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Changes and correlates of household food insecurity during COVID-19: a repeated cross-sectional survey of low-income households in peri-urban Peru

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Abstract

National lockdowns and containment measures to control the spread of COVID-19 led to increased unemployment, lower household incomes and reduced access to affordable and nutritious foods globally. This study aimed to examine changes and correlates of household food insecurity experience and mitigation strategies adopted in peri-urban Peru during the COVID-19 pandemic. Low income households with children age < 2 years in Lima and Huánuco participated in three repeated cross-sectional surveys from 2020 to 2022 (n = 759). We assessed changes in household food insecurity experience using the Food Insecurity Experience Scale. Correlates of moderate-severe food insecurity were analysed using univariate and multivariable linear mixed-effect regressions. We also assessed perceived impacts of the pandemic on livelihoods, coping strategies and receipt of financial or food assistance. Moderate-severe food insecurity was 47.0% in 2020 (survey 1) decreasing to 31.1% in 2022 (survey 3). In adjusted analyses, food insecurity was higher in households with perceived reduced income ($\beta = 12.69$ [6.82; 18.56]); in the lower socio-economic status (SES) tertiles (*compared to the relatively highest SES tertile*; middle tertile ($\beta = 20.91$ [9.89; 31.93]), lowest tertile ($\beta = 39.37$ [28.35; 50.40])); in households with ≥ 2 children < 5 years ($\beta = 8.78$ [2.05; 15.50]); and in Lima (*compared to Huánuco*; $\beta = 10.47$ [1.27; 19.67]). Food insecurity improved more among the relatively lowest SES compared to the relatively highest SES households between survey 1 and 3 (interaction $p = 0.007$). In conclusion, almost half of households experienced moderate-severe food insecurity mid-pandemic with greater risk observed in the most socio-economically disadvantaged households. The inequality gap in food insecurity associated with SES narrowed over time likely due to household coping strategies and reduced poverty.

Keywords COVID-19 · Pandemic · Household food insecurity · Low-income · Urban · Peru · Low- and middle-income country

Hilary M. Creed-Kanashiro and Emily K. Rousham have equally contributed to this work.

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1 Introduction

1.1 COVID-19 and its general effect

The direct impact of the COVID-19 pandemic on morbidity and mortality around the world is well recognised, but the indirect impacts of the pandemic on food security and nutrition are still being understood (Picchioni et al., 2021). COVID-19 disrupted both health and food systems and the subsequent global economic recession hit socially and economically disadvantaged groups hardest (Osendarp et al., 2021). National lockdowns and containment measures to control the spread of disease led to increased unemployment, lower household incomes and reduced access to affordable and nutritious foods globally. Furthermore, essential

nutrition services, including micronutrient supplementation and nutrition promotion programmes in low- and middle-income countries (LMICs) were reduced during the pandemic (Picchioni et al., 2021). The disruptions to health and food systems has implications for food security and malnutrition in all its forms.

1.2 The burden of malnutrition and food insecurity in LMICs and Peru

Prior to the pandemic, the nutritional challenges facing many LMICs stemmed from multiple forms of malnutrition, namely the coexistence of undernutrition and micronutrient deficiencies, alongside an increasing prevalence of overweight and obesity (Development Initiatives, 2018). The prevailing multiple forms of malnutrition were anaemia and overweight (including obesity) in women of reproductive age (WRA) alongside childhood stunting. In 2020, 87% of countries had a high prevalence of two of the three forms of malnutrition above and 30% had a high prevalence of all three forms (Development Initiatives, 2020). These multiple forms of malnutrition are expected to have increased as a result of the pandemic, along with rises in the proportion of the population living in extreme poverty (Osendarp et al., 2021). Within households, WRA and infants and young children (IYC) are at greater risk of developing multiple forms of malnutrition, particularly during adversity, as has been seen in previous global economic recessions (Brinkman et al., 2010), since these groups have higher nutrient requirements for growth, pregnancy and lactation.

In the twenty years before the pandemic, Peru made significant progress in tackling child undernutrition with stunting prevalence declining from 30.0% to 12.1% between 2007–2019 (INEI, 2020a). However, multiple forms of malnutrition coexist (Santos et al., 2021). Before the pandemic, anaemia prevalence was 18.8% in WRA and 38.8% among children aged 6–36 months (INEI, 2020a). In 2019, the prevalence of overweight and obesity was high, affecting 62.9% of WRA (INEI, 2020a).

Food insecurity plays a key role as a shared driver of multiple forms of malnutrition (FAO et al., 2021). In 2020, it was estimated that one third of the global population did not have access to an adequate diet (FAO et al., 2021) with a significant gender disparity. In 2022, moderate-severe food insecurity was estimated to affect 31.9% of women compared to 27.6% of men (FAO et al., 2022). Households headed by women are particularly vulnerable to food insecurity, with a systematic review indicating that the female-headed households were 75% more likely to be food insecure than male-headed households (Jung et al., 2017). Food and nutrition insecurity are also closely intertwined with gender inequalities and gender norms which vary across different countries and contexts, affecting women's access to

resources and services, including food (FAO et al., 2022; Joshi et al., 2019; Silva et al., 2023). This highlights the need for gender-sensitive responses to address food insecurity.

The number of people affected by food insecurity globally due to the pandemic was estimated to have grown by an additional 103 million from 2019–2020, and a further 46 million in 2021 (FAO et al., 2022). Using the Food Insecurity Experience Scale (FIES) (Cafiero et al., 2018), moderate-severe food insecurity increased globally from 26.6% to 30.4% from 2019 to 2020 (FAO et al., 2021). Moreover, the Latin America and the Caribbean region experienced the greatest increase from 29.4% to 37.5% from 2019 to 2020 (FAO et al., 2021). National data on food insecurity in Peru immediately before the pandemic are not available, but the closest survey conducted in 2015 reported 29.9% of households experiencing moderate-severe food insecurity, assessed using the FIES (World Bank, 2021). Furthermore, evidence suggests that those most affected by the pandemic were female headed households, those with a less educated head of household and relatively poorer households. Households that had to borrow rather than use savings were more likely to experience food insecurity (Dasgupta & Robinson, 2022).

1.3 Potential linkages between COVID-19, food insecurity and nutrition in LMICs and Peru

The pandemic impacted food insecurity and household nutrition through several mechanisms.

