

Amidu, Mohammed; Akakpo, Agnes Akpene; Kwakye, Teddy Ossei

Article

Measuring vulnerability index for managing COVID-19 behaviour in Ghana

Cogent Business & Management

Provided in Cooperation with:

Taylor & Francis Group

Suggested Citation: Amidu, Mohammed; Akakpo, Agnes Akpene; Kwakye, Teddy Ossei (2024) : Measuring vulnerability index for managing COVID-19 behaviour in Ghana, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 11, Iss. 1, pp. 1-24, <https://doi.org/10.1080/23311975.2024.2391247>

This Version is available at:

<https://hdl.handle.net/10419/326491>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Measuring vulnerability index for managing COVID-19 behaviour in Ghana

Mohammed Amidu, Agnes Akpene Akakpo & Teddy Ossei Kwakye

To cite this article: Mohammed Amidu, Agnes Akpene Akakpo & Teddy Ossei Kwakye (2024) Measuring vulnerability index for managing COVID-19 behaviour in Ghana, Cogent Business & Management, 11:1, 2391247, DOI: [10.1080/23311975.2024.2391247](https://doi.org/10.1080/23311975.2024.2391247)

To link to this article: <https://doi.org/10.1080/23311975.2024.2391247>



© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 23 Aug 2024.



Submit your article to this journal [↗](#)



Article views: 372



View related articles [↗](#)



View Crossmark data [↗](#)

Measuring vulnerability index for managing COVID-19 behaviour in Ghana

Mohammed Amidu, Agnes Akpene Akakpo and Teddy Ossei Kwakye

University of Ghana Business School, Legon, Accra, Ghana

ABSTRACT

This paper investigates the implications of human behaviour and government support for the quality of life of vulnerable populations during the Covid-19 pandemic. We sample 2,697 households and employ the COM-B model, theory of economic contagion, and information asymmetry to empirically respond to the following research questions: What is the level of vulnerability among informal settlements in Ghana? Did the support vulnerable populations receive during the peak of the Covid-19 outbreak in Ghana improve their state of being? What were the lifestyle changes during the pandemic? Our core finding is that the plight of the vulnerable population is ameliorated when government support brings about positive change in Covid-19 behaviour. Our analysis suggests that cash transfers, free utilities and credit schemes reduce income vulnerability. Moreover, government support for small businesses and tax exemption have the potential of reducing employment vulnerability. It is therefore recommended that policymakers should institutionalize emergency cash transfers, subsidize essential utilities, and establish accessible credit schemes to support vulnerable populations after the Covid-19 crisis.

ARTICLE HISTORY

Received 10 February 2022
Revised 28 July 2024
Accepted 7 August 2024

KEYWORDS

COVID-19; Ghana; global pandemics; and vulnerable population

SUBJECTS

African Studies; Attitudes & Persuasion; Sociology & Social Policy

JEL CLASSIFICATION

B55 I38 N37

1. Introduction

The novel COVID-19 virus was declared a global pandemic by the World Health Organisation (WHO) on March 11, 2020. The pandemic has ravaged human lives and significantly disrupted the world's public health, social and economic systems. As of 26th September 2020, the world reported more than one million covid-19 related deaths. Despite the high levels of disease transmission, Africa shows remarkably low cases of Covid-19 deaths. To control the spread of the virus, the WHO instituted guidelines such as social distancing, regular handwashing with soap under running water, using alcohol-based hand rubs and wearing nose masks. Governments worldwide also put in place lockdowns to restrict human movements and contain the virus in affected communities. In Ghana, a three-week partial lockdown was instituted in the Greater Accra Metropolitan area, including Kasoa and Greater Kumasi. These areas were considered the epicentre of the disease outbreak in Ghana. The lockdown was deemed to have worsened the economic situation of people whose livelihood depended on activities that guaranteed a daily wage. The crippling effect the lockdown was having on the Ghanaian economy prompted the subsequent easing of the lockdown. Vieira et al. (2020) assert that the protective measures put in place to protect physical health and healthcare systems may have an enormous effect on the wellbeing of individuals and therefore suggest collective action on a global scale rather than just resolute government action in fighting the pandemic.

Pandemic outbreaks put vulnerable populations at higher risk, necessitating special attention for the elderly, homeless, migrants, and persons with disabilities. Having the right kind of support and changing human behaviour has proven effective in mitigating related hazards and risks of the pandemic. Flanagan et al. (2011) argue that the most vulnerable people are likely those whose needs are not sufficiently

CONTACT Mohammed Amidu ✉ mamidu@ug.edu.gh 📧 University of Ghana Business School, P.O. Box LG 78, Legon, Accra, Ghana.

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

considered in the planning of local response and relief organisations. Support plays a pivotal role in ameliorating the plight of vulnerable populations when the needs of such groups are taken into consideration. Despite the major economic downturns following the outbreak of the covid-19 pandemic, countries saw support from international donor communities, and civic and humanitarian organisations. The support included economic recovery schemes for developing and developed countries alike.¹

The pandemic literature suggests a bidirectional relationship between human behaviour and pandemics. Pandemics have the potential of changing human behaviour, and human behaviour, on the other hand, can influence the spread of infectious diseases (Acuña-Zegarra et al., 2020; Clark et al., 2020; Hussain et al., 2020; Michie & West, 2021; Bavel et al., 2020). It is asserted that human behaviour played a crucial role in causing COVID-19 (Michie & West, 2021). The success stories of many countries in mitigating the harm of the pandemic to their economies and health have been attributed to the enactment of interventions directed at behavioural change. However, effective behavioural change interventions require an understanding of either or both the changes in capability and motivation or opportunity (Michie & West, 2021). Duan et al. (2020) opine that governments can ride on the public risk perception to encourage citizens to adopt recommended protective actions, which include government communication, government prevention and control and government rescue. In Ghana pandemic related studies have taken diverse forms and perspectives, including but not limited to health financing (Abor & Abor, 2020), the impact of the pandemic on poverty and living standards (Bukari et al., 2021), short term changes in behaviour (Asiamah et al., 2021), and limiting the spread of COVID-19 in Ghana (Bonful et al., 2020).

Although various studies have analysed the variables of interest and established relationships between them and economic, social and health variables, these relationships have been examined independently. These prior studies have failed to explore the relationship between pandemic support and responsible human behaviour and how such a relationship contributes to reducing the risks of vulnerable populations. This paper, therefore, seeks to answer these empirical questions. Did the support vulnerable populations receive during the peak of the Covid-19 outbreak in Ghana go a long way in improving their state of being? What were the lifestyle changes that occurred due to keeping with recommended responsible human behaviour during the pandemic? The current paper fills the gap by empirically analysing the joint effect of support and behaviour on vulnerability by sampling 2,697 households in Ghana to answer these research questions. Mainly, we test for two main hypotheses: First, support and human behaviour independently reduces vulnerability. Second, the interaction between human behaviour and support participation has an overall impact on improving the lives of vulnerable populations.

The paper aims to establish the link between human behaviour and support during the covid-19 pandemic in improving the quality of life of vulnerable populations. Apart from extending the scope of the current literature, this paper makes important contributions regarding developing economies using Ghana as a case model. First, it documents the independent contribution of support and human behaviour in improving the pandemic situation in Ghana among vulnerable populations. Secondly, it evaluates the combined effect of covid-19 support and human behaviour on reducing the risk faced by vulnerable populations in Ghana. Finally, the study attempts to add to the welfare literature by demonstrating the potential mediating role of support and behaviour in improving the welfare of vulnerable populations.

The remainder of this paper is organized into four additional sections. Section (2) reviews relevant literature on human behaviour and support. Section (3) discusses the research methodology, the measurement of key variables used in the study, and data sources. Section (4) discusses the empirical results and sensitivity tests, and finally, section (5) provides the conclusions and policy implications.

2. Literature review

This session reviews relevant theoretical and empirical literature underpinning pandemics, vulnerable populations and strategies to insulate highly vulnerable populations from global pandemics, including COVID-19. We begin with the health belief model, capability-opportunity-motivation-behaviour (COM-B) model, theories of economic contagion and information asymmetry, then discuss the empirical literature on the impact of support and behaviour on Covid-19.

2.1. Theories related to pandemic and vulnerable populations

This section reviews the theoretical underpinnings related to pandemics and vulnerable populations that can be used as the basis for this study. The purpose of reviewing these theories is to argue that the impact of Covid-19 might be very uneven for various populations, depending on various epidemiological factors and national mitigation strategies. Theories discussed here include the health belief model, COM-B model, theory of economic contagion, and information asymmetry.

Responsible human behaviour is essential to the control of the spread of an epidemic. The health belief model has been used to explain various health behaviours, such as weight

reduction, vaccination, helmet use, and nutritional consumption, and identifying fundamental health beliefs. The health belief model emphasizes the psychological decision-making process behind individual protective behaviour, with the formation of health beliefs regarded as the key to adopting protective behaviour. The health belief model explains factors in the public's adjustments to their health behaviour during an epidemic outbreak. The model mainly considers susceptibility to the disease, the severity of the epidemic, the effectiveness of the protective actions, and the cost of taking the protective actions. Individuals who highly perceive susceptibility to an epidemic and are convinced of its severity are more likely to voluntarily adopt forms of protective behaviour. Persons who are also sure that protective behaviour was very effective and perceive a lower cost of adopting protective behaviour are more likely to voluntarily adopt forms of protective behaviour.

The COM-B model is another comprehensive and straightforward way of understanding human behaviour. The model stands for capability-opportunity- motivation- behaviour. It takes its foundation from the fact that for behaviour to occur, individuals must have the appropriate physical and psychological capabilities and the opportunity and greater motivation to perform that behaviour than anything else they could be doing at the time. This model highlights that capability and opportunity feed into motivation, such that having greater capability and opportunity can enhance motivation. Therefore, to create sustained behaviour change, there is the need to make modifications to capability, opportunity and motivation that are mutually reinforcing. In the COM-B model, behaviour is part of an evolving and interacting system. The World Health Organisation has used the COM-B model to make recommendations for improving adherence to the rules and guidance on behaviours that may protect individuals against the COVID-19 pandemic.

Contagion in the economy happens when shocks in a particular economy spread and affect other regions or other aspects of the economy. The term contagion was rarely applied to the international financial markets before the global crisis was influenced by currency devaluation in Asia (Peckham, 2013). Financial contagion addresses two critical questions: what factors determine the course of a crisis and its potential to spread? Is shock propagated through existing channels or along new pathways created by crises? (Favero & Giavazzi, 2002). According to Claessens and Forbes (2004), contagion can occur due to many different fundamental causes. One type of fundamental cause is a common or global shock where an economic shift, such as a change in interest rates, commodity prices, and a fall in global growth in a country, can influence a crisis. Another type is a linkage in trade in the form of direct and competitive devaluations. Thus, a crisis in one country may trigger a decrease in income and a proportionate fall in import demand, affecting trade balance, exports, and related economic fundamentals in other economies via direct trade connection. The economic contagion could lead to competitive devaluation. This effect of 'competitive devaluations' can pressure the other countries' currencies to depreciate or devalue. This theory is employed to explain the possibility of the spread of economic crisis or boom across countries or regions. According to Baker et al. (2020), the Covid-19 pandemic has already created an economic shock beyond the financial crisis that stormed the globe in 2008-2009 and similar to the 1929-1933 great depression. The study adopts the theory of economic contagion and empirically examines pandemics and how it has affected vulnerable populations in Ghana, adopting the theory of economic contagion.

When parties in a market have more information than others, there is an imbalance of information – information asymmetry. Imbalanced information in a market can lead to market failure. Stiglitz (1975) and Spence (1974) have identified two types of information asymmetry: moral hazard and adverse selection. Uncertainties among organizations may affect the flow of information and trade among external parties. The moral hazard type of information asymmetry deals with risk, which happens when a party

trades based on limited information, hence, pays for the consequence of the risk. From the perspective of Jensen and Meckling (1976), moral hazard occurs due to the agency dilemma between principals and agents. In the political context, the moral hazard type of information asymmetry occurs when the principals who are the population elect an agent (government) to act on their behalf in the equitable distribution of resources. Here, the population is unable to detect the action choice of the government due to secrecy, national security concerns, and opacity; hence the government is induced to act in a way that may not meet the expectations of the population. An adverse selection which is classified as the hidden type of information asymmetry is when parties to a transaction are unable to detect the action choices of the other and hence trade based on limited information (Brown & Hillegeist, 2007). The compensation available for information imbalance is a charge of risk premium. Pandemics pose threats and damages to some individuals, groups, organizations, localities, etc. This category of people will need to be compensated for the damages suffered. Information asymmetry occurs when the right policy development cannot identify these groups and their level of required compensation. The challenges of adverse selection and moral hazards becomes the order of the day (Boot et al., 2020; Richter & Wilson, 2020). Covid-19 has created various uncertainty shocks in social and economic contexts (Baker et al., 2020). We, therefore, seek to examine the impact of pandemics within a complex network of asymmetric information among haves and have nots, place-specific interactions among people, the physical and built environments, social institutions, and infectious agents that cause disease.

