ways COVID-19 has impacted livelihoods of some of the most nutritionally vulnerable groups and, in turn, their food and nutrition security. Such information is crucial to identify factors that aggravate or mitigate the impact of the COVID-19 pandemic (e.g. geography, characteristics of the food environment, vulnerable individuals), and to target appropriately early interventions. Documenting and disseminating these lessons and emerging evidence will be key to implementing the most appropriate and effective interventions in the face of this pandemic.

2. Material & methods

A systematic literature review was carried out to identify documented effects of COVID-19 on diet quality and nutritional status of children under-5 years and women of childbearing age in LMICs. A protocol was developed and is available on demand. All research steps were described as recommended in the PRISMA statement.[1]

Evidence was sought against a pre-set list of nutrition and nutrition-related indicators. Eligibility criteria of studies are presented in Table 1. The main outcomes included nutrition, diet quality and food security. Data on other, more distal, indicators (e.g. consumers' behaviours, food availability and affordability) was also collected. Only studies with a design allowing inferences to be made (i.e. including primary data collected since the outbreak of the pandemic) on the impact of COVID-19 on nutrition, diet quality and food security were included. Studies that focused on obesity as a risk factor for COVID-19 infection were not included, as the scope of our research was on the effects of COVID-19 on the nutritional status of individuals and not the reverse. We acknowledge the importance of detailed analysis of the impacts of COVID-19 on overweight and people with obesity in LMICs, which could be addressed in a different study.

The search for peer-reviewed studies published up to 20th August 2020 was done in four databases: MEDLINE (Pubmed®), EMBASE®, Scopus® and Web of Science®. Search strings can be viewed in Table S1–S8, Supplementary Materials. MeSH terms were not used as their sensitivity was deemed to be low, given that the literature on COVID-19 pandemic was recent. For retrieving grey literature we screened a pre-set list of institutions for efficiency purpose. The institutions and websites were selected based on their activities in monitoring the evidence-based impacts of COVID-19 on nutrition and food security, publishing sound evidence-based analysis or conducting web-screening and gathering evidence on this subject (see Table S9, Supplementary Materials).

Because of the rapidly accumulating new evidence, we performed an update of the review in mid-November 2020 and mid-January 2021. For pragmatic reasons, the update of the peer-reviewed literature was performed on two of the databases (Scopus® and MEDLINE (Pubmed®), which cover the bulk of the natural science and social science articles published in academic outlets. Due to a combination of pragmatic approach and time constraints, the update of grey literature was conducted for countries and reports already in the list.

All references were imported into Mendeley (© 2020 Mendeley) where duplicates were detected and eliminated. Title and abstract screening was carried out on Rayyan[2] and irrelevant material eliminated. All remaining reports and studies identified as potentially eligible were assessed on full-text.

The quality appraisal of included studies was based on the grids for observational studies proposed by the Joanna Briggs Institute.[3] These grids serve to appraise a number of items (e.g. appropriate sampling) in a systematic way with no aim of yielding an overall quality score. Data extraction included: 1) information about study reference(s) and author(s); 2) verification of study eligibility; 3) study characteristics; 4) study methods; 5) participants; 6)

[1] http://www.prisma-statement.org/PRISMAStatement/.
[2] https://rayyan.qcri.org/welcome.
[3] https://joannabriggs.org/critical-appraisal-tools.

Table 1
Inclusion & exclusion criteria for evidence retrieval.

Indicators	Inclusion	Exclusion
Setting	LMIC	High income countries
Population	• Under-5 y children and women/girls of childbearing age • Other individuals	
Indicators		
Outcome 1: Nutritional status	• Higher wasting rate in under-5 y • Higher Low Birth Weight rate • Higher Rate of (micronutrient) deficiencies	Studies where overweight and obesity were considered as risk factors for COVID-19 infection (reverse causality)
Outcome 2: diet quality	• Lower Minimum Dietary Diversity for Women (MDD-W) • Lower Minimum Acceptable Diet for children 6–12 (MAD) • Lower Household Dietary Diversity Score (HDDS) • Lower Food Consumption Score (FCS) • Reported changes in quantity and types of food consumed	
Outcome 3: food security	• Higher Household Food Insecurity Experience Scale (H-FIES) • Higher Household Food Insecurity Access Scale (HFIAS) • Changes in Coping Strategy Index (CSI)	
Consumers' behaviours	• Source of foods (self-consumption, market, non-timber forest products, etc.), type of markets (open market, supermarket, etc.)	
Food availability	• Reduced production • Changes in trade flows • Disruptions in transportation of food	
Food affordability	• Reduced household income • Higher market prices	
Food accessibility	• Restricted access to markets • Market closures	
Disruption in health and nutrition services	• Lower vaccination coverage • Lower coverage of micronutrient supplements during pregnancy • Decreased treatment of acute malnutrition	
Study design (For outcomes 1–3)	• Longitudinal studies • Interrupted time series/before-after design/repeated cross-sectional surveys/trend studies • Single cross-sectional survey with questions relating to outcomes before and after the pandemic	• Projection/predictive/modelling studies • Ecological studies • Individual case studies/series • Opinions • Editorial • No data-based analysis
Restrictions	• Language: none • Type of studies (quantitative/qualitative): none	

interventions; 7) outcomes measures and results. Studies selection, quality appraisal, and data extraction were done by one researcher (FP). A second researcher (DR) independently checked a sub-sample of publications and any doubtful inclusion/exclusion and the final decision was made by consensus. No meta-analysis was undertaken because of the wide variety of study designs and heterogeneity of outcomes reported.

