



Impact of COVID-19 on Butchers and Meat Processors in Ghana: Implication on Food (Meat) Biosecurity

Frederick Adzitey^{1,2*}, Stephen K.K. Monten² and Evans Boateng Frimpong³

¹University for Development Studies, Department of Veterinary Science, Box TL 1882, Tamale, Ghana.

²University for Development Studies, Department of Animal Science, Box TL 1882, Tamale, Ghana.

³College of Food Science and Technology, Nanjing Agricultural University, No. 1 Weigang, 210095, Nanjing, P.R China.

Authors' contributions

This work was carried out in collaboration among all authors. Author FA was involved in the conceptualization of the research, data collection, drafted the first manuscript and supported with funding. Author SKKM was involved in data collection, analysis, and proof read this manuscript and supported with funding. Author EBF was involved in data collection, analyzing, funding and proof read this manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: COVID-19 had an impact on the food (meat) biosecurity of Ghana. Butchers and meat processors ensure food biosecurity by making meat available, accessible, stable, and affordable to Ghanaians. This study assessed the impact of COVID-19 on butchers and meat processors in the Tamale metropolis, Ghana.

Study Design: A semi-structured questionnaire was used to obtain data from 98 randomly selected butchers and 4 local meat processors on the impact of COVID-19 on their operations.

Results: COVID-19 had a very negative impact on both butchers and meat processors. Low sales were a prominent impact experienced by both butchers and meat processors. Lack of animals to buy was the most important effect of COVID-19 on their business and threatens the food biosecurity of Ghanaians in terms of protein intake from animal sources. All the meat processors, but only 51% of the butchers were prepared for COVID-19. The butchers (90.8%) expected the government to make farming resources available during the COVID-19 period, while meat processors (50.0%) expected the transport to be provided. To ensure the survival of the meat industry to promote food biosecurity after COVID-19, butchers (59.2%) proposed the provision of financial support for their business whilst the meat processors (50.0%) proposed that animals should be thoroughly checked at the borders.

Conclusion: The findings of the study revealed that COVID-19 negatively affected the meat industry of Ghana and was a potential threat to the country's food (meat) biosecurity.

Keywords: Butchers; COVID-19; food bio-security; meat processors; livestock; storage and conservation; physical hazards.

1. INTRODUCTION

'Butchers' as used in Ghana normally refers to those involved in the buying and or selling of live and slaughtered animals (livestock/poultry). The term is also used for slaughterhouse workers directly involved in the slaughtering (merciful killing and dressing) of animals. Meat processors either slaughter their animals for their meat or purchase meat from butchers to process into meat and meat products. Butchers and meat processors play important roles in ensuring that meat and meat products are readily available for consumers, especially in critical times like the COVID-19 pandemic when animals and meat are in limited supply [1]. The activities of butchers and meat processors have been associated with the contamination of meat and meat products by biological, chemical, and physical hazards [2,3]. In Ghana, butchers and meat processors sometimes slaughter, sell, or process meat under unhygienic conditions and have limited knowledge of meat safety [4-8]; these conditions could make them potential sources for the transmission of COVID-19.

The genesis of the novel coronavirus (COVID-19) outbreak was linked to seafood and wet animal wholesale market in Wuhan, Hubei Province, China [9-11]. The first case was reported in that city on 1st December 2019, and it unprecedentedly spread across the globe, making the World Health Organization (WHO) declare COVID-19 a pandemic on 11th March 2020 [9] [12]. As at now, 18th August 2021, 4:06 pm CEST, 208,470,375 confirmed cases and 4,377,979 deaths due to COVID-19 have been reported worldwide [13]. In addition,

4,543,716,443 doses of vaccine have been administered. In Ghana, the first two cases of COVID-19 were reported on 12th March 2020 [14] [15]. Furthermore, the Imposition of Restriction Act, 2020, Act, 1012 and closing of Ghanaian borders took effect on 15th March 2020 and 21st March 2020, respectively [15]. By 31st March 2020, the number of confirmed COVID-19 cases stood at 8,070, with 2,947 recoveries and 36 deaths [15]. The situation appears to be improving in some countries, judging by the easing of restrictions in these countries.

COVID-19 has impacted the livestock and poultry industry, leading to unprecedented interruptions in economic activities and food biosecurity worldwide. This has been translated into disruptions in the supply of livestock and poultry for meat production and processing into further products [16-18]. Vorotnikov [19] and Biswal [20] reported that poultry production in Poland (Europe's largest broiler meat producer), and India (fourth-largest poultry producers), respectively have suffered because of COVID-19 and could see its poultry industry collapsing due to the pandemic. Anderson [21] reported that the beef, chicken, and pork sectors have all been affected by the COVID-19 pandemic, with market disruptions for consumers, governments, and relevant stakeholders. According to the Food and Agriculture Organization [22], the impact of COVID-19 on livestock and meat production includes reduced access to animal feed, inputs, services and markets, reduced processing capacity, compromised storage and conservation, and reduced demand and purchasing power of consumers.