In the initial stages of lockdown, food availability was affected by disrupted food supply chains; accessibility of foods was reduced due to restrictions on movement outside the home, and affordability of foods was impacted by the rapid increase in unemployment and loss of income (Jafri et al., 2021; Pérez-Escamilla et al., 2020). Loss of income due to the pandemic was greatest among those self-employed and working within the informal sector. Hence, large numbers of already vulnerable households were placed at greater risk of food insecurity (Laborde et al., 2021). Reduced access to foods arose through closures of informal food outlets, such as street vendors, and through restricted access to formal food outlets for example through controlling customer numbers in supermarkets (Pérez-Escamilla et al., 2020). Lockdown measures also threatened livelihoods through disruptions to food supply chains nationally and internationally, affecting commercial food producers and consumers across the world (Hendriks et al., 2022).

The affordability of diets worsened during the pandemic, with an estimated 74% of the total population in 63 LMICs, including Peru, unable to afford a nutrient-adequate diet in the early stages of the pandemic (Laborde et al., 2021). Diet quality may have deteriorated through changes in the types and/or quantities (i.e. either through a reduction in the number of meals and/or portion sizes) of foods consumed, or a

combination of both (Jafri et al., 2021). In some studies, however, dietary diversity was not significantly reduced during the early stages of the pandemic, for example in a rural area of Guatemala (Ceballos et al., 2021) or in low-income urban areas of Peru (Pradeilles et al., 2022). More sustained impacts of the pandemic arose through the overall increase in poverty and economic recession in many countries leading to an increase in household food insecurity.

Peru was severely affected by the COVID-19 pandemic and had the highest mortality rate globally by June 2021 (Dyer, 2021). Despite swift government action to declare a national state of emergency and lockdown in March 2020, this did not effectively reduce transmission. Peru implemented multiple periods of lockdown and social restrictions throughout 2020 and 2021. The national state of emergency remained in place until late October 2022. Social protection measures were put in place after the initial lockdown through a range of emergency government cash transfers distributed to households (Curi-Quinto et al., 2021), but these measures may have been implemented too late to ameliorate the immediate economic crisis affecting many households. The proportion of the Peruvian population living in monetary poverty increased dramatically from 20.2% to 30.1% from 2019 to 2020 due to the pandemic (INEI, 2020b).

In this context, this study aimed to examine changes and correlates of household food insecurity experience and mitigating strategies adopted among low-income peri-urban households in Peru during the COVID-19 pandemic.

2 Methods

2.1 Study design and sampling

A repeated cross-sectional study (STAMINA) was conducted amongst low-income peri-urban households in Peru to assess the impact of the COVID-19 pandemic on household food insecurity, maternal and IYC nutrition. In this paper, we focus solely on food insecurity outcomes.

The study focused on households with IYC aged 6–23 months in two peri-urban communities: one in Lima (Manchay) and one in Huánuco district (Huánuco; Andean highlands ~ 1900 m above sea level) to represent the contrasting ecologies of coastal and highland Peru. Lima and Huánuco are both cities, with inner-city or central suburbs being areas of greater affluence and the peri-urban informal settlements being home to lower income and disadvantaged households. These peri-urban communities are on marginal lands, with limited access to water, electricity and local infrastructure. Selection of the study areas was done through consultation with the local and municipal authorities to target disadvantaged sectors. In each study area, the principal health centre and one subsidiary health centre were

purposely selected. Peri-urban low-income households within the jurisdiction of these health centres were selected to participate.

We conducted three surveys at approximately 6-month intervals over an 18-month period, starting in November 2020. The surveys were carried out in November–December 2020, July–August 2021 and in February–April 2022. The third survey took place over a longer period to allow for a household visit after the telephone interview. Results of the household visit in which anthropometric measurements were taken for the mothers and IYC are not reported here.

The sampling strategy targeting $n = 250$ mother-infant dyads for each survey of the STAMINA study was mixed (i.e. follow-up of participants combined with systematic random sampling for newly recruited participants). Sampling for survey 1 of the STAMINA study was based on follow-up of pre-COVID-19 survey participants from the PERUSANO study for those still eligible (IYC aged 6–23 months) (24.1% of the sample). The PERUSANO survey, conducted just before the pandemic from December 2019 to early March 2020, was part of a wider interdisciplinary project that aimed to address multiple forms of malnutrition, particularly stunting, anaemia, and risk of overweight/obesity, in urban Peru (Pradeilles et al., 2022). Sampling for surveys 2 and 3 of the STAMINA study was based on follow-up of eligible participants included in STAMINA surveys 1 (32.5% of the sample) and 2 (40.5% of the sample), respectively. To achieve the target sample of 250 for each survey, we supplemented this approach with systematic random sampling for the newly recruited participants to reach the target quota for IYC age group (6–11, 12–17 and 18–23 months) and study setting (Lima/Huánuco). The local authority child registration records were used to recruit participants. From the total number of eligible IYC records within an age group, every n^{th} record was selected to attain the required number of participants. At least two attempts were made to contact participants via telephone before noting them as unavailable. If one participant declined or was unavailable, the next birth record after that case was selected.

In all surveys, a screening questionnaire was used to check eligibility of mothers and IYC with the following inclusion criteria: i. singleton IYC aged ≥ 6 months and < 24 months on the day of interview; ii. no congenital malformations affecting nutrition or growth; iii. primary residence of mother/primary caregiver in the study site for the previous six months.

2.2 Data collection

For all surveys, data collection took place via telephone using structured questionnaires with pre-coded responses, administered by trained enumerators in Spanish. The questionnaire used for the STAMINA surveys (see data

availability statement) was similar to the one used previously in the PERUSANO study, however, additional questions in relation to the pandemic were added. The PERUSANO questionnaire was piloted in Lima (n = 20 interviews) using mothers of IYC living in a similar community (Canto Grande) nearby. For STAMINA, new questions were piloted via telephone on 15 caregivers. For all surveys, the questionnaire was produced in English and translated to Spanish and re-checked in both languages by a team member fluent in both languages. Questionnaires were completed using tablets (Samsung Galaxy Tab-A) with electronic data capture (CsPRO). The telephone interviews were conducted by five enumerators and one supervisor was responsible for checking the completed questionnaires. The interviews lasted between 40–90 min.

Data collected that are relevant for this particular study included: household food insecurity experience; socio-demographic characteristics; and COVID-19 pandemic related factors including changes in employment status, adaptations to finance, and sources of financial support such as cash transfers and food assistance. Questions relating to the impact of COVID-19 were developed through engagement with stakeholders and expert discussion forums that highlighted gaps in knowledge and concerns surrounding the potential impacts in Peru.

