Food insecurity and health outcomes during the coronavirus pandemic in South Africa

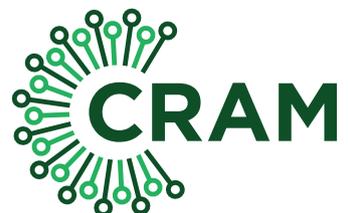**Chijioke O. Nwosu -** Human Sciences Research Council

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Abstract

Given that South Africa experienced significant food insecurity even before the COVID-19 pandemic, it is not surprising that the pandemic and associated control measures would result in even greater food insecurity in the country. This paper seeks to provide additional evidence on the well-known relationship between food insecurity and health. Data came from the National Income Dynamics Study-Coronavirus Rapid Mobile Survey, a four-wave longitudinal survey of adult South Africans. Health was captured using a self-reported indicator of general health status, while food insecurity was measured using information on household hunger, the frequency of hunger, and households running out of money to buy food. We performed descriptive and econometric analyses. Food insecurity has remained stubbornly high even in the face of greater re-opening of the economy, with 37-47% of the population indicating that their households ran out of money to buy food and 16-22% indicating that their households experienced hunger over the May/June 2020 to February/March 2021 period. While hunger generally declined somewhat over this period, the poorest quintile suffered more hunger than before. Moreover, among those whose households experienced hunger, between a quarter and a third struggled with hunger almost everyday or daily. Being in a household that experienced hunger was associated with a 5.5-7.3 percentage point higher probability of worse health compared to not experiencing hunger in May/June 2020-February/March 2021. Compared to being unaffected by hunger, being hungry everyday was associated with a 17-percentage point higher probability of worse health in May/June 2020. These results show the enormity of the hunger problem in South Africa and its adverse effects on welfare. In the face of economic uncertainty and the removal of COVID-19 palliatives like the grant top-ups, policymakers must think of ways to protect the vulnerable from food insecurity.

Keywords: Food insecurity; Hunger; Health; COVID-19; South Africa

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Executive Summary

Introduction

South Africa has historically suffered high levels of food insecurity. For instance, about 16% of households reported inadequate food access in 2017, with 5.5% of the population describing their access to food as severely inadequate and about 11% of households reported vulnerability to hunger (Statistics South Africa, 2019). However, the situation has worsened with the advent of the COVID-19 pandemic. This is hardly surprising given the parlous state of the economy prior to the pandemic and the robust pandemic control measures enacted to stem the tide of infections. South Africa has implemented some of the most stringent lockdowns globally. This has resulted in temporary and permanent business closures, as well as job losses that have added more unemployment to an already strained labour market.

Despite palliative measures aimed at ameliorating the negative effects of the pandemic, especially among the poor—such as government grant top-ups, the establishment of a COVID-19 Social Relief of Distress grant, and job support schemes like the Unemployment Insurance Fund COVID-19 Temporary Employer/Employee Relief Scheme (UIF-TERS)—the sheer scale of vulnerability in the country makes it apparent that these programmes are grossly inadequate to offset the economic dislocation caused by the pandemic. Added to this, the cessation of some of these palliatives—for example, the end to grant top-ups in November 2020 after only about six months of implementation—is likely to severely affect the welfare of the vulnerable. One may argue, therefore, that food insecurity will remain rife.

Given the well-known relationship between food insecurity and health, we ascertained the relationship between both phenomena during the pandemic. Health was measured using a self-assessed health indicator, where fair or poor health was categorized as worse health (relative to excellent, very good or good health). Food insecurity indicators were whether someone in a household went to bed hungry due to a lack of food over the past week, the frequency of hunger in a household, and whether the household ran out of money to buy food. Data came from the National Income Dynamics Study-Coronavirus Rapid mobile Survey, a nationally representative longitudinal survey of South African adults currently with four waves of data collected between May/June 2020 and Feb/March 2021.

Key findings

About 22% of South African adults reported that their households experienced hunger in May/June 2020 (*Figure 1*).

Figure 1: Prevalence of hunger and household running of money to buy food during the coronavirus pandemic in South Africa
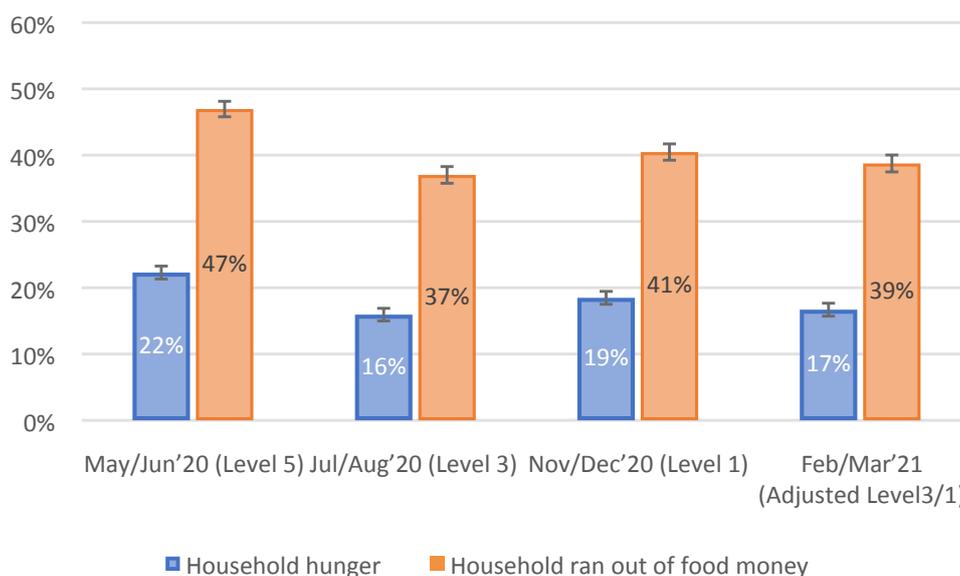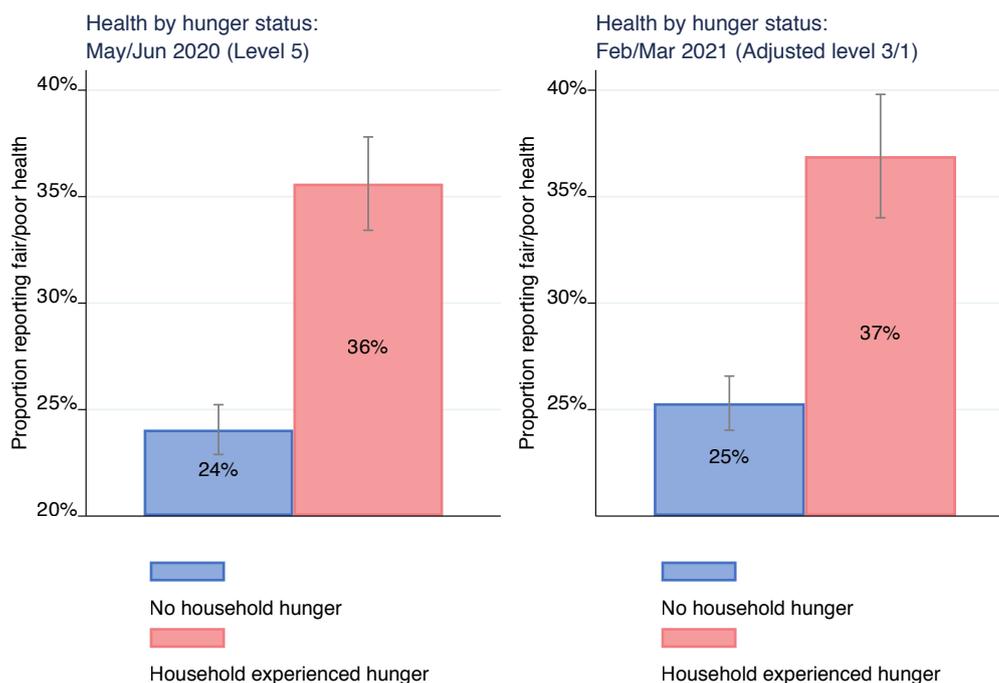

Note: Authors' computation using NIDS-CRAM unbalanced panel; All estimates weighted; 95% confidence intervals

While hunger prevalence significantly declined in July/August as the country eased to level 3 lockdown restrictions, it significantly increased by 2.6 percentage points in November/December 2020 even though most of the economy had been reopened following a further downgrading of lockdown restrictions to level 1 while there was a further insignificant decline by February/March 2021. A similar trend obtained regarding households running out of money to buy food. Given that the period of significant hunger decline is consistent with the period of the grant top-ups, we suspect that grant top-ups were responsible for much of the observed initial decline in hunger and lack of money to buy food.