Butchers and meat processors are vital workers who promote public nutrition, food safety, and food biosecurity, but their livelihood is seriously threatened by COVID-19. In some countries, COVID-19 has caused the closure of abattoirs and meat processing companies, leading to loss of livelihoods and serious food insecurities. In Brazil, three poultry plants were forced to close down due to outbreak of COVID-19 among some of their employees [23]. Major meat companies in Canada and the United States of America closed plants temporarily because of the development of some cases of COVID-19 among workers and there were concerns about its spread [24,25]. Others reduced numbers of workers and production amid the COVID-19 pandemic, thus affecting the meat supply chain [24,25] and food biosecurity.

Research on the impact of COVID-19 in all sectors worldwide is crucial to address the enormity of the problem, developing coping strategies, finding solutions and avoiding any future occurrences. Hitherto, information on the impact of COVID-19 on Agriculture (crop and livestock sectors) and welfare issues are available globally [18,26]. However, reports on the effect of COVID-19 on specific sectors of the animal industry are limited. Therefore, this study was conducted to determine the impact of COVID-19 on butchers and meat processors in Tamale Metropolis, Ghana, and its implication for food (meat) biosecurity.

2. MATERIALS AND METHODS

2.1 Study Area

The Tamale metropolis, where this study was conducted, is the capital of the Northern Region and the only Metropolis in the five regions of the North of Ghana. The Metropolis lies between latitude 9°16 and 9° 34 North and longitudes 0° 36 and 0° 57 West and shares boundaries with the Sagnarigu District to the west and north, Mion District to the east, East Gonja to the south and Central Gonja to the south-west [27]. Most of the animals in Ghana are produced by the five regions of the north, thus making Tamale a major contributor to meat production in Ghana [28,29].

2.2 Study Design and Questionnaire Administration

A cross-sectional survey was conducted among butchers and meat processors using a semi-structured questionnaire (provided as

supplementary data) to assess the impact of COVID-19 on their butchering, processing, and business activities. There are 130 registered butchers in the Tamale metropolis (Personal Communication with the Secretary of Tamale Butchers Association). Using a sample size calculator at a confidence level of 95 %, error margin of 5 %, and population portion of 50 % [30], a population size of 98 was obtained. Simple random sampling was used to select a population of 98 butchers, and purposive non-random sampling was used to determine all meat processors (4) identified in the Tamale metropolis for the interview. The semi-structured questionnaire sought to identify the demographic characteristics of butchers and meat processors, the impact of COVID-19, preparedness towards COVID-19, and interventions to combat future pandemics.

2.3 Data Analysis

One-Way Analyses of Variance (ANOVA) in Statistical Package for Social Sciences version 20 (IBM SPSS, ver. 20, Armonk, NY) was used to analyze the data obtained from the survey. The Chi-Square test (χ^2) was used to determine the relationships between some parameters (age, education, marital status, manner of engagement, and reasons for engagement against impact and preparedness for COVID-19). Significant differences were assessed using *P*-values, and all results were considered important if *P* < 0.05. Results (frequencies and or percentages) from the analyzed data were presented in a figure and tables.

3. RESULTS AND DISCUSSION

3.1 Socio-Demographic Characteristics of Butchers and Meat Processors

The socio-cultural background/activities and economic challenges of workers in meat facilities may contribute to the spread of COVID-19 and its impact on them [31]. Also, the socio-demographic characteristics of butchers and meat processors could influence their gender, notion, and purpose of going into the meat business, and the extent to which they can be food insecure. For instance, butchers and meat processors from poor backgrounds could contribute to much food insecurity due to the COVID-19 pandemic compared to their rich counterparts. All the butchers and meat processors interviewed were males (Table 1). In general, males have the physical strength needed to turn live animals into meats to ensure that safe meat is available and affordable for all

people. Similarly, Adzitey *et al.* [32], Sulleyman *et al.* [6], and Jianu and Golet [33] reported that males dominate butchering and meat processing. Male dominance was attributed to the tradition, or the physical nature of slaughtering, cutting animals into parts, and further processing [8,34,35]. Although women were not interviewed in this study, it was observed during data collection, especially among meat processors, that some women helped during purchasing and processing of meat into meat products. The contribution of women to agriculture and food biosecurity as a whole cannot be underestimated; their role is believed to surpass that of men [36]. Therefore, to promote gender inclusiveness and meet food biosecurity targets in the meat industry of Ghana, meat processing into meat products is recommended instead of the traditional system of slaughtering, which engages mainly men.