2.3 Data management and analyses

2.3.1 Household food insecurity

We measured the experience of household food insecurity using the validated FIES tool (Ballard et al., 2013; FAO, 2016; Cafiero et al., 2018), a global standard for monitoring food insecurity worldwide. The FIES was derived from the adult version of the Latin American and Caribbean Food Security Scale (Escala Latinoamericana y Caribeña de Seguridad Alimentaria, or ELCSA) (FAO, 2012; Pérez-Escamilla et al., 2007) to produce a shortened, standardised experience-based measure for use across sociocultural contexts (Ballard et al., 2013). The FIES survey module consists of eight questions regarding people's access to adequate food in the past 30 days. The internal reliability of the instrument in our study was good, as the modified Rasch reliability test was estimated at 0.80 (survey 1), 0.82 (survey 2), and 0.82 (survey 3) (Agarwal et al., 2009). Statistical techniques borrowed from the toolkit of Item Response Theory (Rasch models) allowed the generation of two prevalence estimates (i.e. probability that represents the range of severity of food insecurity) comparable across countries: i. moderate-severe food insecurity and ii. severe food insecurity only (Cafiero et al., 2018).

2.3.2 Socio-demographic factors

A common household wealth index for all three surveys combined was generated using factor analysis (i.e., multiple correspondence analysis) applied to proxy indicators of the household environment (ownership of consumer durables; source of drinking water and type of toilet facilities; number of household members per room used for sleeping; and type of materials used for the floors, roof and walls). This allowed comparison of relative SES over time. Livestock ownership (i.e. chicken/poultry, pigs, and/or sheep/goat) was not included in the household wealth index as we wanted to assess whether this was independently associated with household food insecurity. Variables with low variability (i.e., either less than 5% or more than 95%) were excluded from the analysis. As there were no major differences in proxy indicators of the household environment between Lima and Huánuco, the factor analysis was run on the two settings combined. The first principal component from the factor analysis explained 84.8% of the overall variance and hence this was retained. The continuous score of household wealth index (i.e. represented by the first principal component) was split into tertiles, with the first tertile representing the relatively poorest households. Internal validity was assessed by tabulating ownership of durable assets and other housing characteristics by SES tertile. Mothers' self-report of completed educational level was categorised as: less than secondary vs. secondary/technical and university level. Other socio-demographic characteristics included maternal employment status (working/not working); marital status (married/living together vs. not); maternal age; number of children U5; and place of residence (Lima vs. Huánuco).

2.3.3 COVID-19 pandemic related factors

Responses to questions on the financial impacts of the pandemic on households, coping strategies, sources of financial support and food assistance were collated (see Supplemental File 1 for definitions of COVID-19 related variables). We constructed a *coping mechanism score* based on responses to six key strategies adopted by households to deal with the financial impact of the COVID-19 pandemic: reduction of food expenditure; use of sharing pot/community kitchens; use of bank/cash savings or selling off assets; borrowing money/buying on credit; receipt of direct financial support from government, nongovernmental organisations (NGO) and/or family/friends; and receipt of direct food assistance from a range of programmes/institutions. The frequencies of responses to questions informed the categorisation and final number of variables to retain in the coping mechanism score. The score was used as both a continuous and dichotomous (<3 vs. ≥3 strategies) variable.

2.4 Statistical analyses

We generated descriptive statistics (mean, standard deviation (SD) or number (n), percent) for socio-demographic, COVID-related and food insecurity variables for each survey. To examine correlates of moderate-severe food insecurity prevalence, we performed univariate and multivariable linear mixed-effect regressions on the pooled sample with a random effect (intercept) to account for repeated measures across the three surveys (32.5% between survey 1 and survey 2, 40.5% between survey 2 and survey 3 and 7.5% between survey 1 and survey 3). Models included main effects of explanatory variables, as well as interactions with survey time when these were associated in non-adjusted models (likelihood ratio test with $p < 0.15$). Associations between financial assistance or safety nets and food insecurity were not analysed because of their potential bidirectional relationships. Specifically, in the modelling we could not determine whether the more food insecure households would have a greater entitlement to safety nets or whether receiving financial support would ameliorate food insecurity. Socio-demographic characteristics associated with the coping mechanism score (i.e. number of strategies (out of six) used to deal with the financial impact of the COVID-19 pandemic) were also studied using mixed-effect models. We used Stata SE version 17 for statistical analyses.

3 Results

3.1 Socio-demographic characteristics of the study samples

Overall, 759 mother-infant dyads were included in the study ($n = 254$ for survey 1, $n = 252$ for survey 2 and $n = 253$ for survey 3) (Table 1). Across the three surveys, socio-demographic characteristics were balanced, except for socio-economic status. The proportion of relatively lowest SES households was similar between surveys 1 and 2 (~37.0%) but lower in survey 3 (25.7%). Equally, the proportion of relatively highest SES households was greater in survey 3 (41.5%) compared to survey 2 (26.2%) and survey 1 (32.3%). Socio-demographic characteristics stratified by area of residence (Lima vs. Huánuco) are presented in Supplemental File 2. Livestock ownership remained stable across the three surveys (~50.0%) (Table 1) but was higher in Huánuco compared to Lima (58.7% vs. 40.5%; $p < 0.001$) (Supplemental File 2). The proportion of households that reported using savings or selling off assets was higher in Huánuco than in Lima (59.2% vs. 41.5%; $p < 0.001$). Similarly, there were more households that reported borrowing money in Huánuco than in Lima (48.3% vs. 19.8%; $p < 0.001$). Finally, more households in Huánuco reported receiving food from any assistance programme (64.8% vs. 54.8% in Lima; $p < 0.009$) (Supplemental File 2).