The decline in hunger between May/June 2020 and Feb/March 2021 (5.6 percentage points) was highly uneven, disfavouring the poor. While all other income quintiles experienced a decline in the burden of hunger over both periods, only the poorest quintile recorded an increase in hunger prevalence. Thus, income-related hunger disparities were sharper in the latter period. Moreover, it is not just isolated hunger episodes that worry many South Africans. Among those affected by hunger, about a tenth reported everyday experience of hunger in each period, with between a quarter and a third of the population whose households experienced hunger suffering from hunger either almost everyday or everyday in each period.

Given the foregoing evidence of substantial poverty, it is not surprising, as shown in *Figure 2*, that hunger was associated with worse health outcomes.

Figure 2: Relationship between health and hunger

Health by hunger status:
May/Jun 2020 (Level 5)

Health by hunger status:
Feb/Mar 2021 (Adjusted level 3/1)

No household hunger
Household experienced hunger

Note: Authors' computation using NIDS-CRAM unbalanced panel; All estimated weighted; 95% confidence intervals

Figure 2 is corroborated by more formal regression analysis, where those whose households experienced hunger had a 5.5-7.3 percentage point higher probability of worse health compared to not experiencing hunger in May/June 2020-February/March 2021. Also, experiencing hunger every day was associated with a 17-percentage point higher probability of worse health relative to not experiencing hunger in May/June 2020.

Conclusion and policy implications

This analysis highlights a serious hunger problem in the face of dwindling government support. The above analysis indicates that from a worrying pre-pandemic prevalence of about 6%, hunger stood at between 16 and 22% during the pandemic (almost a three-fold increase at some point). Moreover, between 37 and 47% of the adult population reported that their households ran out of money to buy food in the same period, a direct precursor to hunger and an indication of severe deprivation. Among the hungry, between a quarter and a third came from households that suffered from hunger either everyday or almost daily. A direct consequence of these grim statistics is a significant hunger toll on health outcomes, with the health effect of frequent hunger even more worrying especially in the initial phase of the pandemic. Furthermore, the significant fall in food insecurity measures during the implementation of the grant top-ups coupled with an uptick in hunger especially soon after their cessation suggests that grant top-ups might have played a more important role than the lowering of lockdown restrictions in improving the country's food security. This is not surprising for a high unemployment country like South Africa.

Consequently, every effort must be made to significantly reduce the hunger burden in the country. While we recognize the poor state of the economy compounded by the pandemic, it may help to reverse the recent removal of the grant top-ups. This is especially urgent given the seemingly important association of the top-ups with reduced food insecurity and the fact that these grants are more likely to be accessed by women who provide better nutritional outcomes to households than men (Duflo, 2003). Furthermore, given that hunger is to a large extent an income issue, there is need for structural change towards significantly reducing the very high unemployment rates in the country as social assistance cannot provide enough resources to eliminate hunger and significantly reduce other forms of food insecurity. Particularly, further employment support to firms in addition to a well-managed UIF-TERS programme may be important in curbing the menace of hunger and its associated health effects.

Introduction

A substantial part of the global population suffered from various forms and degrees of food insecurity even before the current 2019 coronavirus disease (COVID-19) pandemic. The Food and Agricultural Organization (FAO) defines food security as a situation where all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 2001). According to the FAO's The State of Food Security and Nutrition in the World Report 2020, almost 690 million people (8.9% of the world's population) were undernourished in 2019, with the figure expected to exceed 840 million by 2030. Unfortunately, Africa bears a disproportionate share of global undernutrition, with 19.1% of the continent (more than 250 million people) being undernourished in 2019 (FAO, n.d.).

While the full extent of the effect of COVID-19 on food insecurity is not yet known, the pandemic has had a devastating impact on food security globally. This is partly due to domestic food price inflation owing to supply chain disruptions caused by COVID-19 social distancing regulations (World Bank, 2021). Other pandemic control measures such as border restrictions and lockdowns slowed harvests in some countries, leaving seasonal workers without livelihoods while militating against food transport to markets (United Nations, 2020).

Like every other country, South Africa has been severely affected by COVID-19. While the country already suffered high levels of food insecurity before the pandemic, there is ample evidence that this situation has likely worsened over the course of the pandemic. Prior to the pandemic, approximately 16% of households reported inadequate food access in 2017, with 5.5% of households describing their access to food as severely inadequate. Moreover, about 11% of households reported vulnerability to hunger (Statistics South Africa, 2019).

Data collected during the course of the pandemic indicate that the situation has worsened considerably. For instance, about 47% of the adult population reported that their households ran out of money to purchase food around April 2020 (a period characterized by the strictest lockdown restrictions in the country) (Wills et al., 2020). Also, in May/June 2020, 23% reported that someone in their household went to bed hungry over the past 7 days due to a lack of food. While this figure declined to 16% in July/August, it deteriorated to 18% in November/December 2020, with the worsening of hunger likely driven in part by the removal of government grant top-ups earlier introduced as part of the country's pandemic response measures (Van der Berg et al., 2021). (As part of pandemic palliative measures, the government topped up the child support grant with ZAR300 (USD20) per child in May 2020 and later changed it to ZAR500 (USD33.33) per caregiver per month from June-October 2020. Other grants received a ZAR250 (USD16.67) top-up per month for six months also ending in October 2020 (Kohler & Bhorat, 2020))

The above situation is not very surprising since South Africa is one of the countries most afflicted by the pandemic in sub-Saharan Africa (SSA). In addition, the country has implemented one of the most robust pandemic response measures globally. South Africa declared a State of National Disaster on 15 March 2020, a declaration which laid the groundwork for the implementation of a series of nationwide lockdowns beginning with level 5 lockdown restrictions – the highest – on 26 March 2020. This lockdown proscribed all non-essential movement including for work and was only slightly downgraded to level 4 – still outlawing most movements – on 1 May. Level 4 lasted until 31 May 2020. From 1 June to 17 August 2020, the country was under level 3 lockdown restrictions which allowed for some non-essential movement, thus marking some progress towards a full re-opening of the economy. Further lowering of the restrictions to level 2 occurred from 18 August to 20 September 2020. This was followed by level 1 restrictions (the least restrictive) between 21 September and 28 December 2020. However, with a surge in infections and the discovery of a new and more infectious virus strain, the country increased restrictions to adjusted level 3 on 29 December 2020, lasting until 28 February 2021. This was reduced to the current adjusted level 1 restrictions on 1 March 2021 (South African Government, 2021).

