Socio-Economic Planning Sciences xxx (xxxx) xxx

Contents lists available at ScienceDirect

Socio-Economic Planning Sciences

journal homepage: www.elsevier.com/locate/seps

Stockpiling and food worries: Changing habits and choices in the midst of COVID-19 pandemic

Franklin Amuakwa-Mensah [a,b,*], Salome Amuakwa-Mensah [b], Rebecca Afua Klege [c,e], Philip Kofi Adom [d]

[a] Environment for Development, University of Gothenburg, Box 645, SE 405 30, Göteborg, Sweden
[b] Department of Business Administration, Technology and Social Sciences, Luleå University of Technology, 971 87, Luleå, Sweden
[c] School of Economics, University of Cape Town, Private Bag, Rondebosch, 7701, Cape Town, South Africa
[d] Department of Development Policy, School of Public Service and Governance, Ghana Institute of Management and Public Administration (GIMPA), Ghana
[e] Henry J Austin Health Center, 321 N. Warren Street, Trenton, 08618, New Jersey, USA

ARTICLE INFO

Keywords:
COVID-19
Food security
Food waste
Stockpiling
Sub-Saharan Africa

ABSTRACT

Albeit, governments have instituted strong containment measures in the wake of the COVID-19 pandemic, concerns of continuous local spread and economic impact of the virus are impacting global food chains and food security. This paper investigates the effect of concern about the i) local spread and ii) economic impact of COVID-19, on the change in the amount of food and necessities bought in twelve Sub-Sahara African countries. In addition, we examine if these effects are channeled through food worries. The study uses a unique survey dataset by GeoPoll collected in April 2020 (first round) and May 2020 (second round) and employs a multinomial logit and generalized structural equation models. We find significant effect of concern about COVID-19 on change in the package size of food and necessities bought, which is heterogeneous across gender group and rural-urban divide. Our results reveal that concerns of COVID-19 might be promoting stockpiling behavior among females and those with no food worries (due to having sufficient money or resources). This if not properly managed could in the medium to long-term affect the food supply chain, food waste and exacerbate food worries problem especially for already food deprived homes. We discuss the policy implications.

1. Introduction

Since its first discovery in December 2019 in the Wuhan city of China and onward pronouncement as a pandemic by the World Health Organization in January 2020 [1], COVID-19 virus cases continue to increase from as low as 823,626 beginning April 2020 to over 183 million cases in July 4, 2021 [2,3]. The deaths toll due to the virus has increased to almost 4 million as at July 4, 2021 from 40,598 as at April 1, 2020 [2,3]. While the severity of cases and deaths differ across regions and continents, Africa has experienced its fair share of the recorded cases and deaths. Cases in Sub-Saharan Africa have increased from 135,375 in May 30, 2020 to 4,172,433 in July 4, 2021, with death rates from 3923 in May 30, 2020 to 97,682 in July 4, 2021 [3].

The novel virus has shaken the foundations of economies in the world, causing severe slack in economic activities [4]. The natural economic tendencies for governments globally were to, among other things, institute restrictions on local and international movements either partial or a complete lockdown of their economy. It is a well-known fact that these restrictions on goods and persons have had varied effects on incomes and the food supply chain [4,5], with implications on food security and hunger [6,7]. Bene [5] notes that the threat of the novel virus goes beyond the threat on health to include the induced fragility on global food systems.

The crisis and the imposed restrictions on movements of people and goods, together with temporary closure of food processing business have induced behavioral changes among consumers of food, especially in Africa. These changes include stockpiling, panic buying, and hoarding. These behaviors serve as risk-mitigating measures to improve the resilience of consumers towards the highly vulnerable food system. For example, through stockpiling, consumers hedge against the risk of food and necessities shortage. In addition, stockpiling is a strategy used to minimize the number of times one visits the market [8]. Despite the risk-mitigating potential of stockpiling, stockpiling can cause disruptions in the food system, such as causing shortages, food price inflation,

* Corresponding author. Environment for Development, University of Gothenburg, Box 645, SE 405 30, Göteborg, Sweden.
E-mail address: franklin.amuakwa-mensah@efd.gu.se (F. Amuakwa-Mensah).

https://doi.org/10.1016/j.seps.2021.101181
Received 20 February 2021; Received in revised form 3 October 2021; Accepted 22 October 2021
Available online 30 October 2021

uneven distribution of food, a break in the food supply chain, and wastage of food [9]. In sub-Saharan Africa, where there is severe food shortage, stockpiling behaviors can instigate greater damage on the already fragile food systems in Africa and cause significant food worries.

In this study, we analyze these behavioral patterns caused by the pandemic in 12 sub-Saharan African countries. Specifically, we ask the questions; a) how do concern about the (i) local spread and (ii) economic impact of COVID-19 affect the purchasing habit of food (i.e. package size of food and necessities bought); b) is the effect in the previous question above facilitated by the relationship between concerns about the local spread and economic impact of COVID-19, and the probability of food worries? Women tend to be more risk-averse than men [10], and are therefore more prone to engage in stockpiling behaviours than men. In the same way, stockpiling might be heterogeneous depending on whether the individual reside in a rural or urban area. In answering the above questions, we investigate the potential heterogeneities that concerns about local spread of the virus and economic impact can have on the purchasing habit of food.

Our study is an extension of the work by Chiwona-Karltun et al. [11]; where we contribute to the literature in the following ways. First, we investigate the effect of concern about; (1) local spread and (2) economic impact of COVID-19 on the amount of food and necessities bought by considering 12 Sub-Sahara African countries. Unlike Chiwona-Karltun et al. [11]; we explore how COVID-19 concerns influence the purchasing habits of individual during health pandemic. We investigate whether the local spread and economic impact of COVID-19 affect individual's habit of buying less, same or bigger amount/size of food and necessities using Sub-Saharan Africa as case study. In addition, we examine whether the effect of COVID-19 concerns on food worries could translate to a change in the purchasing habits of individuals. Earlier study by Chiwona-Karltun et al. [11] did not consider the association between food worries and purchasing habits of individuals. Our study provides quantitative evidence of these relationship, which is scarce in the literature, especially within the context of developing countries.

The study uses a unique survey dataset by GeoPoll collected in April 2020 (first round) and May 2020 (second round) and employs a multinomial logit model and generalized structural equation model. The uniqueness of the dataset is due to the fact that it is the only dataset which was collected from several Sub-Saharan Africa countries for two waves during the earlier periods of COVID-19 and the time when countries were implementing restrictive measures. The remainder of the study is structured as follows: section 2 reviews relevant literature on food security and Covid-19, Covid-19 restriction, stockpiling and food worries, and Covid-19 restriction and food waste. Section 3 presents the methodology and data, and section 4 presents and discusses the results of the study. The final section 5, concludes the studies and proffers policy directions based on the results.