Table 1 Socio-demographic characteristics of the sample at each survey

	Survey 1 ^(a)	Survey 2 ^(a)	Survey 3 ^(a)	p-value ^(b)
	n = 254	n = 252	n = 253	
Maternal age at date of survey completion (years)	29.8 (6.1)	29.9 (6.0)	30.5 (6.5)	< 0.001
Maternal employment (working) ^(c)	55 (21.7%)	45 (17.9%)	62 (24.5%)	0.038
Maternal education ^(c)				0.44
< secondary	72 (28.5%)	82 (32.5%)	73 (28.9%)	
≥ secondary	182 (71.5%)	170 (67.5%)	180 (71.1%)	
Maternal marital status (married/living together) ^(c)	215 (85.0%)	207 (82.1%)	223 (88.1%)	0.27
Place of residence				0.98
Lima	128 (50.4%)	128 (50.8%)	127 (50.2%)	
Huánuco	126 (49.6%)	124 (49.2%)	126 (49.8%)	
Caregiver = mother	245 (96.5%)	249 (98.8%)	249 (98.4%)	0.30
Socio-economic status (tertiles)				< 0.001
lowest	94 (37.0%)	94 (37.3%)	65 (25.7%)	
middle	78 (30.7%)	92 (36.5%)	83 (32.8%)	
highest	82 (32.3%)	66 (26.2%)	105 (41.5%)	
At least 2 children < 5 y	43 (16.9%)	50 (19.8%)	62 (24.5%)	0.18

Means and SD (standard deviation) are presented for continuous variables; n (%) for categorical variables

^(a)Survey 1, November–December 2020; Survey 2, July–August 2021; Survey 3, February–April 2022

^(b)Continuous variables: mixed linear regression; and categorical variables: mixed ordinal logistic / logistic regressions

^(c)1 missing data for Survey 1

3.2 Household food insecurity changes over time

The prevalence of moderate-severe food insecurity decreased over time from 47.0% (2020) to 31.1% (2022). The largest decline was found between surveys 2 and 3 (43.5% vs. 31.1%) (Fig. 1a). The prevalence of severe food insecurity was low in each survey, ranging from 4.1% to 1.3% (survey 1 to survey 3) (Fig. 1b). The prevalence of moderate-severe food insecurity was higher at all time points in Lima compared to Huánuco. Food insecurity decreased over time in both locations, but the decrease was relatively greater in Huánuco (Fig. 1a).

3.3 Factors associated with moderate-severe food insecurity

Estimates from univariate models are shown in Table 2. Food insecurity was higher in households perceiving reduced income ($\beta = 20.69$ [95% CI: 15.33; 26.06]); in the lower SES tertiles (compared to the relatively highest SES tertile; middle tertile ($\beta = 18.05$ [11.43; 24.68]), lowest tertile ($\beta = 29.56$ [22.59; 36.53])); in households with ≥ 2 children

U5 ($\beta = 11.82$ [4.40; 19.24]); and in Lima (vs. Huánuco) ($\beta = 13.92$ [7.74; 20.10]). Food insecurity was lower in households with married/cohabiting mothers ($\beta = -7.11$ [-15.61; 1.39]); working mothers ($\beta = -10.72$ [-17.73; -3.70]); and mothers with secondary education (vs. primary) ($\beta = -7.84$ [-14.56; -1.12]). Moderate-severe food insecurity was also lower in surveys 2 ($\beta = -6.75$ [-12.58; -0.91]) and 3 ($\beta = -18.33$ [-24.88; -11.78]) compared to survey 1. Preliminary analyses revealed interaction effects on food insecurity between time of survey and place of residence ($p = 0.14$); time of survey and household SES ($p = 0.003$); time of survey and maternal education ($p = 0.09$); and time of survey and maternal employment status ($p = 0.06$) (data not shown). For household SES, the inequality gap of FIES was higher at survey 1 (>40% percentage points (pp) difference between the relatively lowest and highest tertile) and decreased over time (27.7% pp at survey 2 and 17% pp at survey 3) (Fig. 2a).

In multivariable models, food insecurity was higher in households perceiving reduced income ($\beta = 12.69$ [6.82; 18.56]); in the lower SES tertiles (compared to the relatively highest SES tertile; middle tertile ($\beta = 20.91$ [9.89; 31.93]), lowest

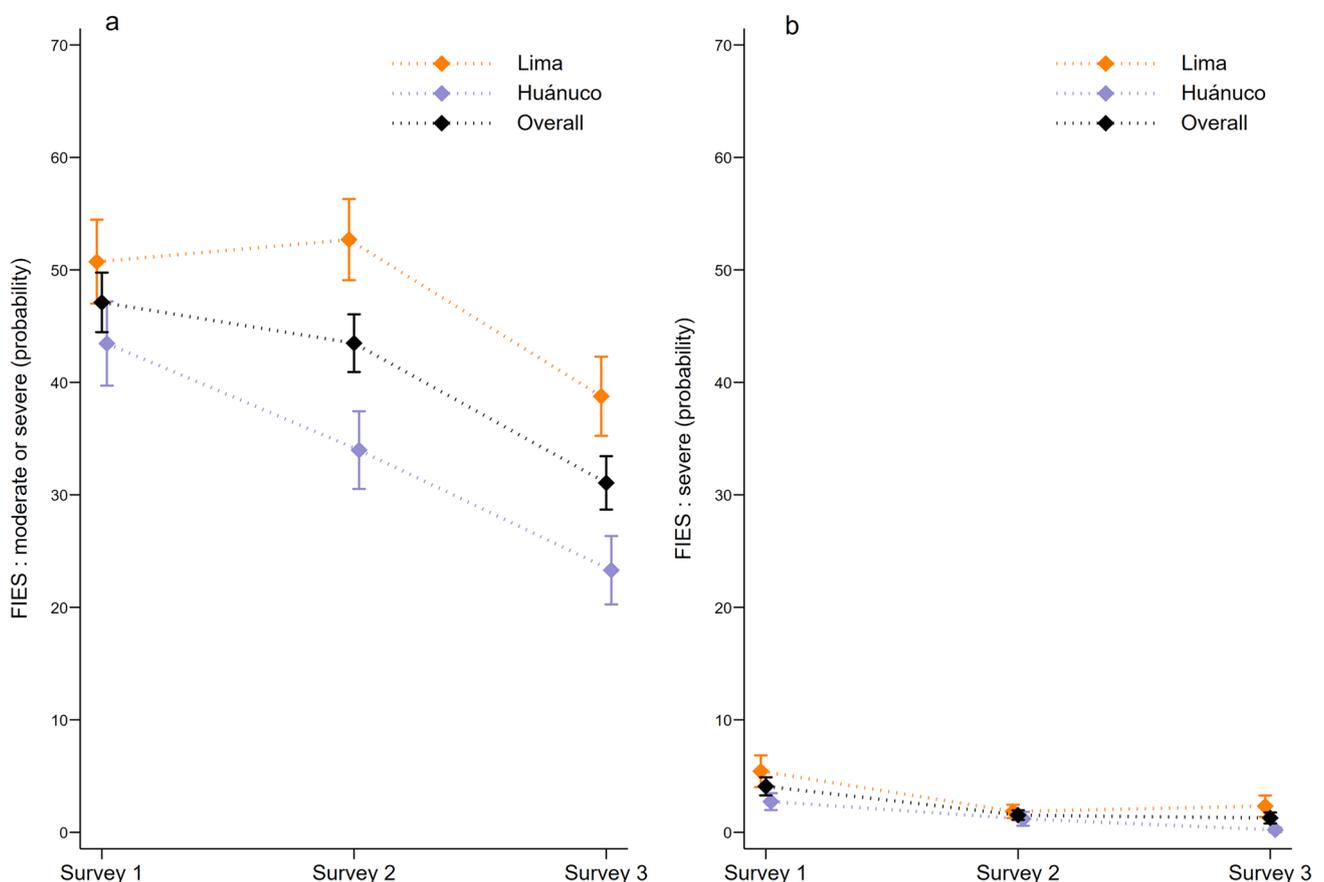


Fig. 1 Prevalence of moderate-severe and severe food insecurity at each survey point (overall and according to place of residence). Footnote: Panel **a** moderate or severe food insecurity; **b** severe food insecurity