2.2. Empirical review

The far-reaching impact of the COVID-19 pandemic on human behaviour and the significant role of intervention in all manner and forms have been documented in the literature. Given the importance of these variables towards pandemic mitigation, Dwomoh et al. (2021), sought to evaluate the impact of integrated government and individual-level interventions. Findings from their study suggest that enhanced government and individual level interventions and the intensity of media coverage could substantially suppress transmission of new COVID-19 cases and reduce death rates in Ghana until such a time that a potent vaccine or drug is discovered. Given that the public can oppose government interventions during pandemic outbreaks due to lack of trust, awareness, knowledge and perception about pandemics, Paek et al. (2008) explored public support for government actions during a flu pandemic. In their study, more than half of respondents trusted the government to handle a flu pandemic and showed strong support for many proposed government actions. The only proposed action that respondents objected was the offering of non-fully approved drugs. From the perspective of the transportation sector, Abate et al. (2020) assessed government support measures to the air transport sector following the covid-19 pandemic. Their assessment was viewed through the lenses of factors that shape governments to support airlines and the various types of support that may be provided, considering country-level factors. The study highlights that government support for the airline industry is backed by its intention to maintain jobs, protect economic activity and maintain air transport connectivity. Ashraf (2020), on the other hand, analysed the economic impact of government interventions during the covid-19 pandemic on financial markets. They observe that income support packages, among others, largely resulted in positive stock market returns. Social distancing, however, showed both positive and negative economic impacts.

Similarly, Haldar and Sethi (2020) also investigated the effect of country-level factors and government intervention on the incidence of COVID-19. They employ multivariate negative binomial regression models to explore the association between the country-level factors and recorded new COVID-19 cases. Their investigations conclude that periodic lockdowns are the best prerogative for countries with high COVID-19 cases. In Nigeria, Doherty et al. (2020) studied government intervention strategies among variables such as knowledge during the covid-19 pandemic in Nigeria. The findings suggest that about 70% of sampled respondents express that government intervention strategies during the pandemic were inadequate, although a significant number of them show adequate knowledge about the transmission, symptoms, and preventive measures of COVID-19. They arrived at these results by analysing responses from 387 respondents using descriptive statistics and analysis of variance.

Liu et al. (2020) research work contributes to the relationship between human behaviour and disease epidemics. Their paper proposes the coupling model of human behaviour and epidemics whilst advancing game theory as an essential tool for studying human behaviour. Their study results confirm the disease outbreak suppressing attribute of human behaviour. They also draw attention to the need for state intervention in influencing people's behaviour to achieve the best effect on curbing disease epidemics. On the other hand, Hussain et al. (2020) analysed the impact of the covid-19 pandemic on human behaviour based on data collected through questionnaires designed to assess human behaviour during the COVID-19 pandemic. They find a detrimental effect of COVID-19 on the physical and mental health of individuals and suggest that future studies should focus on more detailed aspects of the impact of COVID-19. The pandemic is significantly impacting societies around the world in an unprecedented manner. Due to their nature, vulnerable populations are much affected by the negative consequences of COVID-19. First, it is important to note that vulnerable populations have low capacities to cope with the COVID-19 pandemic. Most vulnerable people do not have savings and safety nets and have less access to support mechanisms. As a result, they need more attention to cope with the negative consequences of the COVID-19 pandemic.

Broadly, there have been two main coping strategies: those from government and civil society organisations. Realising that the COVID-19 pandemic has an economic, social and political impact, governments worldwide have adopted various measures to protect people's livelihoods, facilitate business continuity and sustain their economies. In most countries across the globe, central governments have extended social protection support to vulnerable populations. For instance, in Ghana, the central government extend food supply (both cooked and uncooked), free water and free electricity to vulnerable populations. Most governments worldwide have provided financial support to their citizens, especially the vulnerable, to ensure their survival and minimising their suffering. Non-Governmental Organisations (NGOs) and civil society organisations have played and continue to play a significant role in society. In this pandemic era, NGOs that were already working closely with communities have found new ways of continuing to provide humanitarian aid. Indeed, around the globe, NGOs have been responding to the COVID-19 pandemic through supporting health centres, raising awareness about how to prevent the spread of the pandemic, and providing essential supplies ranging from medicine and hygiene kits to Personal Protective Equipment (PPE) to, especially vulnerable and disadvantaged people.

3. Methodology

3.1. Sampling and data collection methods

Data for this study was collected from one hundred (100) informal settlements across eleven administrative regions (Greater Accra, Central, Volta, Ashanti, Western, Northern, Savanna, North East, Bono East, Bono and Ahafo) in Ghana where information on slum is available. The information on the number of informal settlements was obtained from Peoples Dialogue, Ghana, a Non-Governmental Organisational that focuses on informal settlements in Ghana. Peoples Dialogue, Ghana, has conducted enumerations of informal settlements in specific areas in Accra (Farouk & Owusu, 2012), and later conducted a national survey of informal settlements in Ghana. Peoples Dialogue has therefore become one of the reliable organisations to obtain data on informal settlements in Ghana. From this and for accessible data collection, the informal settlements were zoned into thirteen (13). The sample size for this study consists of 2,697 households. The sample size was obtained using Stratified random sampling. Stratified random sampling is appropriate for this study because it assures regional representation, accounts for variability within informal settlements, and improves the precision and dependability of the results. A total of twenty (23) enumerators were engaged to collect the data for three weeks. The enumerators visited the residents and administered the questionnaires to them.

3.2. Quality and validity of the data

To ensure the data quality, we acquire tablets for each of the enumerators and engage the services of a Data Manager to coordinate the process of the transmission of the response of the interviewee on the

field to a station at Accra, the national capital. The use of tablets to collect the data enhanced the quality of data collected by prompting and disallowing some responses that were not consistent per checks in the survey instrument. The instant synchronization of the data right at the end of the interview helped the survey management team to follow what was happening at all survey sites with ease. However, interviews conducted in areas where internet connection was poor could only be synchronized in the evening when the team returned to the district capitals where they lodged.²

3.3. Variable measurements

3.3.1. Measurement of vulnerable index

We begin with the construction of the vulnerability index. The questionnaire adopts the vulnerability index questionnaire by Flanagan et al. (2011) and Acharya and Porwal (2020). Flanagan et al. (2011) social vulnerability index includes four domains: (1) socioeconomic status; comprising income, poverty, employment, and education variables; (2) household composition and disability, comprising age, single parenting, and disability variables; (3) minority status and language, comprising race, ethnicity, and English language proficiency variables, and (4) housing and transportation, comprising housing structure, crowding, and vehicle access variables. Acharya and Porwal (2020) expanded the Flanagan et al. (2011) social vulnerability index under different thematic domains, extending beyond social vulnerability to accommodate vulnerability related to the COVID-19 pandemic. Therefore, Acharya and Porwal (2020) considered the following five domains, which are important in the context of the COVID-19 epidemic. These are (1) socioeconomic condition; (2) demographic composition; (3) housing and hygiene condition; (4) availability of health-care facilities; and (5) COVID-19-related epidemiological factors. This study, therefore, adopted Acharya and Porwal (2020) vulnerability index and measured the variables as follows:

Socioeconomic vulnerability: This variable encapsulates the various socioeconomic factors that affect the ability of a community to recover quickly when hit by a wide range of disasters, including pandemics. Given that in disasters, the socially vulnerable are more likely to be severely affected, in the sense that they are less likely to recover and more likely to die, attention must be paid to these variables to decrease economic loss and reduce human suffering to the barest minimum. The socioeconomic status of individuals is influenced by income, poverty, employment and education. The income of individuals is considered because household income can influence how well individuals can prepare for unforeseen events and their recovery possibilities. Even among economically disadvantaged populations, variations exist in the proportions and magnitude they are affected by disasters. This is made possible by insurance policies, financial investments and a stable source of employment. Individuals with some level of education can read and understand information regarding pandemics and measures they can take to prevent wide transmission and reduce their infection rate. On the other hand, education influences household income as it provides employable skills for entrepreneurship and well-paid jobs. In defining the socioeconomic vulnerability of populations, this study adopts four indicator variables: attaining some level of education with the primary level being the least, employment status of respondents, monthly household income and as a proxy for poverty is the proportion of the population who did not have any of certain household assets. These assets include but are not limited to television, radio, bicycle, phone, and refrigerator.

Demographic vulnerability: The demographic condition of a population may reduce its resilience to pandemics. The nature of the COVID-19 pandemic is such that the demographic composition of a population influences the pace of transmission and mortality. This attribute makes demography an important variable in the construction of a vulnerability index. This study measures demographic vulnerability using the proportion of the elderly population (this includes persons aged 60 years and above), place of residence (whether urban or rural), location density and how well homes are suited.

Housing and hygiene conditions: Housing and hygiene conditions have a bearing on the transmission of infectious diseases. Housing conditions especially crowding within homes, poor sanitation and poor hand hygiene practices, make individuals susceptible to infectious diseases transmitted through close human contact and contact with infected surfaces due to unsanitary conditions. The COVID-19 transmission is reduced by spacing out individuals (social distancing), regular hand washing with soap under safe running water, and applying alcohol-based hand sanitisers. These measures highlight the importance of

living in a spacious and hygienic environment. Thus, making housing and hygiene conditions a variable worth considering in constructing a vulnerability index. Therefore, in this study, we employ four variables to assess respondents' housing and hygiene conditions. They are the number of people per room, availability of toilet facility within a household, availability of hand hygiene facility and household access to water.

Availability of health care: The availability of health care is crucial in an outbreak of diseases. Health facilities serve as primary care giving units that expedite recovery and restoration of health. Thus, if persons recover from pandemics like COVID-19, it greatly depends on the ease of access and affordability of a well-resourced and functioning health care system. In accessing the availability of health care, we employ variables, including possessing of health insurance, access to health care, willingness to visit and access health facilities and the number of health care facilities in a community.

Epidemiological factors: Epidemiological factors cannot be overlooked in the construction of a vulnerability index in the context of a pandemic like the novel coronavirus. Epidemiological factors increase the chances of morbidity and mortality in the event of an infection outbreak. They may be underlying health conditions that increase one's chances of being infected and reduce the probability of recovery when one contracts the virus. In Ghana, most reported COVID-19 deaths resulted from previous underlying health conditions of infected persons rather than the virus. In constructing the index, this study considers three main indicators as the proxy for epidemiological factors. They include persons current health condition, persons with any current chronic morbidity, persons undergoing any long term medical treatment.

The variables chosen for each component of vulnerability (income, education, employment for socio-economic situation; age, type of residence for demographic composition) are justified in terms of their relevance to the COVID-19 pandemic and their influence on vulnerability. Data is gathered from reputable groups such as Peoples Dialogue in Ghana, which has performed comprehensive studies on informal settlements.

3.3.2. Responsible COVID-19 behaviour

Even before the introduction of vaccines, the control of pandemics has been linked to the responsible behavioural response of individuals. Behaviour, as it is, can be learned and unlearned, whereas the learning process can be voluntary or involuntary. In the wake of the COVID-19 pandemic, the WHO issued guidelines that constituted responsible behaviour to reduce the transmission and spread of COVID-19. Measures implemented at individual and organisational levels included the 'no mask no entry' signs at the entrances of homes, shops and organisations, maintaining skeletal staff through running of shifts, and lockdowns to restrict human movement. Also, an effort was made to provide running water and soap at vantage points to ensure regular handwashing before entering public spaces. All these measures were to solicit the right response from individuals. This responsible COVID-19 behaviour constitutes handwashing, maintaining good personal hygiene, staying home, working from home, cleaning surfaces, wearing a nose mask and stocking up home supplies and medicines. The score is based on a Likert scale ranging from '1 being never to 5 as always'. A total score of 28 shows good behaviour.