2. Literature

2.1. Food security and Covid-19

COVID-19 is noted to have continuous effect on food security, destabilizing agriculture value chains, and these problems are predicted to be severe in low-income countries that already face food insecurity [12]. In such countries, food insecurity that may result from the COVID-19 may compound wide spread of malnutrition [12] and wide spread of incidence of chronic diseases [13,14].

COVID-19 has the potential of affecting all the pillars of food security proposed by FAO, which are: (i) availability (ii) access (iii) utilization and (iv) stability [15]. Available evidence indicates that whereas adverse impacts of COVID-19 on food security are yet to be felt, globally, the pandemic has significantly affected agricultural supply chains [16,17], which if not mitigated, could perpetuate wide spread impact. The pandemic has immensely stressed farm labor availability, agricultural food production, food processing capacity, transport and logistics, and access to food [18]. The majority of the pandemic related disruptions have arisen from the inauguration of national policies meant to contain the virus spread [15,18]. The fact that almost all farm sectors are labor intensive [18], and yet the curtailment of mobility of persons is one of the measures to contain virus spread, farm labor availability has been affected [15]. As most developing countries are labor intensive in relation to agricultural production, there is the tendency of farm labor disruption [15,17]. Farm labor shortages may further disrupt harvesting [17], and hence the amount of food that enters the markets and/or factories for processing.

Agricultural production has also been affected, by the pandemic, through the unavailability of quality seed to farmers. African seed companies have not been able to produce and/or import certified seeds [19], which may in the medium- or long-term cause wide spread food insecurity as poor-quality seeds affect production. Furthermore, there are instances where farmers rely on harvested seeds as food to meet the household's food security needs due to low production, hence raising food shortage threat later on [20].

Besides agricultural production, food processing has not been spared either, and the effects of the COVID-19 pandemic on that segment of the value chain have also threatened food security. The control measures of the spread of COVID-19 have affected food processing; where social distancing has resulted into labor shortages at industrial level [21], and a reduction of processing efficiency [18]. In France, for instance, meat processing facilities registered a 30% increase in staff absence during the initial stages of the outbreak [21], significantly affecting meat availability in the country. The United Nations [22] has predicted that such an occurrence will most likely result into a reduction of food stocks of especially perishable commodities like fish, meat, and dairy, given their higher vulnerability to logistical challenges [23].

In addition, the usual agricultural produce markets have been affected due to COVID-19 control measures, as a result of closure of schools and some restaurants. This has made market outlets harder to find on the part of the farmers and other suppliers. This had led to widespread wastage of food and a disruption of food distribution programs [15], which has threatened food security of especially vulnerable groups. The potential impact of COVID-19 on food security has and is still being exacerbated by the ongoing trade restrictions that have disrupted the imports and exports [19], of especially staples such as wheat and rice. As such, for African countries with high food import needs, the food security threats may be higher, as local food markets therein are already disrupted by virus spread measures [24].

2.2. Covid-19 restriction, stockpiling and food worries

Human behavior is not constant and is likely to change in the event of crisis or disasters [25–27]. A common observed behavior in such situations is panic buying and stockpiling which can arise due to the fear of scarcity. The ongoing COVID-19 pandemic is not any different. The pandemic which is characterized by several restrictions forced people to stay home at the early stages of the outbreak resulting in high levels of emotional distress [28]. This emotional distress was intensified by the constant media update of infections and mortality rates [29], which led to a wave of fear and uncertainties about food availability. The resulting effect was an acute increase in consumer food purchases translating into bulk buying, hoarding and stockpiling (Jezewska-Zychowicz, 2020).

While stockpiling behaviors may be regarded as irrational, psychology and economic theories suggest otherwise. Psychologically, stockpiling arises from the need to take charge of a situation [9,30–33]. Such self-fulfilling behaviors are known to have exponential peer and community effect [34], as more people are likely to increase their private food stocks when they observe or suspect their neighbors are stockpiling food which intend can lead to shortages. Dammeyer [35] associated two personal traits: "extraversion" and "neuroticism" with COVID-19 stockpiling behaviors. In economics, Tversky and

Kanneman's (2009) prospect theory tends to explain such consumer behaviors. During the pandemic (a risky event), risk averse individuals are likely to choose options that will provide them with a sense of security in response to the pandemic. Stockpiling food in the event of a pandemic therefore creates a medium through which consumers believe they can hedge against risk. Also, stockpiling may be seen as a response for consumers to reduce the number of times they frequent the shopping centers to enable them limit their COVID-19 exposure rates [8]. Nonetheless, stockpiling can disrupt food markets due to the shortages, increase in price, waste, and the uneven food distribution that comes along with it, as well as can cause a break in the food supply chain. This may lead to an actual scarcity of food which can further increase anxiety over food availability and cause further increases in prices [9].

Despite the negative effects, evidence suggest that COVID-19 restriction measures may result in some food benefits. In Qatar, Haseen et al. [8] observed changes in the way consumers interacted with food during the COVID-19 restrictions. The study showed an increase in the consumption of healthier diets, change in the acquisition of food as more people were shopping online, and a rise in the use of domestic products due to safety concerns. Di Renzo et al. [36] revealed that consumers were 30% more likely to reuse left over food during lockdown in Italy. Similarly, Jribi et al. [37] found that consumers in Tunisia were able to prevent food wastage during the lockdown. In the U.S.A, the close down of restaurants and coffee shops also led to a 41% increase in the number of people who cooked (The Food Industry Association).

In a recent study, Chiwona-Karltun et al. [11] find that concern about the local spread of COVID-19 and economic impact of the virus increase the probability of food worries in Sub-Saharan Africa. The authors conclude that the effect of COVID-19 concerns (local spread or economic impact) on food worries increases with the level of restrictive measures instituted by government. Food worries and stockpiling continues to be a subject of interest as the world faces a surge in COVID-19 cases. The literature on the subject is rapidly increasing, however, the knowledge generation process on the subject for African countries within the context of quantitative analysis is rather low. Examining stockpiling and food worries for the Africa region is vital to further understand changes in behavior in specific context during a pandemic.