These restrictions resulted in several adverse consequences, not least the placing of an already weak labour market under severe stress. The restrictions resulted in, among other things, a significant fall

in demand which resulted in massive outright job losses and furloughs (Nwosu & Oyenubi, 2021; Statistics South Africa, 2020). While the government introduced some social assistance programmes like the top-up of existing government grants and the establishment of a Special COVID-19 Relief of Distress grant worth 350 Rands – about USD23 – per month for an initial period of six months (eventually extended to 9 months) payable to unemployed South Africans, these measures were clearly inadequate to compensate for job losses and already high unemployment rates. As noted elsewhere, about 3 million South Africans lost their jobs between February and April 2020 (Spaull & The NIDS-CRAM Team, 2020). While these figures partly recovered over time, recent figures indicate that the unemployment rate, already at the worryingly high level of 29% in the last quarter of 2019, reached a high of 32.5% in the final quarter of 2020 (Statistics South Africa, 2021).

This situation would no doubt have exacerbated an already bad situation regarding food insecurity. Prior to the pandemic, a number of indicators, like stunting and hunger, suggested that food insecurity in South Africa was too high for an upper middle-income country (Jacobs et al., 2020; NDoH et al., 2018). Unfortunately, the pandemic has worsened the situation, with many households experiencing hunger and acute lack of resources to purchase food (Van der Berg et al., 2021).

One of the implications of food insecurity is adverse health outcomes, with the condition a leading cause of health and nutritional problems globally. According to the Lancet's 2019 Global Burden of Disease (GBD) Report, child and maternal malnutrition was the leading Level 2 risk factor for disability-adjusted life years (DALYs) globally in 2019, accounting for 295 million DALYs (11.6% of global DALYs) (Murray et al., 2020). Moreover, SSA and south Asia remain particularly vulnerable to malnutrition in general and undernutrition in particular and its health consequences (Müller & Krawinkel, 2005).

Most of the literature on the health implications of food insecurity focus on children (Gundersen & Ziliak, 2015). This body of research has found that food insecurity is associated with conditions like lower nutrient intake (Cook et al., 2006), cognitive disorders (Howard, 2011), birth defects (Carmichael et al., 2007), aggression and anxiety (Whitaker et al., 2006), anaemia (Eicher-Miller et al., 2009; Skalicky et al., 2006) and adverse general health status (Cook et al., 2006; Gundersen & Kreider, 2009; Hernandez & Jacknowitz, 2009), among others.

Empirical evidence on the relationship between food insecurity and physical or general health exists in both developed and developing countries. For instance in the USA, children in food insecure households had twice higher odds of fair or poor health (relative to excellent or good health) than those in food secure households (Cook et al., 2006). Also, children in food insecure households had 2-3 times higher odds of anaemia than children in food secure households in the USA (Eicher-Miller et al., 2009; Skalicky et al., 2006). In developing countries, particularly in south Asia and SSA, the lack of macronutrients and micronutrients results in malnutrition presenting a significant public health concern especially for children (Müller & Krawinkel, 2005). In addition, malnutrition increases the risk and severity of infections in the region, thus constituting a major source of illness and death especially among children (Carmichael et al., 2007; Chi et al., 2014; McIntyre et al., 2013; Melchior et al., 2012).

For adults, some developing country studies have also ascertained significant relationships between food insecurity and health. In Iran, for instance, Gholami et al. (2017) found a statistically significant association between household food insecurity and mean health-related quality of life as well as the latter's eight dimensions comprising physical and mental health indicators. Among the Aboriginal population in Canada, food insecurity has been found to be associated with reporting poor general health (Willows et al., 2011).

Limited evidence exists on the relationship between food insecurity and health in South Africa while some of the evidence is spatially limited. For instance, in Khayelitsha, an urban informal settlement, Case and Deaton (2005) found that hunger has a powerful effect on depression while household food expenditure per capita is significantly correlated with self-reported health. In contrast, another study in Khayelitsha reported no relationship between food insecurity (measured as not having food in the house for the next meal) and common mental disorders (Havenaar et al.,

2008; Lund et al., 2010). However, Havenaar et al. (2008) found a positive relationship in Agincourt, another community in South Africa. Similarly, Sorsdahl et al. (2011) found that food insufficiency was significantly associated with twelve-month and lifetime Diagnostic and Statistical Manual of Mental Disorders outcome.

A few issues are apparent from the above review especially regarding the state of the literature on food insecurity and health outcomes in South Africa. One, there is a paucity of empirical evidence on the issue in general. In addition, most of the literature emanate from community surveys covering a restricted geographical area. Hence, there is a paucity of studies based on nationally representative data.

This paper, therefore, makes an important contribution by examining the relationship between three measures of food insecurity: household hunger, respondents' households running out of money to buy food, and the frequency with which households experienced hunger on the one hand, and general health, captured by self-assessed health (SAH) on the other. Such a variety of food insecurity measures will assist in ascertaining the robustness of the relationship, if any, while the global nature of the health outcome will provide an indication of the implication of food insecurity for overall health status in contrast to being restricted to a specific indicator of health for which there may or may not be any relationship. Furthermore, examining the relationship over the course of a severe shock like COVID-19 provides an invaluable piece of evidence on how vulnerable the population has become over various stages of the pandemic. Related to this, the longitudinal nature of the underlying dataset provides an opportunity to interrogate important issues like the relationship between health and persistent food insecurity, questions that are not possible to explore with the cross-sectional data available to most of the previous authors who studied the issue in South Africa. Finally, we utilize nationally representative datasets which enable us to make population-wide inferences on the relationship between health and food insecurity in South Africa.

Material and methods

Data and main variables

We used the National Income Dynamics Study (NIDS)-Coronavirus Rapid Mobile Survey (CRAM) dataset for the analysis (NIDS-CRAM, 2020a, 2020b, 2020c, 2021). NIDS-CRAM is a rapid nationally representative telephonic survey conducted roughly two months apart over the course of the COVID-19 pandemic in South Africa. It is based on the fifth (i.e. final) wave of the adult sample of the NIDS survey. NIDS is the first nationally representative longitudinal survey in South Africa. The first wave was conducted in 2008 while subsequent waves were conducted approximately two years apart with the final wave conducted in 2017. (Nwosu & Woolard, 2017).

NIDS-CRAM currently comprises four waves. The first wave was conducted from 7 May to 27 June 2020 while the second wave conducted between 13 July and 13 August 2020. Wave 3 was conducted between 2 November and 13 December 2020, while wave 4 data were collected from 2 February to 10 March 2021.

The survey team employed stratified sampling with batch sampling to select respondents for interview. This entailed providing survey teams with the contact details of sampled respondents in batches of 2,500 randomly drawn from 99 strata. Thus, the sampling rate in each stratum was adjusted as more information became available, allowing for flexibility in the implementation of the survey (Kerr et al., 2020).

Wave 1 of NIDS-CRAM successfully interviewed 7,073 respondents. About 80% of these (5,676 respondents) were successfully re-interviewed in wave 2. Given the 19% attrition rate between wave 1 and wave 2, a top-up sample randomly drawn from the original NIDS wave 5 sample was included

in wave 3 resulting in 6,130 observations being successfully interviewed in wave 3. Finally, 5,629 respondents were successfully interviewed in wave 4 (Ingle et al., 2021).

While the descriptive component of the analysis in this paper utilized data from all four waves of the NIDS-CRAM dataset, the main regression analysis (including the descriptive statistics table) only utilized data from wave 1 and wave 4 coinciding with the country's lockdown levels 5 and adjusted levels 3/1 respectively (South African Government, 2021). This is because the outcome variable was only collected in these two waves.