3.3.3. Government support of COVID-19

The vulnerability of a population can be linked to the support they receive from individuals, businesses, civic and community-based organisations, families and government. This is true because the sufficient support a population receives, the less vulnerable they are. Loss of support places populations at greater risk. Providing support is a way of protecting the health of vulnerable populations. To effectively provide support to vulnerable populations, there is the need to carry out a critical need assessment not to waste resources on interventions that such populations may deem unbeneficial. To effectively provide support, specific, unique needs and concerns must be considered. Further strategies and specific approaches needed to make support relevant must be considered. To address support of COVID-19, this study asks respondents relevant questions on the kind of support they expect or received from the government that will improve or improved their conditions. The questions bother on food support, public education, cash transfer and wage support, free utilities, credit schemes, business support, tax exemptions, liquidity

support and hand sanitisers' supply. We constructed an index, 1-8, with 8 being a person with more support.

3.4. Estimation strategy

We explore how government support influences vulnerable populations and responsible behaviour during the COVID-19 pandemic. We assume individuals are rational and would therefore alter their behaviours in order to reduce their risk. Also, the presence of support will be a motivating factor that will elicit the right kind of behaviour. Therefore, we hypothesize a reverse relation between COVID-19 support and vulnerability in that support can ameliorate the vulnerable populations' plight and bring about a behaviour change. We use the following model to explore the interconnections between support and vulnerability.

$$Y_{1j}^* = X'_{1j}\alpha + R'_{1j}\beta + \varepsilon_{1j} \quad (1)$$

Where, Y_{1j}^* is the dependent variable, vulnerability. The subscript j refers to the individual. X'_{1j} is a vector of individual household level characteristics such as gender, marital status, geographical location etc. $R'_{1j}\beta$ is an index score of COVID-19 support respondents received or expected to receive during the pandemic. Support comprises eight (8) indicative variables. An individual's support score indicates the level of support received. Vulnerability in this study is constructed as an index comprising five main constructs: socioeconomic, demographic, housing and hygiene condition, availability of health care and epidemiological factors. A respondent scores 1 when he demonstrates or finds him/herself in a vulnerable situation and scores 0 when otherwise is observed. A total score of 18 denotes high vulnerability. ε_{1j} is a normally distributed random error term with zero mean and constant variance.

Having estimated the mitigating effect of support on vulnerability, we go ahead to evaluate the impact of COVID-19 behaviour on vulnerable populations. The rationale is that even in the face of expected support, support may not achieve the intended outcomes when the proper behaviour is not exhibited.

$$Y_{2j}^* = X'_{2j}\alpha + P'_{2j}\beta + \varepsilon_{2j} \quad (2)$$

Where, Y_{2j}^* is the dependent variable, vulnerability. The subscript j refers to the individual. X'_{2j} is a vector of individual household level characteristics such as gender, marital status, geographical location etc. $P'_{2j}\beta$ represents the COVID-19 behaviour score of respondents. Responsible behaviour constitutes handwashing, maintaining good personal hygiene, staying home, working from home, cleaning surfaces, wearing a nose mask and stocking up home supplies and medicines. The score is based on a Likert scale ranging from 1-5. A total score of 28 shows good behaviour. ε_{2j} is a normally distributed random error term with zero mean and constant variance. The econometric models employed in our study are appropriate for analyzing the impact of government support and individual behaviour on the vulnerability of the population during the COVID-19 pandemic.

Furthermore, we estimate the joint effect COVID-19 support and responsible behaviour has on vulnerable populations. We use the model below:

$$Y_{3j}^* = X'_{3j}\alpha + R'_{3j}\beta + P'_{3j}\beta + (R'_{3j}\beta * P'_{3j}\beta) + \varepsilon_{3j} \quad (3)$$

Here, Y_{3j}^* is the dependent variable, vulnerability. The subscript j refers to the individual. X'_{3j} is a vector of individual household level characteristics such as gender, marital status, geographical location etc. $R'_{3j}\beta$ is an index score of COVID-19 support respondents received or expected to receive during the pandemic. $P'_{3j}\beta$ represents the COVID-19 behaviour score of respondents. In equation (3) above, $(R'_{3j}\beta * P'_{3j}\beta)$ represents the interaction between support and behaviour. ε_{3j} is a normally distributed random error term with zero mean and constant variance.

Alternatively, and for the robustness test for improvement of vulnerability, we use welfare methodology to evaluate how COVID-19 support ameliorates the plight of vulnerable populations. The indicators

of welfare at the household level will include changes in income level (continuous) and having access to employment (dummy). The assumptions underlying these measures are that (1) we assume that if a vulnerable person receives support in credit schemes, it will enhance the income earning capacity. A higher income is expected to enable households to satisfy their welfare needs; (2) we assume that if COVID-19 support is efficient and useful, it would help reduce labour turnout and job losses; (3) we also assume that providing vulnerable households with free utilities in the form of provision of portable water and electricity will enable households to be in a better position to meet their welfare needs. We use the following model to explore the interconnections between support and vulnerability.

$$W_{ik} = f(V_{ik}, G_{ik}, U_{ik}, Q_{ik}, R_{ik}, S_{ik}) \quad (4)$$

Where W_{ik} is our welfare measure, subscript i represents household, subscript k ($k=1, 2$) represents the two proxies of welfare and V, G, U, Q , and R , respectively, are vectors of vulnerability hypothesized to influence household welfare. As earlier defined, vulnerability in this study is constructed as an index comprising five main constructs: socioeconomic, demographic, housing and hygiene conditions, availability of health care and epidemiological factors. A respondent scores 1 when he demonstrates or finds himself in a vulnerable situation and scores 0 when otherwise is observed. A total score of 18 denotes high vulnerability. S is an index score of COVID-19 support respondents received or expected to receive during the pandemic. Support comprises eight (8) indicative variables. An individual's support score indicates the level of support received. All variables used in the models, their definitions and measurements are shown in [Appendix A](#).

4. Empirical results

4.1. Summary and descriptive statistics

This section provides the summary and descriptive statistics of variables employed in this study. [Appendix B.1](#) shows the demographic profile of respondents sampled across the eleven regions in Ghana. From the table, females constitute 60.33% of respondents, with the remaining 39.67% being male. Concerning the marital status of respondents, the appendix in reference once again reveals that a large number of respondents are married. They constitute about 50% of the sampled population. Single or persons who have never been married make up 33% of the total sample. Separated or divorced respondents represent 6.82%, whereas widowed and co-habiting make up 5.78% and 4.67 respectively. The religious background and the regional distribution of respondents are also highlighted in [Appendix B.2](#). The Greater Accra Region had the highest representation in the study, followed by the Ashanti Region with 38.78% and 18.98%, respectively. The region with the least representation is the North East Region with 1.08%. The religious distribution indicates that the majority of persons are Christians, with 63.18%. Muslims constitute 36.41%, whereas those who ascribe to the traditional religion and other religions make up 0.15% and 0.26%, respectively.

[Appendix B.2](#) presents the results of the Covid-19 responsible behaviour index. It scores the behavioural responses of sampled respondents. From the table, the least index score recorded was 5, whereas the highest score reported was 28. An examination of the table reveals that about 233, constituting the majority of the sampled respondents, scored 19. This table also demonstrates good behaviour because as the index score increases, the frequency of respondents also increases at an increasing level until we notice a fluctuation in the frequencies from the index score of 14. Forty respondents attained the highest score of 28, indicating good behaviour, whereas 4 exhibited the least good behaviour, scoring 5.

We employ eight indicators to measure government support, and the results are presented in [Appendix B.3](#). The Yes or No responses of respondents on various support measures they received or expected to receive are highlighted. In terms of food support, 12.01% of respondents answered in the affirmative, 17.09% for public education, 34.59% for cash transfers and 23.95% were in favour of free utilities. Similarly, credit schemes, support for SMEs, tax exemptions and hand sanitizers affirmative responses reported are 38.04%, 71.04%, 22.32% and 15.42%, respectively. We could observe from the frequencies that respondents were more interested in receiving or received support for their small businesses. The

support indicators were further indexed from 1 to 7. The majority of respondents ranked the support received at the second least index, which is 2.

4.2. Measurement of the level of vulnerability of the population in Ghana

In Table 1, we present results from computing vulnerability indices of 100 slums located in various regions in Ghana. Similar to Acharya and Porwal (2020), vulnerability indices were constructed along five domains: socioeconomic condition, demographic composition, housing and hygiene conditions, availability of health-care facilities, and COVID-19-related epidemiological factors. Individual domain vulnerability scores range from 0, which denotes the lowest level of vulnerability, to 2.536, which is the highest. Regarding the total vulnerability scores across the sampled slums, the lowest score is 3.781, with the highest being 6.649. Analysis of vulnerability scores below 0.5 along individual indicators reveals 16 slum areas for socio-economic vulnerability, 28 for demographic vulnerability, 8 for housing and hygiene, 0 for health care vulnerability and 90 for epidemiological vulnerability, respectively.

Regarding total vulnerability, 38 slum areas scored at least 5, with 21 in the Greater Accra Region. Intra-slum domain vulnerability reveals each area's uniqueness even though these areas have been broadly classified as slums and are expected to exhibit some similarities. The following slum areas scored the highest along the individual domain vulnerability indicators: Atuwei (2) in terms of socio-economic vulnerability, Adabraka (1.348) for demographic, Dagbandabi (2.536) for housing and hygiene, Fisheries (2.5) for health and hygiene and Ho (1.281) for epidemiological vulnerability. Atuwei, Adabraka and Fisheries are located in the Greater Accra region, whereas Dagbandabi and Ho are located in the Northern and Volta regions of Ghana, respectively. Despite not recording the highest vulnerability score along any individual domain, Ketan in the Western Region cumulatively scored the highest total vulnerability. Intra-slum domain vulnerability comparison may be misleading when their total vulnerability is not considered. However, focusing attention on domain vulnerabilities will help target the correct responses leading to a reduction in total vulnerability. Also, investigating slum specific vulnerability will improve understanding of the factors that make one slum more vulnerable than the other.

The slum areas-level vulnerability index is designed to assist government efforts to effectively respond to the fast-developing Covid-19 epidemic in Ghana. These vulnerability scores are meant to be used by the health authorities to specifically target the vulnerable population of slum areas and propose the needed government support to mitigate and reduce the health and socioeconomic consequences of Covid-19.

4.3. The effect of government support on vulnerability

In Tables 2 and 3, we present the effect of government support on COVID-19 vulnerability in Ghana. In Table 2, we regress all five vulnerability domains against support individuals received or expected to receive from the government, whereas in Table 3, we regress all 8 individual support indicators against the total vulnerability index of respondents sampled across 100 slums in Ghana. In both cases, we control for gender, marital status, religion and geographical location.

The results in Table 2 confirm the study's hypothesis that government support reduces vulnerability considerably. We observe a negative relationship between government support and three domain vulnerability indicators, of which two are highly significant. These are demographic, housing and hygiene and epidemiological vulnerability. The composite score of the individual vulnerabilities (total vulnerability) also shows a negative and highly significant relationship with government support. Although health care and socio-economic vulnerability show a positive relationship with government support, which seems unexpected by the study, this association is insignificant. From this, we can confidently conclude without any reservations that government support during crisis times like the COVID-19 pandemic goes a long way to reduce vulnerability.

The study also reveals that males are less vulnerable than their female counterparts during pandemics with the government support. This can be attributed to the fact that they are often the head of households. Thus, they serve as the first point of contact or recipients of government support and further decide the allocation and distribution of support received. Also, given the gendered role females play,

Table 1. Measurement COVID-19 vulnerability index.

