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Research Paper

Exponential Mean Modeling of Coping Strategies and Dietary Diversity During the COVID-19 Pandemic in Mozambique

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Abstract

The COVID-19 pandemic has brought significant socioeconomic problems to many developing countries. In Mozambique, the impacts of the pandemic were felt in different spheres of households' livelihoods. This study contributes to the existing body of knowledge by analyzing the effects of coping strategies and other factors on households' dietary diversity scores (HDDS). The data were collected in two non-longitudinal waves in 2021 and 2022 from 3975 households by the Food and Agriculture Organization (FAO). The instrumental Poisson regression model was used for data analysis. The results showed that across the two periods, cereals were mostly consumed (96.93%), while meats (15.75%), milk and dairy (13.99%), and eggs (9.16%) were the least consumed. There was an increment in the proportion of households that consumed between zero and four food groups. Furthermore, there were declines in the utilization of coping strategies, while depletion of savings (50.62%) and credit (45.21%) were mostly used. The instrumental variable Poisson regression results revealed that expected HDDS decreased significantly ($p<0.05$) with sold animals, eating elsewhere, consumption of seed stock, decreased agricultural input expenditures, and emergency begging, whereas illegal activities increased it. In addition, household incomes, crop farming, and being younger than 35 years significantly increased ($p<0.05$) the expected HDDS, while all regions except Gaza had significantly higher expected HDDS than Cabo Delgado. It was concluded that adopted coping mechanisms could not offset households' food problems during the pandemic, although some regional differences existed. Therefore, initiatives to promote human nutrition in Mozambique should enhance households' resilience to income shocks through region-specific income-promoting activities.

Keywords *Dietary diversity, Human Nutrition, Resilience, Coping Strategies, COVID-19 Pandemic, Mozambique*

INTRODUCTION

COVID-19 remains one of the most severe economic shocks the world had recently witnessed (World Bank, 2020). The socioeconomic consequences of the pandemic were aggravated by the fact that it came at a time when many developing countries were recovering from drastic economic recessions that were exacerbated by some global economic shocks and the residual impacts of the 2008-2009 global financial crisis (Calderón & Kubota, 2021). The pandemic was a development in reverse for fragile economies like Mozambique, which despite being ravaged by civil wars between 1976 and 1992, exhibits significant vulnerability to environmental hazards like floods, droughts, and cyclones (da Conceição, 2024). In addition, while floods are an annual occurrence in some regions, the country experiences droughts and cyclones within every three to four years (da Conceição, 2024).

Therefore, the pre-COVID Mozambique economy was exposed to civil and environmental shocks that ultimately affected some economic development indicators (Artur & Hilhorst, 2017). Specifically, Santos and Salvucci (2016) submitted that Mozambique's poverty incidence was 80% in 1990. At the end of the civil wars, the economy has seen some growth, although poverty alleviation remains a daunting challenge. In absolute term, the number of people whose incomes are below the federal poverty threshold did not decline significantly in 2014/2015, despite a

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reduction in poverty incidence to 46.1% from 69.70% in 1996/97 (Daniel, 2020). Poverty in Mozambique is associated with malnutrition, which worsened in 2021 and 2022 when absolute poverty incidences measured as living below $2.15 per person per day were 76.1% and 75.6%, respectively (World Bank, n.d.-a).

Policymakers have emphasized that some improvements in some development indicators—the cumulative impacts of the resources channeled toward the Millennium Development Goals (MDGs) - have been diametrically reversed by the pandemic. More importantly, many countries joggle and muddle policy instruments to address the lingering challenges of attaining the laudable Sustainable Development Goals (SDGs). Therefore, although the majority of the world's leaders seem to have taken respite from the economic disturbances associated with the clinical management of COVID-19, the struggles to reverse the deepening problems of unemployment, hunger, and poverty in many developing countries are factual revelations that we cannot say that we have really seen the ultimate end of the pandemic.