3. Results

Three searches – end of August and mid-November 2020, mid-January 2021 – for both the peer-reviewed and grey literature were conducted. The first search yielded 1079 and 139 peer-reviewed and grey literature citations respectively, of which 16 (2 peer-reviewed and 14 grey literature studies) were included. The second search yielded 308 peer-reviewed and 48 grey literature papers and reports, of which 11 (5 peer-reviewed and 6 grey literature studies) were retained. The last search in January 2021, yielded 508 peer-reviewed papers and 29 grey literature citations, of which 10 (5 each for both types of studies) were included. Therefore, 35 primary studies were included, of which 10 were peer-reviewed and 25 were studies and report retrieved from grey literature sources. The overall selection process is presented in the PRISMA flow chart (Fig. 1). Excluded studies after full text examination are presented in the Supplementary Material section, with reasons for exclusion (see Table S10.1 and S10.2).

Table 2 summarises the number of studies based on the selected outcome indicators. Most studies were single or repeated cross-sectional studies (see Table 3). The vast majority of them presented the common weaknesses of not describing the sampling process nor the proportion of no respondents. Therefore, included studies were evaluated low quality except the interrupted time series study in Bangladesh [25] which was rated high quality. Table 4 summarises the main information of the search results, including outcomes measured and study design. We did not find any study designed to explicitly monitor the diet quality and nutrition of children under-5 years old or and women/girls of childbearing age, although they were the priority groups. Few studies included the gender and urban-rural breakdown of results. In terms of geographical coverage, the selected papers included Bangladesh (two studies) [25,33], Ivory Coast (two studies) [34,35], Ethiopia (15 papers) [12–15,17,19,20,22,26,31], India (two papers) [16,27], Kenya (one paper) [18], Mexico (one paper) [23], Nepal (two papers) [28,32], Nigeria (seven papers) [21,24], Senegal (one paper) [32], South Africa (one paper) [37], Uganda (one paper) [18], Vanuatu (one paper) [29], and Zambia (one paper) [30]. The 15 studies on Ethiopia include 6 rounds of the World Bank high-frequency phone survey conducted between May–October 2020. The 7 studies on Nigeria include 6 rounds of the World Bank high-frequency phone survey conducted between May–November 2020. Each of these 2 batches was referenced in the table as one unique entry for space reason.

The majority of the studies were longitudinal (7 studies) and cross-sectional phone surveys (13 studies). The remaining studies were: interrupted time series (1 study), phone exploratory qualitative assessment (2 studies) and repeated cross-sectional (3 studies).

Data extraction tables and quality appraisal can be found in a separate document (available on demand).

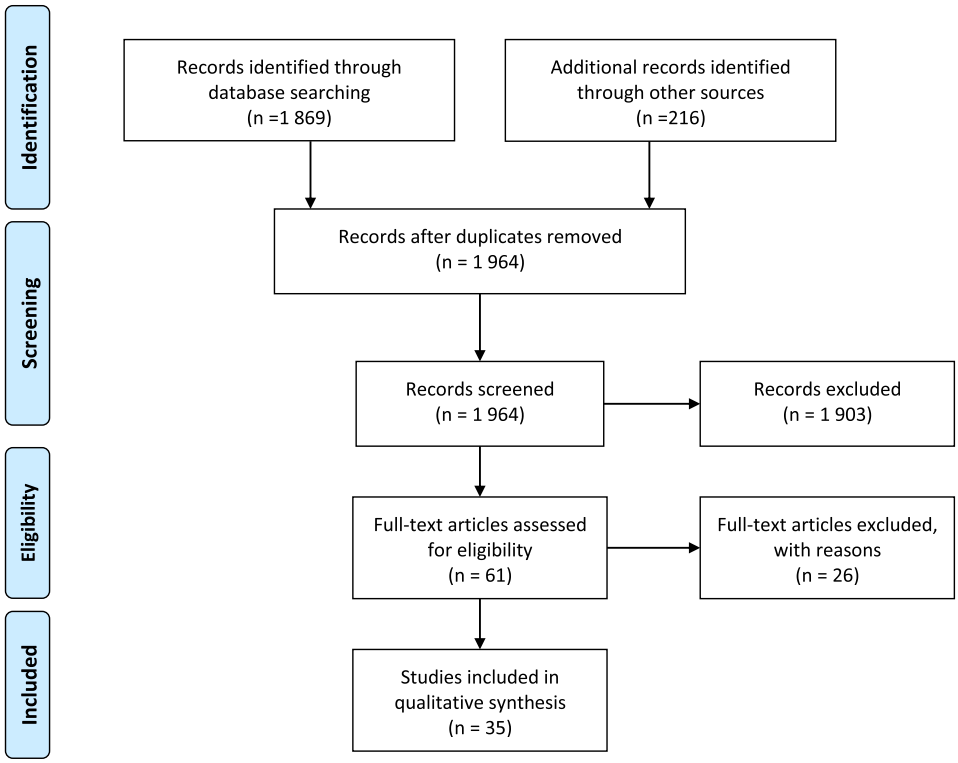

Fig. 1. PRISMA flowchart.