2.3. Covid-19 restriction and food waste

Food waste is often characterized by economic, environmental, and social challenges [38–40]. According to the Food and Agriculture Organization [41], about 1.3 billion tons of food is wasted every year. While low-income countries tend to report significant waste at the food production and processing stages, developed countries are more inclined to wasting food at the retail and consumption stages [37,42]. Many fears and food worries during the COVID-19 lockdown restrictions led to consumer behavior changes towards supermarket visits, food purchases, and cooking. This behavior change sparked several concerns about potential food waste during the pandemic. The restrictions on movement made market outlets harder to find on the part of the farmers and other suppliers. This led to widespread wastage of food and a disruption of food distribution programs [15], which has threatened food security of especially vulnerable groups.

Existing empirical studies on COVID-19 and food waste suggest that food wastage was relatively low despite consumer stockpiling behaviors during the lockdown. Rogers et al. [42]; examine food waste behaviors in Italy and the United States of America (U.S.A) during the COVID-19 pandemic. Their results show that while about half (49%) of respondents from Italy reported a reduction in food waste, individuals in the U.S.A revealed a higher reduction (61%) in food waste. They attribute the observed changes in consumer behavior to fear of food scarcity and reliance on homemade food. Similarly, Pappalardo et al. [43] show that although COVID-19 restrictions led to increases in non-perishable food purchases in Italy, consumers became more mindful about their food-wasting behaviors leading to food waste reductions. Principato et al. [44] in their study in Italy show that young consumers and people who implemented good food management practices in the form of using shopping list and planning meal more frequently reduced food wasted during lockdown. In addition, given the logistical difficulties in grocery shopping experienced by consumers during the lockdown, they ended up reducing food waste.

Dou et al. [45] highlight how consumers in U.S.A and China preferred takeout and home deliveries during the COVID-19 restrictions, reducing their food waste. In Tunisia, about 85% of survey respondents revealed that they did not waste any food bought during the pandemic lockdown [37]. The decision to waste food is grounded on contextual and demographic factors [46,47]. Thus, cultural differences can contribute to or explain consumers' food waste behaviors during a pandemic. Given that the few studies conducted on food waste and COVID-19 are largely skewed toward Western countries, additional insight from sub-Saharan Africa is necessary to further understand food consumption behaviors during a pandemic.

3. Methodology and data

3.1. Empirical model and estimation

In achieving the first aim of the study, we model the amount of food and necessities bought as a function of Covid-19 concerns and socio-economic factors. As government policies on COVID-19 control measures vary by countries and they having specific macroeconomic and political features, we account for country fixed effect. The empirical model is specified as;

$$y_{ijt} = \beta_0 + \beta_1 Covid19\_Concern_{ijt} + \boldsymbol{X}_{ijt}\boldsymbol{\beta} + \eta_j + \gamma_t + \varepsilon_{ijt} \quad (1)$$

where the dependent variable y_{ijt} is a categorical variable which captures the amount of food and necessities bought by individual, i, in country, j, during time period, t. The dependent variable is categorical with three levels, that is, whether the individual buys a) smaller package size than usual, b) same package size and c) bigger package size than usual. Individuals were asked to indicate the package size they choose when they shop for food and necessities during the period of COVID-19. In this study, package size represents both the number and actual size of goods bought. The variable *Covid*19_*Concern* represents the individual's level of concern about (1) the local spread and (2) economic impact of COVID-19. Individuals were asked to indicate their level of concern about the local spread (or economic impact) of COVID-19 in their respective country on a scale of 1–5, with 1 being not concerned and 5 being very concerned. The control variables are represented by the vector $\boldsymbol{X}$ and this comprises socioeconomic and demographic factors, such as gender, age, locality (that is, urban-rural). Country and time fixed effects are represented by η_j and γ_t respectively. And ε_{ijt} is the random error term.

Given the nature of the dependent variable (that is, categorical), we estimate equation (1) using a multinomial logit model. Although our dependent variable seems ordered, it does not follow a Likert scale nature as most ordinal variables according to Daykin and Moffatt [48]. In addition, ordinal regression model is presented as a latent-variable model where the latent variable is continuous [49]. In our case, respondents were asked to indicate whether there has been a change in the amount of food and necessities bought relative to their usual amount purchased before the pandemic. They were provided with three categories to choose from; a) smaller package size than usual, b) same package size and c) bigger package size than usual. One will note that respondents are to evaluate the amount bought relative to their previous amount purchased prior to the pandemic, and choose one of the options as stated above. According to Long and Freese (2014, p.309), there are cases where variables that seems ordered can be unordered or ordered differently when used for another purpose. Our choice of nominal regression model is due to the restriction of the relationship between the

independent variables and the probabilities of outcomes categories in the case of ordinal regression model, which is unrealistic in most cases. Following the recommendation by Long and Freese (2014, p.385), the potential loss of efficiency in using multinomial model is outweighed by avoiding potential bias. Thus, the multinomial logit model used in this study based on equation (1) can be expressed as;

$$ln\Omega_{m|b}(\mathbf{x}) = ln\frac{Pr(y=m|\mathbf{x})}{Pr(y=b|\mathbf{x})} = \mathbf{x}\boldsymbol{\beta}_{m|b} \quad \text{for} \quad m=1 \ \text{to} \ 3 \tag{2}$$

where m represents the three categories of the outcome variable (which are; a) smaller package size than usual, b) same package size and c) bigger package size than usual). Also, b is the base outcome (that is, the reference category). In our study, the base outcome or reference category is "same package size" category. The vector, $\mathbf{x}\boldsymbol{\beta}$, represents the product of the explanatory variables listed in equation (1) and their respective coefficients. Since m ranges from 1 to 3, three equations could be specified and can be solved to compute the probabilities for each of the outcomes based on the equations below with "same package size" as the reference category;

$$\Pr(y=m|\mathbf{x}) = \frac{exp(\mathbf{x}\boldsymbol{\beta}_{m|2})}{\sum_{j=1}^{3} exp(\mathbf{x}\boldsymbol{\beta}_{j|2})} \tag{3}$$

In estimating the multinomial logit model, the standard errors are clustered at the primary administrative unit. This allows us to account for possible correlation in the residual of the outcome variable (that is, the amount of food and necessities bought) among individuals within the same community. The quantity of food and necessities bought by individuals is influenced by prices, however, the dataset used for this study does not have price information and other relevant factors, which may affect demand for food and necessities. Since prices for a particular food item or necessity could not vary much among individuals in the same community, we cluster the standard errors at the community level in order to adjust the standard errors for inference, following Amuakwa-Mensah et al. [50]. In addition, sample weight is applied to our estimation in order to adjust the results to the population distribution of each country. The weighting is based on population distribution across administrative area, age group and gender in each country.