Table 2 Factors associated with moderate-severe food insecurity (univariate models) across all three surveys (n = 759)

	Beta ^(a)	CI 95% ^(a)	p-value ^(a)
Survey (ref=survey 1)			<0.001
<i>survey 2</i>	-6.75	-12.58; -0.91	0.023
<i>survey 3</i>	-18.33	-24.88; -11.78	<0.001
Place of residence (Lima) (ref=Huánuco)	13.92	7.74; 20.10	<0.001
Maternal age (per 5 y)	1.80	-0.72; 4.32	0.16
Maternal employment status=working (ref=not working)	-10.72	-17.73; -3.70	0.003
Maternal education ≥ secondary (ref= < secondary)	-7.84	-14.56; -1.12	0.022
Maternal marital status=married/living together (ref=not married/living together)	-7.11	-15.61; 1.39	0.10
At least 2 children < 5 y	11.82	4.40; 19.24	0.002
Socio-economic status (tertiles) (ref=highest)			<0.001
<i>lowest</i>	29.56	22.59; 36.53	<0.001
<i>middle</i>	18.05	11.43; 24.68	<0.001
Livestock ownership	0.69	-5.16; 6.54	0.82
Current household income levels considered less	20.69	15.33; 26.06	<0.001

^(a)Estimates are obtained from linear mixed-effect regressions on the pooled sample

tertile ($\beta=39.37$ [28.35; 50.40]); in households with ≥ 2 children U5 ($\beta=8.78$ [2.05; 15.50]); and in Lima (vs. Huánuco) ($\beta=10.47$ [1.27; 19.67]) (Table 3). Food insecurity was lower

in households with married/cohabiting mothers ($\beta=-9.32$ [-17.14; -1.49]). Furthermore, we found that the interaction between the time of survey and SES on food insecurity

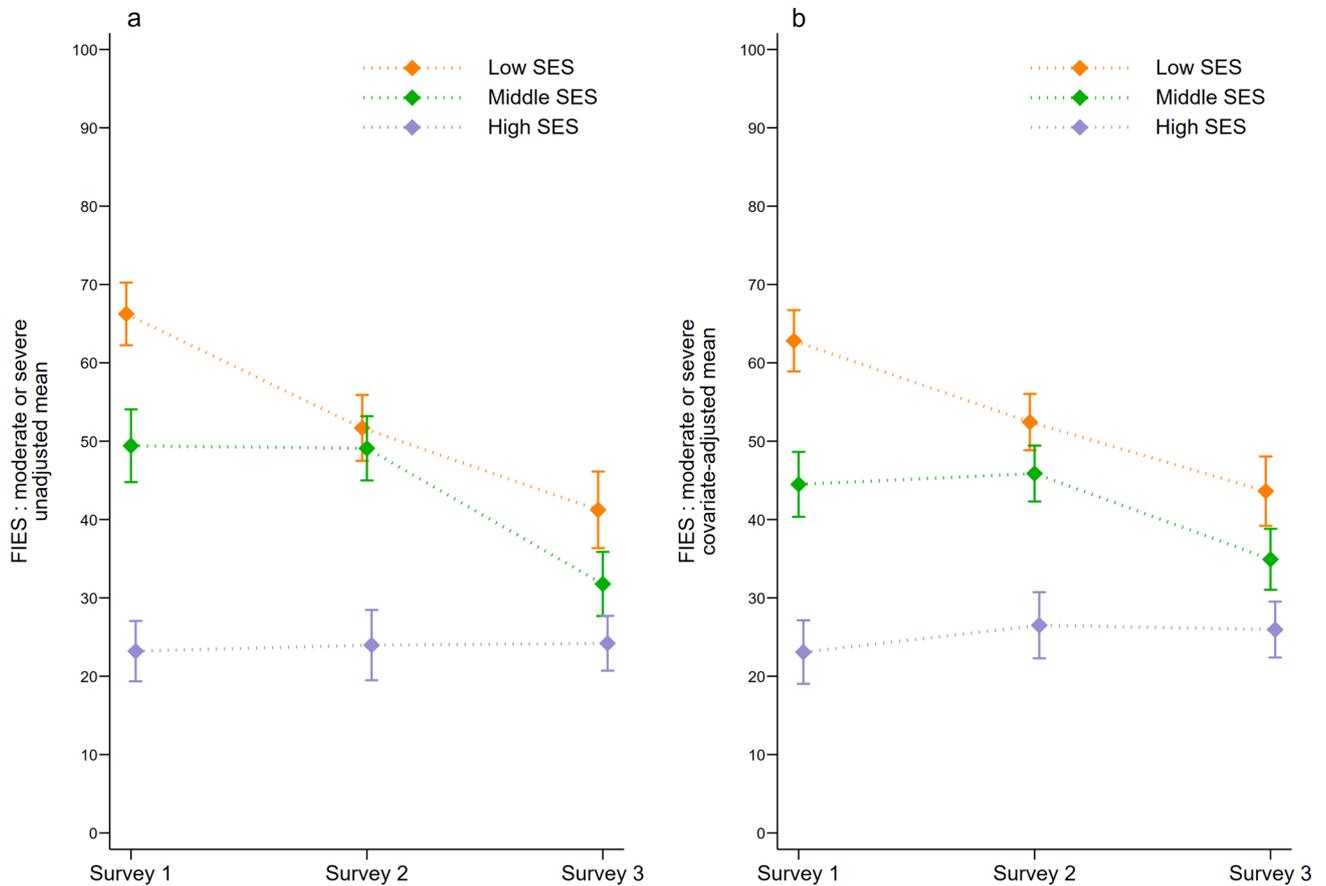


Fig. 2 Prevalence of moderate-severe food insecurity at each survey point according to socio-economic status. Footnote: **a** unadjusted means; **b** covariate-adjusted means. (1) Mixed effect models with random effect (intercept) included main effects of explanatory variables