Table 2
Number of studies based on selected outcomes indicators.

Indicator	Number of studies found	Citations
Nutrition Indicators	0	
Diet quality (DQ) indicators: Household dietary Diversity Score (HDDS); Food Consumption Score (FCS) and other non-standardized measures	7	[12–18]
Food Security: Food Insecurity Experience Scale (FIES); Household Food Insecurity Access Scale (HFIAS); direct questions on food insecurity perceptions	11[a]	[12–14,18–25]
Food availability (FAV): changes in agricultural operations; changes in trade flows; disruptions of food transportation.	7	[20,26–31]
Food accessibility (FAC): restricted access to markets	5	[20,21,27,32,33]
Food affordability (FAF): income decline and food price increase	22	[12–22,24,25,27,29,32–37]
Disruption in health and nutrition services (HNS)	4	[20,21,30,35]

[a] The studies we report in this table include the 6 rounds of the World Bank high-frequency phone survey conducted in Nigeria and Ethiopia that are referenced once for space reasons.

3.1. Nutritional indicators

No study reporting on nutritional status (e.g. BMI, child stunting and wasting) was found.

3.2. Diet quality indicators

Seven studies contained information on dietary quality using a variety of indicators [12–18], including: Household Dietary Diversity Score (HDDS) (57), Food Consumption Score (FCS) (58), food consumption and diets variations since the start of the pandemic. No study reported Minimum Dietary Diversity for Women (MMDW) and Minimum Acceptable Diet (MAD). The reviewed studies illustrate that the pandemic had disrupted the diets of the surveyed population, especially at the beginning of the outbreak and the imposition of restriction measures. For example, aggregate HDDS in Addis Ababa deteriorated at early stages of the pandemic (going from 9.3 in January–February 2020 to 8.5 in May and June 2020), but returned to pre-pandemic levels in August 2020 as restrictions were lifted (9.4) [12–14,17]. However, even when aggregate dietary diversity indicators improved as lockdown measures were lifted, all studies suggest that there had been a shift from relatively more expensive sources of calories (e.g., legumes, nuts, animal source foods) to cheaper ones (staples) raising concerns about the long-term effects of COVID-19 on dietary diversity and healthy diets [12,13,15–18]. In Addis Ababa (Ethiopia), Food Consumption Score (FCS) collected over three survey rounds (May–July 2020) [12–14,17] showed that compared to pre-pandemic baseline (January–February 2020) households were consuming fruit and animal source foods less frequently. In a study conducted in rural

Table 3
Summary table of included studies.