The outcome variable was an indicator of SAH. Each respondent was asked to rate the present state of their health along a scale with the following options: excellent (1), very good (2), good (3), fair (4) and poor (5). This characterization of health is common in the literature and has been demonstrated to be a significant predictor of mortality in South Africa (Ardington & Gasealahwe, 2014). In this paper, we dichotomized the variable, grouping respondents with excellent, very good and good together while grouping fair and poor responses together. For convenience, we refer to both groups as being in the better and worse health groups respectively. This convention of dichotomizing SAH is not uncommon in the literature (Newbold, 2005; Nwosu & Oyenubi, 2021; Nwosu & Woolard, 2017; Sharkey et al., 2011).

The main covariates were three indicators of food insecurity. These were household hunger, the frequency with which household members experienced hunger, as well as the respondent's household running out of money to buy food. Household hunger was obtained from a question about whether anyone in the respondent's household had gone hungry because there was not enough food in the past 7 days. This was followed by the frequency of hunger episodes, with the following options: never, 1 or 2 days, 3 or 4 days, almost everyday, and everyday. Finally, for the variable capturing households lacking money to buy food, respondents were asked whether their household ran out of money to buy food in the preceding month. Thus, for wave 1 (wave 4), the reference month was around April 2020 (January 2021). We complemented these indicators with variables capturing the chronicity/persistence of food insecurity. For hunger, respondents whose households did not experience hunger in any of the four waves were compared with those whose households experienced hunger for one, two, three and four waves. Similar chronicity measures were created for running out of money to buy food.

These indicators of food insecurity were complemented by controls drawn from the health literature in a multiple regression context. These were gender, employment status, years of education, type of housing, age, race, negative income shocks and location. We also included an indicator of respondents' perception of their risk for COVID-19.

Analytical methods and models

We employed the linear probability model (LPM) to ascertain the health-food insecurity relationship given the binary nature of the outcome, with our empirical model taking the following form:

$$H_i = \alpha F_i + X'\beta + \varepsilon_i$$

where H, F, X and ε are SAH, food insecurity, control variables and an error term respectively, while α and β are parameters. Given the five-category nature of the original SAH variable, we also estimated the relationships using ordered logit models. The results (available on request) were not an improvement over the LPM. Both the descriptive and econometric estimates below are appropriately weighted using the relevant weights designed by the NIDS-CRAM data curators (Ingle et al., 2021).

Results

Descriptive analysis

We present the distribution of SAH for wave 1 and wave 4 in *Table 1*.

***Table 1: Distribution of health outcomes***

Health category	Wave 1 (May/Jun 2020)	Wave 4 (Feb/Mar 2021)
	Percentage	Percentage
Excellent	16.3	16.1
Very good	21.6	24.3
Good	35.4	32.2
Fair	19.4	19.1
Poor	7.3	8.3

Note: Estimates weighted (NIDS-CRAM unbalanced panel)

Table 1 indicates that SAH outcomes were similar between both periods, with about 27% of the population reporting fair/poor health.

Figure 1 tracks the percentage of individuals who reported that their households experienced hunger across the various waves as well as those who indicated that their households ran out of money to buy food.

Figure 1: Prevalence of hunger and household running of money to buy food during the coronavirus pandemic in South Africa
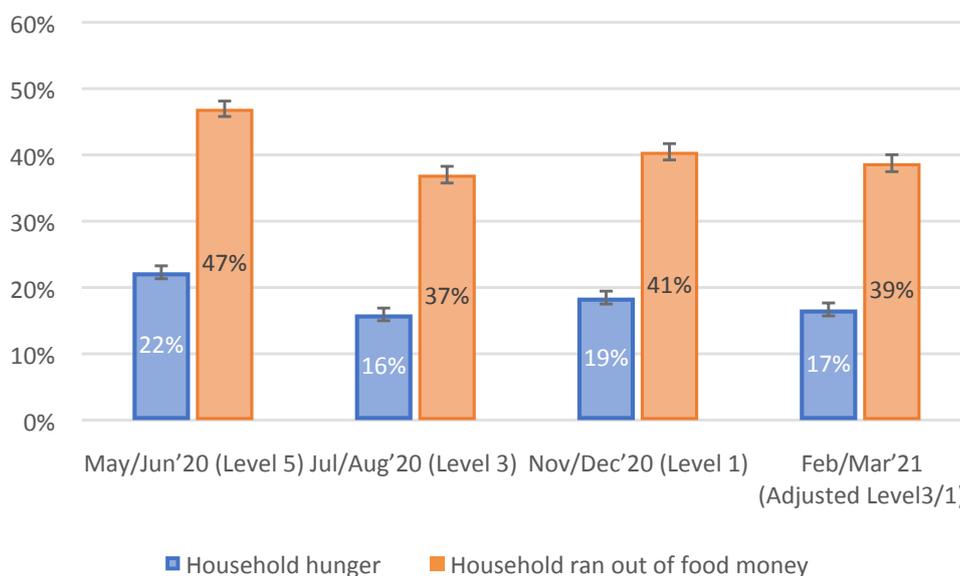
Note: Authors' computation using NIDS-CRAM unbalanced panel; Estimates weighted; 95% confidence intervals

Figure 1 indicates that 22.3% of South African adults reported that their households experienced hunger over the past 7 days in May/June 2020. While this significantly declined in July/August 2020 as the country implemented grant top-ups and eased to level 3 lockdown restrictions, the country recorded a significant 2.6-percentage point increase in household hunger prevalence in November/December 2020 even though most of the economy had been reopened following a further

downgrading of the country's lockdown restrictions to level 1. Furthermore, the country recorded a non-significant decline in hunger prevalence in February/March 2021. A similar trend obtained regarding households running out of money to buy food across the waves. Considering the latter measure, food insecurity during the pandemic was worse than what one observes from hunger statistics, as 37-47% of adults reported that their households lacked money for food across the waves.

One would expect that food insecurity is strongly associated with socioeconomic condition. We present the relationship between hunger and per capita household income in *Figure 2*[4].