The majority of the butchers (63.3%) and meat processors (100.0%) were aged between 21 and 40 years, married (butchers, 90.8% and meat processors, 100.0%), and Muslims (butchers, 96.9% and meat processors, 75.0%). Age had no influence ($P > 0.05$) on the level of preparedness ($X = 1.246$, $df = 2$, $P = 0.536$) of butchers towards COVID-19, but did influence ($P < 0.05$) the impact of COVID-19 on their business ($X = 19.381$, $df = 8$ and $P = 0.013$). This study showed that the younger men were more involved in butchering and meat processing, which concurs with reports by Sulleyman *et al.* [6]. The physical nature of butchering also drives the involvement of younger rather than older people. In addition, it presents opportunities for younger people for self-employment, and high meat turnover to ensure availability and accessibility to sufficient protein. Married men dominated the butchering and meat processing activities. This means that butchering and meat processing provide important sources of income for households. These incomes are required for the purchasing of other foodstuffs to promote food biosecurity among butchers' and meat processors' families. This is supported by the fact that most of the respondents engaged in it as a business. Nonetheless, marital status did not influence ($P > 0.05$) the level of preparedness ($X = 1.771$, $df = 2$, $P = 0.412$) and impact ($X = 6.211$, $df = 8$, $P = 0.624$) of COVID-19 on butchers. In Ghana, Muslims form a large proportion of the population who work in meat production and processing [6,8,32]; the findings of this study confirmed this. The implication of this is that most animals are slaughtered based on Islamic principles and, meat produced in Ghana is mostly halal.

Butchers were dominated by members of the Dagomba tribe (95.9%), while 50.0% of meat processors were Dagombas. Tribal affiliations are associated with the method of slaughtering and the group of people that might be affected by COVID-19. The Dagombas engaged in butchering mainly as a business (76.5%) and to a lesser extent, both business and tradition (19.4%). The negative impact of COVID-19 on the business of butchers and meat processors affected their income and their abilities to provide adequate food for their families. Those who practiced butchering as a tradition were born into families involved in butchering and inherited the trade from their families. The conclusion that butchering is a form of business and tradition is consistent with the findings of Mahaboubil-Haq and Adzitey [34]. Besides being a business, some meat processing companies were owned by the family and practiced slaughtering and processing as a tradition. It was also interesting to find that one of the meat processors was involved in training. This is good for sharing current information in the field, assists innovation and maintenance of butchering and processing skills. Training of butchers, meat processors, and relevant stakeholders provides opportunities to reduce meat wastage, produce safe meat, and promote food biosecurity. The manner of engagement (full time or part-time) in the meat business influenced ($P < 0.05$) the level of preparedness ($X = 8.585$, $df = 2$, $P = 0.014$), but not ($P > 0.05$) the impact ($X = 8.325$, $df = 8$, $P = 0.402$) of COVID-19 on the butchers. However, the reasons for engagement in butchering (either as a business, tradition, for training and/or a combination) had no influence ($P > 0.05$) on the level of preparedness ($X = 0.113$, $df = 1$, $P = 0.737$), but affected the impact ($X = 15.124$, $df = 4$, $P = 0.004$) of COVID-19 on butchers.

Education and experience are essential requirements for a better understanding of one's business and how to handle it, especially in times of crisis. In this study, most of the butchers and meat processors had primary (53.1%) and senior high (50.0%) education, respectively. Some of the butchers (3.1%) and meat processors (25.0%) had tertiary education. Education is important for the introduction and acceptance of new technologies, observance of personal hygiene, and safe handling of meat and meat products. The adoption of the aforementioned practices will help prevent the spread of COVID-19 and other diseases. They will also help to improve production and to reduce post-harvest losses of meat, thereby contributing toward food

biosecurity. Poor meat handling due to a low level of education among butchers has been reported [6,8]. In the present study, education had significant influence ($P < 0.05$) on the level of preparedness ($X = 9.732$, $df = 4$, $P = 0.045$) and impact ($X = 38.764$; $df = 16$ and $P = 0.0017$) of COVID-19 on the butchers. Education is required for acceptance of and adherence to COVID-19 safety protocols.