Geographic area and citation	Sample and unit of analysis	Nationally representative	Survey round(s) and month	Study Design	Indicators[a]	Peer Review (P) or Grey Literature (G)
Bangladesh [25]	2424 Mothers/female carers[b]	No	1 Round: May to June 2020 (compared to baseline 2017−2019)	Interrupted time-series	FS; FAF	P
Bangladesh [33]	1876 households	No	1 Round: 7−15 September 2020	Cross-sectional face-to-face and online survey[c]	DQ, FS, FAC, FAF	P
Cote D'Ivoire [35]	666 Households	No[d]	1 Round − April 2020	Cross-sectional telephone survey	FAF; HNS	G
Ethiopia [20]	3249 Households[e]	Yes	6 Rounds (May−October 2020)[f]	Longitudinal Phone Survey	FS; FAF; FAC; HNS	G
Ethiopia [14]	600 Households	No[g]	Rounds 1 May 2020	Longitudinal Phone Survey[h]	DQ; FS; FAV; FAF	G
Ethiopia [13]	589 Households	No	Round 2 June 2020	Longitudinal Phone Survey	DQ; FS; FAV; FAF	G
Ethiopia [12]	584 Households	No	Round 3 July 2020	Longitudinal Phone Survey	DQ; FS; FAV; FAF	G
Ethiopia [17]	577 Households	No	Round 4 August 2020	Longitudinal Phone Survey	DQ	G
Ethiopia [19]	2471 young people[i]	No	1 Round: June−July 2020 (compared with 2016 data)	Longitudinal Phone Survey	FS; FAF	G
Ethiopia [26]	100 value chain actors[j]	No	1 Round: April−May 2020	Cross-sectional Phone Survey on qualitative aspects	FAV	G
Ethiopia [15]	1188 Households[k]	No[l]	1 Round: June 2020	Cross-sectional phone survey	DQ[m], FAF	G
Ethiopia [31]	235 value chain actors[n]	No	2 Rounds: May 2020 (compared with Jan/Feb 2020 data)	Repeated cross-sectional phone survey	FAV; FAF	G
Ethiopia [22]	436 Households[o]	No	1 Round: July 2020	Cross-sectional phone survey	FA; FAF	G
India [16][p]	448 Adult men and women[q]	No	1 Round: May 2020	Cross-sectional phone survey	DQ; FAF	P
India [27]	1515 farming households[r]	No	1 Round (early-April and mid-May 2020)	Cross-sectional phone survey	FS; FAV; FAC	P
Kenya and Uganda [18]	Kenya: 313 & Uganda: 129	No[s]	1 Round: April 2020	Cross-sectional Online Survey	DQ; FS, FAF	P
Mexico [23]	833 Adult men and women[t]	Yes[u]	3 Rounds: April−June 2020	Cross-sectional Phone Survey[v]	FS	P
Nepal and Senegal [32][w]	Adult male and female Nepal: 656 Senegal: 503	No	1 Round: June to mid-July 2020	Cross-sectional phone survey	FAF, FAC	G
Nepal [28]	25 key informants[x]	No	2 Rounds (Mid-April and Mid-October 2020)	Repeated key informant interviews and literature review	FAV	P
Nigeria [21]	1950 Households[y]	Yes	6 Rounds: May−November 2020[z]	Longitudinal Phone Survey	FS; FAC; FAF; FAV; HNS	G
Nigeria [24]	Households and adult individuals Baseline sample: 4976 COVID-19 sample: 1950	Yes	2 rounds: May, June 2020 + Baseline Jul/Aug 2018	Panel Data	FS, FAF	G
South Africa [37]	30 Adult male and female[aa]	No	1 round: month not mentioned (likely to be March or April)	Exploratory qualitative study (via phone)	FAF	P
Vanuatu [29]	31 Adult male and female[ab]	No	1 round: April 2020	Cross sectional telephone rapid appraisal	FAV; FAF	P
Zambia [30]	40 self-employed women[ac]	No	1 Round: March−July 2020	Cross-sectional telephone semi-structured interviews	FAV; HNS	P

[a] DQ: Diet quality, FAV: Food Availability, FAF: Food Affordability, FAC: Food Accessibility, FS: Food Security, HNS: Disruption in health and nutrition services, NU: Nutrition.
[b] All participants were mothers or female guardians of children enrolled in the "Benefits and risks of iron interventions in children" (BRISC) trial—a randomised controlled trial of preventive iron supplementation or placebo given to infants aged 8 months (ACTRN12617000660381) with a primary outcome of child cognitive development after 3 months of intervention. The BRISC trial was set in Rupganj upazila (county) of Narayanganj district, a rural area about 35 km northeast of Dhaka, which covers about 235 km^2 and comprises about 82 000 households.
[c] Face-to-face survey was conducted in areas where contagion rates were low (green and yellow zones) while online surveys were conducted in areas with high contagion rates (red zones). Data from 1164 (62%) participants were collected randomly via face-to-face interviews, and data from 712 (38%) participants were collected using online platforms.
[d] The study was conducted in 30 districts of Abidjan.
[e] By the time this study was finalised, the World Bank High-frequency Phone Survey in Ethiopia had conducted 6 survey rounds (early May−October 2020). Each round included a different sample sizes: Round1: 3249; Round 2: 3107; Round 3: 3058; Round 4: 2878; Round 5: 2770; Round 6: 2704.
[f] Round 1: 2020-04-22/2020-05-13; Round 2: 2020-05-14/2020-06-03; Round 3: 2020-06-04/2020-06-26; Round 4: 2020-07-27/2020-08-14; Round 5: 2020-08-24/2020-09-17; Round 6: 2020-09-21/2020-10-14. Survey Methodology document can be found at the following link: http://documents1.worldbank.org/curated/en/107141590729601148/pdf/Survey-Methodology-Document.pdf.
[g] The study was conducted in Addis Ababa.
[h] Longitudinal reports conducted by IFPRI in Addis Ababa [12−14, 17] are part of the same study.
[i] This includes 1687 Younger Cohort respondents, aged 19, and 784 Older Cohort respondents, aged 25 years old.
[j] 100 commercial and small dairy farmers dairy processors, traders, development agents, urban retailers, and consumers in rural and urban Ethiopia.
[k] Respondents were all beneficiaries of the fourth phase of Ethiopia's Productive Safety Net Program (PSNP4) and who also participate in the USAID-funded Strengthening PSNP4 Institutions and Resilience (SPIR) project.
[l] The study setting was rural Ethiopia: North Wollo and Wag Hemra zones in Amhara, and primarily in East and West Hararghe zones in Oromia.