It should be noted that the global coverage of the COVID-19 pandemic streamlined international assistances to several developing countries, thereby deepening the compounded impacts of job and income losses due to some mandatory economic lockdowns (OECD, 2020). Therefore, post-COVID-19 economic norms are characterized by a reduction in international remittances, with many countries-like Mozambique-who were at the edge of economic recovery witnessing some unprecedented contraction in economic growth. Specifically, since 2014 when Mozambique recorded the highest economic growth, a downward trend in growth has been recorded, with negative growth of 1.3% in 2020 (World Bank, n.d-a). Although the fiscal balance was 0.3% of GDP in 2019, 2020 declined to -4.7% of GDP, with forecasts for 2021 to 2023 showing negative values (World Bank, n.d-a). Therefore, the economic implications of the COVID-19 pandemic on Mozambican economy are notably visualized through several macroeconomic development indicators (Betho et al., 2021).

At the microeconomic level, food remains the fundamental need of man, and its secure access is a development indicator with the utmost socioeconomic consequences. The SDG targets 2.1 and 2.2 systematically address food and nutrition problems throughout the world. However, based on available data, no empirical facts support the notion that the world is on track to achieve many of these targets (World Health Organization, 2020). More importantly, the interrelationships among several SDG mandate cognizant attention to providing a favorable environment through which all the SDGs can be pursued with maximum progress.

The COVID-19 pandemic is a game changer in development. Egger et al. (2021) specifically found a significant decline in employment levels and food and security, while poverty incidence increased in many developing countries, including Mozambique, during the COVID-19 pandemic. The case of Mozambique is unique and pathetic, given the country's prevailing fragility after the initiation of economic recovery processes in 1992, when the civil war that ravaged the economy since 1977 was eventually put to an end (Barletta et al., 2022). Therefore, COVID-19 significantly affected some socioeconomic indicators in Mozambique, with urban households being more affected (Salvucci & Tarp, 2024). Moreover, in a qualitative study, Krauss et al. (2022) noted that food security was among the major challenges facing households during the pandemic. It is emphasized that several survival strategies were adopted, while female respondents seemed to be more concerned about the food situation at home than male respondents.

Although some empirical assessments of the impacts of COVID-19 on Mozambican households have been conducted, the aspect of food consumption diversity among households has been rarely researched. Specifically, an understanding of households' dietary diversity (HDD) can provide cogent policy directions to facilitate the design of nutrition enhancement and food demand initiatives even as countries grapple with the challenges of achieving certain SDGs. Dietary

diversity is fundamentally relevant to some specific SDGs, such as attainment of zero hunger (SDG 2) and good health and well-being (SDG 3) (Chen et al., 2022). This model can also provide some fundamental hints about the magnitude of nutritional deprivations suffered by households during the pandemic, with emphasis on policy-related variables to administer regional or national marginal reforms. Therefore, this study provides an important addition to the economic literature by using the most comprehensive dataset collected from households during the COVID-19 pandemic along with a veritable econometric approach to analyze the determinants of HDD during the COVID-19 pandemic in Mozambique. Specifically, it seeks to answer the question of whether the adopted coping methods enhanced households' nutrition through dietary diversity. In the remaining parts of this paper, a literature review, materials and methods, results, and discussion and conclusion are presented.

LITERATURE REVIEW

Different concepts are directly related to food and nutrition insecurity. The first is the concept of hunger, which in the nomenclature of the Food and Agriculture Organization (FAO) is directly associated with undernourishment (Food and Agriculture Organization, n.d.). Hunger results from an inability to satisfy one's natural craving for food to ensure the availability of sufficient calories for daily activities. It causes emotional stress and discomfort that can degenerate into other health complications (Action Against Hunger, n.d.). Another important concept is undernutrition, which indicates inadequate intake of "energy, protein, and/or essential vitamins and minerals" (Action Against Hunger, n.d.). Furthermore, malnutrition is a concept that defines a situation where individuals are either undernourished or overnourished, while food security is a situation of having "consistent and adequate access to enough safe and nutritious food to maintain an active and healthy life" (Action Against Hunger, n.d.).

Food security was defined by the World Food Summit as a situation 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (World Bank, n.d.-b). This definition emphasizes the four pillars of food security, namely, "physical availability of food, economic and physical access to food, food utilization and stability of the other three dimensions over time" (World Bank, n.d.-b). There has been growing interest in understanding the correlates of food insecurity. Therefore, researchers have proposed several indicators. There have been some progressive emphases from global and national perspectives to a clearer understanding of the state of food insecurity at the household and individual levels (Maxwell, 1996).