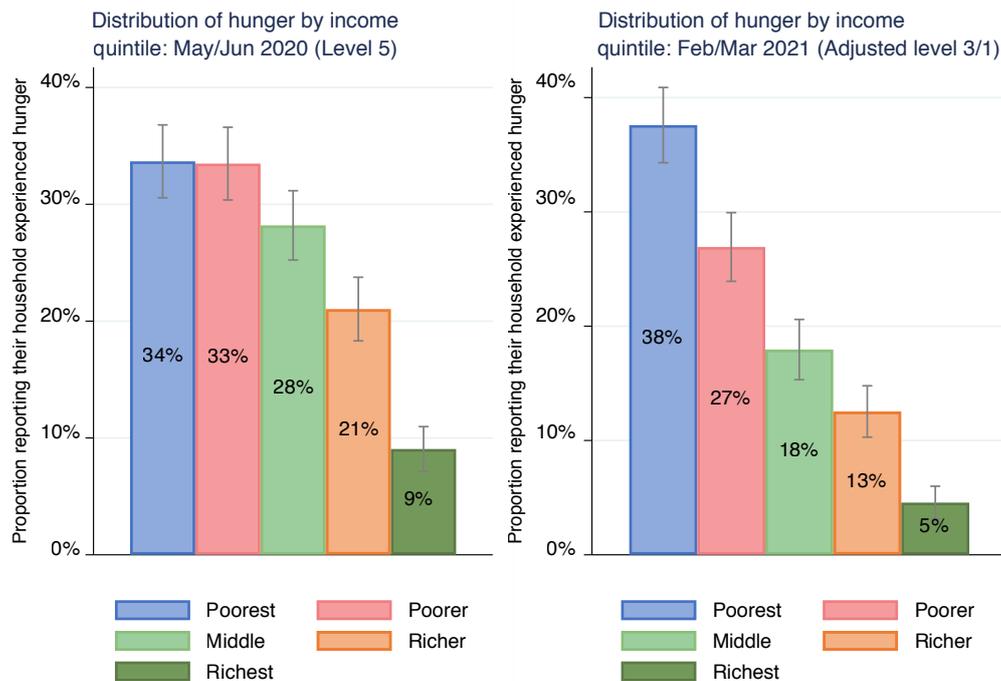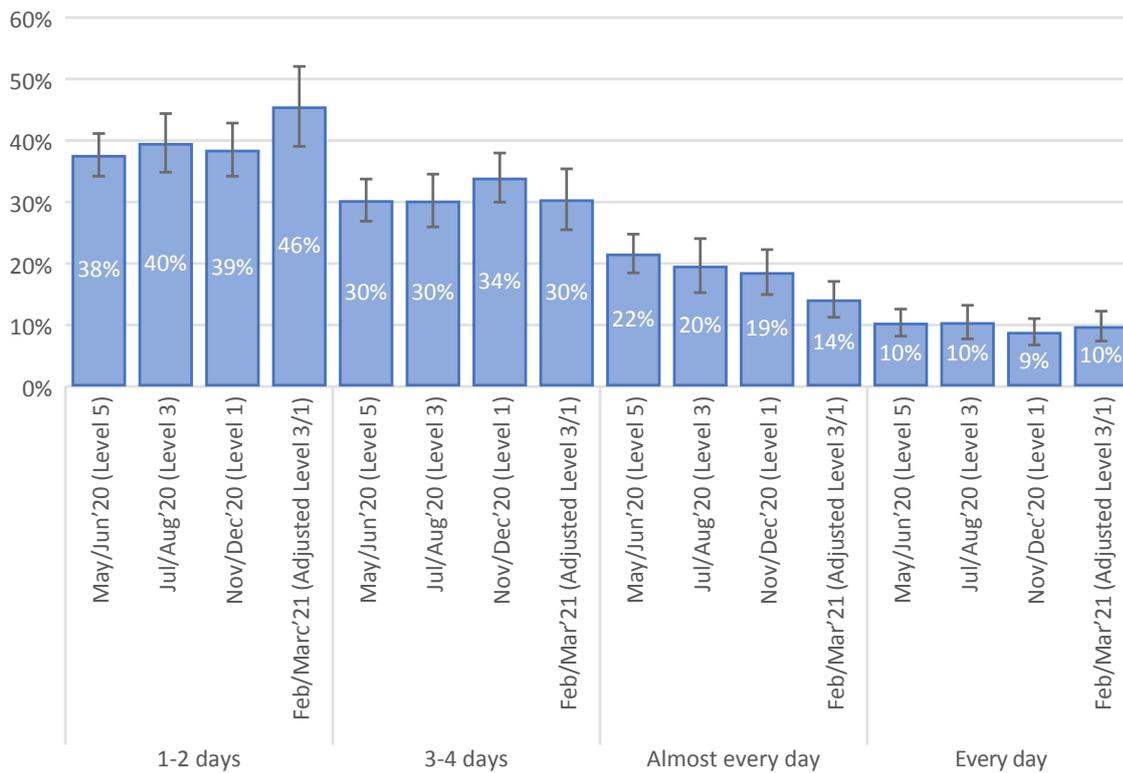*Figure 2: Distribution of household hunger across per capita household income quintiles*

Note: Authors' computation using NIDS-CRAM unbalanced panel; Estimates weighted; 95% confidence intervals

While *Figure 2* shows a clear hunger-income gradient in both wave 1 and wave 4, two other important issues are prominent. First, apart from the poorest income quintile, every other socioeconomic class reported significantly lower prevalence of hunger in wave 4 relative to wave 1. Thus, the decline in hunger was not uniform across income classes. (Note that the populations in both waves were not identical as we intentionally did not utilize the balanced panel so as to show the state of these outcomes in the entire population in each period). The aforementioned analysis was reinforced by more formal analysis as concentration indices (measuring income-related inequalities in hunger) indicate that hunger significantly disfavoured the poor in each wave, with the magnitude of the inequalities higher in wave 4 (i.e. -0.28, p<0.01) than wave 1 (-0.23, p<0.01).

Figure 3 reports the distribution of hunger frequencies among those whose households experienced hunger.

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4   We note that there were many missing income observations due to "don't know" and "refused" responses, with these cumulatively accounting for 38% (26%) of the samples in wave 1 (wave4). Therefore, one must treat every income-based estimate with caution.

Figure 3: Distribution of hunger rates conditional on household being affected by hunger

Those whose households were affected by hunger for 1 or 2 days in a week dominated, while those whose households experienced hunger everyday were in the minority as expected. However, the levels and stability of everyday hunger experience is worrying given that a tenth of individuals whose households were affected by hunger had to deal with hunger everyday while between a quarter and a third of the hunger-affected population reported experiencing hunger daily or almost everyday.

Figure 4a and *Figure 4b* depict the relationship between health on the one hand and hunger and lack of money to buy food, on the other.

Figure 4a: Relationship between health and hunger
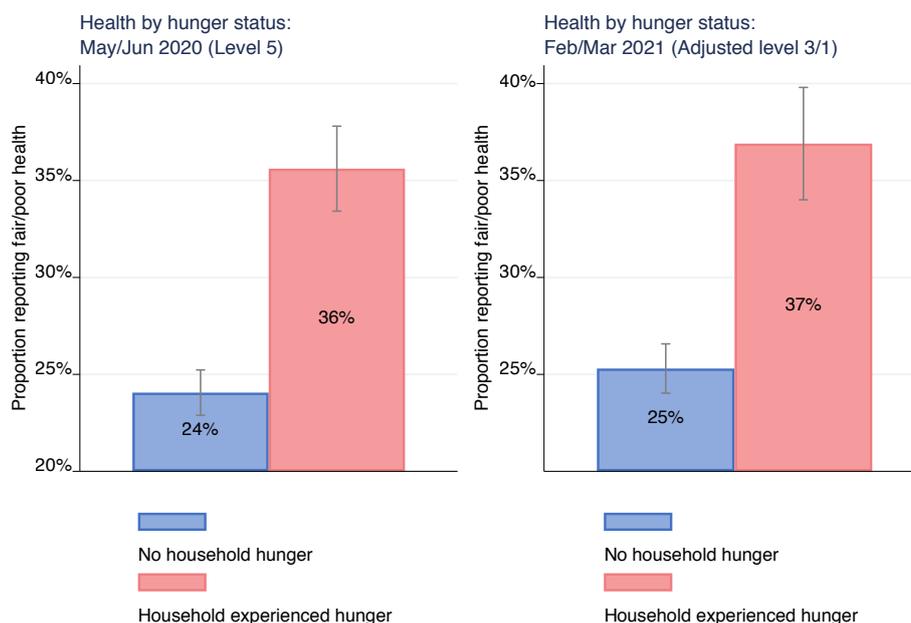
Figure 4b: Relationship between health and household running out of money to buy food
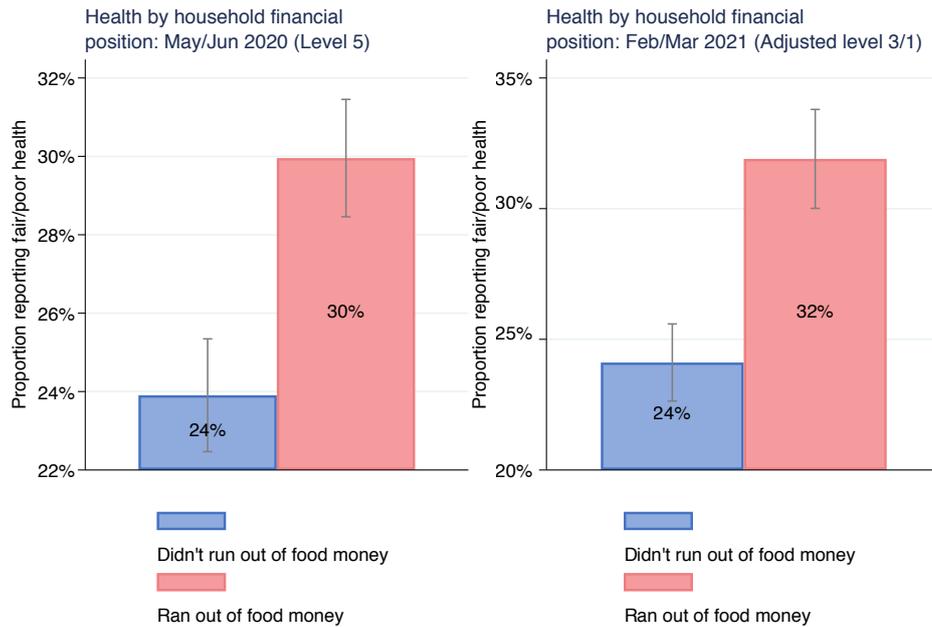
Health by household financial position: May/Jun 2020 (Level 5) — Health by household financial position: Feb/Mar 2021 (Adjusted level 3/1)