Pertaining to the second aim of the study where we examine if the level of COVID-19 concerns affects the amount of food bought by individuals via whether the individual has been worried about food (that is, not having enough food to eat in the past 7 days prior to the survey) due to lack of money or resource, we employ two different techniques. First, we re-estimate equation (1) using the multinomial model discussed earlier but considering subsamples of individuals who worry about food and those who do not worry about food. Secondly, we employ generalized structural equation model (GSEM) on the pooled sample. For the GSEM, we make use of two-stage model where we express the probability of food worries as a function of COVID-19 concerns and socio-economic factors in the first stage. In the second stage, we link the probability of food worries to the amount of food and necessities bought. The generalized structural equation model is preferred to the normal structural equation model because the dependent variable of interest, that is, amount of food and necessities bought, is categorical. Within the generalized structural equation model, the first- and second-stage models are estimated simultaneously. GSEM is an extension of general linear modelling such as multiple regression and analysis of variance, which enables direct and indirect effects between variables to be determined by including the measurement errors [51].

3.2. Data, study design and sampling strategy

The study relied on an open-access survey dataset designed and collected by GeoPoll.[1] The survey was administered through SMS and mobile web. This dataset entails two waves of individual level survey in 12 Sub-Saharan Africa countries. These countries are Benin, the Democratic Republic of Congo (DRC), Ghana, Ivory Coast, Kenya, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Zambia. The first and second waves were rollout between April 2nd – April 9th, 2020, and April 24th - May 8th, 2020, respectively. Both rounds of survey included all the 12 countries, except Uganda and Tanzania which were excluded in the second-round. In total, 4788 and 3994 individuals responded to the survey in the first and second waves respectively, across the countries. For the first-round survey, a sample of 400 individuals were selected from each country, with the exception of DRC, which had a sample size of 388. Similarly, the second-round sampled 400 individuals from each country, except Rwanda which had a sample size of 394. For each round, the sample sizes give a margin of error of 5%.

Depending on the country, the survey was administered in English, French, Portuguese, Swahili, and Kinyarwanda. The sample is made up of literate adults with access to mobile phones, hence reaching relatively wealthier population. GeoPoll employed a random sampling technique in selecting respondents from their database, which consists of a list of mobile subscribers in each country surveyed. The sample in the survey is nationally representative based on age, gender and location (urban-rural) groupings.

For this study, we restrict our sample to individuals ages 18 years and older, who are legally considered as adults. It should be noted that our unit of analysis is the individual and not the household. Table 1 shows the descriptive statistics of the key variables used for this study. Relatively, a higher percentage of individuals bought a bigger package size of food and necessities than usual during the period of COVID-19 restrictions (about 41%). This is followed by those who bought the same package size as usual, represented by 34%. However, about 80% of the sample indicated that they have been worried about not having enough food to eat in the past seven days prior to the survey due to lack of money or other resources. Most individuals were concerned about both the local spread and economic impact of COVID-19, with an average score of 4.26 and 4.3 respectively. Whereas, 67% of the sample are urban dwellers, 33% lives in rural areas. The sample comprises of about 45% females and 55% males, with an average age of around 31 years. The relatively high number of males than females is due to the mode of the survey (mobile) and the sample design where literate adults with

Table 1
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
COVID-19 local spread concerns	8704	4.263	1.364	1	5
COVID-19 economic impact concern	8704	4.295	1.284	1	5
Age	8704	30.96	9.85	18	91
Food amount bought category					
Smaller packsize	8704	0.249			
Same as usual	8704	0.341			
Bigger packsize	8704	0.410			
Food worries	8704	0.804			
Female	8704	0.446			
Urban	8704	0.669			

Source: Authors' own construction from GeoPoll data.

[1] GeoPoll dataset can be accessed from https://data.humdata.org/dataset/covid-19-impacts-africa. The survey instrument can also be obtained from the same website. The dataset for both waves was directly requested from GeoPoll.

access to mobile phones were selected, hence reaching relatively wealthier population. In order to make our sample reflective of the population in each country, we applied survey weighting in the econometric analysis based on the population distribution of age, gender and administrative area in each country.

4. Results and discussion

4.1. Effect of COVID-19 concerns on amount of food and necessities bought

Tables 2 and 3 show the effect of concerns about local spread and economic impact of COVID-19 on amount of food and necessities bought, respectively, where "same package size" is selected as the base or reference outcome in the multinomial regression. In both tables, we account for demographic variables, such as age, gender and locality (urban or rural) in the estimation. We also account for wave fixed effect in model A, and then both country and wave fixed effects in model B. From Table 2, we find that an increase in concerns about the local spread of COVID-19 increases the probability of individuals buying smaller and bigger package size of food and necessities relative to their usual package size.

Table A1 in the appendix contains the marginal effect estimates. Marginal effects are quick and easier way to assess and interpret the effects of independent variables for multinomial logit models. We prefer marginal effect to odds ratios (Relative-Risk-Ratios) due the following limitations of the latter. Odds ratios do not provide a complete picture of the effects of variables on the outcomes and does not resolve the problem of nonlinearity [49]; p.234). In addition, the central meaning of a given odds ratio depends on the specific value of the odds before a change [49]; p.235). For this study, the marginal effect shows the marginal change in the probability of the outcome (that is, amount of food and necessities bought: 1) smaller package size than usual, 2) same package size and 3) bigger package size than usual) resulting from a marginal change in each covariate. It should be noted that across all categories of amount of food and necessities bought, the sum of average marginal effects must equal to zero, since any increase in the probability of one category must be offset by a decrease in another category. According to the result, a marginal increase in the level of concern about local spread of COVID-19 significantly decreases the probability of buying the same package by 1%. However, the probabilities of buying smaller and bigger package sizes increase by 0.4% and 0.6% respectively, following a marginal increase in concern about local spread of the virus, albeit, statistically insignificant. This implies that, concerns about the local spread of COVID-19 may cause individual consumers to change their food buying decision.

Table 2
Multinomial logit estimates: Concern about local spread of COVID-19 on amount of food and necessities bought.