Table 3 Factors associated with moderate-severe food insecurity across all three surveys (multivariable models) (n = 757)

	Beta ^(a)	CI 95% ^(a)	p-value ^(a)
Survey (ref = survey 1)			0.41
<i>survey 2</i>	-4.89	-22.02; 12.25	0.58
<i>survey 3</i>	-11.85	-29.36; 5.65	0.18
Place of residence = Lima (ref = Huánuco)	10.47	1.27; 19.67	0.026
Survey x Place of residence (ref = survey 1 & Lima)			0.43
<i>survey 2 & Lima</i>	7.65	-3.90; 19.19	0.19
<i>survey 3 & Lima</i>	4.83	-7.73; 17.38	0.45
Maternal occupation = working (ref = not working)	-10.43	-21.37; 0.51	0.062
Survey x Maternal occupation (ref = survey 1 & Maternal working (yes))			0.31
<i>survey 2 & Maternal working (yes)</i>	4.86	-10.25; 19.96	0.53
<i>survey 3 & Maternal working (yes)</i>	11.42	-3.35; 26.19	0.13
Maternal education ≥ secondary	-8.85	-18.56; 0.85	0.074
Survey x Maternal education (ref = survey 1 & Maternal education ≥ secondary)			0.14
<i>survey 2 & Maternal education ≥ secondary</i>	4.49	-7.94; 16.92	0.48
<i>survey 3 & Maternal education ≥ secondary</i>	13.17	-0.28; 26.62	0.055
Socio-economic status (tertiles) (Ref = highest)			<0.001
<i>lowest</i>	39.37	28.35; 50.40	<0.001
<i>middle</i>	20.91	9.89; 31.93	<0.001
Survey x Socio-economic status (SES) (ref = survey 1, SES highest)			0.060
<i>survey 2 & SES (lowest)</i>	-13.47	-28.24; 1.29	0.074
<i>survey 2 & SES (middle)</i>	-2.26	-17.48; 12.96	0.77
<i>survey 3 & SES (lowest)</i>	-21.59	-37.19; -5.99	0.007
<i>survey 3 & SES (middle)</i>	-12.59	-27.46; 2.28	0.097
Maternal age (per 5 y)	1.26	-1.06; 3.58	0.29
Maternal marital status = married/living together (ref = not married/living together)	-9.32	-17.14; -1.49	0.020
At least 2 children < 5 y	8.78	2.05; 15.50	0.011
Livestock ownership (yes vs. not)	-1.80	-7.21; 3.60	0.51
Current household income levels considered less	12.69	6.82; 18.56	<0.001

^(a)Estimates are obtained from linear mixed-effect regressions on the pooled sample. Models included main effects of explanatory variables, as well as interactions with survey time. Interactions were tested using the likelihood ratio test

remained significant after adjustment (Fig. 2b). The levels in food insecurity improved more between survey 1 and 3 among the relatively lowest SES tertile compared to the relatively highest SES tertile ($\beta = -21.59$ [-37.19; -5.99]) (Table 3 and Fig. 2b).

3.4 Perceived impacts of COVID-19 on households and coping strategies

The proportion of households who reported being financially impacted by the pandemic was high across the three surveys, but lower in survey 3 (84.6% vs. 98.0% in survey 1 and 94.0% in survey 2) (Table 4). The proportion of households who reported a reduced household income due to the pandemic was 90.9% in survey 1 and fell to ~50% or less in surveys 2 and 3.

The overall coping mechanism score (out of six) was 3.4 (1.3) in survey 1, 2.9 (1.4) in survey 2 and 1.8 (1.2) in survey 3 ($p < 0.001$). A very high proportion of households (> 75.0%) declared making changes or adjustments within their household

due to the financial impact of the pandemic. These included: reducing food expenditure; using sharing pot/community kitchens; using bank/cash savings or selling assets; and borrowing money. The proportion of households reporting using these strategies was lower in both surveys 2 and 3, compared to survey 1.

The proportion of households receiving financial assistance (i.e. financial help from government, nongovernmental organisations or family) during the pandemic was relatively high in surveys 1 and 2 (77.5% and 62.7%, respectively) but fell to 2.0% in survey 3 ($p < 0.001$). More than half of households received food assistance from programmes/institutions across the three time points. Receipt of the *vaso de leche* programme (glass of milk provided to children aged 0–6 years and pregnant women) increased over time, being nearly four times higher in survey 3 compared to survey 1 (Table 4). Household strategies according to area of residence are presented in Supplemental File 2.

Table 4 The impact of the COVID-19 pandemic on household livelihoods, coping strategies, and financial and food assistance received during the pandemic at three survey points