[m] The study included one question asked about the variations of children's egg and fresh dairy product consumption.
[n] Farmers included smallholders and investors (depending on the amount of land they were renting in) and they resided in the four major vegetable producing districts in East Shewa zone in the Oromia region (Adami Tulu, Bora, Dugda, and Lume). Urban wholesalers operated in Addis Ababa and urban retailers were located in five sub-cities in Addis Ababa.
[o] The population sample included urban poor households and "special segment" population (i.e. particularly vulnerable groups such as day labourers). The study was conducted in 10 selected cities in Ethiopia: Addis Ababa, Mekelle, Dire Dawa, Adama, Gambela, Bahir Dar, Jigjiga, Bule hora, Logia, and Semera. Participants were part of the Urban Productive Safety Net Project (UPSNP), households who own a small-scale business (SSB), and refugees/IDPs/returnees.
[p] The study was conducted in Jharkhand, Assam, Andhra Pradesh, and Karnataka.
[q] All respondents were farmers and producing vegetables.
[r] 1275 farmers in Haryana State and 240 farmers in Odisha State participated in the survey.
[s] The questionnaire was sent to random respondents in Kenya and Uganda using social media (WhatsApp, Facebook, Telegram, and Twitter), and via email.
[t] The study was included in 3 survey rounds with different sample sizes: Round1: 833; Round2: 850; Round3: 1674.
[u] The monthly surveys were collected based on a one-stage probabilistic sample of mobile telephone numbers which are randomly selected from the publicly available National Dialing Plan.
[v] ENCOVID-19 is a monthly telephone cross-sectional survey, representative at a national level of individuals 18 years and older who have a mobile phone.
[w] Farmers in rural Nepal (Dang district of Province 5) and rural Senegal (across the country).
[x] Online panel discussion and phone surveys were conducted between mid-April 2020 and mid- October 2020 among 10 government officers and 15 civil society and NGO officials working at different administrative levels.
[y] By the time this study was finalised, the World Bank High-frequency Phone Survey in Nigeria had conducted 6 survey rounds (May-November 2020). Each round included a different sample sizes: Round1: 1,950; Round 2: 1,820; Round 3: 1,737; Round 4: 1,691; Round 5: 1,656; Round 6: 1,640
[z] Full methodological details are reported here: https://microdata.worldbank.org/index.php/catalog/3712.
[aa] All individuals were residents of the Informal settlement in the city of Tshwane and they are beneficiaries of relief supplies from humanitarian organisations.
[ab] 22 men and 9 women (>18 years old) who have a position of leadership in the community were interviewed in 23 coastal sites.
[ac] All respondents were self-employed women and resided in the district of Ndola in Zambia.

Table 4
Examples of household food insecurity variation pre- and during-COVID-19 pandemic in selected countries.

Country	Pre-COVID-19	Post-COVID-19	Indicator
Nigeria [21]	51% (July/Aug 2018)	77% & 68% (Jun & Aug 2020)	FIES (Moderate and Severe Food Insecurity)
Kenya [18]	50%	88% (April 2020)	FIES (% of food insecure households)[a]
Uganda [18]	43%	87% (April 2020)	FIES (% of food insecure households)[a]
Mexico [23]	31% (2018)	42% (May 2020)	ELCSA[b] (Mild Food insecurity
Bangladesh [25]	6% (2017–2019)	36% (May–June 2020)	HFIAS (Moderate Food Insecurity)

Source: reproduction using multiple sources [18,21,23,25].
[a] Self-assessed FIES conducted in April 2020.
[b] ELCSA is an adapted version of HFIAS and has been extensively validated for Mexico to measure multidimensional poverty [23].

Ethiopia (regions of Oromia and Amhara), 70% and 68% of interviewed parents reported children's consumption of eggs and dairy had decreased, respectively, between February and June 2020 [15]. In India, Harris et al. [16] showed that, 62% of surveyed farm households reported changes in their diets as a result of COVID-19[4]; 17% of households did report a fall in ability to procure staple foods; approximately 50% and 25% reported falls in consumption of fruit and animal source foods (other than dairy) and pulses respectively. In Kenya and Uganda, a study conducted in April 2020 reported that 40% and 55% of respondents in the respective countries changed their diets involuntarily (especially to the detriment of nutritious foods) since the outbreak of the virus [18].

When gendered disaggregated data was available, evidence on dietary degradations, since the COVID-19 outbreak and imposition of restriction measures, showed women were affected to a larger degree than men. HDDS and FCS in Addis Ababa was consistently lower among female-headed households between May and July 2020 [12–14]; in India, women farmers were significantly more likely than men to report a stronger reduction in consumption of vegetables, fruit, and dairy products [16]. Since the pandemic 16% and 30% of women farmers reported that they were eating less and purchasing cheaper foods, respectively (compared to 5% and 6% of men, respectively).

3.3. Food security indicators

Eleven[5] studies assessed the status of food security since the outbreak of COVID-19 [12–14,18–25]. Studies used a variety of indicators including: Food Insecurity Experience Scale (FIES) (59), Household Food Insecurity Access Scale (HFIAS) (60) and non-standard food insecurity questions. The reviewed studies agree that levels of food insecurity during the pandemic were high; when pre-pandemic data were available, food insecurity indicators worsened during the COVID-19 outbreak [18,21,23–25] (Table 4).