There is yet to be a consensus among policymakers and researchers on the most appropriate indicators for ensuring proper monitoring of food insecurity within some "global, national, household, and individual" perspectives (Carletto et al., 2013). In some instances, researchers have adopted specific indicators based on the convenience and availability of data. Therefore, effective monitoring of food security at a global level is complicated by several factors. Specifically, there are qualitative and quantitative indicators, composite indicators combining several dimensions of food security and unidimensional indicators that address the correlates of food insecurity and national/global perspective against those with level of analysis being households or individuals (Manikas et al., 2023).

Empirical analyses of food security and consumption diversity were conducted by some researchers during the COVID-19 pandemic. Specifically, in a study by Kundu et al. (2021) in Bangladesh, low food security and dietary diversity scores were associated with rural residence, not having government employment, no formal education, and low income. In other studies, Shahbaz et al. (2022) and Ochieng et al. (2017) found that female respondents had significantly lower dietary diversity scores. The effect of body mass index on the dietary diversity was analyzed

by Tayyem et al. (2022). It was found that overweight respondents had significantly higher dietary diversity scores. The effect of the number of working members in a household was analyzed by Loopstra and Tarasuk (2013), whereas Olaimat et al. (2022) reported the effect of income on severe food insecurity. In another study in Ethiopia, the dietary diversity score was influenced by education level and family size.

Banna et al. (2022) also found that the household dietary diversity score during COVID-19 in Bangladesh was influenced by food scarcity and job loss. Geng et al. (2022) found that during the COVID-19 pandemic, the household diversity score was influenced by household size and income. Iheme et al. (2020) found that during the COVID-19 pandemic in Nigeria, adoption of food coping strategies was influenced by income, education, and self-employment. Balana et al. (2023) found that during the COVID-19 pandemic in Nigeria, food insecurity was influenced by wealth ownership in the form of livestock, while social assistance did not have a significant impact. In another study conducted among children under 5 years old in Bangladesh, dietary diversity was associated with the child's age, mother's age, household income, and residence in a slum. Cordero-Ahiman et al. (2021) found that household dietary diversity was associated with family size, food expenditure per capita, land area cultivated, education level, and marital status of heads of household.

Furthermore, Tambe et al. (2021) found a negative association between food security and household dietary diversity in Cameroon, whereas males had significantly higher dietary diversity scores. Shahzad et al. (2024) found that the dietary diversity scores of households in Pakistan were influenced by age, residence in urban areas, gender, and household wealth. Dirghayu et al. (2023) found that dietary diversity is influenced by ethnicity, education level, chronic illness, and age.

There are clearly identified gaps in the existing literature on the determinants of food insecurity in Mozambique during the COVID-19 pandemic. Specifically, this study proposes using an econometric model that addresses the problem of endogeneity, which many previous studies have failed to consider. In addition, focusing on the HDD, we proposed using Poisson regression to analyze the count of the number of foods consumed within the 24-hour recovery period instead of reclassifying the data into ordinal or binary settings, thereby truncating some existing trends.

RESEARCH METHOD

The Data

The data for this study were the second and third waves of the Emergencies Monitoring Household Survey (DIEM), which was initiated and implemented by FAO in 2021 and 2022, respectively. FAO granted access to the researcher to use the dataset based on ethically specified conditions. Ethical approval for the survey was obtained by the primary investigators (FAO, Data in Emergency Hub, and World Food Program) – from the Mozambique government. Note that the capital city of Mozambique was not included in the data due to its urbanity. Therefore, 10 of the 11 regions in Mozambique were covered. Households were selected using the stratified sampling method. The data comprised 2206 households during the second wave and 1769 during the third wave. The data are not panel-based, thereby warranting pooled regression analysis. In addition, the data for the second wave were collected between August 26 and October 6, 2021, while the third wave was collected between September 22 and October 31, 2022 (Food and Agriculture Organization, 2022a, 2022b). During the second wave, a total of 197-252 households were successfully interviewed in each province, while between 150 and 260 households were successfully interviewed in the third wave. The administration of the questionnaire followed conventional ethical procedures with voluntary participation, and only adult members of the households were the respondents. The data were collected using the Computer Assisted Telephone Interview (CATI) (Food and Agriculture Organization, 2022a, 2022b). The respondents' data were anonymized by FAO before the data were released, and part of the conditions for granting access is

that no effort would be made to trace or identify any of the households that participated in the study.