Note: Authors' computation using NIDS-CRAM unbalanced panel; Estimates weighted; 95% confidence intervals

Both figures provide a clear descriptive evidence of a positive relationship between food insecurity and fair/poor health in both periods. While about a quarter of the adult population with no reported experience of household hunger reported being in fair/poor health (relative to excellent/very good/ good health), it ranged between 36-37% for those affected by hunger. Similarly, while a quarter of those whose households ran out of food money reported fair/poor health, it was 30-32% for those whose households ran out of food money.

We present the descriptive statistics of the variables used in the regression analyses in *Table 2*. The estimation samples for both the descriptive statistics and regression analyses were based on observations with non-missing values in hunger, lack of food money and the regression controls.

Table 2: Descriptive statistics

Variable	Wave 1 (Level 5)			Wave 4 (Adjusted level 3/1)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Better health	Worse health	(1)-(2)	Better health	Worse health	(4)-(5)
	Mean/%	Mean/%		Mean/%	Mean/%	
Household experienced hunger in the past 7 days	19.3	29.5	-10.1***	13.7	21.8	-8.1***
Hunger frequency over the past 7 days[a]						
No one in household experienced hunger	82.1	71.7	10.3***	86.5	78.5	8.0***
Household experienced hunger 1-2 days	6.6	11.2	-4.6***	6.7	9.4	-2.7*
Household experienced hunger 3-4 days	5.9	7.9	-1.9*	3.7	6.9	-3.2***
Household experienced hunger almost every day	3.8	5.5	-1.7**	1.9	2.8	-0.8
Household experienced hunger every day	1.6	3.7	-2.1***	1.2	2.4	-1.2*
Household ran out of money to buy food last month	44.6	51.4	-6.8***	36.0	44.9	-8.9***
Main income source lost/declined[b]	38.6	42.6	-4.0*	17.5	25.8	-8.4***
Male	46.9	48.0	-1.1	47.6	43.5	4.1*
Not employed	53.0	60.8	-7.9***	48.4	57.1	-8.7***
Lives in a house or flat (base = traditional/informal/other type of house)	80.6	76.6	4.0**	81.6	73.6	8.1***
Self-perceived risk of COVID-19 infection						
Not at risk of infection	60.3	55.6	4.7**	49.8	41.9	7.9***
Uncertain about risk of infection	11.4	11.8	-0.4	10.5	10.9	-0.4
At risk of infection	28.3	32.6	-4.4**	39.7	47.2	-7.5***
Race						
African	73.5	90.3	-16.8***	71.7	92.9	-21.2***
Coloured	11.7	4.8	6.9***	12.8	4.0	8.8***
Asian/Indian	2.9	1.6	1.3*	3.4	1.2	2.1**
White	11.9	3.2	8.7***	12.1	1.9	10.2***
Location						
Traditional location	13.0	16.5	-3.6**	19.0	27.4	-8.4***
Urban location	83.5	79.6	3.9**	79.3	69.1	10.1***
Farm location	3.5	3.9	-0.3	1.7	3.4	-1.7**
Years of schooling	11.4	10.6	0.9***	11.6	10.4	1.3***
Age (in years)	39.9	40.9	-1.0	41.3	42.4	-1.1
Number of observations	**4666**	**1935**		**3400**	**1493**	

Note: Estimates weighted by the wave-specific weights; *. **. *** indicate statistical significance at 10%, 5% and 1% levels of significance respectively; a N: Wave 1= 6,466, Wave 4 = 4,875; b Wave 1: whether household lost its main source of income, wave 4: whether household's main source of income decreased (relative to increased or remained unchanged)

Table 2 highlights the statistically significant differences between the population in the better health group and those in the worse health group for most of the variables included in the analysis. For instance, the prevalence of hunger in the better health group was 10 (8) percentage points lower than in the worse health group in wave 1 (wave 4). Also, the proportion of the worse health group who reported somebody in their household going hungry everyday in wave 1 – not conditional on experiencing hunger –was at least double what obtained in the better health group in both waves, with the differences statistically significant. Similarly, the worse health group reported significantly higher prevalence of running out of money to buy food, with a 7-9 percentage point difference in both waves. Thus, for all the food insecurity indicators, there was descriptive evidence of worse outcomes among those in worse health than those in better health.

The better health group had a higher expectation of no self-perceived risk of COVID-19 in both waves. Conversely, those in the worse health group significantly perceived themselves at higher risk of COVID-19 than the better health group. Furthermore, the better health group was significantly better educated and richer than those in the worse health group.

We provide a more formal analysis below to ascertain the nature of the relationships. *Table 3* provides a set of regression analyses of the relationship between SAH and food insecurity. For each wave, we regressed SAH on individual food insecurity indicators and the controls while finally including both hunger and lack of food money in the final specification (columns 4 and 8).