The impact of food insecurity was differentiated among different demographic groups, such as female-headed households, poorer families, young adults and workers in the informal sector. In Addis Ababa, where the percentage of households in moderate and severe food insecurity status in July 2020 reduced compared to May and June 2020 (by approximately 5%), food insecurity remained higher among female-headed and poorer households [12–14]. In Ethiopia, a longitudinal study conducted among young individuals (June–July 2020) the likelihood of experiencing food insecurity was 27% higher among those that suffered food insecurity in the baseline survey (2016) and that lived in urban areas [19]. Similarly, urban vulnerable households, whose survival depends on daily generated income, restrictions and lockdowns led to food insecurity: the percentage of households who consumed an average of three meals a day reduced from 87.6% before COVID-19 to 62.2% at

[4] The study was conducted in May 2020, six weeks into the national lockdown and in the early stages of various states' relief packages. The paper reports that the question was asked in binary terms as: "Has your household diet changed as a result of COVID-19?" Therefore, it was unclear if the effects of COVID-19 are intended from when the first cases were registered in India (Jan 2020) or since lockdown measures took place (24th March 2020).

[5] The studies we report in this table include the 6 rounds of the World Bank high-frequency phone survey conducted in Nigeria and Ethiopia that are referenced once for space reasons.

the time of the interview [22][6]. A study conducted in Mexico [23] for which socio-economic status data disaggregation was available showed that, even though mild food insecurity was present at every SES level, moderate and severe food insecurity increased among lower socio-economic groups.

3.4. Food access indicators

Food access information were included in five studies [20,21,27,32,33]. Similarly to the previous indicators, food access was not measured in a uniform way among studies. Overall, the reviewed studies indicated food access was affected negatively since the start of the pandemic and hit poorer household to a larger degree [32]. Therefore, even if at later stages of the pandemic food access improved (i.e. when lockdown measures are lifted), the percentages of households having difficulties to access food are higher among lower income quintiles [21]. In Bangladesh, Kundu et al. [33] illustrated that 45.3% and 61.0% of interviewed households in September 2020 reported that they did not access the same quantity or type of food respectively as they did prior to COVID-19, respectively. The studies that reported access to different food items show that the changes were product specific, suggesting heterogeneous impacts across different food value chains. For example, yams and teff were the commodities less accessible by households in Nigeria and Ethiopia, respectively [20,21]. We observed that in Ethiopia there was a recovery a few months after the beginning of the pandemic [20], likely due to the easing of lockdown measures and distribution agricultural inputs.

3.5. Food availability indicators

In total seven studies reported food availability information [20,26–31]. Because standardised indicators were not used, the analysis firstly summarizes the evidence on the impacts of the pandemic and lockdown on food value chains and agricultural operations (4 studies [26–28,31]). It then moves to observational data on consumers self-assessment of food availability (3 studies [20,29,30]). The studies on the impacts of COVID-19 and the lockdown on value chains and farming operations provide snapshot of the status of a few value chains: dairy products and vegetables in Ethiopia [26,31]; wheat and pulses in India [27]; and a more generic overview of Nepal's food system [28]. These studies suggested that shorter value chains were better placed to survive the pandemic and movement restriction measures. However, poorer farmers living in areas with lack of adequate storage facilities and infrastructures were adversely affected by the marketing delays posed by restriction measures.

3.6. Food affordability indicators

Household income reductions and variations of food prices were selected to evaluate food affordability. One study, conducted in India (the states of Haryana and Odisha) directly asked farmers about affordability since the start of the lockdown [27][7]. The study shows large differences between the richer Haryana state, where in the period after the lockdown (April 2020) approximately 5% of farmers reported difficulties to afford sufficient variety of food, and the poorer state of Odisha, where baseline instances of food unaffordability were already high (approximately 90%), and no significant difference in affordability before and after the lockdown was found. Authors suggested more diverse cropping patterns, a higher prevalence of homestead gardens, and shorter value chains for agricultural products helped food affordability of farmers in Odisha [27].

3.6.1. Reduced income

There is much consensus among the studies that the major direct effect of COVID-19 and the measures put in place by local and national authorities has been through its impact on employment and, in turn, on income (22 studies [12–22,24,25,27,29,32–35,37]). Between 80% and 58% of respondents interviewed across Ethiopia, Nigeria, Kenya, Uganda, South Africa and Senegal reported either their incomes had decreased compared to the pre-pandemic baseline period directly affecting their food affordability due to adverse impacts on their regular source of income caused by reduction or closure of business activities, cessation of remittances, and government restrictions measures [12–15,18,20,21,32,37]. In Bangladesh, studies reported income decreased due to COVID-19 among 71,8% of respondents [33]; 96% of surveyed women reported a reduction in paid work and median monthly family income fall of 72% (USD 212 was the baseline level) [25].