Slum area	Reg	Socio economic vulnerability	Demographic vulnerability	Housing & hygiene vulnerability	Health care vulnerability	Epidemiological vulnerability	Total vulnerability score
Abesim	BR	0.656	0.156	1.094	1.469	0.406	3.781
Wenchi Zongo	BAR	0.750	0.094	0.719	1.500	0.188	3.250
Kpando	VR	0.750	0.219	0.281	1.531	0.719	3.500
Nima	GAR	0.364	0.909	0.591	1.591	0.091	3.545
Tunga	GAR	0.273	0.545	0.773	1.818	0.227	3.636
Agortin	GAR	0.409	0.727	0.273	2.000	0.273	3.682
Tuba	GAR	0.364	0.545	0.591	1.864	0.318	3.682
Pig Farm	GAR	0.353	0.941	0.412	2.000	0.000	3.706
Sunyani Zongo	BR	0.781	0.125	0.938	1.656	0.219	3.719
Madina Zongo	GAR	0.545	0.227	0.909	1.909	0.136	3.727
Adam Nana	GAR	0.682	1.045	0.227	1.727	0.091	3.773
Pankrono	ASR	0.500	0.529	1.088	1.441	0.265	3.824
Choggu	NR	0.643	0.000	1.143	1.857	0.214	3.857
Redco Down	GAR	0.682	0.136	1.364	1.636	0.136	3.955
Zongo	NR	0.818	0.636	0.273	2.136	0.091	3.955
Hohoe	VR	0.719	0.125	0.625	1.813	0.688	3.969
Bechem Zongo	AHR	0.906	0.094	1.156	1.719	0.156	4.031
Gupe	NR	0.679	0.000	1.714	1.536	0.107	4.036
Walewale Zongo	NER	0.966	0.172	1.966	0.793	0.207	4.103
Amakom	ASR	0.412	1.029	0.706	1.735	0.235	4.118
Kwabanya	GAR	0.917	0.708	0.375	1.750	0.375	4.125
Nasawa	GAR	0.409	1.000	0.727	2.000	0.045	4.182
Maamobi	GAR	0.556	0.407	1.111	1.963	0.148	4.185
Fiapre Zongo	BR	0.781	0.344	1.063	1.656	0.344	4.188
Zabarma Line	GAR	0.864	0.409	1.000	1.682	0.273	4.227
Sabon Zongo	GAR	0.826	0.522	1.043	1.870	0.000	4.261
Mallam Atta	GAR	0.136	1.045	0.591	2.227	0.273	4.273
Shukura	GAR	0.545	0.818	1.091	1.727	0.091	4.273
Sawaba	ASR	0.412	1.059	0.912	1.853	0.059	4.294
Obulogo	GAR	0.682	0.227	1.182	2.091	0.182	4.364
Nyanshiegu	NR	0.966	0.000	1.586	1.621	0.207	4.379
Berekum Zongo	BR	0.879	0.152	1.394	1.667	0.303	4.394
Chiraa	BR	0.813	0.188	1.375	1.719	0.313	4.406
Essikado	WR	0.842	0.684	0.684	1.921	0.289	4.421
Chiggli	NR	0.679	0.071	1.857	1.750	0.107	4.464
Goaso Zongo	AHR	0.906	0.219	1.250	1.719	0.375	4.469
Manfro	GAR	0.591	0.545	1.273	2.045	0.045	4.500
Nsakina	GAR	0.500	1.000	0.818	2.045	0.136	4.500
Kintampo Zongo	BER	0.906	0.188	1.219	1.531	0.688	4.531
Walantu	GAR	1.000	1.000	0.500	2.045	0.000	4.545
Arab City	GAR	0.524	1.000	0.571	2.238	0.238	4.571
Opeikuma	GAR	0.381	1.048	0.762	2.048	0.333	4.571
Yaliwa	ASR	0.382	1.059	1.235	1.735	0.176	4.588
Bawaleshie	GAR	0.864	0.045	1.227	2.000	0.500	4.636
Kalpohini	NR	0.607	0.036	2.071	1.750	0.179	4.643
Avenue / Avenor	GAR	0.636	0.909	0.955	1.955	0.227	4.682
Mempeasem	GAR	0.545	0.591	1.500	2.045	0.045	4.727
Asawase	ASR	0.412	1.235	1.176	1.765	0.176	4.765
Tulaku	GAR	0.682	0.545	1.136	2.136	0.273	4.773
Adiembra	WR	0.865	1.162	1.081	1.459	0.216	4.784
Asokwa Zongo	ASR	0.441	1.029	1.412	1.853	0.059	4.794
Asebi Zongo	ASR	0.486	1.229	1.171	1.800	0.114	4.800
Agbogbloshie	GAR	0.955	0.727	1.000	1.955	0.182	4.818
Alajo	GAR	0.727	1.045	0.727	2.227	0.091	4.818
Nima 441	GAR	0.522	0.957	1.522	1.826	0.000	4.826
Dormaa Zongo	BR	1.273	0.242	1.152	1.879	0.333	4.879
Salaga Zongo	SR	1.067	0.100	2.033	1.467	0.233	4.900
Buokrom	ASR	0.618	1.176	1.588	1.441	0.118	4.941
Ga-Mashie	GAR	1.364	0.682	0.818	1.909	0.182	4.955
Awoshie	GAR	0.625	1.083	0.625	2.333	0.292	4.958
Dome	GAR	1.000	0.792	0.625	2.125	0.458	5.000
Nkoranza	BER	0.844	1.188	1.094	1.656	0.219	5.000
Aboabo	ASR	0.559	1.118	1.618	1.735	0.000	5.029
Nima Alafia	GAR	0.700	1.050	1.250	2.000	0.050	5.050
Dagomba Line	SR	0.371	1.171	1.457	2.000	0.057	5.057
Osu Alata	GAR	1.522	0.826	0.435	1.783	0.522	5.087
Teshie Sea Side	GAR	1.522	0.739	0.391	2.087	0.348	5.087
Ajumaku	GAR	1.455	0.727	0.682	1.909	0.318	5.091
Kawo Kudi	GAR	0.727	0.955	1.045	2.182	0.182	5.091
Fijai	WR	0.919	1.162	1.243	1.486	0.351	5.162
Ayigya	ASR	0.353	1.029	1.735	1.941	0.118	5.176

(Continued)

Table 1. Continued.

Slum area	Reg	Socio economic vulnerability	Demographic vulnerability	Housing & hygiene vulnerability	Health care vulnerability	Epidemiological vulnerability	Total vulnerability score
Old Tafo	ASR	0.765	1.265	1.235	1.676	0.235	5.176
Moshie Zongo	NR	0.952	0.698	1.651	1.603	0.333	5.238
Nima Suraj	GAR	0.696	1.043	1.261	2.000	0.261	5.261
Atebubu Zongo	BER	0.875	0.313	1.688	1.906	0.500	5.281
Old Offinso	ASR	0.794	1.176	1.294	1.794	0.235	5.294
Kisseman	GAR	0.708	1.167	1.000	2.292	0.250	5.417
Adiembra Zongo	WR	0.921	1.158	1.289	1.684	0.395	5.447
Kojokrom	GAR	1.079	1.211	1.184	1.605	0.447	5.526
Old Fadama	GAR	0.818	1.000	1.636	2.045	0.045	5.545
Ayikai Doblo	GAR	0.727	1.045	1.182	2.455	0.182	5.591
Ho	VR	1.406	0.188	1.063	1.719	1.281	5.656
Ayigbe Town	GAR	0.636	0.909	1.545	2.227	0.364	5.682
Dagbandabi	NR	1.250	0.179	2.536	1.643	0.143	5.750
Chorkor	GAR	1.095	0.857	1.524	2.286	0.048	5.810
Abuja	GAR	0.818	1.318	1.455	2.045	0.182	5.818
Budumburam	CR	0.545	1.091	1.864	2.318	0.045	5.864
Atuwei	GAR	2.000	0.900	0.700	2.050	0.250	5.900
Sempe-Tinpon	ASR	0.588	1.265	2.147	1.912	0.000	5.912
Ofaarkor	GAR	1.545	1.136	0.864	2.318	0.091	5.955
Adakope	GAR	0.870	0.783	2.000	2.304	0.000	5.957
Adabraka	GAR	1.087	1.348	1.261	2.217	0.130	6.043
Glefe	GAR	1.000	1.091	1.909	2.045	0.045	6.091
Effiakuma Zongo	WR	1.351	1.108	1.730	1.649	0.270	6.108
La Maamli	GAR	1.636	1.182	0.818	2.409	0.136	6.182
Sogakope	VR	0.875	1.156	1.438	1.781	1.156	6.406
Fisheries	GAR	1.500	1.136	1.182	2.500	0.318	6.636
Ketan	WR	1.216	1.324	1.838	1.784	0.486	6.649

The table presents the vulnerability scores of the 100 slums located in the regions of Ghana. Vulnerability related to the COVID-19 pandemic are considered in the five domains: (1) socioeconomic condition; (2) demographic composition; (3) housing and hygiene condition; (4) availability of health-care facilities, and (5) COVID-19-related epidemiological factors. GAR means Greater Accra Region, ASR is Ashanti Region, WR is Western Region, VR is Volta Region, NR is Northern Region, CR represents Central Region, SR is Savannah Region, BR is Bono Region, BER is Bono East Region, AHR is Ahafo Region and NER is North East Region.

they cannot benefit so much from support because they have to ensure the needs of their families are first met at their very own expense, making them more vulnerable than their male counterparts.

The married also stand a high probability of being less vulnerable than the unmarried when provided with government support during pandemics. The negative co-efficient of two domain vulnerability variables confirms this. We observe a negative relationship between the status of married and socio-economic vulnerability, demographic vulnerability and epidemiological vulnerability. We also observe that this relationship is highly significant for socio-economic and epidemiological vulnerability. The total vulnerability of the married, on the other hand, also shows a significant negative relationship. Thus, when couples join forces, they will be able to overcome or reduce their vulnerability. Despite not having a significant relationship with total vulnerability, religion shows a negative relationship. This result suggests that Christians are less likely to suffer vulnerability in the presence of support. Regarding the specific vulnerabilities, they are less likely to be disadvantaged in terms of socio-economic, demographic, housing and hygiene vulnerability. However, it is surprising to observe that support will not inure any benefit to Christians when we observe the co-efficient of healthcare and epidemiological vulnerability. They show a positive relationship with government support, with the epidemiological vulnerability being highly significant. This observation calls for a probe into the role religiosity plays in reducing vulnerability through government support.

The regional analysis reveals variations in terms of the relationship between government support and domain vulnerabilities. Across all the regions, we observe that government support reduces total vulnerability. This is shown by the negative and highly significant co-efficient of the regions. However, some domain vulnerabilities of the Central, Ashanti, Bono East, Northern and Savannah Regions show a positive relationship.

Next is the analysis of the individual support variables on total vulnerability, as shown in Table 3. It highlights that not all kinds of support yield the intended outcome of reducing vulnerability and underscores the importance of need assessment and targeting bespoke responses to populations. The table shows that public education, free utilities, and tax exemptions significantly reduce total vulnerability.

Table 2. The effect of government support on vulnerability.

	(1)	(2)	(3)	(4)	(5)	(6)
	Socio economic vulnerability	Demographic vulnerability	Housing& hygiene vulnerability	Health care vulnerability	Epidemio logical vulnerability	Total vulnerability score
Support	0.00655 (0.0276)	-0.0130 (0.0236)	-0.137*** (0.0362)	0.0524 (0.0333)	-0.119*** (0.0263)	-0.0489*** (0.0156)
Gender	-0.0644*** (0.00748)	-0.00262 (0.00655)	-0.0630*** (0.00982)	-0.0304*** (0.00823)	0.0957*** (0.00734)	-0.0125*** (0.00417)
M.status	-0.0267*** (0.00743)	-0.00937 (0.00665)	0.00636 (0.00993)	0.00640 (0.00847)	-0.0457*** (0.00722)	-0.0152*** (0.00415)
Religion	-0.0219** (0.00891)	-0.00294 (0.00798)	-0.0294** (0.0117)	0.00680 (0.00994)	0.0148* (0.00857)	-0.00745 (0.00502)
Central	-0.0541** (0.0242)	-0.0554*** (0.0170)	-0.0846*** (0.0299)	-0.0633*** (0.0237)	0.101*** (0.0218)	-0.0281** (0.0122)
Gt. Accra	-0.0511*** (0.0141)	-0.101*** (0.0124)	-0.0763*** (0.0191)	-0.0479*** (0.0169)	0.0743*** (0.0126)	-0.0367*** (0.00858)
Volta	-0.0177 (0.0233)	-0.233*** (0.0204)	-0.112*** (0.0275)	0.210*** (0.0360)	-0.0103 (0.0206)	-0.0348** (0.0146)
Ashanti	-0.128*** (0.0147)	-0.00393 (0.0134)	0.0236 (0.0202)	-0.0646*** (0.0181)	0.0205 (0.0139)	-0.0301*** (0.00913)
Ahafo	-0.0305 (0.0212)	-0.318*** (0.0206)	-0.00593 (0.0366)	-0.0258 (0.0313)	-0.00291 (0.0238)	-0.0661*** (0.0140)
Bono	-0.0473*** (0.0179)	-0.311*** (0.0146)	-0.0437* (0.0239)	-0.0130 (0.0222)	-0.00524 (0.0132)	-0.0754*** (0.0106)
Bono East	-0.0428** (0.0187)	-0.185*** (0.0254)	0.00939 (0.0311)	0.0432 (0.0351)	0.0132 (0.0224)	-0.0281** (0.0137)
Northern	-0.0406** (0.0197)	-0.351*** (0.0141)	0.120*** (0.0283)	-0.0437* (0.0232)	0.00896 (0.0182)	-0.0460*** (0.0122)
Savanna	-0.0345 (0.0246)	-0.355*** (0.0159)	0.124*** (0.0378)	-0.0460 (0.0295)	-0.0428* (0.0242)	-0.0565*** (0.0147)
North East	-0.0108 (0.0352)	-0.314*** (0.0267)	0.169*** (0.0436)	-0.0364 (0.0415)	-0.223*** (0.0284)	-0.0730*** (0.0162)
Constant	0.307*** (0.0177)	0.384*** (0.0154)	0.402*** (0.0247)	0.101*** (0.0223)	0.436*** (0.0159)	0.335*** (0.0107)
Observation	2697	2697	2697	2697	2697	2697
R-square	0.0642	0.336	0.0900	0.0758	0.143	0.0391
Adj.R ²	0.0593	0.333	0.0853	0.0710	0.138	0.0341
P-values	0.000	0.000	0.000	0.000	0.000	0.000

The table presents the results on the effect of government support on vulnerability. In this table, the index score of *support* (which is measured as an index score of COVID-19 support respondents received or expected to receive during the pandemic) is regressed against the individual indicators of *vulnerability* (which has five domains: (1) socioeconomic condition; (2) demographic composition; (3) housing and hygiene condition; (4) availability of health-care facilities, and (5) COVID-19-related epidemiological factors) and the total respectively. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a male and zero otherwise. The parameters are estimated with the small sample adjusted standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level respectively.