	Model A		Model B	
	(1)	(2)	(3)	(4)
VARIABLES	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize
Age	−0.006	−0.014***	−0.002	−0.014***
	(0.004)	(0.003)	(0.004)	(0.003)
COVID-19 spread concern	0.065**	0.109***	0.052*	0.047*
	(0.030)	(0.025)	(0.030)	(0.025)
Female	0.030	0.174***	0.121*	0.172***
	(0.076)	(0.056)	(0.068)	(0.057)
Urban	−0.593***	0.085	−0.406***	0.130*
	(0.126)	(0.073)	(0.085)	(0.076)
Constant	−0.166	0.019	−0.748***	−0.191
	(0.236)	(0.162)	(0.228)	(0.189)
Observations	8704	8704	8704	8704
Country FE	NO	NO	YES	YES
Wave FE	YES	YES	YES	YES
Pseudo R2	0.0148	0.0148	0.0815	0.0815
Wald chi2	85.44***	85.44***	1068***	1068***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. Dependent variable is a categorical variable capturing the amount of food and necessities bought in times of COVID-19 restrictions. The categories are "smaller package size", "same as usual" and "bigger package size". The results from the multinomial logit model are shown in the table. "Same as usual" category is the base outcome in the model estimations. We controlled for wave and country fixed effect in all the models. Survey weight is applied to all models. Standard errors are clustered at primary administrative unit.

Table 3
Multinomial logit estimates: Concern about COVID-19 economic impact on amount of food and necessities bought.

	Model A		Model B	
	(1)	(2)	(3)	(4)
VARIABLES	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize
COVID-19 Economic impact concern	0.066**	0.084***	0.055*	0.045
	(0.032)	(0.025)	(0.029)	(0.027)
Constant	−0.174	0.118	−0.766***	−0.184
	(0.220)	(0.167)	(0.207)	(0.196)
Observations	8704	8704	8704	8704
Country FE	NO	NO	YES	YES
Wave FE	YES	YES	YES	YES
Pseudo R2	0.0140	0.0140	0.0815	0.0815
Wald chi2	82.51***	82.51***	1089***	1089***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. Dependent variable is a categorical variable capturing the amount of food and necessities bought in times of COVID-19 restrictions. The categories are "smaller package size", "same as usual" and "bigger package size". The results from the multinomial logit model are shown in the table. "Same as usual" category is the base outcome in the model estimations. We can for age, gender and locality in the models. We controlled for wave and country fixed effect in all the models. Survey weight is applied to all models. Standard errors are clustered at primary administrative unit.

Considering the association of the demographic variables and the amount of food and necessities bought, we find a significant relationship between age and buying bigger package size relative to buying regular package size (see Table 2). The marginal effect shows that an increase in age reduces the probability of buying bigger package size by 0.3% but increases the probability of buying smaller and the same package size as usual by 0.1% and 0.2%, respectively (see Table A1 in appendix). Our results show that females are more likely to buy smaller and bigger package sizes than usual compared to males (see Table 2). From the marginal effect estimation, we find that a change from male to female decreases the probability of buying the same package size of food and necessities by 3.2% but increases the probability of buying bigger package size than usual by 2.8% (see Table A1 in appendix). Thus, female could stockpile food and necessities in the event of a pandemic and this creates a medium through which they can hedge against risk. Females in Sub-Saharan Africa are risk averse and are likely to choose options that will provide them with a sense of security in response to the pandemic as stipulated by Tversky and Kanneman's (2009) prospect theory. In relation to locality, we find urban dwellers relative to rural, have lower probability of buying smaller package size of food and necessities than usual, and higher probability of buying bigger package size than usual, as compared to the base outcome (see Table 2). A change from rural to urban locality decreases the probability of buying smaller package size by 8.1% but increases the probability of buying bigger package size by 6.7%. Again, this suggests that urban dwellers are more likely to engage in stockpiling behavior than their rural dweller counterparts. Because food is largely grown in rural settings, food worries are likely to be severe in urban areas. The restrictive measures imposed due to the pandemic could affect supply of food to urban areas, and this might cause urban dwellers to engage in stockpiling behavior as a risk-

mitigating measure.

Similarly, from Table 3, we find that concern about the economic impact of COVID-19 increases the probability of buying smaller and bigger package sizes but statistically robust only in the former case. From the marginal effect, a marginal increase of concern about economic impact of COVID-19 leads to a significant decrease in the probability of buying the same package size by 1% (see Table A1 in appendix). Although, the estimated marginal effects of concern of local spread of virus suggest an increase in probability of 0.05 to buy small and bigger package sizes, statistically, these estimated effects are weak. Restrictive measures put in place to curtail the spread of COVID-19 could significantly affect economic activities and cause individuals to lose their means of livelihood. Consequently, food worries could grow among individual consumers. A recent study by Chiwona-Karltun et al. [11] found that concern about impact economic of COVID-19 have significant effect on food worries in Sub-Saharan Africa. However, our findings provide very weak statistical support to this claim.

4.2. Heterogeneity of the effect of COVID-19 concerns on amount of food and necessities bought

There is the tendency that the effect of concerns of spread and economic impact of COVID-19 could be heterogeneous when we consider gender and locality. Therefore, in this section, we restrict our analysis of the effect of COVID-19 concerns on the amount of food and necessities bought, to gender and locality groupings. Tables 4 and 5 present the results of concerns about local spread and economic impact of COVID-19 on the amount of food and necessities bought, respectively, across gender and locality.

4.2.1. Gender

In the case of concerns about the local spread of the virus, we find females relative to males increase their probability to buy smaller and bigger package sizes compared to the base outcome, when there is an increase in concern about the local spread of the virus (see Table 4). The probability of buying the same package size as usual reduces by 2% but the probability of buying the bigger package size increases by 1.4% when there is a unit increase in the level of concern about local spread of COVID-19 (see Table A2 in appendix). The results for the concerns about the economic impact show that, for females, a unit increase in concern about economic impact of COVID-19 decreases the probability of buying the same package size by 2% but increases the probability of buying bigger package size by 2.1% (see Table 5 and Table A2 in appendix). Males are likely to increase the probability of buying small package by 1% due to a unit increase in concern about economic impact of the virus. Both concerns about local spread and economic impact of the virus could increase food worries [11], we, however, observe that the phenomenon of stockpiling is likely to be higher among females than males.

This is because females are risk averse and are more likely to choose options that will provide them with a sense of security in response to the pandemic. In addition, females could see stockpiling as a response to reducing the number of times they frequent shopping centers in an attempt to limit COVID-19 exposure rates [8].

4.2.2. Location (Urban vrs rural)

For the geographical analysis, we find that concern about the local spread of COVID-19 significantly increases the probability to buy smaller package sizes relative to the base outcome of buying the usual package size, in rural areas. The marginal effect shows that a unit increase in the concern about the local spread of the virus increases the probability of buying smaller package size by 1.5%, however, the probability of buying the usual package size reduces by the same amount 1.5% (see Table A2 in appendix). Given the fact that the spread of COVID-19 in urban areas is more pronounced than in the rural areas, this result is unexpected. However, this can be explained by the fact that response measures put in place to curtail the local spread of the virus has the tendency of disrupting the supply chain of agricultural produces which is the main income earner of rural dwellers, hence making individuals to buy smaller package size of food and necessities.