Specifications of the Instrumental Variable Poisson Regression Model

The instrumental variable Poisson regression model was estimated to achieve the objective of this study. Poisson regression is appropriate when the dependent variable is a zero or positive integer. The use of an instrumental variable is mandatory when one continuous independent variable is suspected to be endogenous. The dependent variable in the estimated model is the number of food groups consumed by the household within 24 hours. It is suspected that income, a dependent variable, is endogenous. Therefore, the instrumental variable Poisson regression model was estimated. Following STATA (n.d.), the estimated model in its additive version is presented as:

$$Y_i = exp(\alpha_0 + X_i\beta + M_i\tau) + \varepsilon_i \quad (1)$$

$$M_i = \theta_0 + X_{ik}\mu_k + C_i\rho + T_i\emptyset + I_{il}\pi_l + s_i \quad (2)$$

Y_i is the count of the number of food groups consumed by respondents. X_i is the vector of explanatory variables which are involvement in agriculture [no agricultural activity is the reference group coded as yes =1, 0 otherwise and the dummy variables are crop and livestock (yes =1, 0 otherwise); crop alone (yes =1, 0 otherwise) and livestock alone (yes =1, 0 otherwise)], formal education (yes =1, 0 otherwise), received extension service (yes =1, 0 otherwise), province of residence [Cabo Delgado (reference group), Gaza (yes =1, 0 otherwise), Inhambane (yes =1, 0 otherwise), Manica (yes =1, 0 otherwise), Maputo (yes =1, 0 otherwise), Nampula (yes =1, 0 otherwise), Niassa (yes =1, 0 otherwise), Sofala (yes =1, 0 otherwise), Tete (yes =1, 0 otherwise) and Zambezia (yes =1, 0 otherwise), male headship (yes =1, 0 otherwise); wave three (yes =1, 0 otherwise), access to improved lighting energy (L_i) (coded as 1 for improved sources and 0 otherwise), livelihood coping strategy [spent savings (yes =1, 0 otherwise), sold more animals (yes =1, 0 otherwise), eat elsewhere (yes =1, 0 otherwise), sought credit (yes =1, 0 otherwise), sold production assets (yes =1, 0 otherwise), consumed seek stock (yes =1, 0 otherwise), and decreased agricultural input (yes =1, 0 otherwise)], emergency assistances [begged for assistance (yes =1, 0 otherwise), did illegal things (yes =1, 0 otherwise) and migrate (yes =1, 0 otherwise)], total number of income shocks and age groups [<35 years being the reference group while others were coded as 1=35<49, 0 otherwise; 1=49<70, 0 otherwise; and 1=≥70, 0 otherwise.

FINDINGS AND DISCUSSION

Distribution of HDDS and Coping Strategies

Table 1 presents the distribution of food groups consumed by household members within 24 hours across the two waves of data collection. Food consumption diversity is a prerequisite for meeting the daily body's nutritional requirements (Ruel, 2003). This is fundamental for ensuring the adequacy of micro- and macronutrients essential for proper functioning of the body (Nair et al., 2016). Table 1 shows that during both periods, 96.93% of the consumed cereals. Similarly, cereal consumption was high during the two data waves. This trend is expected because cereals are the primary staple food in many African countries, including Mozambique (Temba et al., 2016; Taylor, 2016). The diversity of the forms in which cereals are processed and consumed enhances their selection as the primary choice for breakfast and snacks in many households (Kantor et al., 2001).