3.2 Impact of COVID-19 on Butchers and Meat Processors, and Disruption of Their Businesses

The meat industry is an essential component of Ghana's food industry and directly or indirectly employs many people. Thus, the industry is a major source of income for many households, especially in the five regions of the North of Ghana (which includes the study area). The meat industry also contributes to the food security and protein intake of all Ghanaians. The impact of COVID-19 among butchers and meat processors in the Tamale metropolis is shown in Table 2. Low sales impacted the businesses of butchers and meat processors, notably among butchers (54.1%) and meat processors (100.0%). The butchers also lost some clients, lost some working capital, had financial challenges, and feared clients could transmit COVID-19 to them. COVID-19 had a very negative impact on the activities of butchers (80.6%) and meat processors (75.0%). The implications are that butchers and meat processors had reduced income levels, were challenged with money to continue their operations, and worked under capacity to fear contracting COVID-19. Subsequently, their families and dependents will have food biosecurity issues. Also, meat availability, accessibility, and stability were affected, exposing Ghanaians to meat protein insecurities. In this study, the meat processors were affected negatively because of fear of breaking government policies, making them reduce their working hours, resulting in financial challenges due to reduced operations and sales and shortages of animals due to COVID-19. In addition to these problems, butchers were negatively hit because of the closure of the hospitality industry and customers' fears that they might contract COVID-19 from meat. It concerns that none of the butchers or meat processors confirmed that COVID-19 had a positive or no impact on their business. Unlike other industries such as the pharmaceutical industry that is generally seen as thriving, primarily due to the production of Personal

Protective Equipment (PPE) [37], meat production and processing industries are among those that were negatively affected by COVID-19 [38]. International Labour Organization (ILO) [39,40] stated that COVID-19 led to the shutdown of some meat industries globally. These companies either halted their operations, reduced production, or closed down temporarily, hitting the meat industry hard. In the United Kingdom, a meat processing site owned by Associated Dairies (ASDA), and other meat processing plants closed down due to the COVID-19 outbreak among workers [41]. Also, the Kumasi Abattoir in Ghana reduced the production of meat three weeks into the COVID-19 period, with beef production declined by 57.5% while goat and sheep meat production was reduced by 23.4% [42]. Obese *et al.*, 2021 [43] reported a similar result of a decline in livestock production and animal products importation in Ghana due to COVID-19. Nonetheless, abattoir/meat processing plant operations in Ghana (a tropical country) could be better than in temperate regions as far as the transmission of COVID-19 was concerned. This is because the COVID-19 virus appears to survive better in a cold environment than in a warm environment [44]. Mass transmission of COVID-19 among meat processing plant workers in temperate regions has been reported. Heil [45] stated that "the owners of Europe's largest meat-processing plant must be asked to account for the mass COVID-19 outbreak among their workers". In addition, a whole region has been held hostage due to the failure of a meat processing factory to protect its workers. Lillist [46] described the impact of COVID-19 in meat processing plants around the world as a "very chaotic and crazy situation" such that some farmers have to euthanize their animals. All of these led to massive loss of meats and threatened global food biosecurity.

The severity of COVID-19 among the meat processors and butchers concerning the rank of disruptions caused are presented in Fig 1 and 2 respectively.

Disruptions in many sectors of the economy, including health, education, business, tourism, and manufacturing worldwide, are recognized. Meat and Livestock Australia [47] reported disruptions to the red meat supply across various markets in Australia. A devastating disruption is the death of meat facility workers due to COVID-19; such instances have been reported in the USA [31].

Table 1. Socio-demographic characteristics of butchers and meat processors in the Tamale Metropolis of Ghana

Variable	Butchers		Meat processors	
	No. of respondents	Percentage	No. of respondents	Percentage
Gender				
Male	98	100	4	100
Female	0	0	0	0
Age				
21-40	62	63.3	4	100
41-60	35	35.7	0	0
Above 60	1	1	0	0
Marital Status				
Married	89	90.8	4	100
In a relationship	4	4.1	0	0
Single	5	5.1	0	0
Religion				
Christianity	3	3.1	1	25
Islamic	95	96.9	3	75
Tribe				
Dagomba	94	95.9	2	50
Islamic	4	4.1	2	50
Education				
None	16	16.3	1	25
Primary School	52	53.1	0	0
Junior High School	3	3.1	0	0
Senior High School	24	24.5	2	50
Tertiary	3	3.1	1	25
Purpose of work				
Business	75	76.5	1	25
Tradition	19	19.4	2	50
Business and Tradition	4	4.1	0	0
Business and Training	0	0	1	25
Manner of engagement				
Full time	91	92.9	4	100
Part time	7	7.1	0	0