Other studies in South East Asia indicated income losses in the first half of the year: farm income reportedly dropped for 90% of vegetable farmers in India [16]; a loss of income was reported among 85% of rural Nepalese households interviewed in June and mid-July 2020 [32]. Several of the reviewed studies highlighted that the figures are usually higher for informal workers and younger adults in urban areas [19,22,37], and in remote areas [29].

3.6.2. Food prices

The review of the impacts of the Covid-19 pandemic on food prices suggests a nuanced picture. Food price increases were reported in Nigeria [24][8], where, since the outbreak of COVID-19, the food consumer price index (CPI) increased by 24% and between April/May 2020 90% of households reported facing food price increase, compared to 85% in mid-March, and 19% between January 2017 and January 2018 [21]. In the capital of Côte d'Ivoire (Abidjan), 61% of respondents reported significant increases in food prices since the outbreak of the pandemic [35]. In Bangladesh [33], 94% of the 1876 households that took part in the study reported that they faced food price increases due to COVID-19.

Other studies suggested a more heterogeneous and variable food price situation, where prices can fluctuate over the course of several weeks. For example in Ethiopia, prices was the main reason to explain households' inability to purchase food items at the start of the pandemic (approx. 40% of respondents) [20]. However, this gradually decreased so by October 2020, high food prices were mentioned by <10% of respondents (mainly in urban areas).

3.7. Information on health and nutrition services disruption

Evidence on the impacts of COVID-19 and resulting government restriction measures on the provision of health and nutrition

[6] The 10 selected cities in Ethiopia include: Addis Ababa, Mekelle, Dire Dawa, Adama, Gambela, Bahir Dar, Jigjiga, Bule hora, Logia, and Semera. The study was conducted among 436 households part of Urban Productive Safety Net Project (UPSNP), households who own a small-scale business (SSB), and refugees/IDPs/returnees. The study had planned to conduct monthly interviews between July–December 2020.

[7] The survey included questions on self-assessed food affordability in the month prior to the interview (during the lockdown) and the month before the start of lockdown. Data was collected in April 2020.

[8] The Food Consumer Price Index (CPI) employed in the study was collected and constructed by the Nigeria Bureau of Statistics (NBS), which measures the average change in prices over time consumers pay for a basket of food items. Food CPI measures changes in the retail prices of food items and was the principal indicator of changes in retail food prices. It was used to measure consumer inflation in Nigeria's economy. The paper used food CPI for May 2019 and May 2020, corresponding to both survey rounds we employ in this study.

services in LMICs is scattered. Four studies (based in Nigeria, Ivory Coast, Zambia and Ethiopia) reported reductions of visits to health and nutrition services [20,21,30,35]. When rural-urban comparison was available, reductions were more prominent in rural areas [20]. The main reasons for declining recourse to these services included: lack of available medical personnel, movement restrictions and poor transport network lockdown and poor transport network during lockdown and fear of infection.

4. Discussion

4.1. Impact on diet and nutrition outcomes

In spite of their heterogeneity, studies converge to demonstrate a detrimental effect of COVID-19 pandemic and associated containment measures on diet quality and food insecurity in a range of LMICs countries. Studies in Nigeria, Mexico and Bangladesh showed a significant deterioration of food security pre- and post-COVID-19 pandemic periods, based on the existence of pre-pandemic data [21,23–25]. The same trend was reported for Uganda and Kenya using self-assessed food insecurity surveys. The COVID-19 pandemic may have affected diets and food security through various pathways [2]. There is a large consensus among the literature that one of the major direct effects of COVID-19 on food and nutrition outcomes has been through its impact on the employment, income and associated purchasing power. This is corroborated by the studies we assessed in the report [12–14,19–22,25,32,33,37] as well as by commentaries and reports produced by international organisations [38,39]. However, the link between a fall in income and changes in consumption behaviours and diet quality, although plausible, was not studied as such. Other channels of impact, such as physical access, availability and affordability of food provided a heterogeneous picture and were assessed via binary (and often simplistic) questions [20,21,27,32,33].

A shift from relatively more nutritious foods groups and expensive sources of calories (e.g., legumes, nuts, animal source foods) to relatively nutrient poor and cheaper ones (staples) was observed since the start of COVID-19 [12–18]. The production and distribution of perishable and more nutritious foods are often more prone to disruptions during a crisis [40,41]. Increased consumption of cheaper sources of calories and decreased levels of dietary diversity, are increasing concerns about the deepening of the triple burden of malnutrition (i.e. undernutrition; overweight and obesity; and micronutrient deficiencies) especially in light of rapid urbanization in LMICs [42,43]. Studies have described the incidence of elevated consumption of ultra-processed foods, alcohol and lack of physical activity during lockdown [44,45]. While these issues were not included in the primary outcomes of this review, there is urgent need to systematically assess the effects of COVID-19 on overweight and obesity, as a result of changes in consumers' behaviour, access to healthy diets and a general degradation in healthy diets environments.