These results have policy implications as some support have more impact than others. For example, the tax exemption (TE) is 1.77 times the effects of free utilities (FU), 1.65 times the effects of public education (PE) in reducing vulnerability in Ghana. These support variables all show a negative and significant relationship with total vulnerability. Food support and cash transfer, however, show a positive and highly significant relationship with total vulnerability. The coefficient and the sign on food and cash transfer support suggest that the vulnerable population did not like the type of food offered (hot meal) or how the cash transfer was being executed. The directions of the control variables, as shown in Table 2, did not change even when individual support variables were regressed against total vulnerability in Table 3.

4.4. The effect of responsible covid-19 behaviour on vulnerability

Having analysed the mitigating effect of government support on vulnerable populations, we evaluated how responsible Covid-19 behaviour affects vulnerability. The results are presented in Table 4 and in columns: 1 for socio-economic vulnerability, 2 for demographic vulnerability; 3 for housing and hygiene vulnerability; 4 for health-care vulnerability; and 5 for epidemiological vulnerability. Here, the covid-19 behaviour index is regressed against all five vulnerability domains and total vulnerability. Similar to Table 2, in analysing the relationship of interest, we control for gender, marital status, religion and geographical location (region). The results confirm that total vulnerability is reduced by responsible behaviour

Table 3. The effect of government support on vulnerability.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FS	0.0114* (0.00628)							
PE		−0.0211*** (0.00540)						
CT			0.00766* (0.00455)					
FU				−0.0197*** (0.00512)				
CS					0.00142 (0.00437)			
SSME						0.00282 (0.00467)		
TE							−0.0348*** (0.00502)	
HS								0.00616 (0.00581)
Gender	−0.013*** (0.00417)	−0.0120*** (0.00418)	−0.0133*** (0.00417)	−0.0132*** (0.00417)	−0.0130*** (0.00418)	−0.0129*** (0.00418)	−0.0101** (0.00414)	−0.0129*** (0.00418)
M. status	−0.014*** (0.00416)	−0.0165*** (0.00415)	−0.0146*** (0.00416)	−0.0153*** (0.00415)	−0.0152*** (0.00417)	−0.0153*** (0.00417)	−0.0129*** (0.00412)	−0.0150*** (0.00416)
Religion	−0.00703 (0.00503)	−0.00802 (0.00502)	−0.00750 (0.00501)	−0.00692 (0.00502)	−0.00741 (0.00503)	−0.00727 (0.00502)	−0.00753 (0.00495)	−0.00736 (0.00502)
Central	−0.0255** (0.0123)	−0.0277** (0.0122)	−0.0249** (0.0123)	−0.0298** (0.0123)	−0.0261** (0.0123)	−0.0253** (0.0123)	−0.0326*** (0.0122)	−0.0271** (0.0123)
Gt. Accra	−0.034*** (0.00874)	−0.0377*** (0.00858)	−0.0351*** (0.00877)	−0.0377*** (0.00866)	−0.0348*** (0.00875)	−0.0344*** (0.00875)	−0.0400*** (0.00848)	−0.0350*** (0.00875)
Volta	−0.0308** (0.0145)	−0.0352** (0.0145)	−0.0333** (0.0146)	−0.0346** (0.0144)	−0.0312** (0.0145)	−0.0297** (0.0147)	−0.0392*** (0.0145)	−0.0312** (0.0146)
Ashanti	−0.035*** (0.00923)	−0.0363*** (0.00905)	−0.0362*** (0.00935)	−0.0286*** (0.00924)	−0.0348*** (0.00942)	−0.0343*** (0.00922)	−0.0443*** (0.00912)	−0.0343*** (0.00925)
Ahafo	−0.067*** (0.0139)	−0.0704*** (0.0138)	−0.0674*** (0.0140)	−0.0672*** (0.0140)	−0.0675*** (0.0140)	−0.0670*** (0.0140)	−0.0681*** (0.0141)	−0.0668*** (0.0140)
Bono	−0.077*** (0.0108)	−0.0788*** (0.0106)	−0.0787*** (0.0108)	−0.0769*** (0.0107)	−0.0779*** (0.0108)	−0.0775*** (0.0108)	−0.0799*** (0.0105)	−0.0774*** (0.0108)
Bono East	−0.0305** (0.0139)	−0.0338** (0.0138)	−0.0325** (0.0140)	−0.0296** (0.0137)	−0.0306** (0.0139)	−0.0302** (0.0139)	−0.0288** (0.0135)	−0.0305** (0.0139)
Northern	−0.044*** (0.0124)	−0.0452*** (0.0122)	−0.0416*** (0.0124)	−0.0438*** (0.0122)	−0.0426*** (0.0123)	−0.0423*** (0.0123)	−0.0551*** (0.0122)	−0.0427*** (0.0123)
Savanna	−0.054*** (0.0148)	−0.0574*** (0.0147)	−0.0516*** (0.0147)	−0.0526*** (0.0146)	−0.0525*** (0.0148)	−0.0526*** (0.0148)	−0.0657*** (0.0146)	−0.0523*** (0.0147)
North East	−0.075*** (0.0167)	−0.0706*** (0.0161)	−0.0740*** (0.0167)	−0.0753*** (0.0167)	−0.0751*** (0.0168)	−0.0744*** (0.0166)	−0.0882*** (0.0164)	−0.0753*** (0.0167)
Constant	0.319*** (0.00978)	0.327*** (0.00962)	0.319*** (0.00979)	0.326*** (0.00970)	0.321*** (0.00972)	0.319*** (0.0104)	0.332*** (0.00957)	0.320*** (0.00974)
Obs	2697	2697	2697	2697	2697	2697	2697	2697
R ²	0.0365	0.0406	0.0364	0.0406	0.0354	0.0355	0.0521	0.0358
Adj R ²	0.0315	0.0356	0.0314	0.0356	0.0304	0.0305	0.0471	0.0308
P- <i>vlv</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

In this table, we present results on the effect of government support on vulnerability. Unlike the table above, individual support indicators are regressed against the total vulnerability scores while controlling for gender, marital status and religion of respondents. FS is Food Support, PE is Public Education, CT is Cash Transfer, FU is Free Utilities, CS is Credit Schemes, SSME is Support for SMEs, TE is Tax Exemption and HS is Hand Sanitizer. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a Christian and zero otherwise.

adopted during pandemic situations. The relationship between responsible covid-19 behaviour and total vulnerability is negative and highly significant.

Considering domain vulnerabilities, we observe a negative and highly significant relationship between Covid-19 behaviour, housing and hygiene vulnerability, and epidemiological vulnerability. Although socio-economic vulnerability also shows a negative relationship, this association is not significant. However, our results suggest that the population over 60 years, residing in the urban area, and living in poorly suited rooms increases. Gender wise, males who practice responsible covid behaviour are less likely to be vulnerable than females. For males, we notice a negative and highly significant relationship across all the vulnerability measures used by the study except for epidemiological vulnerability, which is positive and highly significant. Despite that demographic vulnerability is negative, it is insignificant. Again, the married are less vulnerable when they practice responsible behaviours during pandemics, unlike the unmarried. We notice a negative and highly significant relationship with the married for

Table 4. The effect of responsible Covid-19 behaviour on vulnerability.

	(1)	(2)	(3)	(4)	(5)	(6)
	Socio economic vulnerability	Demographic vulnerability	Housing & hygiene vulnerability	Health care vulnerability	Epidemiological vulnerability	Total vulnerability score
Covid-19 Behaviour	-0.00735 (0.00672)	0.00872 (0.00538)	-0.0719*** (0.00769)	0.0146** (0.00701)	-0.0337*** (0.00590)	-0.0212*** (0.00344)
Gender	-0.0655*** (0.00756)	-0.00132 (0.00662)	-0.0760*** (0.00972)	-0.0275*** (0.00832)	0.0890*** (0.00741)	-0.0165*** (0.00419)
M.status	-0.0257*** (0.00748)	-0.0105 (0.00672)	0.0159 (0.00989)	0.00444 (0.00853)	-0.0412*** (0.00724)	-0.0123*** (0.00416)
Religion	-0.0220** (0.00890)	-0.00281 (0.00797)	-0.0299*** (0.0115)	0.00686 (0.00994)	0.0147* (0.00856)	-0.00760 (0.00497)
Central	-0.0557** (0.0244)	-0.0532*** (0.0169)	-0.0904*** (0.0290)	-0.0633*** (0.0236)	0.101*** (0.0221)	-0.0295** (0.0124)
Gt. Accra	-0.0523*** (0.0140)	-0.0997*** (0.0124)	-0.0805*** (0.0190)	-0.0481*** (0.0168)	0.0746*** (0.0128)	-0.0376*** (0.00868)
Volta	-0.0183 (0.0232)	-0.231*** (0.0204)	-0.102*** (0.0269)	0.206*** (0.0359)	-0.00125 (0.0206)	-0.0311** (0.0144)
Ashanti	-0.127*** (0.0145)	-0.00532 (0.0132)	0.0145 (0.0205)	-0.0607*** (0.0180)	0.0116 (0.0138)	-0.0335*** (0.00916)
Ahafo	-0.0338 (0.0214)	-0.315*** (0.0207)	-0.0416 (0.0368)	-0.0181 (0.0317)	-0.0207 (0.0237)	-0.0768*** (0.0139)
Bono	-0.0500*** (0.0179)	-0.308*** (0.0147)	-0.0785*** (0.0242)	-0.00487 (0.0226)	-0.0238 (0.0164)	-0.0861*** (0.0108)
Bono East	-0.0459** (0.0189)	-0.181*** (0.0254)	-0.0297 (0.0313)	0.0523 (0.0351)	-0.00759 (0.0225)	-0.0400*** (0.0138)
Northern	-0.0398** (0.0195)	-0.352*** (0.0141)	0.142*** (0.0286)	-0.0499** (0.0229)	0.0232 (0.0181)	-0.0389*** (0.0123)
Savanna	-0.0340 (0.0245)	-0.355*** (0.0159)	0.145*** (0.0381)	-0.0523* (0.0294)	-0.0284 (0.0242)	-0.0496*** (0.0147)
North East	-0.00843 (0.0352)	-0.317*** (0.0265)	0.186*** (0.0440)	-0.0392 (0.0408)	-0.217*** (0.0277)	-0.0682*** (0.0165)
Constant	0.335*** (0.0288)	0.349*** (0.0232)	0.617*** (0.0342)	0.0648** (0.0313)	0.520*** (0.0257)	0.396*** (0.0155)
Observation	2697	2697	2697	2697	2697	2697
R-square	0.0647	0.337	0.113	0.0764	0.147	0.0496
Adj. R ²	0.0598	0.333	0.108	0.0716	0.142	0.0447
P-values	0.000	0.000	0.000	0.000	0.000	0.000

This table presents the results of responsible Covid-19 behaviour on vulnerable population. Covid-19 responsible behaviour measurement is based on a Likert scale ranging from '1 being never to 5 as always' with the total score of 28 shows a good behaviour. Vulnerability related to the COVID-19 pandemic are considered in the five domains: (1) socioeconomic condition; (2) demographic composition; (3) housing and hygiene condition; (4) availability of health-care facilities, and (5) COVID-19-related epidemiological factors. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a Christian and zero otherwise. parameters are estimated with the small sample adjusted standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level respectively.

socio-economic, epidemiological vulnerability and overall vulnerability. Religion, to some extent, contributes to reducing vulnerability when covid-19 responsible behaviour is exhibited. The results suggest Christians can reduce their socio-economic, demographic, housing and hygiene and total vulnerability through responsible behaviour than others who belong to other religious faiths under consideration in this study. On the geographical location, the results suggest that total vulnerability is reduced across all regions through practising behaviours deemed to be good during pandemics like covid-19 despite observing a few positive domain vulnerability co-efficient among some regions.