	Survey 1 ^(a)	Survey 2 ^(a)	Survey 3 ^(a)	p-value ^(b)
	n = 254	n = 252	n = 253	
Household financially impacted by the pandemic	249 (98.0%)	237 (94.0%)	214 (84.6%)	< 0.001
Current household income levels considered less	231 (90.9%)	129 (51.2%)	107 (42.3%)	< 0.001
Changes/adjustments within the household due to economic impact of pandemic ^(c)	238 (93.7%)	216 (86.4%)	192 (75.9%)	< 0.001
Coping strategies to deal with financial impacts				
Reduced food expenditure ^(c)	146 (57.5%)	127 (50.8%)	88 (34.8%)	< 0.001
Sharing pot/community kitchens ^(c,d)	105 (41.3%)	83 (33.2%)	60 (23.7%)	< 0.001
Used bank/cash savings/sold off assets ^(c)	172 (67.7%)	122 (48.8%)	86 (34.0%)	< 0.001
Borrowed money / bought on credit ^c	101 (39.8%)	89 (35.6%)	66 (26.1%)	0.0056
Receipt of financial assistance				
Any financial help (at least one of the options below)	196 (77.5%)	158 (62.7%)	5 (2.0%)	< 0.001
Government bonus (for independent worker)	13 (5.1%)	37 (14.7%)	0 (0.0%)	0.012
Government bonus (stay home)	170 (67.2%)	81 (32.1%)	1 (0.4%)	< 0.001
Child < 2 y bonus	27 (10.7%)	85 (33.7%)	2 (0.8%)	0.002
NGO bonus	1 (0.4%)	0 (0.0%)	0 (0.0%)	.. ^(e)
Electricity bonus	31 (12.3%)	5 (2.0%)	0 (0.0%)	0.002
Financial help from family member/ friend/ acquaintance	4 (1.6%)	2 (0.8%)	1 (0.4%)	0.41
Other Government bonus	3 (1.2%)	1 (0.4%)	2 (0.8%)	0.68
Receipt of food assistance				
Household receiving food from any programme/institutions	151 (59.4%)	157 (62.3%)	145 (57.3%)	0.43
Vaso de leche (glass of milk for children under 6 y, pregnant women)	24 (9.4%)	76 (30.2%)	91 (36.0%)	< 0.001
Qaliwarma for primary school children (food baskets for home)	38 (15.0%)	87 (34.5%)	81 (32.0%)	< 0.001
Municipality food basket	71 (28.0%)	36 (14.3%)	11 (4.3%)	< 0.001
Other programme/institution	47 (18.5%)	39 (15.5%)	38 (15.0%)	0.53
Coping mechanism score ^c (financial help, used bank savings...) / 6 ^(f)	3.4 (1.3)	2.9 (1.4)	1.8 (1.2)	< 0.001
Concerns pandemic has brought (3 max)				
Unemployment/loss of income	217 (85.4%)	204 (81.0%)	171 (67.6%)	< 0.001
High cost of food	43 (16.9%)	104 (41.3%)	116 (45.8%)	< 0.001
Social distancing	18 (7.1%)	11 (4.4%)	15 (5.9%)	0.42
Fear of getting infection/dying for yourself	187 (73.6%)	192 (76.2%)	185 (73.1%)	0.74
Fear of infection/dying for other family members	76 (29.9%)	71 (28.2%)	59 (23.3%)	0.30
Loss of a family member in the household	5 (2.0%)	5 (2.0%)	13 (5.1%)	0.070
Travel/transport restrictions	7 (2.8%)	5 (2.0%)	5 (2.0%)	0.79
Food supply shortages	20 (7.9%)	12 (4.8%)	6 (2.4%)	0.025
Quarantine/isolation/ mental wellbeing	78 (30.7%)	38 (15.1%)	47 (18.6%)	< 0.001
Shops being closed	213 (83.9%)	202 (80.2%)	167 (66.0%)	< 0.001
Schools/daycare centres/Cuna Mas being closed	19 (7.5%)	24 (9.5%)	24 (9.5%)	0.58
Difficulty accessing health services	52 (20.5%)	15 (6.0%)	22 (8.7%)	< 0.001
Other concern	9 (3.5%)	2 (0.8%)	4 (1.6%)	0.098

n (%) are presented for categorical variables and mean (SD) for continuous variables

^(a)Survey 1, November–December 2020; Survey 2, July–August 2021; Survey 3, February–April 2022

^(b)binary variables: mixed logistic regressions; continuous variables: mixed linear regression

^(c)2 missing data for survey 2

^(d)Sharing pots: shared cooking between neighbours; community kitchens: Community spaces that receive food donations from the municipality or food programmes

^(e)Convergence not achieved

^(f)The coping mechanism score (maximum six) was the sum of any of the following: reduced food expenditures; sharing pot/community kitchens; used bank/cash savings/sold off assets; borrowed money/bought on credit; household receiving direct financial support; household receiving food from any programme/institutions

Most of the concerns associated with the pandemic decreased over time; except concerns around the high cost of food which increased from 16.9% to 45.8% from survey 1 to survey 3 ($p < 0.001$) (Table 4).

Household SES was the only socio-demographic factor associated with the coping mechanism score when analysed as a dichotomous variable (≥ 3 strategies vs. < 3) (Table 5). Households in the relatively lowest SES tertile were more likely to use ≥ 3 strategies vs. < 3 (38.7% vs. 26.4%, overall p trend < 0.001) whilst households in the relatively highest SES tertile were less likely to use ≥ 3 strategies vs. < 3 (27.2% vs. 40.9%, overall p trend < 0.001).

4 Discussion

4.1 Summary and interpretation of findings

This study demonstrates the dynamic changes in food insecurity experienced during the COVID-19 pandemic among vulnerable households with IYC in a middle-income country. The study highlights how households navigated through the crises by adopting a range of coping strategies, assisted in part by direct receipt of financial

and food support. Within this comparatively low-income sample, households in the relatively poorest tertile were significantly more likely to adopt a greater number of coping strategies (≥ 3) yet were more likely to experience moderate-severe food insecurity compared to the relatively highest SES tertile. Importantly, however, we also found that the inequality gap in food insecurity between the relatively highest and lowest SES tertiles narrowed over time from a difference of > 40 percentage points to 17 percentage points (survey 1 to survey 3), indicating some amelioration of conditions for the relatively poorest households.

A high prevalence of moderate-severe household food insecurity was sustained at 47.0% and 43.5% (November–December 2020 to July–August 2021) and then declined to 31.1% in the final survey (February–April 2022). A 47.0% prevalence of moderate-severe food insecurity in the present study is markedly higher than the prevalence (22.6%) reported among young adults in urban Peru between March and December 2020 (Curi-Quinto et al., 2021). Our prevalence is also higher than that found in a retrospective online survey conducted in eight cities in Peru (19.4%) in December 2020 (Zila-Velasque et al., 2022), potentially reflecting the higher education level of those in the sample (65% university/technical education students). In Mexico,

Table 5 Socio-demographic characteristics of households according to the coping mechanism score (< 3 compared to ≥ 3) during the pandemic

	Coping mechanism score ^(a) < 3	Coping mechanism score ^(a) ≥ 3	p-value ^(b)
	n = 330	n = 426	
Socio-demographic characteristics			
Mothers age (y) at date of survey completion	29.8 (6.5)	30.3 (6.0)	0.38
Maternal employment status = working	80 (24.2%)	82 (19.2%)	0.11
Maternal education (2 categories)			0.22
$< secondary$	91 (27.6%)	136 (31.9%)	
$\geq secondary$	239 (72.4%)	290 (68.1%)	
Maternal marital status = married/living together	282 (85.5%)	361 (84.7%)	0.79
Place of residence			0.19
Lima	176 (53.3%)	207 (48.6%)	
Huánuco	154 (46.7%)	219 (51.4%)	
Caregiver = mother	324 (98.2%)	416 (97.7%)	0.55
Socio-economic status (tertiles)			< 0.001
lowest	87 (26.4%)	165 (38.7%)	
middle	108 (32.7%)	145 (34.0%)	
highest	135 (40.9%)	116 (27.2%)	
At least 2 children < 5 y	60 (18.2%)	95 (22.3%)	0.18
Mother/primary caregiver tends to make decisions about food expenditure	223 (67.6%)	293 (68.8%)	0.77