However, Table 2 shows that roots and tubers were consumed by 40.16% of households in the second data wave and 35.50% in the third wave. The decline in the consumption of roots and tubbers can be associated with persistent impacts of the pandemic, with some limiting impacts on

households' production and marketing of perishable crops. Vegetables were consumed by 69.51% of all respondents, while only 28.40% consumed fruits. Among the foods consumed by the combined respondents, eggs (9.16%), meats (15,75%), and milk and dairy products (13.99%). Oil, condiments, sugar, and legumes were consumed by more than half of the respondents. The choice of food items during the pandemic reflects households' income levels, affordability, and perception of the essentiality of such products for healthy living (Carson & Boege, 2020; Mwambi et al., 2023). More importantly, although consumption of balanced diets was a prerequisite to building a strong immune system that can withstand infection by the virus (Chatterjee et al., 2022), inadequate income compelled many households to eat whatever was available to sustain their existence (Jayawardena & Misra, 2020).

Table 1. Household consumption of food items during 24-hours memory recall

Food groups	**2nd Wave %**	**3rd Wave %**	**All %**
Cereals	96.65	97.29	96.93
Roots and tubers	40.16	35.50	38.09
Vegetables	68.86	70.32	69.51
Fruits	28.47	28.32	28.40
Meats	16.36	14.98	15.75
Eggs	9.02	9.33	9.16
Fish	40.89	36.63	38.99
Legumes	53.85	52.18	53.11
Milk and Dairy	17.86	9.16	13.99
Oils	78.15	67.61	73.46
Sugar	60.06	56.92	58.67
Condiments	89.80	81.01	85.89

Table 2 shows the distribution of the total number of food groups that the household members ate during the COVID-19 pandemic. The results show very little variation in the percentage of respondents in each food group across the two data waves. Specifically, 20.68% of the respondents consumed 6 types of food. In addition, 17.76% and 15.45% ate five and seven food classes, respectively.

Table 2. Distribution of households' dietary diversity scores.

HDDS	**Second Wave**		**Third Wave**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
Zero	0	0.00	6	0.34	6	0.15
One	12	0.54	7	0.40	19	0.48
Two	58	2.63	108	6.11	166	4.18
Three	130	5.89	146	8.25	276	6.94
Four	305	13.83	269	15.21	574	14.44
Five	396	17.95	310	17.52	706	17.76
Six	480	21.76	342	19.33	822	20.68
Seven	343	15.55	271	15.32	614	15.45
Eight	238	10.79	177	10.01	415	10.44
Nine	130	5.89	99	5.60	229	5.76
Ten	93	4.22	25	1.41	118	2.97

Eleven	16	0.73	8	0.45	24	0.60
Twelve	5	0.23	1	0.06	6	0.15
Total	2206	100.00	1769	100.00	3975	100.00

The coping strategies of the households are presented in Table 3. The results show that personal savings utilization declined from 54.71% during second wave to 45.51% in third wave. This reflects the likelihood of personal savings being exhausted as the pandemic progresses. The role of personal savings as a form of precautionary insurance against idiosyncratic risks has been emphasized in the literature (Zeller & Sharma, 2000). Savings are therefore insurance against future financial problems because a household sets aside money to fall on in case of unexpected declines in their regular incomes (Lunt & Livingstone, 1991; Gjertson, 2016). It should also be noted that since food is a basic need of man, the composition of households' food consumption is always of paramount priority in times of income shock (Pruntseva et al., 2021). Therefore, the primary goal of savings is to enhance consumption smoothing across space and time by steadily facilitating purchasing power (Steinert et al., 2018; Khanal et al., 2019).

The sale of animals and production assets were also highlighted as part of households' coping strategies. The results show a decline in the sale of more animals from 23.03% to 16.85% in waves 2 and 3, respectively. Livestock is often used as a store of wealth among rural households and a form of security against income shocks. Therefore, periods of economic crises like those witnessed during the COVID-19 pandemic are often characterized by mandatory sale of livestock to offset accumulated debt and meet pressing households' food needs (Devereux, 1993; Lai, 2007; Teka et al., 2024; Alemayehu & Tesfaye, 2024).

Similarly, the sale of production assets declined from 19.76% in the second wave to 9.61% in the third wave. The reduction in the usage of these coping strategies can reflect the likelihood of exhausting opportunities to sell personal belongings as the pandemic progresses. It may also indicate a reduction in the severity of the problem as time progresses. Although the sale of assets is often perceived as an anti-development initiative based on the likelihood of needing the assets being sold in the future (Davies, 2016), the peculiar nature of the COVID-19 pandemic underscored the need to explore every survival strategy available to households given its absolute deadliness.