4.5. The sensitivity of vulnerability to support and covid-19 behaviour

This section analyses the sensitivity of vulnerability to the interactions between government support and responsible Covid-19 behaviour. The findings are presented in Table 5. We can infer from the table that not all kinds of support coupled with responsible behaviour will reduce certain populations' vulnerability. We observe that combining government support in public education, free utilities, credit schemes, business support for SMEs and tax exemptions can reduce overall vulnerability, unlike responsible behaviour combinations with food supply, cash transfer, and provision of hand sanitizers. The results suggest that the vulnerability of populations may transcend basic needs, although basic needs are vital for survival during pandemics. Analysis of control variables also provides some evidence worth considering.

Table 5. The sensitivity of vulnerability to support and Covid-19 behaviour.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FS*CB	0.00131 (0.00173)							
PE*CB		−0.0071*** (0.00150)						
CT*CB			0.000494 (0.00135)					
FU*CB				−0.0073*** (0.00141)				
CS*CB					−0.000052 (0.00124)			
SSME*CB						−0.00141 (0.00129)		
TE*CB							−0.0106*** (0.00146)	
HS*CB								0.00124 (0.00155)
Gender	−0.013*** (0.00418)	−0.0123*** (0.00417)	−0.0130*** (0.00417)	−0.0135*** (0.00416)	−0.0130*** (0.00418)	−0.0134*** (0.00420)	−0.0104** (0.00414)	−0.0129*** (0.00418)
M.status	−0.015*** (0.00416)	−0.0165*** (0.00414)	−0.0151*** (0.00416)	−0.0150*** (0.00414)	−0.0151*** (0.00417)	−0.0147*** (0.00418)	−0.0126*** (0.00412)	−0.0151*** (0.00416)
Religion	−0.00724 (0.00503)	−0.00807 (0.00501)	−0.00739 (0.00502)	−0.00683 (0.00501)	−0.00735 (0.00502)	−0.00755 (0.00502)	−0.00754 (0.00495)	−0.00737 (0.00502)
Central	−0.0257** (0.0123)	−0.0277** (0.0122)	−0.0256** (0.0123)	−0.0311** (0.0122)	−0.0258** (0.0123)	−0.0269** (0.0123)	−0.0349*** (0.0121)	−0.0267** (0.0123)
Gt. Accra	−0.034*** (0.00874)	−0.0385*** (0.00854)	−0.0347*** (0.00874)	−0.0389*** (0.00861)	−0.0346*** (0.00874)	−0.0353*** (0.00879)	−0.0411*** (0.00846)	−0.0350*** (0.00875)
Volta	−0.0309** (0.0145)	−0.0359** (0.0144)	−0.0315** (0.0146)	−0.0355** (0.0143)	−0.0310** (0.0146)	−0.0333** (0.0147)	−0.0403*** (0.0144)	−0.0312** (0.0146)
Ashanti	−0.034*** (0.00923)	−0.0365*** (0.00900)	−0.0347*** (0.00936)	−0.0274*** (0.00917)	−0.0342*** (0.00941)	−0.0340*** (0.00924)	−0.0450*** (0.00911)	−0.0343*** (0.00924)
Ahafo	−0.067*** (0.0140)	−0.0715*** (0.0137)	−0.0671*** (0.0140)	−0.0682*** (0.0140)	−0.0670*** (0.0140)	−0.0675*** (0.0140)	−0.0701*** (0.0140)	−0.0669*** (0.0140)
Bono	−0.077*** (0.0108)	−0.0798*** (0.0106)	−0.0777*** (0.0108)	−0.0775*** (0.0107)	−0.0774*** (0.0108)	−0.0779*** (0.0108)	−0.0816*** (0.0105)	−0.0774*** (0.0108)
Bono East	−0.0304** (0.0139)	−0.0348** (0.0137)	−0.0307** (0.0139)	−0.0302** (0.0136)	−0.0303** (0.0139)	−0.0311** (0.0139)	−0.0303** (0.0135)	−0.0304** (0.0139)
Northern	−0.043*** (0.0124)	−0.0458*** (0.0121)	−0.0423*** (0.0123)	−0.0442*** (0.0122)	−0.0425*** (0.0123)	−0.0427*** (0.0123)	−0.0562*** (0.0122)	−0.0427*** (0.0123)
Savanna	−0.053*** (0.0148)	−0.0585*** (0.0147)	−0.0523*** (0.0148)	−0.0527*** (0.0145)	−0.0525*** (0.0147)	−0.0523*** (0.0147)	−0.0669*** (0.0146)	−0.0524*** (0.0147)
North East	−0.074*** (0.0167)	−0.0688*** (0.0159)	−0.0744*** (0.0167)	−0.0749*** (0.0167)	−0.0744*** (0.0168)	−0.0744*** (0.0167)	−0.0894*** (0.0164)	−0.0752*** (0.0167)
Constant	0.320*** (0.00977)	0.329*** (0.00958)	0.320*** (0.00976)	0.327*** (0.00966)	0.321*** (0.00972)	0.325*** (0.0105)	0.334*** (0.00955)	0.320*** (0.00973)
Obs	2697	2697	2697	2697	2697	2697	2697	2697
R-square	0.0356	0.0431	0.0354	0.0442	0.0354	0.0358	0.0538	0.0356
Adj. R ²	0.0305	0.0381	0.0304	0.0392	0.0303	0.0308	0.0489	0.0306
P-values	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CB is Covid Behaviour, FS is Food Support, PE is Public Education, CT is Cash Transfer, FU is Free Utilities, CS is Credit Schemes, SSME is Support for SMEs, TE is Tax Exemption and HS is Hand Sanitizer. These government support variable are interacted with Covid-19 responsible behaviour. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a Christian and zero otherwise. Parameters are estimated with the small sample adjusted standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level respectively.

The gender and marital status of respondents both show a negative and highly significant relationship with total vulnerability when support variables and responsible behaviour interact. Religion, however, does not show any significant relationship with total vulnerability despite being negative.

4.6. Robustness tests: Evaluating vulnerability and government support

In order to provide precise inference on the relationship between government support and vulnerability, the welfare situation needs to be considered thoroughly. There are three assumptions underlying the use of employment and income measures of the welfare methodology: (1) we assume that if a vulnerable person receives support in the form of credit schemes, it will enhance the income earning capacity. A higher income is expected to enable households to satisfy their welfare needs; (2) we assume that if COVID-19 support is efficient and useful it would help reduce labour turnout and job losses; (3); we also

assume that providing vulnerable households with free utilities in the form of provision of portable water and electricity will enable households to be in a better position to meet their welfare needs. The results are presented in Tables 6 and 7.

In Table 6, we regress government support on the employment vulnerability of respondents. To be vulnerable in terms of employment, this study categorised the employment vulnerability status of respondents into two. The employed were deemed not vulnerable, whereas the unemployed were classified as vulnerable. We observe that food support, public education, cash transfers and provision of hand sanitizers did not reduce the employment vulnerability of respondents, which is expected in the sense that these support measures have no bearing on the employment status of people and would not also be a motivating factor to find jobs, unlike support to SMEs and tax exemptions. Support to SMEs and tax exemptions have the potential of reducing employment vulnerability by motivating the unemployed to be engaged in some activity to enjoy the benefit that accrues to the self-employed and businesses. SME business support and

Table 6. Robustness tests: Evaluating vulnerability and government support (Employment).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FS	0.0469** (0.0238)							
PE		0.0702*** (0.0207)						
CT			0.0664*** (0.0166)					
FU				-0.0180 (0.0169)				
CS					0.0000671 (0.0154)			
SSME						-0.103*** (0.0182)		
TE							-0.0428** (0.0177)	
HS								0.0669*** (0.0225)
Gender	-0.0164 (0.0152)	-0.0202 (0.0151)	-0.0187 (0.0151)	-0.0168 (0.0152)	-0.0167 (0.0152)	-0.0209 (0.0151)	-0.0131 (0.0153)	-0.0153 (0.0152)
M.status	-0.095*** (0.0149)	-0.0930*** (0.0148)	-0.0934*** (0.0149)	-0.0977*** (0.0149)	-0.0976*** (0.0149)	-0.0912*** (0.0148)	-0.0949*** (0.0149)	-0.0967*** (0.0149)
Religion	-0.00648 (0.0178)	-0.00559 (0.0178)	-0.00908 (0.0177)	-0.00740 (0.0178)	-0.00780 (0.0179)	-0.0110 (0.0177)	-0.00801 (0.0178)	-0.00788 (0.0178)
Central	0.0248 (0.0426)	0.0299 (0.0424)	0.0313 (0.0427)	0.0198 (0.0426)	0.0234 (0.0428)	0.00503 (0.0427)	0.0150 (0.0424)	0.00986 (0.0427)
Gt. Accra	0.0888*** (0.0260)	0.0979*** (0.0261)	0.0845*** (0.0259)	0.0852*** (0.0260)	0.0880*** (0.0260)	0.0775*** (0.0258)	0.0814*** (0.0261)	0.0838*** (0.0262)
Volta	0.0730* (0.0431)	0.0862** (0.0434)	0.0521 (0.0436)	0.0690 (0.0432)	0.0723* (0.0433)	0.0256 (0.0438)	0.0621 (0.0435)	0.0702 (0.0429)
Ashanti	-0.085*** (0.0263)	-0.0751*** (0.0264)	-0.0992*** (0.0264)	-0.0769*** (0.0269)	-0.0820*** (0.0269)	-0.0806*** (0.0262)	-0.0944*** (0.0269)	-0.0829*** (0.0262)
Ahafo	0.0551 (0.0551)	0.0661 (0.0555)	0.0518 (0.0546)	0.0549 (0.0555)	0.0550 (0.0556)	0.0548 (0.0546)	0.0538 (0.0554)	0.0574 (0.0554)
Bono	0.00327 (0.0329)	0.00862 (0.0330)	-0.00624 (0.0331)	0.00487 (0.0330)	0.00434 (0.0333)	0.00444 (0.0326)	0.00138 (0.0330)	0.00490 (0.0328)
Bono East	0.00753 (0.0450)	0.0194 (0.0454)	-0.0105 (0.0454)	0.00862 (0.0453)	0.00795 (0.0453)	0.00312 (0.0451)	0.00987 (0.0452)	0.00665 (0.0457)
Northern	0.0328 (0.0404)	0.0484 (0.0400)	0.0476 (0.0397)	0.0383 (0.0399)	0.0394 (0.0400)	0.0320 (0.0392)	0.0239 (0.0404)	0.0381 (0.0397)
Savanna	-0.00923 (0.0499)	0.0144 (0.0492)	0.00598 (0.0482)	-0.00200 (0.0488)	-0.00191 (0.0490)	-0.00108 (0.0476)	-0.0181 (0.0495)	0.000823 (0.0484)
North East	0.0335 (0.0733)	0.0236 (0.0718)	0.0407 (0.0732)	0.0358 (0.0734)	0.0365 (0.0738)	0.0317 (0.0721)	0.0197 (0.0738)	0.0277 (0.0729)
Constant	0.207*** (0.0296)	0.191*** (0.0299)	0.196*** (0.0292)	0.218*** (0.0296)	0.213*** (0.0294)	0.294*** (0.0333)	0.228*** (0.0300)	0.204*** (0.0293)
Obs	2697	2697	2697	2697	2697	2697	2697	2697
R2	0.0439	0.0469	0.0485	0.0427	0.0423	0.0562	0.0443	0.0462
Adj. R ²	0.0389	0.0419	0.0436	0.0377	0.0373	0.0513	0.0393	0.0412
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The dependent variable is employment vulnerability, FS is Food Support, PE is Public Education, CT is Cash Transfer, FU is Free Utilities, CS is Credit Schemes, SSME is Support for SMEs, TE is Tax Exemption and HS is Hand Sanitizer. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a Christian and zero otherwise. Parameters are estimated with the small sample adjusted standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level respectively.