Table 3: The relationship between self-assessed health and food insecurity in South Africa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wave 1 (Level 5)				**Wave 4 (Adjusted level3/1)**			
Household experienced hunger in past 7 days	0.073***			0.073***	0.055*			0.049
	(0.021)			(0.023)	(0.033)			(0.035)
Hunger frequency past 7 days (base = no hunger)								
1-2 days		0.106***				0.025		
		(0.036)				(0.043)		
3-4 days		0.035				0.094**		
		(0.035)				(0.048)		
Almost every day		0.065*				0.040		
		(0.037)				(0.054)		
Every day		0.167***				0.095		
		(0.063)				(0.077)		
Household ran out of money to buy food in the past month			0.023	0.002			0.028	0.011
			(0.018)	(0.019)			(0.022)	(0.023)
Male	0.015	0.018	0.016	0.015	-0.019	-0.019	-0.019	-0.018
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
Not employed	0.051***	0.050***	0.054***	0.050***	0.045**	0.045**	0.045**	0.044**
	(0.018)	(0.018)	(0.018)	(0.019)	(0.021)	(0.021)	(0.021)	(0.021)
Years of schooling	-0.004*	-0.005*	-0.005*	-0.004*	-0.009***	-0.009***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Lives in a house/flat (base = lives in a traditional/informal/other type house)	-0.003	-0.003	-0.007	-0.003	-0.054**	-0.055**	-0.055**	-0.053**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.027)	(0.027)	(0.027)	(0.027)
Age (years)	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**	0.001*	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Self-perceived COVID-19 risk of infection (base = no risk)								
Uncertain risk	0.011	0.009	0.013	0.011	0.005	0.006	0.006	0.005
	(0.026)	(0.026)	(0.026)	(0.026)	(0.035)	(0.034)	(0.034)	(0.034)
At risk	0.083***	0.084***	0.085***	0.083***	0.108***	0.108***	0.109***	0.108***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Race (base = African)								
Coloured	-0.183***	-0.185***	-0.189***	-0.183***	-0.215***	-0.216***	-0.220***	-0.216***
	(0.029)	(0.029)	(0.030)	(0.030)	(0.028)	(0.028)	(0.028)	(0.029)
Asian/Indian	-0.136***	-0.133***	-0.147***	-0.137***	-0.173***	-0.174***	-0.178***	-0.173***
	(0.049)	(0.050)	(0.049)	(0.049)	(0.058)	(0.057)	(0.057)	(0.057)
White	-0.210***	-0.210***	-0.215***	-0.210***	-0.231***	-0.232***	-0.233***	-0.230***
	(0.028)	(0.028)	(0.029)	(0.028)	(0.029)	(0.029)	(0.029)	(0.029)

Location (base = Traditional)								
Urban	-0.006	-0.005	-0.009	-0.006	-0.030	-0.029	-0.029	-0.030
	(0.025)	(0.026)	(0.025)	(0.025)	(0.023)	(0.023)	(0.023)	(0.023)
Farm	0.004	0.007	0.001	0.004	0.118*	0.119*	0.115*	0.118*
	(0.047)	(0.047)	(0.047)	(0.047)	(0.066)	(0.066)	(0.066)	(0.066)
Main income source lost/declined	0.004	0.003	0.007	0.004	0.062**	0.062**	0.063**	0.061**
	(0.017)	(0.016)	(0.017)	(0.017)	(0.026)	(0.026)	(0.027)	(0.027)
Constant	0.220***	0.228***	0.238***	0.219***	0.344***	0.338***	0.345***	0.339***
	(0.055)	(0.055)	(0.056)	(0.056)	(0.062)	(0.062)	(0.061)	(0.062)
Observations	**6,601**	**6,466**	**6,601**	**6,601**	**4,893**	**4,875**	**4,893**	**4,893**
R-squared	**0.054**	**0.057**	**0.050**	**0.054**	**0.091**	**0.092**	**0.090**	**0.091**

Note: All models are LPM; Outcome is SAH, i.e. fair/poor health (base = excellent/very good/good health); Estimates weighted; *, **, *** indicate statistical significance at 10%, 5% and 1% levels of significance respectively; Standard errors in parentheses

In *Table 3*, we estimated separate regressions for the various food insecurity measures for both wave 1 and wave 4 as well as another specification combining both hunger and lack of money to buy food.

Table 3 indicates that household hunger was positively and significantly associated with worse health outcomes in both waves. In wave 1, one's household experiencing hunger in the past seven days was associated with a 7.3-percentage point higher probability of reporting worse health compared to one's household not experiencing hunger. The hunger coefficient was 5.5 in wave 4 even though it lost statistical significance when lack of money for food was controlled for (however remaining nontrivial). Expectedly, the frequency with which households experienced hunger had important implications for health especially in wave 1. Those who reported their households experiencing hunger for 1-2 days, almost everyday and everyday were significantly more likely to report worse health in wave 1 compared to those who did not experience hunger. Similarly, being affected by hunger for 3-4 days in a week was positively and significantly associated with worse health outcomes in wave 4. Surprisingly, running out of money to buy food did not have a statistically significant association with health in either wave.

The control variables generally conformed to expectations. Non-employment, age and perceiving oneself at risk of COVID-19 were positively associated with worse health in both waves. Similarly, living in a farm (relative to a traditional location) and a fall in main income source were positively associated with worse health outcomes in wave 4. More education and being non-African were negatively associated with worse health outcomes in both waves while living in a flat was only negative and significant in wave 4.

The longitudinal nature of the data allowed for determining whether the degree of persistence of food insecurity was associated with health. We therefore estimated wave 4 health outcome as a function of various degrees of persistence in food insecurity while controlling for wave 4 characteristics. Thus, for both hunger and running out of food money, we obtained the following conditions: not food insecure in any wave (benchmark category), food insecure in one, two, three and all waves. The estimation sample for each wave was restricted to that used in *Table 3*. The results are depicted in *Table 4*, where the first two columns included the food insecurity persistence variables separately, while they were both controlled for in column 3.

Table 4: Persistence of food insecurity and health outcomes

	(1)	(2)	(3)
Household hunger (base = household did not experience hunger in any wave)			
Household experienced hunger in one wave	0.059**		0.050*
	(0.027)		(0.029)
Household experienced hunger in two waves	0.054		0.063
	(0.042)		(0.040)
Household experienced hunger in three waves	0.109**		0.136**
	(0.049)		(0.054)
Household experienced hunger in four waves	0.070		0.110
	(0.060)		(0.068)
Lack of food money (base = household did not experience lack of food money in any wave)			
Household had lack of food money in one wave		0.053**	0.048*
		(0.027)	(0.028)
Household had lack of food money in two waves		0.094***	0.073**
		(0.031)	(0.033)
Household had lack of food money in three waves		0.049	-0.005
		(0.030)	(0.030)
Household had lack of food money in four waves		0.046	-0.022
		(0.031)	(0.037)
Male	-0.017	-0.014	-0.012
	(0.020)	(0.020)	(0.020)
Not employed	0.050**	0.055**	0.055**
	(0.023)	(0.023)	(0.023)
Years of schooling	-0.008**	-0.009**	-0.008**
	(0.004)	(0.004)	(0.004)
Lives in a house/flat (base = lives in a traditional/informal/other type house)	-0.058**	-0.054*	-0.052*
	(0.029)	(0.029)	(0.029)
Age (years)	0.002*	0.002*	0.002**
	(0.001)	(0.001)	(0.001)
Self-perceived COVID-19 risk of infection (base = no risk)			
Uncertain risk	0.019	0.012	0.020
	(0.044)	(0.042)	(0.044)
At risk	0.113***	0.112***	0.116***
	(0.023)	(0.023)	(0.023)

Race (base = African)			
Coloured	-0.256***	-0.265***	-0.248***
	(0.030)	(0.030)	(0.030)
Asian/Indian	-0.158**	-0.196***	-0.155**
	(0.071)	(0.064)	(0.067)
White	-0.202***	-0.204***	-0.194***
	(0.037)	(0.037)	(0.037)
Location (base = Traditional)			
Urban	0.008	0.006	0.009
	(0.028)	(0.028)	(0.028)
Farm	0.182**	0.184**	0.182**
	(0.087)	(0.080)	(0.083)
Main income source declined	0.030	0.029	0.025
	(0.029)	(0.029)	(0.029)
Constant	0.271***	0.260***	0.233***
	(0.074)	(0.072)	(0.074)
Observations	**3,332**	**3,330**	**3,302**
R-squared	**0.099**	**0.099**	**0.103**

Note: All models are LPM; Outcome is wave 4 SAH, i.e. fair/poor health (base = excellent/very good/good health); Wave 4 controls; Estimates weighted; *, **, *** indicate statistical significance at 10%, 5% and 1% levels of significance respectively; Standard errors in parentheses

Compared to never experiencing food insecurity, indicators of various spells of food insecurity were positively associated with worse health outcomes. For hunger, the significant spells (hungry in one wave and three waves) had between 5 and 14 percentage point higher probability of worse health depending on specification. For lacking food money, the significant spells were one and two waves, with between 5 and 9 percentage point higher worse health probabilities depending on specification.