Means and SD (standard deviation) are presented for continuous variables; n (%) for categorical variables

^(a)The coping mechanism score (maximum six) was the sum of any of the following: reduced food expenditures; sharing pot/community kitchens; used bank/cash savings/sold off assets; borrowed money/bought on credit; household receiving direct financial support; household receiving food from any programme/institutions

^(b)Continuous variables: mixed linear regression; and categorical variables: mixed ordinal logistic / logistic regressions

food insecurity was estimated to have increased by 25% nationally from 2018–2020 with moderate or severe food insecurity increasing from 24.0% in 2018 to 30.2% in June 2020 (Gaitán-Rossi et al., 2021). The higher prevalence in the present study likely reflects the disadvantaged socio-economic conditions in peri-urban communities in Peru.

In parallel with the decrease in food insecurity, we see evidence of an improvement of SES over time, with a greater proportion of relatively higher SES households in survey 3 (41.5%) compared to survey 2 (26.2%) and survey 1 (32.3%). This accords with national data from Peru reporting a decrease in monetary poverty from 2020 to 2021 (from 30.1% to 25.9%, respectively) (INEI, 2022). In the present study, other socio-demographic indicators (maternal education, number of children U5) remained constant over time, which suggests that the increase in SES may be actual rather than due to sampling effects.

The very high prevalence of food insecurity found in the current study is likely to impact the diet quality of mothers and IYC feeding practices in the targeted households. Dietary surveys in the same low-income peri-urban communities in Peru indicated that maternal dietary diversity and IYC dietary indicators (6–23 months) did not deteriorate from pre-pandemic to pandemic (December 2020) (Pradeilles et al., 2022), which is at odds with the high prevalence of moderate-severe food insecurity in the first survey. Dietary indicators, however, do not capture data on the quantity of foods consumed, nor the variety of different foods within a food group hence would not have detected reductions in quantities of food consumed or deterioration in nutrient coverage. In the current study, however, a high proportion of households reported a reduction in food expenditure, as well as moderate-severe food insecurity, which means food quantities may have been reduced, or more affordable food items may have been purchased, for example cheaper animal-source foods such as processed meats, or reduced variety of different fruit and vegetables. In other LMICs (Kenya, Uganda and Ethiopia), studies reported a shift away from nutritious foods and greater consumption of more affordable foods such as staples, leading to a worsening of diet quality (Hirvonen et al., 2021; Kansiime et al., 2021).

Similar coping strategies to those adopted in our sample have been reported elsewhere (Angeles-Agdeppa et al., 2022; Nguyen et al., 2021). In food insecure households in India, strategies included reductions in non-food expenditures, borrowing money to buy food, selling jewellery or other assets and spending savings (Nguyen et al., 2021). In the Philippines, purchasing food on credit, borrowing food from family and loans from relatives and friends were among the coping strategies of food insecure households (Angeles-Agdeppa et al., 2022). In the same study, the relatively poorest households were more likely to become moderate

to severely food insecure compared to middle income households. In our study, food insecurity may have been lower among peri-urban households in Huánuco compared to Lima due to the greater access to safety nets (financial and food assistance) as well as a greater proportion of households reporting selling assets, using savings or borrowing/buying on credit. Cross-sectional surveys in nine African countries found that cash safety nets were slightly more effective than food provision in reducing food insecurity during the pandemic (Dasgupta & Robinson, 2022).

4.2 Strengths and weaknesses

The repeated cross-sectional design allowed direct comparison of food insecurity experience of households with IYC aged 6–23 months at three time points over the course of the pandemic. We chose households with IYC aged 6–23 months to represent the complementary feeding period which is a critical period in nutrition across the life span. A strength of the study is that we recruited from health registration records which, while not necessarily fully comprehensive, are likely to have captured a representative proportion of households with IYC in the study areas. Accurate assessment of household food security in many countries was hampered during the pandemic by the challenges of collecting data remotely. Many studies employed online, self-completion surveys or questionnaires circulated via social media which generally over-represented the more socio-economically advantaged households (Jafri et al., 2021; Kansiime et al., 2021). Our recruitment method minimised self-selection bias compared to online surveys and avoided the barriers of self-completion questionnaires for participants with lower literacy and numeracy. A further strength was the use of experienced enumerators who had worked directly in the communities (in person) before the pandemic struck and therefore knew the context of these households. The significant restrictions in movement and social contact through the different waves of the pandemic in Peru, with social distancing measures such as school closures continuing up to March 2022, meant that telephone interviews were the safest and most acceptable way to conduct the surveys for participants and researchers.

A limitation of our study design was that we could not infer causality from the factors associated with food insecurity. Further, our sample may not be representative of all low-income, peri-urban populations of Peru. Finally, we had no measure of food insecurity in these communities during the early months of the pandemic (March to November 2020) when the prevalence may have been even higher. For example, Rudin-Rush et al. (2022) reported an initial spike in food insecurity in four African countries in the early months of the pandemic.

5 Conclusion

The severe disruptions to the health and food systems in Peru during the COVID-19 pandemic and the subsequent global economic recession has profound implications for food and nutrition security, particularly amongst vulnerable households with IYC and their mothers.

Almost half of sampled households in our study experienced moderate-severe food insecurity in December 2020. Risk of food insecurity was increased with socio-economic disadvantage. Mitigation of the negative impacts of COVID-19 included a range of coping mechanisms as well as government safety nets of financial support and food assistance. Moderate-severe food insecurity declined to less than one third after 18 months, with a narrowing of the inequality gap in food insecurity between the relatively highest and lowest SES households. The wider improvements in SES as the country recovered from the pandemic likely contributed to reductions in food insecurity.

While financial support, such as cash transfers, was an essential safety net at the height of the crisis due to high unemployment and dependence on the informal economy, households still had to employ a variety of other coping mechanisms. As such, social protection programmes that effectively reach the most socio-economically vulnerable food insecure households, particularly households with mothers and IYC, should be urgently implemented and scaled-up to facilitate access to affordable healthy diets.

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Data availability The survey questionnaires and data that support the findings are available as open access resources via the Loughborough University Research Repository for the STAMINA study <https://doi.org/10.17028/rd.lboro.c.6344954> following a period of embargo.

Declarations

Conflicts of interest The authors declare that they have no conflicts of interest.

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