In relation to concern about the economic impact of the virus, we find that relative to the reference outcome (that is, buying the usual package size), there is an increase in the probability of buying smaller package size also in the rural areas. The marginal effect shows 1.3% reduction in the probability of buying the same package size if the concern about the economic impact increases by 1 unit in rural areas. Thus, both concerns about local spread and economic impact of COVID-19 is likely to increase food worries in rural areas of Africa. In most developing countries, poorer households spend a greater proportion of their income (that is, 80%) on food and necessities (Bashir and Schilizzi, 2013) and have limited access to financial credit. This makes them vulnerable when there are crises in the form of pandemics and economic downturns which makes their income unpredictable. As a result, the economic impact of the virus has the tendency of reducing income, hence a decrease in the package size of food and necessities bought. In the urban areas, we do not find any strong statistical evidence of stockpiling or food worries as a result of the concerns of local spread and economic impacts of COVID-19.

Table 4
Multinomial logit estimates: Heterogeneous effect of concern about local spread of COVID-19 on amount of food and necessities bought.

	Female		Male		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize
COVID-19 spread concern	0.096**	0.099***	0.023	0.008	0.015	0.042	0.109**	0.054
	(0.041)	(0.037)	(0.040)	(0.031)	(0.042)	(0.031)	(0.044)	(0.037)
Constant	−1.055***	−0.433	−0.462	0.108	−1.064***	−0.098	−0.926***	−0.145
	(0.295)	(0.265)	(0.299)	(0.226)	(0.279)	(0.194)	(0.320)	(0.308)
Observations	3880	3880	4824	4824	5820	5820	2884	2884
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Wave FE	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.0918	0.0918	0.0773	0.0773	0.0636	0.0636	0.102	0.102
Wald chi2	1087***	1087***	781.6***	781.6***	714.5***	714.5***	650.2***	650.2***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.
Dependent variable is a categorical variable capturing the amount of food and necessities bought in times of COVID-19 restrictions. The categories are "smaller package size", "same as usual" and "bigger package size". The results from the multinomial logit model are shown in the table. "Same as usual" category is the base outcome in the model estimations. We controlled for age and location variables and wave and country fixed effect in all the models. Survey weight is applied to all models. Standard errors are clustered at primary administrative unit.

Table 5
Multinomial logit estimates: Heterogenous effect of concern about COVID-19 economic impact on amount of food and necessities bought.

	Female		Male		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize
COVID-19 Economic impact concern	0.062	0.118***	0.053	−0.014	0.027	0.038	0.088**	0.051
	(0.041)	(0.035)	(0.034)	(0.035)	(0.037)	(0.035)	(0.044)	(0.037)
Constant	−0.929***	−0.521*	−0.575**	0.186	−1.115***	−0.086	−0.852***	−0.135
	(0.289)	(0.272)	(0.275)	(0.232)	(0.258)	(0.204)	(0.305)	(0.317)
Observations	3880	3880	4824	4824	5820	5820	2884	2884
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Wave FE	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.0920	0.0920	0.0778	0.0778	0.0636	0.0636	0.101	0.101
Wald chi2	1130***	1130***	940.7***	940.7***	673.3***	673.3***	639.7***	639.7***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.
Dependent variable is a categorical variable capturing the amount of food and necessities bought in times of COVID-19 restrictions. The categories are "smaller package size", "same as usual" and "bigger package size". The results from the multinomial logit model are shown in the table. "Same as usual" category is the base outcome in the model estimations. We controlled for age and location variables and wave and country fixed effect in all the models. Survey weight is applied to all models. Standard errors are clustered at primary administrative unit.

4.3. Food worries, COVID-19 concerns and amount of food and necessities bought

In this section, we examine if the level of COVID-19 concerns affects the amount of food bought by individuals via whether the individual has been worried about not having enough food to eat in the past 7 days prior due to lack of money or resource. We first re-estimate equation (1) using the multinomial model discussed earlier but considering sub-samples of individuals who worry about food and those who do not worry about food. Secondly, we employ generalized structural equation model (GSEM) on the pooled sample to find out the intermediation role of food worries in connection with the relationship between COVID-19 concerns and the package size of food and necessities bought.

From Table 6, we find no significant effect of concern about the local spread and economic impact of COVID-19 on package size of food and necessities bought, for individuals who have been worried about not having enough food to eat in the past seven days prior to the survey due to lack of money or other resources. However, for individuals with no food worries, our results show that concern about the local spread and economic of COVID-19 increase the probability of buying bigger package size relative to buying the usual package size. The marginal effect shows that a unit increase in the level of concern about the local spread of the virus reduces the probability of buying the usual package size by 2.1% (see table A3 in appendix). For the economic impact, the marginal effect for individuals with no food worries shows that a unit increase in the level of concern about economic impact decreases the probability of buying the small package size by 2.4% but increases the probability of buying bigger package size by 3.5%. This brings to play the context of stockpiling as individuals buy bigger package size than usual. The reason for stockpiling as stated earlier could be a means of consumers reducing the number of times, they frequent shops as a response to limiting exposure rate to the virus [8]. There is, however, a disadvantage of stockpiling which could lead to food market disruption, as it induces shortage, and increase in prices and food waste. As individuals hoard food and necessities, if this stock is not well managed, it could lead to food waste. Given the extended movement restriction due to COVID-19 and its economic impact, we expect behavior change in the form of stock management at home due to the fear of food scarcity and reliance on homemade food.

In Fig. 1 and Table A4 (in appendix), we show the relationship between COVID-19 concerns and amount of food and necessities bought, and the role played by food worries. Similar to Chiwona-Karltun et al.

Table 6
Multinomial logit estimates: Association between COVID-19 concerns and amount of food and necessities bought within food worries context.