4.2. Interacting factors

Dietary changes and food insecurity manifested various intensity degrees, duration and in different forms between and within countries. Several interacting factors can contribute to these. Firstly, the few studies on food value chains assessments suggested that shorter value chains and traditional smallholder farms were somewhat more resilient in the face of COVID-19. They depended on local inputs (local indigenous seeds, compost, and family and community labour exchange) as opposed to commercial or semi-commercial farms, more severely hit [26,28,46]. However, with the exception of one article [27], to our knowledge there were no other studies that linked the impacts of COVID-19 on agricultural processes and the dynamics and implications on rural households' incomes and food insecurity. Despite food systems thinking and analysis is recognised as an important and meaningful framework to conduct food security analysis, studies tended to focus separately either on food production or on aspects related to food consumption.

Secondly, different food systems actors and groups have experienced and suffered from the pandemic in different ways. Studies in Ethiopia and India have illustrated that poorer and female headed households were among those with the lowest levels of dietary diversity and food security indicators [12–14,20]. Moderate and severe food insecurity increased among lower socio-economic groups [23]. The impact of the pandemic has been particularly adverse on informal workers and young adults that relied on daily wages [19,22]. Given the informal nature of large sections of the food system in LMICs (where women represent large sections of food processing and sales in wet and formal markets), assessing the impacts on informal actors and defining targeted policies is considered a top priority to build back more resilient food systems [42].

Finally, there have been heterogeneous government responses to curb the virus and the timing and stringency of containment measures were variable. Moreover, interventions to mitigate the deleterious effect of the pandemic had also variable timing and intensity.

4.3. Effective mitigating strategies

It has been demonstrated that existing and well-functioning social protection programmes and public distribution of food can buffer the adverse effects on food insecurity during health crises [27,47,48]. For example, the evaluation of the Productive Safety Net Programme (PSNP) in Ethiopia during COVID-19 demonstrated that the likelihood of becoming food insecure by 9.3 percentage points in participants [47]. A recent simulation on government employment and income protection in Ethiopia has also demonstrated to be effective measures to protect vulnerable population food security during the pandemic [48]. But social safety nets cannot be effective on their own and there is a need for broader food systems interventions and investments to support food and nutrition security [49]. These include (and not limited to): i) building resilience of health and food systems to withstand shocks such as the COVID-19 pandemic; ii) strengthening and ring-fencing maternal and child essential health and nutrition services so that they are not sacrificed for emergency measures; iii) enhancing nutrition programme coordination and implementation; iv) engaging effectively with young people and women to support both the immediate COVID-19 efforts and the long-term aim of building back better [50]. For example, actions on external food environment domains can go from monitoring food prices, diet diversity, food security and malnutrition indicators to adopting subsidies and taxes that promote the purchase and consumption of nutritious foods based on food-based dietary guidelines [2,51]. Actions on personal food environment domains can encompass improving accessibility and affordability of foods by social protection programmes, or the promotion of sustainable healthy diets. Finally, this crisis can represent a window of opportunity for positive reforms to achieve the SDGs, including: enhancing shorter, sustainable and local food systems; investing in primary care, especially at the local level; valuing the role of informal workers in the food system (and other sectors).

4.4. Challenges and limitations

The situation is still multifaceted and sometimes difficult to interpret. A limited set of studies included baseline pre-COVID-19 data [17,21,23,25]. Without comprehensive longitudinal pre-

pandemic data, it may be difficult to disentangle the effect of the pandemic and annual and seasonal dietary diversity fluctuations or other factors to COVID-19 (e.g. Orthodox fasting in Ethiopia or infestations from armyworm and desert locusts [52]).

COVID-19 has also posed significant obstacles to collecting information on maternal and child nutritional outcomes [53], or standardized indices such as the MDD-W. We retrieved no data on such outcomes. Diet diversity and food security data were collected via phone and online surveys. While valuable in times of social distancing and movement restrictions such methods may have led to a bias toward easily or quickly 'measurable' or quantifiable data/indicators and respondents accessing digital devices. Also more data is needed from other countries and specific groups, e.g. under-5 children or women of child-bearing age. The nutrition status of populations also needs to be monitored and remote anthropometric assessment be done [54], possibly complemented by COVID-19 safe in-person visits. A thorough appraisal of mitigating policies is also needed. We acknowledge that such appraisal is difficult for complex interventions in time of crisis. However, we advocate for improved data collection to identify vulnerable groups and measure how interventions are successful in protecting them.

5. Conclusion

In conclusion, the current economic and heath crisis impact diet quality and food security, and this raises concerns about long term impacts on access to and affordability of nutrient-rich, healthy diets and their health implications [40,41,55]. Women and individuals with a low socio-economic are the most at risk of food insecurity. Social safety nets can be effective to protect them and must be urgently implemented. We advocate for improved data collection to identify vulnerable groups and measure how interventions are successful in protecting them.

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Author contribution

DR and LG: defined the methodology; FP: searched the databases; FP and DR carried out studies selection, quality appraisal, and data extraction; FP and DR wrote the paper; DR and LG made the necessary recommendations; and FP, DR, LG revised the manuscript. All authors have read and approved the final version of manuscript.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnu.2021.08.015.

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