Formal and informal borrowing is another important coping strategy against income shocks. The results show that 45.12% of all respondents took one form of credit. However, credit use declined from 46.74% in the second wave to 43.30% in the third wave. Such a systematic decline may reflect the exhaustion of every possible avenue for borrowing. The role of credit in cushioning the impacts of shocks on households' food insecurity has been emphasized in the literature (Zeller & Sharma, 2000; Doocy et al., 2005; Truong et al,.2020; Lemessa & Gemechu, 2016).

Other forms of coping methods that households used were consumption of seed stock (25.64%), decreases in expenses for farm inputs (24.45%), and emergency begging (10.06%). Depletion of seed stocks for planting is a coping method that can be used at the climax of economic crises (Kemboi et al., 2024). The implication of this approach is that it promotes the risk of perpetual hunger and deprivation because there may be nothing left for the household to plant during the planting season. Moreover, a drastic decline in agricultural input expenditure poses a significant threat to future crop productivity and sustainable livelihoods among farming households (Brunet, et al., 2024; Kiunisala et al., 2024). Migration was also used by 7.75% of respondents. However, 4.91% of the respondents indicated engagement in some illegal activities such as stealing and prostitution as survival methods. The implication is that without adequate interventions, the COVID-19 pandemic also bred social vices that could have long-term impacts on peaceful coexistence in a fragile economy like Mozambique.

Table 3. Household methods of coping with financial stress and emergencies

Coping methods	2nd Wave %	3rd Wave %	All %
Spent savings	54.71	45.51	50.62
Sold more animals	23.03	16.85	20.28
Eat elsewhere	22.53	17.92	20.48
Credit	46.74	43.30	45.21
Sold production assets	19.76	9.61	15.25
Consumed seed stocks	28.38	22.22	25.64
Decreased agricultural input expenditures	29.28	18.43	24.45
Emergency begging	11.24	8.59	10.06
Emergency illegal deals	7.07	2.20	4.91
Emergency migration	9.29	5.82	7.75

Determinants of Household Dietary Diversity Scores (HDDS)

Table 4 presents the results of the exponential mean modeling of the HDDS determinants. The results show that income has a positive parameter and is statistically significant ($p<0.01$). This result shows that holding other variables constant leads to an increase in income and an increase in the expected value of HDDS. This trend is expected because income was the major economic indicator of households affected by the pandemic. This finding is in line with basic economic theory that defines consumption as a function of income (Aguiar & Hurst, 2005). Similarly, the findings are in line with those of Kundu et al. (2021), Olaimat et al. (2022), Geng et al. (2022), Iheme et al. (2020), Rashid et al. (2011), and Ahmed and Naphtali (2014). This result can be juxtaposed with that of the improved lighting parameter, which is positive and statistically significant ($p<0.01$). This implies that respondents who used improved lighting energy had higher expected HDDS than their counterparts who used unimproved sources. Clean energy use is often associated with wealth, which Ahmed and Naphtali (2014) found to have a significant influence on HDDS.

The parameter of total income shocks is positive and statistically significant ($p<0.01$). This implies that holding other variables constant leads to an increase in shocks resulting in an increase in expected HDDS. The economic trajectory through which an income shock translates into dietary diversity is complex. Specifically, the nature of the shock and its economic transmission channels will influence several economic engagements and the depletion of accumulated savings, with a concomitant impact on food demand (Wang et al., 2024). However, the finding is contrary to expectations based on some findings that have reported a negative association between income shocks and food security (Chileshe, 2014). Specifically, Kaicker et al. (2024) reported a negative association between pandemic-induced income shocks and HDDS in India.

However, shock exposure often induces the adoption of several coping strategies that may eventually offset the impact of shocks. In this study, the effects of some adopted coping strategies on the HDDS were analyzed. The results showed that across all the adopted coping strategies, statistical significance ($p<0.05$) was shown by selling more animals, eating elsewhere, taking credit, consuming seed stock, decreasing agricultural input expenditures, and emergency begging all had negative signs. This implies that households that use these strategies have lower expected HDDS. The findings are testimony to the depth of deprivation suffered by many households during the pandemic, with the possibility of being lifted out of poverty line requiring significant social assistance. However, households who were engaged in illegal activities when experiencing emergency needs had significantly higher expected HDDS. This finding implies that households who indulged in culturally and morally bad activities had higher HDDS.