	Worried about food		Not worried about food		Worried about food		Not worried about food	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize	Smaller packsize	Bigger packsize
COVID-19 spread concern	0.028	0.021	0.057	0.103*				
	(0.031)	(0.025)	(0.074)	(0.058)				
COVID-19 Economic impact concern					0.040	0.006	−0.038	0.145***
					(0.034)	(0.033)	(0.067)	(0.042)
Constant	−0.724***	−0.178	−0.808*	−0.306	−0.774***	−0.122	−0.500	−0.469
	(0.234)	(0.200)	(0.464)	(0.358)	(0.239)	(0.229)	(0.418)	(0.317)
Observations	6998	6998	1706	1706	6998	6998	1706	1706
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Wave FE	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.0813	0.0813	0.0826	0.0826	0.0813	0.0813	0.0852	0.0852
Wald chi2	861.8***	861.8***	351.3***	351.3***	868.5***	868.5***	360.3***	360.3***

Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.
Dependent variable is a categorical variable capturing the amount of food and necessities bought in times of COVID-19 restrictions. The categories are "smaller package size", "same as usual" and "bigger package size". The results from the multinomial logit model are shown in the table. "Same as usual" category is the base outcome in the model estimations. We controlled for age and location variables and wave and country fixed effect in all the models. Survey weight is applied to all models. Standard errors are clustered at primary administrative unit.

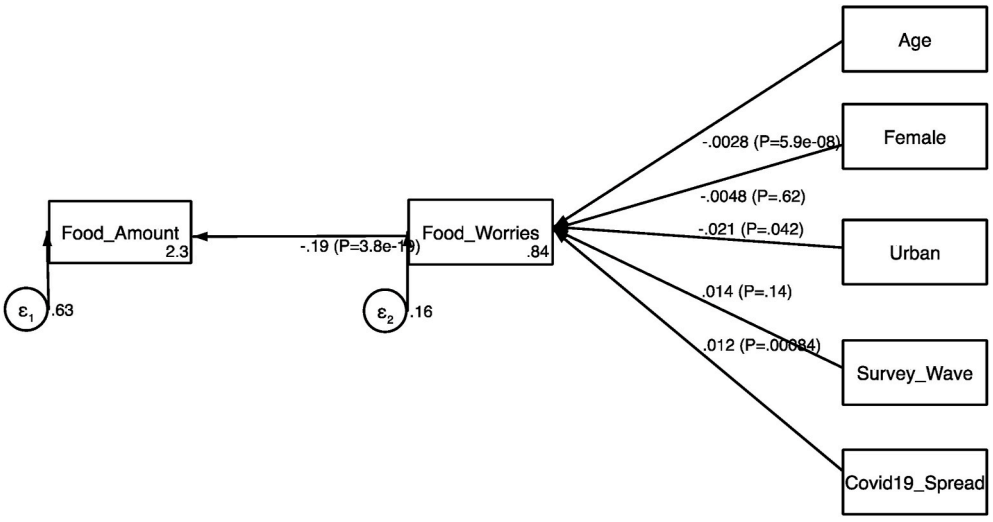

Fig. 1. Generalized structural equation model (GSEM).

[11]; we find positive significant association between COVID-19 concerns and food worries (see Table A4 and Fig. 1). Thus, an increase in COVID-19 concerns is likely to increase the probability of individuals worrying about not having enough food to eat due to lack of income or resources. This food worries lead to individuals reducing the amount (that is, package size) of food and necessities bought. Our results show that as individuals worry about food due to lack of money or resources, the probability of the amount of food and necessity bought reduces by 19% (see Fig. 1 and table A4). This implies that COVID-19 concerns increase food worries and this in turn reduces the amount of food and necessities bought by individuals.

5. Conclusion

This paper sought to find answers to the following questions; a) how do concern about the (i) local spread and (ii) economic impact of COVID-19 affect the purchasing habit of food (i.e., package size of food and necessities bought); and b) is the effect in the previous question above facilitated by the relationship between concerns about the local spread and economic impact of COVID-19, and the probability of food worries due to lack of money or resources? We made use of a unique dataset designed and collected by GeoPoll in April 2020 (first round) and May 2020 (second round) on twelve Sub-Saharan Africa countries. We applied multinomial logit and generalized structural equation models in our analysis. We conclude that concerns about COVID-19 spread and economic impact might be changing the food package sizes bought by individual consumers in these African countries. As indicated in this study, the marginal effect shows that a unit increase in either local spread or the economic impact of COVID-19 decreases the probability of buying the same package size of food and necessities by 1%. Specifically, we find that concerns about local spread increases the probability to buy smaller and bigger package sizes than the usual package size but concerns about the economic impact of COVID-19 seems to increase the probability to buy smaller package sizes than the usual package size. These results suggest that concerns about COVID-19 could promote both stockpiling behaviour and food worries among individual consumers. Our results suggest that concerns of food worries (most likely to be instigated by concerns of economic impact of COVID-19) could be common in rural areas while concerns of stockpiling behaviour (most likely to be caused by concerns about local spread of COVID-19) might be more common among females than males.

Further, we observed that individuals who are not worried about food due to having sufficient income or resources, are more likely to engage in stockpiling behaviors while those facing food worries because of lack of income are more likely to buy smaller package sizes than the usual package size due to the concerns of economic impact of COVID-19. Thus, for group of individual consumers already facing food worries, the economic impact of COVID-19 might further exacerbate their food worries while for individual consumers not facing food worries, concerns of COVID-19 might cause them to engage in stockpiling, with the tendency of food waste.

The above findings have important implications on the food supply chain, welfare of food deprived individuals and future research. First, stockpiling behavior could disturb the food supply chain if not properly managed. Given the economic hardship brought about by the response measures to COVID-19, it is expected that individuals would manage the stock of food and necessities at home as evident in other places like Italy, USA, Tunisia, etc. [37,42–45]. Although, it has been reported that, low-income countries tend to report relatively less food waste at the retail and consumption stages compared to developed countries [37,42], the key issue of concern about food security during the COVID-19 movement restriction pertains to the likely food waste at the production, processing and transportation stages in developing countries, as this is estimated to be high [37,42]. In the short-term, stockpiling might increase the availability of food in an anticipation of demand rush but depending on the readiness of supply, stockpiling behavior in the medium to long-term might cause perpetual food shortage in the economy. Consequently, this could push price up and further increase the food worries woes of food deprived homes. Albeit, the act is currently not illegal, government can as a way to manage the problem seize food stockpiles. Alternatively, a quota of food purchase can be set and then a prohibitively high price for purchase beyond the quota set especially for consumers with no food worries.

Second, concerns of COVID-19 could impose more food security constraints on already food deprived homes. This definitely calls for economic recovery programs to support the livelihood of individuals. As there is non-existence of livelihood support programs in most developing countries, some governments in these countries (e.g. Ghana) have introduced innovative policies to provide financial relief through the subsidization of utility bills (i.e water and electricity) to the population. These kinds of interventions can free resources especially for vulnerable groups to help ease their food burden.