Table 7. Robustness tests: Evaluating vulnerability and government support (Income).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FS	0.0430* (0.0225)							
PE		−0.0301 (0.0195)						
CT			−0.0244* (0.0145)					
FU				−0.0287* (0.0166)				
CS					−0.0338** (0.0142)			
SSME						−0.00720 (0.0160)		
TE							−0.118*** (0.0157)	
HS								0.0339* (0.0204)
Gender	−0.084*** (0.0138)	−0.087*** (0.0138)	−0.0874*** (0.0138)	−0.0861*** (0.0138)	−0.0839*** (0.0138)	−0.0855*** (0.0138)	−0.078*** (0.0137)	−0.0854*** (0.0138)
M.status	−0.0105 (0.0161)	−0.0126 (0.0160)	−0.0112 (0.0160)	−0.0110 (0.0160)	−0.0104 (0.0160)	−0.0119 (0.0160)	−0.0123 (0.0159)	−0.0117 (0.0160)
Religion	−0.203*** (0.0500)	−0.207*** (0.0503)	−0.207*** (0.0498)	−0.210*** (0.0501)	−0.196*** (0.0500)	−0.205*** (0.0500)	−0.227*** (0.0485)	−0.211*** (0.0495)
Gt. Accra	−0.254*** (0.0322)	−0.260*** (0.0322)	−0.254*** (0.0319)	−0.260*** (0.0322)	−0.251*** (0.0317)	−0.256*** (0.0321)	−0.274*** (0.0312)	−0.257*** (0.0322)
Volta	−0.139*** (0.0489)	−0.145*** (0.0492)	−0.132*** (0.0489)	−0.144*** (0.0489)	−0.135*** (0.0487)	−0.142*** (0.0492)	−0.167*** (0.0483)	−0.140*** (0.0491)
Ashanti	−0.387*** (0.0322)	−0.387*** (0.0320)	−0.378*** (0.0319)	−0.376*** (0.0319)	−0.370*** (0.0321)	−0.384*** (0.0322)	−0.418*** (0.0318)	−0.384*** (0.0323)
Ahafo	−0.338*** (0.0454)	−0.343*** (0.0458)	−0.337*** (0.0451)	−0.339*** (0.0454)	−0.327*** (0.0453)	−0.338*** (0.0454)	−0.342*** (0.0440)	−0.337*** (0.0456)
Bono	−0.282*** (0.0383)	−0.283*** (0.0380)	−0.277*** (0.0379)	−0.280*** (0.0379)	−0.272*** (0.0380)	−0.281*** (0.0382)	−0.289*** (0.0372)	−0.280*** (0.0383)
Bono East	−0.387*** (0.0358)	−0.391*** (0.0355)	−0.379*** (0.0354)	−0.385*** (0.0354)	−0.380*** (0.0353)	−0.386*** (0.0356)	−0.381*** (0.0350)	−0.387*** (0.0358)
Northern	−0.229*** (0.0439)	−0.227*** (0.0440)	−0.226*** (0.0441)	−0.225*** (0.0441)	−0.222*** (0.0438)	−0.223*** (0.0440)	−0.266*** (0.0440)	−0.224*** (0.0442)
Savanna	−0.365*** (0.0411)	−0.365*** (0.0408)	−0.361*** (0.0407)	−0.359*** (0.0403)	−0.360*** (0.0404)	−0.358*** (0.0406)	−0.403*** (0.0405)	−0.357*** (0.0408)
North East	−0.196** (0.0817)	−0.188** (0.0802)	−0.195** (0.0809)	−0.195** (0.0808)	−0.180** (0.0808)	−0.194** (0.0810)	−0.240*** (0.0808)	−0.198** (0.0809)
Constant	0.485*** (0.0352)	0.501*** (0.0355)	0.498*** (0.0351)	0.499*** (0.0351)	0.496*** (0.0348)	0.497*** (0.0370)	0.531*** (0.0345)	0.487*** (0.0351)
Obs	2697	2697	2697	2697	2697	2697	2697	2697
R ²	0.0986	0.0982	0.0982	0.0982	0.0991	0.0973	0.113	0.0983
Adj. R ²	0.0939	0.0934	0.0934	0.0935	0.0943	0.0926	0.109	0.0936
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The dependent variable is income vulnerability, FS is Food Support, PE is Public Education, CT is Cash Transfer, FU is Free Utilities, CS is Credit Schemes, SSME is Support for SMEs, TE is Tax Exemption and HS is Hand Sanitizer. *Gender* is measured as a dichotomous variable that takes the value of one if the respondent is a male and zero otherwise. *Marital status* is a dummy variable, taking the value of one if the respondent is a married person and zero otherwise. The *religion* is a dichotomous variable taking the value of one if the respondent is a Christian and zero otherwise. Parameters are estimated with the small sample adjusted standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level respectively.

tax exemptions will also reduce the number of people who may become unemployed due to worsening conditions associated with the pandemic leading to them being laid off by their employers.

The marital status of respondents is likely to reduce their employment vulnerability, as shown by the negative and significant relationship when support is extended. This phenomenon can be explained by the fact that the married are seen as people with responsibilities; thus, in many cases, they are offered employment opportunities to fend for their dependants. Thus in pandemic situations, they are less likely to be unemployed and more likely to find jobs than the unmarried. The results also suggest that employment vulnerability is only reduced in the Ashanti region, as shown by the negative and highly significant relationship. In contrast to this observation, employment vulnerability seems to worsen in the Greater Accra region, like many other regions. However, in the case of the Greater Accra region, the relationship is highly significant.

We present results on the effect of support on income vulnerability in Table 7. Cash transfers, free utilities, credit schemes and tax exemptions will reduce the income vulnerability of people during

pandemics. These support measures, to some extent, serve as cost-saving. Cash transfers increase the disposable income of the income vulnerable, whereas the others reduce the out-of-pocket cost of the income vulnerable. Persons deemed to be vulnerable income-wise by this study are those with monthly incomes below GHS313. Furthermore, income vulnerability is reduced across all regions, among males and persons who are Christians. We observe a negative and highly significant relationship between the aforementioned and income vulnerability in the presence of government support.

5. Concluding remarks and policy implications

This study contributes to the vulnerability literature by reporting on the vulnerability indices of 100 slum areas located in a developing economy (Ghana), which among many other countries, is experiencing a surge in the number of reported cases and deaths due to the Covid-19 pandemic. Also, among the studies carried out across the sub-region, this study provides empirical evidence on the relationship between government support and vulnerability, the effect of responsible Covid-19 behaviour and the interconnections between responsible behaviour and government support on the general vulnerability of the slum population. To arrive at these findings, we estimate the relationships using a robust regression estimation technique and check for the robustness of the relationship between vulnerability and support using welfare methodology.

We arrive at the following results, which establish the relationship between our key variables, namely, vulnerability, government support and responsible covid-19 behaviour, which also informs the conclusion and policy implications of this study. Our results first demonstrate unique domain vulnerabilities across sampled slums in Ghana, which requires that tailored or slum specific responses are provided to reduce overall vulnerability within slums. Thereby reducing the risk of spillage across the general population. Secondly, government support is important in ameliorating the plight of vulnerable populations, as exhibited by the negative and highly significant relationship between these variables. Thirdly we also find responsible behaviour playing a crucial role in reducing the overall vulnerability. There is, therefore, the need to promote the need for practising and maintaining recommended pandemic protocols to ensure that vulnerabilities are reduced to the barest minimum to safeguard human lives. Finally, vulnerability is sensitive to both responsible behaviour and government support during pandemics. The study highlights that support should transcend basic human needs for the intended outcomes of government support to be achieved. This, therefore, calls for proper need assessment and not just dumping foreign policies, which may have been effective in reducing vulnerability in other jurisdictions. The proper assessment of needs will prevent wastage of resources, which are often scarce during pandemics. The study also highlights the need to focus on females, the unmarried and certain marginalised religious groups.

The following are the limitations of our study: First, our study focuses primarily on Ghana's slums. Therefore, the findings may not be relevant to slums in other nations or locations with varying socio-economic situations and administrative institutions. Also, the study focuses on vulnerabilities associated with Covid-19. Other sorts of vulnerabilities (such as environmental factors) may interact differently with government support which has not been investigated in this study.

Notes

1. The World Bank, on April 2, 2020, provided \$100 million to Ghana. On April 13, 2020, the Executive Board of the International Monetary Fund (IMF) approved the disbursement of a rapid credit facility of US\$1billion to Ghana to address the COVID-19 pandemic. At the national level, the Government of Ghana rolled out interventions like absorbing the utility bills of Ghanaians, providing hot meals, and free transportation for health-care workers.
2. The data manager run the field check tables to assess the quality of data received through the Dropbox on daily basis, whilst the fieldwork was ongoing. Observations from the field check tables were then shared with the enumerators and the team members through a WhatsApp page. Meetings were then held regularly with the field enumerators to ensure that all queries raised were addressed and if there were clarification required, the project team responded to them before the teams proceeded to the next survey areas. These protocols were put in place to provide assurance for quality data.

Acknowledgment

Mohammed Amidu would like to thank the AXA Research Funds for funding this research which is part of AXA Research Project 'Mitigating risk in the wake of the COVID19 Pandemic'.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was funded by the AXA Research Fund.

About the authors

Mohammed Amidu is a Professor at the University of Ghana Business School. He earned his PhD in Banking from Southampton Business School, University of Southampton, UK. He is a researcher with African Economic Research Consortium (AERC). He has contributed significantly to the accounting and finance literature in the area Accounting information quality, financial inclusion and literacy, corporate governance, corporate tax policy, development finance, banking market structure and stability. He is also a Senior Research Fellow of VolkswagenStiftung Foundation, Germany and has also held Visiting Scholar positions at the International Monetary Fund (IMF), Washington DC. Currently, he is part of a collaborative research project on 'Delivering inclusive financial development and growth' funded by Department for International Development (DFID), and Economic and Social Research Council (ESRC). University of Ghana Business School awarded him the '**BEST RESEARCHER**' of University of Ghana Business for 2015/2016 Academic year. He has published in the European Journal of Finance, Review of Quantitative Finance and Accounting, International Review of Financial Analysis, and Accounting Research Journal.

Agnes Akpene Akakpo is a young researcher with an MPhil degree in Accounting from University of Ghana. She has been researching and serving as a Research and Teaching Assistant University of Ghana Business School. Her area of research includes: challenges of small and Medium Businesses (SME's) corporate governance, information quality and disclosure and financial literacy and financial markets. She is also interested in how financial reporting impact social and economic policies in a country, especially in the public sector.

Teddy Ossei Kwakye is a senior lecturer at the Department of Accounting, University of Ghana Business School. Teddy has an extensive teaching experience across the accounting curriculum at the diploma, undergraduate, postgraduate and professional levels. Teddy's research focuses on addressing strategic management accounting, corporate governance, corporate reporting, social and environmental reporting, accounting education, and behavioural accounting issues. His research expertise relates to the application of panel data analysis and other quantitative research techniques to accounting and business management problems. He has publications in international and reputable scholarly journals, and he is an ad-hoc reviewer of some of these journals.