The results further showed that the parameter of crop farming is positive and statistically

significant (p<0.01). This implied that compared with those who were not engaged in farming, crop farmers had higher expected HDDS. This is expected because the pandemic has caused serious economic distortions to several economic activities, thereby affecting people's ability to generate income. However, for those who were engaged in farming, especially those who were crop farmers, the expectation was that they would consume their home-produced crops pending the time that normalcy returned with the lifting of some emergency lockdowns. This finding is consistent with Salvucci and Tarp (2024), who also reported that urban households in Mozambique were the worst affected by the COVID-19 pandemic. However, this does not imply that farmers did not feel the impacts of the pandemic. In other studies, Mutegi et al. (2024), Nchanji et al. (2021), Yazdanpanah et al. (2021), and Jaacks et al. (2021) highlighted the different socioeconomic impacts of COVID-19 on farming households.

There are regional differences in poverty distribution across Mozambique (Fox et al., 2005; De Vletter, 2007). Given this background, the results showed that in comparison with residents from Cabo Delgado, those from Inhambane, Manica, Maputo, Nampula, Niassa, Sofala, Tete, and Zambezia had significantly higher expected HDDS (p<0.05). It should be noted that the northern parts of Mozambique, especially Cabo Delgado, are among the poorest provinces in Mozambique due to prevailing political insurgencies and climatic shocks (Gomes & Schmidt, 2021; Maviza et al., 2024). This may have influenced the fact that the provinces with significantly higher HDDS are located in southern and central Mozambique. It should also be noted that in terms of COVID-19 incidence, Cabo Delgado had the highest number of positive cases. This would have further slowed economic activities in a region conventionally marked by insurgencies and conflicts (Jimenez & Daniels, 2020). More importantly, across the entire country, rising inflation has been implicated in pre-COVID-19 poverty incidence in Mozambique (Salvucci & Tarp, 2024). This underscores the relevance of some macroeconomic variables to promoting nutritional security in any country.

The parameter of the survey round was statistically significant (p<0.01) with a negative sign. This implies that holding other variables constant, the expected HDDS of households in the third data wave is lower than that of their second wave counterparts. The negative parameter for the third wave reflects difficulties in households' ability to recover from the impacts the pandemic. Specifically, although 2022 is expected to witness lower economic impacts in the form of lockdowns, the cumulative impacts of COVID-19 in terms of job losses and an increase in standard of living will require time for proper adjustments (Jimenez & Daniels, 2020).

Finally, compared with those who were less than 35 years old, the elderly household heads had significantly lower expected HDDS. This finding emphasizes that the pandemic may have affected the incomes and consumption patterns of households with older individuals. In another study, Shahzad et al. (2024) found that age was a significant determinant of HDDS. In the absence of significant social interventions, aged households face significant economic problems during the COVID-19 pandemic due to their existing vulnerability and fragility.

Table 4. Results of exponential mean modeling of HDDS determinants

Variables	Coef.	Robust Std. Err.	z-stat	P>z
Total income	4.70e-06***	6.73e-07	6.98	0.000
Agric activities (none is reference)				
Crop and livestock	0.0368*	0.0203	1.81	0.070
Crop alone	0.0373***	0.0140	2.67	0.008
Livestock alone	0.0205	0.0190	1.08	0.281