Discussion

This paper has examined an important, yet under-studied issue in South Africa – whether food insecurity is related to worse health outcomes. We examined the relationship between general health status proxied by SAH on the one hand, and three indicators of food insecurity: household hunger, hunger frequency and lack of money to purchase food, on the other. First, our descriptive analysis showed that many South Africans reported worse health outcomes, with a quarter of the population reporting being in fair/poor health in May/June 2020 and February/March 2021. Moreover, the scourge of food insecurity has remained both substantial and chronic. For instance, after an initial significant decline between May/June 2020 and August/September 2020, both hunger and lack of money to purchase food have basically climbed up since then (with only a marginal insignificant decline between November/December 2020 and February/March 2021. This is worrying and lays bare an economy that was already in dire straits with worryingly high food insecurity and economic decline prior to the pandemic (Naidoo, 2020; NDoH et al., 2018). Thus, an already bad situation was compounded by a pandemic that has severely weakened the country in terms of severe job losses

(that are yet to fully recover), income loss and the associated anxiety (Statistics South Africa, 2020, 2021).

It is also important to note that the significant decline in hunger coincided with the period when grants were increased as part of the pandemic response. The subsequent uptick in hunger in the face of largely greater relaxation of lockdown restrictions is consistent with a high unemployment economy where a simple relaxation of lockdown restrictions is not enough to significantly enhance people's livelihoods. Moreover, it was not only that overall hunger prevalence was high. Among those households that experienced hunger, about 10% across the waves indicated that it was an everyday experience while between a quarter and a third of this subpopulation indicated a hunger experience that occurred either daily or almost everyday[5].

As expected, hunger, an extreme form of food insecurity, had a significant socioeconomic gradient, with the less affluent more likely to experience it. This is intuitive and supported by prior evidence (Ekholuenetale et al., 2020). Moreover, though the prevalence of hunger declined between wave 1 and wave 4, the decline was not uniform across socioeconomic strata. As shown in *Figure 2* and the accompanying formal analysis, income-related inequalities in household hunger not only disfavoured the poor but increased over time. This result supports earlier results which indicate significant socioeconomic inequality in hidden hunger albeit among children in SSA (Ekholuenetale et al., 2020). Similarly, another cross-national study showed evidence of hunger inequality globally (Von Grebmer et al., 2017). One clear indication from these studies is that most of the evidence on the socioeconomic inequality in hunger mostly focus on child hunger, with studies on adult hunger like ours a relative rarity. That said, the conclusions from both sets of studies point to a significant socioeconomic gradient of hunger irrespective of the population of interest.

In both the descriptive and regression analyses, we found evidence of a numerically nontrivial and statistically significant positive relationship between hunger and worse health outcomes. In a population sense, this is significant given the high prevalence of worse health outcomes – about 27%. This concurs with Willows et al. (2011) who found that food insecurity was positively and significantly associated with general self-reported poor health among the Canadian Aboriginal community, even though this relationship disappeared when income adequacy was controlled for.

In contrast to hunger, the statistically significant bivariate relationship between health and running out of money to buy food (*Figure 4b*) was lost when relevant confounding factors were controlled for. This contrasts with some of the results found by Sharkey et al. (2011) in the USA. Their food insecurity measure, while similar to ours, was significantly associated with self-reporting fair/poor health in the general model (as well as reporting poor physical health and frequent mental distress). A more geographically nuanced analysis showed that for fair/poor health, food insecurity was only statistically significant in urban locations.

We also found that relative to not experiencing hunger, those who experienced hunger once or twice, 3-4 days, almost everyday as well as everyday over the past 7 days were more likely to report worse health. This finding was similar to another study which found that repeated hunger episodes were very toxic for children's health and that multiple episodes of hunger (relative to never experiencing hunger) were associated with higher likelihood of asthma and chronic conditions among children (Ke & Ford-Jones, 2015; Kirkpatrick et al., 2010). As in the foregoing, it is difficult to find comparable studies which analysed adults as in our paper.

Our results demonstrate that short-term and persistent hunger experience were significantly associated with worse health. Unfortunately, the literature on the impact of persistent food insecurity, of the kind employed in this analysis, on health outcomes is scanty. Some exceptions have however found that past food insecurity is associated with overweight and obesity among women (Casey et al., 2006; Olson, 1999; Peterman et al., 2010) as well as students (Darling et al., 2017).

Regarding the controls, numerous studies corroborate our findings. For instance better educational

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5   About 7% (4%) of the general population experienced hunger almost everyday or everyday in wave 1 (wave 4).

attainment is negatively (positively) associated with worse (better) health (Case, 2004; Gravelle & Sutton, 2009). However, Case and Deaton (2005) found no evidence that better educated people suffer less from poor health than their worse educated counterparts in South Africa and India. The latter may be due to the restricted nature of the study as it was based on a low-income township in South Africa and a city in India. Conversely, older people have poorer health outcomes, a consequence of the ageing process (Case, 2004; Taimela et al., 2007). Finally, our finding that perceiving oneself to be at risk of COVID-19 is detrimental to health corroborates previous findings in this regard especially with respect to mental health outcomes (Nwosu, 2021; Oyenubi & Kollamparambil, 2020). However, reverse causation is a possibility as prior poor health may induce higher perception of risk to pandemics (Jacobs et al., 2010).

This study has potential limitations. While the longitudinal nature of the dataset allowed for studying persistence in food insecurity, our inability to conduct a causal analysis is a shortcoming. This challenge is not unique to this study but is a common problem for most studies of this nature due to possible reverse causation, where poor health can adversely affect one's food security especially through, say, a negative impact on labour market earnings (Luft, 1975). Unfortunately, data limitations could not allow us to rule out the possible endogeneity of food insecurity.

Conclusion

This paper has investigated an important issue – whether food insecurity is significantly related to health outcomes in South during the COVID-19 pandemic. This is especially important given widespread food insecurity during the pandemic as well as a large proportion of the population self-reporting worse health outcomes. Indeed, it is worrying that rather than witnessing a significant decline in food insecurity in recent months with the further re-opening of the economy, food insecurity remains stubborn at very high levels. The only significant reduction in food insecurity occurred during the period when grant top-ups were disbursed. While the prevalence of hunger significantly declined between May/June 2020 and February/March 2021, the decline has been far from uniform across all economic strata. In fact, while other income quintiles generally witnessed a significant decline in hunger, the poorest quintile experienced a 4-percentage point increase (though not statistically significant). Consequently, income-related inequality in hunger, disfavouring the poor in both time periods, worsened over time. Individuals whose households experience hunger have up to a 7.3-percentage point higher probability of reporting worse health outcomes relative to those whose households do not experience hunger. Those whose households experience hunger everyday have a 17-percentage point higher probability of reporting worse health than those unaffected by hunger.

The foregoing highlight the urgent need to address food insecurity in the country especially as some of the pandemic-induced palliatives are being phased out or entirely removed. There is far too much hunger in the country especially as many jobs are yet to recover, if they have not permanently disappeared. This study highlights the wider implication of food insecurity, especially its extreme manifestation in hunger, namely that food insecurity has adverse health implications and mostly affect the poorest segment of society. It is hoped that policy makers and implementers as well as the private sector and non-profit organizations will redouble efforts to significantly alleviate the scourge of food insecurity in South Africa.

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