References

- Abate, M., Christidis, P., & Purwanto, A. J. (2020). Government support to airlines in the aftermath of the COVID-19 pandemic. *Journal of Air Transport Management*, 89, 101931. <https://doi.org/10.1016/j.jairtraman.2020.101931>
- Abor, P. A., & Abor, J. Y. (2020). Implications of COVID-19 Pandemic for Health Financing System in Ghana. *Journal of Health Management*, 22(4), 559–569. <https://doi.org/10.1177/0972063420983096>
- Acharya, R., & Porwal, A. (2020). A vulnerability index for the management of and response to the COVID-19 epidemic in India: An ecological study. *The Lancet. Global Health*, 8(9), e1142–e1151. [https://doi.org/10.1016/S2214-109X\(20\)30300-4](https://doi.org/10.1016/S2214-109X(20)30300-4)
- Acuña-Zegarra, M. A., Santana-Cibrian, M., & Velasco-Hernandez, J. X. (2020). Modeling behavioural change and COVID-19 containment in Mexico: A trade-off between lockdown and compliance. *Mathematical Biosciences*, 325, 108370. <https://doi.org/10.1016/j.mbs.2020.108370>
- Ashraf, B. N. (2020). Economic impact of government interventions during the COVID-19 pandemic: International evidence from financial markets. *Journal of Behavioral and Experimental Finance*, 27, 100371. <https://doi.org/10.1016/j.jbef.2020.100371>
- Asiamah, N., Opuni, F. F., Mends-Brew, E., Mensah, S. W., Mensah, H. K., & Quansah, F. (2021). Short-Term changes in behaviors resulting from COVID-19-Related social isolation and their influences on mental health in Ghana. *Community Mental Health Journal*, 57(1), 79–92. <https://doi.org/10.1007/s10597-020-00722-4>
- Baker, S. R., Bloom, N., Davis, S. J., & Terry, S. J. (2020). *COVID-induced economic uncertainty* (No. w26983). National Bureau of Economic Research.
- Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten,

- J., ... Willer, R. (2020). Usinigsocial and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, 4(5), 460–471. <https://doi.org/10.1038/s41562-020-0884-z>
- Bonful, H. A., Addo-Lartey, A., Aheto, J. M., Ganle, J. K., Sarfo, B., & Aryeetey, R. (2020). Limiting spread of COVID-19 in Ghana: Compliance audit of selected transportation stations in the Greater Accra region of Ghana. *PloS One*, 15(9), e0238971. <https://doi.org/10.1371/journal.pone.0238971>
- Boot, A. W., Carletti, E., Kotz, H. H., Krahnen, J. P., Pelizzon, L., & Subrahmanyam, M. G. (2020). *Corona and financial stability 4.0: Implementing a European pandemic equity fund*. (No. 84). SAFE Policy Letter.
- Brown, S., & Hillegeist, S. A. (2007). How disclosure quality affects the level of information asymmetry. *Review of Accounting Studies*, 12(2-3), 443–477. <https://doi.org/10.1007/s11142-007-9032-5>
- Bukari, C., Essilfie, G., Aning-Agyei, M. A., Otoo, I. C., Kyeremeh, C., Owusu, A. A., & Bukari, K. I. (2021). Impact of COVID-19 on poverty and living standards in Ghana: A micro-perspective. *Cogent Economics & Finance*, 9(1), 1879716.
- Claessens, S., & Forbes, K. (2004, November). International financial contagion: The theory, evidence, and policy implications. In Conference "The IMF's role in emerging market economies: Reassessing the adequacy of its resources", Amsterdam.
- Clark, C., Davila, A., Regis, M., & Kraus, S. (2020). Predictors of COVID-19 voluntary compliance behaviours: An international investigation. *Global Transitions*, 2, 76–82. <https://doi.org/10.1016/j.glt.2020.06.003>
- Doherty, F. V., Odeyemi, O. A., Adeola, A., Amolegbe, O., & Ajagbe, F. E. (2020). Evaluation of knowledge, impacts and government intervention strategies during the COVID-19 pandemic in Nigeria. *Data in Brief*, 32, 106177. <https://doi.org/10.1016/j.dib.2020.106177>
- Duan, T., Jiang, H., Deng, X., Zhang, Q., & Wang, F. (2020). Government intervention, risk perception, and the adoption of protective action recommendations: evidence from the COVID-19 prevention and control experience of China. *International Journal of Environmental Research and Public Health*, 17(10), 3387. <https://doi.org/10.3390/ijerph17103387>
- Dwomoh, D., Iddi, S., Adu, B., Aheto, J. M., Sedzro, K. M., Fobil, J., & Bosomprah, S. (2021). Mathematical modeling of COVID-19 infection dynamics in Ghana: impact evaluation of integrated government and individual level interventions. *Infectious Disease Modelling*, 6, 381–397. <https://doi.org/10.1016/j.idm.2021.01.008>
- Farouk, B. R., & Owusu, M. (2012). "If in doubt, count": the role of community-driven enumerations in blocking eviction in Old Fadama, Accra. *Environment and Urbanization*, 24(1), 47–57. <https://doi.org/10.1177/0956247811434478>
- Favero, C. A., & Giavazzi, F. (2002). Is the international propagation of financial shocks non-linear?: Evidence from the ERM. *Journal of International Economics*, 57(1), 231–246. [https://doi.org/10.1016/S0022-1996\(01\)00139-8](https://doi.org/10.1016/S0022-1996(01)00139-8)
- Flanagan, B. E., Gregory, E. W., Hallisey, E. J., Heitgerd, J. L., & Lewis, B. (2011). A social vulnerability index for disaster management. *Journal of Homeland Security and Emergency Management*, 8(1), 1–24. <https://doi.org/10.2202/1547-7355.1792>
- Haldar, A., & Sethi, N. (2020). The effect of country-level factors and government intervention on the incidence of COVID-19. *Asian Economic Letters*, 1(2), 17804.
- Hussain, M. W., Mirza, T., & Hassan, M. M. (2020). Impact of COVID-19 Pandemic on the Human Behavior. *International Journal of Education and Management Engineering*, 10(6), 35–61. <https://doi.org/10.5815/ijeme.2020.05.05>
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*, 3(4), 305–360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
- Liu, M., Zhang, R., & Xie, B. (2020). The impact of behavioural change on the epidemic under the benefit comparison. *Mathematical Biosciences and Engineering: MBE*, 17(4), 3412–3425. <https://doi.org/10.3934/mbe.2020193>
- Michie, S., & West, R. (2021). Sustained behaviour change is key to preventing and tackling future pandemics. *Nature Medicine*, 27(5), 749–752. <https://doi.org/10.1038/s41591-021-01345-2>
- Paek, H. J., Hilyard, K., Freimuth, V. S., Barge, J. K., & Mindlin, M. (2008). Public support for government actions during a flu pandemic: lessons learned from a statewide survey. *Health Promotion Practice*, 9(4 Suppl), 60S–72S. <https://doi.org/10.1177/1524839908322114>
- Peckham, R. (2013). Economies of contagion: Financial crisis and pandemic. *Economy and Society*, 42(2), 226–248. <https://doi.org/10.1080/03085147.2012.718626>
- Richter, A., & Wilson, T. C. (2020). Covid-19: implications for insurer risk management and the insurability of pandemic risk. *The Geneva Risk and Insurance Review*, 45(2), 171–199. <https://doi.org/10.1057/s10713-020-00054-z>
- Spence, M. (1974). Competitive and optimal responses to signals: An analysis of efficiency and distribution. *Journal of Economic Theory*, 7(3), 296–332. [https://doi.org/10.1016/0022-0531\(74\)90098-2](https://doi.org/10.1016/0022-0531(74)90098-2)
- Stiglitz, J. E. (1975). The theory of " screening," education, and the distribution of income. *The American Economic Review*, 65(3), 283–300.
- Vieira, C. M., Franco, O. H., Restrepo, C. G., & Abel, T. (2020). COVID-19: The forgotten priorities of the pandemic. *Maturitas*, 136, 38–41. <https://doi.org/10.1016/j.maturitas.2020.04.004>

Appendix A. Summary of variables and their definitions

Variable	Definition	Measurement
<i>Personal/household characteristics</i>		
Gender	Gender of respondent	1 = if male; 0 = otherwise
Age	Age range of respondent	Years
Marriage Status	Marital Status of respondents	1 = if married; 0 = otherwise
Region	Residence in a particular region	1 = if yes; 0 = otherwise
Religion	Religion of respondent	1 = if Christian; 0 = otherwise
Variable	Definition	
<i>COVID-19 behaviour</i>		
Hand washing	Hand washing	Ranging from 1, never to 5 always
Personal hygiene	Covering your nose when sneezing	Ranging from 1, never to 5 always
Staying home	Staying at home when sick	Ranging from 1, never to 5 always
Working at home	Working from home	Ranging from 1, never to 5 always
Cleanliness	Cleaning surface daily	Ranging from 1, never to 5 always
Wearing mask	Wearing nose mask	Ranging from 1, never to 5 always
Stocking up	Stocking up supplies and medicine	Ranging from 1, never to 5 always
	Covid-19 behaviour index	Highest score of 28 indicating good behaviour
	Covid-19 behaviour scoring	Higher proportion indicating good behaviour
Vulnerability (index score of how vulnerable a respondent is)		
<i>Socioeconomic</i>		
Level of education	Education attainment of the person	1 = if primary or lower, 0 otherwise
Employment status	Employment status of respondent	1 = if unemployment, 0 otherwise
Poor household	Household with assets	1 = if no assets, 0 otherwise
Household income	Monthly household income	1 = if income less than 313, 0 otherwise
<i>Demographic condition</i>		
Elderly population	Person aged 60 and above	1 = if age is less than 60, 0 otherwise
Urbanisation	Place of residence (Urban or Rural)	1 = if urban; 0 = otherwise
Poorly suited home	Poorly suited accommodation	1 = if yes; 0 = otherwise
<i>Housing and hygiene condition</i>		
People per room/over crowding	Proportion of Number of people in the room	1 = if average more than 3 in the room, 0 otherwise
Household with toilet	Availability of toilet facility	1 = no toilet facility in the house, 0 otherwise
Household with hand hygiene facility	Household without hand hygiene facility	1 = household without hand hygiene facility, 0 otherwise
Household with water	Household with reliable water supply	1 = house without water supply, 0 otherwise
<i>Availability of health care</i>		
Health insurance	Possession of health insurance	1 = if no health insurance, 0 otherwise
Access to health care	Availability of health care	1 = if no health care, 0 otherwise
Visit to health facility	Visiting of health care	1 = if no visit has been made, 0 otherwise
The number of health care facility	The number of health care facility in the neighbourhood	1 = if no health care facility, 0 otherwise
<i>Epidemiological factors</i>		
Person current health condition	Person current health condition	1 = if the person is experiencing any illness, 0 otherwise
Person with any chronic morbidity	Person with any chronic morbidity	1 = if the person has any chronic illness, 0 otherwise
Person undergoing long-term medical treatment	Person undergoing long-term medical treatment	1 = if the person undergoing a long-term medical treatment, 0 otherwise
	Vulnerability index	Total score = 18 being the most vulnerable
COVID-19 personal support		
Food	Food support	1 = if select, 0 otherwise
Public education	Public Education	1 = if select, 0 otherwise
Cash or wage	Cash transfers and wage and employment support	1 = if select, 0 otherwise
Free utilities	Free utilities (water and electricity)	1 = if select, 0 otherwise
Credit scheme	Credit schemes	1 = if select, 0 otherwise
Support SMEs	Business support for SMEs	1 = if select, 0 otherwise
Tax exemption	Tax and liquidity support	1 = if select, 0 otherwise
Hand sanitizer	Supply of hand sanitizers	1 = if select, 0 otherwise
	Personal support index	1-8 with highest score of 8 indicating more support
	Personal support proportion index	Higher proportion indicating more support

Appendix B.1. Frequency distribution of demographics

	Freq	Percent	Cum
Gender			
Female	1627	60.33	60.33
Male	1070	39.67	100
Marital Status			
Single/never married	883	32.74	32.74
Co-habiting	126	4.67	37.41
Married	1348	49.98	87.39
Separated / Divorced	184	6.82	94.22
Widow	156	5.78	100
Religion			
Christianity	1704	63.18	63.18
Islam	982	36.41	99.59
Traditional religion	4	0.15	99.74
Other	7	0.26	100
Region			
Western	262	9.71	9.71
Central	106	3.93	13.64
Greater Accra	1046	38.78	52.43
Volta	128	4.75	57.17
Ashanti	512	18.98	76.16
Ahafo	62	2.3	78.46
Bono	228	8.45	86.91
Bono East	96	3.56	90.47
Northern	170	6.3	96.77
Savanna	58	2.15	98.92
North East	29	1.08	100

Appendix B.2. COVID-19 behaviour

Covid-19 behaviour index	Freq	Percent	Cum
5	4	0.15	0.15
6	14	0.52	0.67
7	14	0.52	1.19
8	30	1.11	2.3
9	46	1.71	4
10	79	2.93	6.93
11	106	3.93	10.86
12	122	4.52	15.39
13	189	7.01	22.4
14	215	7.97	30.37
15	207	7.68	38.04
16	171	6.34	44.38
17	187	6.93	51.32
18	206	7.64	58.95
19	233	8.64	67.59
20	225	8.34	75.94
21	192	7.12	83.06
22	153	5.67	88.73
23	108	4	92.73
24	88	3.26	96
25	35	1.3	97.29
26	25	0.93	98.22
27	8	0.3	98.52
28	40	1.48	100
The highest score of 28 indicating a good behaviour			

Appendix B.3. Government support

	Frequency		Percentage	
	Yes	No	Yes	No
Covid-19 personal support				
Food support	324	2373	12.01	87.99
Public education	461	2236	17.09	82.91
Cash transfer	933	1764	34.59	65.41
Free utilities	646	2051	23.95	76.05
Credit scheme	1026	1671	38.04	61.96
SMEs support	1916	781	71.04	28.96
Tax exemption	602	2095	22.32	77.68
Hand sanitizer	416	2281	15.42	84.58

Appendix B.4. COVID-19 support

Personal support index	Freq	Percent	Cum
1	764	28.33	28.33
2	839	31.11	59.44
3	618	22.91	82.35
4	380	14.09	96.44
5	72	2.67	99.11
6	20	0.74	99.85
7	4	0.15	100
The highest score of 7 indicating more personal support			