Variables	Coef.	Robust Std. Err.	z-stat	P>z
Household heads' education	0.0140	0.0140	1.00	0.317
Received extension services	0.0955	0.0725	1.32	0.188
Province (Cabo Delgado is the reference)				
Gaza	0.0512*	0.0272	1.89	0.059
Inhambane	0.0996***	0.0269	3.70	0.000
Manica	0.0823***	0.0291	2.83	0.005
Maputo	0.1084***	0.0257	4.22	0.000
Nampula	0.0659**	0.0287	2.29	0.022
Niassa	0.1292***	0.0254	5.08	0.000
Sofala	0.0937***	0.0277	3.39	0.001
Tete	0.0890***	0.0267	3.33	0.001
Zambezia	0.1103***	0.0278	3.98	0.000
Male headship	0.0091	0.0133	0.69	0.491
3rd Wave	-0.0646***	0.0118	-5.49	0.000
Improve the lighting energy	0.0405**	0.0179	2.26	0.024
Spent savings	0.0047	0.0122	0.39	0.698
Sold more animals	-0.0354**	0.0166	-2.13	0.033
Eat elsewhere	-0.0642***	0.0154	-4.17	0.000
Credit	-0.0628***	0.0124	-5.05	0.000
Sold production assets	-0.0242	0.0178	-1.36	0.173
Consumed seed stocks	-0.0671***	0.0168	-4.00	0.000
Decreased agricultural input expenditures	-0.0519***	0.0162	-3.21	0.001
Emergency begging	-0.0860***	0.0227	-3.79	0.000
Emergency illegal deals	0.0800***	0.0274	2.92	0.004
Emergency migration	-0.0247	0.0237	-1.04	0.298
Total shocks	0.0296***	0.0043	6.80	0.000
Age groups (<35 is the reference group)				
35<49	-0.0495***	0.0147	-3.36	0.001
49<70	-0.0399**	0.0185	-2.15	0.031
>=70	-0.1312**	0.0580	-2.26	0.024
Constant	1.5772***	0.0323	48.83	0.000

Note: *** =Significant at 1%; ** =Significant at 5%; * - Significant at 10%

CONCLUSIONS

COVID-19 remains one of the strongest negative economic influences the world recently witnessed. A proper understanding of the state of food insecurity during the crisis is necessary for designing interventions to address income shocks and their nutritional implications among households. This is fundamental for Mozambique, given its fragility and its progressive efforts to ensure steady economic growth at the end of the protracted civil wars. This study presents a novel approach to understanding the implications of coping strategies and other associated variables on HDDS in Mozambique. The study has contributed to our understanding of the magnitude of households' engagement with dietary diversity in an effort to promote good health during the pandemic using a sound econometric approach. The results showed that dietary diversity among households worsened between 2021 and 2022. This underscores the need to assess the current nutritional status of households to ensure progress and return to normality after the pandemic. The

implication is that existing socioeconomic deprivations may have contributed to the worsening HDDS during the COVID-19 pandemic.

In addition, the coping methods used by households had no positive impact on HDDS. This reflects the need to ensure adequate social protection programs for households in Mozambique. Although the pandemic has strongly highlighted the need for social protection initiatives among people, especially to ensure protection of households against income shocks, proper coordination and provision of sufficient financial commitments on the part of the government are needed. This will maximize the economic impact of such interventions. In addition, some households engaged in illegal activities to mitigate the impacts of the pandemic. There is a need to ensure the absorption of people who may have erred from being good citizens back into the society through counseling and provision of psychological support. More importantly, an economic stabilization procedure to mitigate the impacts of prevailing civil unrest in some parts of Mozambique will play a significant role in defining a stable pathway for sustainable economic growth and development after the pandemic.

Income was found to have a strong influence on promoting HDDS during the pandemic. This underscores the need to facilitate economic recovery at all micro production levels. Specifically, efforts should target the promotion of initiatives to revive agricultural, trade and commercial activities in Mozambique. The findings also imply that efforts to facilitate the income or earnings of some Mozambican households would promote nutritional security for the attainment of some Sustainable Development Goals (SDGs). Finally, there is a need to promote regional development in line with existing vulnerabilities to ensure improvements in nutritional status and poverty alleviation. This is particularly fundamental for the northern region, where Cabo Delgado is extremely fragile

LIMITATION & FURTHER RESEARCH

The primary limitation of this study is the reliance on data collected through telephone interviews. This may have influenced the responses of the participants since the enumerators were not physically present to assess their sincerity in answering the questions. Future studies should evaluate HDDS levels using more recent data to ensure positive progress after the wane of the pandemic. In addition, research initiatives that follow a longitudinal design would be helpful in understanding the role of some fixed and random effects in explaining households' nutritional status. There is also the need for proper inclusion of variables like households' size and education (which were missing across the two periods), and age should be explored in a continuous form instead of the categorical format in which it was presented in the database.

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