From our multinomial logit estimations, it can be seen that the pseudo r-square (McFadden) is low and this is mostly common with the estimation technique used. The low pseudo r-square could imply low predictive power of our estimations. However, the Wald chi-squares from our estimations are statistically significant. This means that the dependent variable from our models based on the multinomial logit

estimations are significantly explained by the independent variables. It should be noted that data on the topic under investigation is still developing, therefore, our results might suffer from some biases due to specific data problems. First, in this study, the quantity of food and necessities bought by individuals is influenced by price, but the dataset used for this study do not have price information and other relevant factors, which may affect demand for food and necessities. Because the price for a particular food item or necessity would not vary much among individuals in the same community, clustering the standard errors of our estimation at the community level could adjust the standard errors for inference.

Second, our dataset does not have individual information, such as employment status, income and education level of the individual which could be important for this analysis. Third, the data used in this study do not have household information about the respondent, such as household size, household dependency ratio, and housing characteristics which may affect food security. Definitely, omitting these important variables could affect the causal interpretation of our findings. Future studies can consider the analysis at the household level considering all the above-mentioned omitted variables when data becomes available. This article studied the effect of COVID-19 concerns on food basket purchase, which is just one dimension of food security. However, the effect of the pandemic could extend to other dimensions of food security, which are not independent of each other. Analysing these complex interactions in the midst of a pandemic is certainly interesting but beyond the scope of this current study. Future research could focus on the effect of the pandemic on dietary diversity or nutritional status of individuals or households.

CRediT author statement

Franklin Amuakwa-Mensah: Conceptualization of idea, Methodology, Estimation, Data curation, Writing- Original draft preparation, Revision of manuscript.

Salome Amuakwa-Mensah: Conceptualization of idea, Writing- Original draft preparation, Result discussion, Revision of manuscript-writing, review & editing.

Rebecca Afua Klege: Conceptualization of idea, Writing- Original draft preparation, Result discussion, Revision of manuscript-writing, review & editing.

Philip Kofi Adom: Conceptualization of idea, Writing- Original draft preparation, Result discussion, Revision of manuscript-writing, review & editing.

Acknowledgement

We thank the Editor and two anonymous reviewers for the comments and suggestions which have improve the quality of this paper.

Appendix

Table A1
Marginal effects on amount of food and necessities bought from Tables 2 & 3 models.

	(1)	(2)	(3)
VARIABLES	Smaller packsize	Same packsize	Bigger packsize
Age	0.001*	0.002**	-0.003***
COVID-19 spread concern	0.004	-0.010**	0.006
Female	-0.004	-0.032**	0.028**
Urban	-0.081***	0.014	0.067***
COVID-19 economic impact concern	0.005	-0.010**	0.005

*** p<0.01, ** p<0.05, * p<0.1.

Table A2
Marginal effects on amount of food and necessities bought from Tables 4 & 5 models.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Smaller packsize	Same packsize	Bigger packsize	Smaller packsize	Same packsize	Bigger packsize
	Female			Male		
COVID-19 spread concern	0.006	-0.020***	0.014*	0.003	-0.003	-0.000
COVID-19 economic impact concern	0.001	-0.020***	0.021***	0.010*	-0.002	-0.008
		Urban			Rural	
COVID-19 spread concern	0.001	-0.007	0.009	0.015**	-0.015**	-0.001
COVID-19 economic impact concern	0.001	-0.007	0.006	0.011	-0.013*	0.002

*** p<0.01, ** p<0.05, * p<0.1.

Table A3
Marginal effects on amount of food and necessities bought from Table 6 models.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Smaller packsize	Same packsize	Bigger packsize	Smaller packsize	Same packsize	Bigger packsize
	Worried about food			Not worried about food		
COVID-19 spread concern	0.003	-0.005	0.002	0.001	-0.021*	0.021
COVID-19 economic impact concern	0.007	-0.004	-0.003	-0.011	-0.024***	0.035***

*** p<0.01, ** p<0.05, * p<0.1.

Table A4
Generalized Structural Equation Model (GSEM).

	(1)	(2)	(3)
VARIABLES	Food Worries		Food Amount
Covid19 Spread Concern	0.0123***		
	(0.0037)		
Covid19 Economic Impact Concern		0.0203***	
		(0.0039)	
Food Worries			-0.192***
			(0.0215)
Constant	0.836***	0.803***	2.307***
	(0.028)	(0.0283)	(0.0182)
var(e.Food Amount)			0.6296***
			(0.006)
var(e.Food Worries)			0.158***
			(0.0028)
Observations	8,704	8,704	8,704

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.
The results from the GSEM is shown in the table. We controlled for age, gender and location variables and wave fixed effect in the model. Standard errors are clustered at primary administrative unit.

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Franklin Amuakwa-Mensah: Franklin doubles as a research manager and researcher at Environment for Development (EfD), University of Gothenburg. He is also a senior lecturer in economics at Luleå University of Technology. His former position was as a post-doctoral researcher at the department of economics at the Swedish University of Agricultural Sciences (SLU) and European Investment Bank (EIB)-Global Development Network (GDN) research fellow in applied development finance for the 2018/2019 cohort. He holds a PhD degree in economics from the Swedish University of Agricultural Sciences, a master of philosophy degree in economics and a bachelor's degree in economics with mathematics, all from University of Ghana. His primary research interest is in the areas of environmental and natural resource economics, development economics, and agricultural and food economics. His research is empirical in nature with applied econometric methods.

Salome Amuakwa-Mensah: Salome is a doctoral candidate in economics at the Luleå University of Technology. She has a masters degree in agricultural economics and management from the Swedish University of Agricultural Sciences. Her research interests include development, energy, environmental and agricultural economics.

Rebecca Afua Klege: Rebecca is the research director at Henry J Austin Health Center, USA. She is also a researcher at the Environmental Research Policy Unit where she recently completed her doctoral studies at the School of Economics, University of Cape Town. Her research interests include environmental, poverty, behavioural economics, and gender-related issues. She has experience designing and implementing surveys and providing experimental solutions for environmental goods through behavioural nudges, lab experiments, and randomized control trials in developing countries. Rebecca also works with the EfD Global Hub, to develop a research focus that looks at developmental and environment-related economics through the lens of gender.

Philip Kofi Adom: Philip is a Senior Lecturer at the Ghana Institute of Management and Public Administration (GIMPA) and a research fellow at EfD Ghana. He holds a PhD in Economics from the Swedish University of Agriculture Sciences. His research interest is in energy and environmental economics. This includes energy finance, demand and supply modelling, pricing modelling, energy transitions, energy efficiency, renewable energy and pricing, economics of wastewater and environmental pollution, and water use efficiency.