All the butchers and meat processors employed others, ranging from 1 to 10 for meat processors and 1 to 20 for butchers, although the majority of the butchers (79.6%) and meat processors (75.0%) had between 1 and 5 employees. Out of the 98 butchers, 28 laid off some workers and 3 butchers paid their workers based on daily sales. However, the butchers stated that they would re-employ those they had laid off when the situation returned to normal. As stated earlier, the meat business serves as a source of livelihood for farmers, butchers, meat processors, and others in Ghana. Therefore, layoffs and the collapse of firms could raise the poverty level and food insecurity in Ghana. Some butchers and meat processors did not lay off workers (44.9% for butchers and 50.0% for meat processors) or reduce wages for workers (23.5% for butchers and 50.0% for meat processors). Apart from the

meat industry, COVID-19 has caused other industries to lay off workers. Sharma [48] stated that the COVID-19 pandemic had triggered layoffs, pay cuts, and a hiring freeze across Indian Industries. The meat processors stated they would lay off workers (25.0%) or have their business collapse (75.0%) if COVID-19 continued for more than 5 months from the time they were interviewed. For butchers, businesses will collapse (84.7%), be out of working capital (9.2%) and run into debt (6.1%) if lockdown goes beyond 5 months. Adrian and Natalucci [49] stated that the COVID-19 pandemic would pose a major crisis and a threat to financial stability worldwide if it continues for long, and could expose the world at large to food insecurity since able countries will not be able to produce to their capacities.

Table 2. Impact of COVID-19 on butchers and meat processors in the Tamale metropolis

Variable	Butchers		Meat processors	
	No. of respondents	Percentage	No. of respondents	Percentage
The current impact of COVID-19 on business				
Fear by clients	12	12.2	0	0
Financial challenges	14	14.3	0	0
Lost clients	14	14.3	0	0
Lost working capital	5	5.1	0	0
Low sales	53	54.1	4	100
Rate the impact				
Negative	19	19.4	1	25
Very negative	79	80.6	3	75
Why is the impact negative or very negative				
Fear of breaking government regulations	18	18.4	2	50
Financial challenges	20	20.4	1	25
Shortage of animals	26	6.1	1	25
Close-down of hospitality industry	24	24.5	0	0
Fear of eating meat	7	7.1	0	0
Fear of contracting the virus	23	23.5	0	0
How many people have you employed?				
1-5	78	79.6	3	75
6-10	16	16.3	1	25
11-15	2	2	0	0
16-20	2	2	0	0
How many people have you laid off?				
There is no layoff	44	44.9	2	50
There is no layoff but low wages for workers	23	23.5	2	50
I have laid off some workers	28	28.6	0	0
Payment is based on sales	3	3.1	0	0
If this lockdown continues for more than 5 months, how will it affect your business				
It will collapse my business	83	84.7	3	75
Lay off workers	0	0	1	25
I will be out of working capital	9	9.2	0	0
I will run into debt with my financiers	6	6.1	0	0

3.3 Preparedness and Potential Interventions for COVID-19 According to Butchers and Meat Processors

The preparedness and potential government intervention proposed by butchers and meat processors during the COVID-19 period is shown in Table 3. All (100.0%) the meat processors were prepared for COVID-19; however, 49.0% of the butchers were not prepared for COVID-19. This is not surprising since meat processors had better educational level and engaged more in their business on full time basis compared to butchers. By way of preparedness to ensure food (meat) biosecurity, the meat processors purchased animals in advance (50%), stored meat for their clients (25.0%), and already had safety measures in place (25.0%). Also, 6.1%,

9.2%, and 35.7% of butchers stored meat for their client purchased animals in advance and already had safety and biosecurity measures in place, respectively. Some of the butchers were not prepared for COVID-19 because they did not think that COVID-19 would enter Ghana or get to Tamale, nor expected it would cause the current crisis and thought it was not a black disease (that would affect Africans). The notion that COVID-19 was not a black disease was linked to a butcher without formal education. Butchers and meat processors expected the government of the Republic of Ghana to provide them with transport (7.1% for butchers and 50.0% for processors) and make farm resources available (90.8% for butchers and 25.0% for meat processors) during the COVID-19 period. Some meat processors (25%) also wanted the government to assist

them in buying farm animals by providing credit. Some butchers (2.0%) expected the government to give them some compensation for the loss of income during the COVID-19 period to promote continuous production, availability, and accessibility of meat, and for their families to be food secured. The government of Ghana has put in place measures to mitigate the spread of

COVID-19 and the collapse of businesses in Ghana. Such efforts include the closure of Ghanaian borders (affecting the importation of live animals and meat), social distancing (affecting interaction), and provision of a stimulus package (meant to bring some financial relief for businesses).

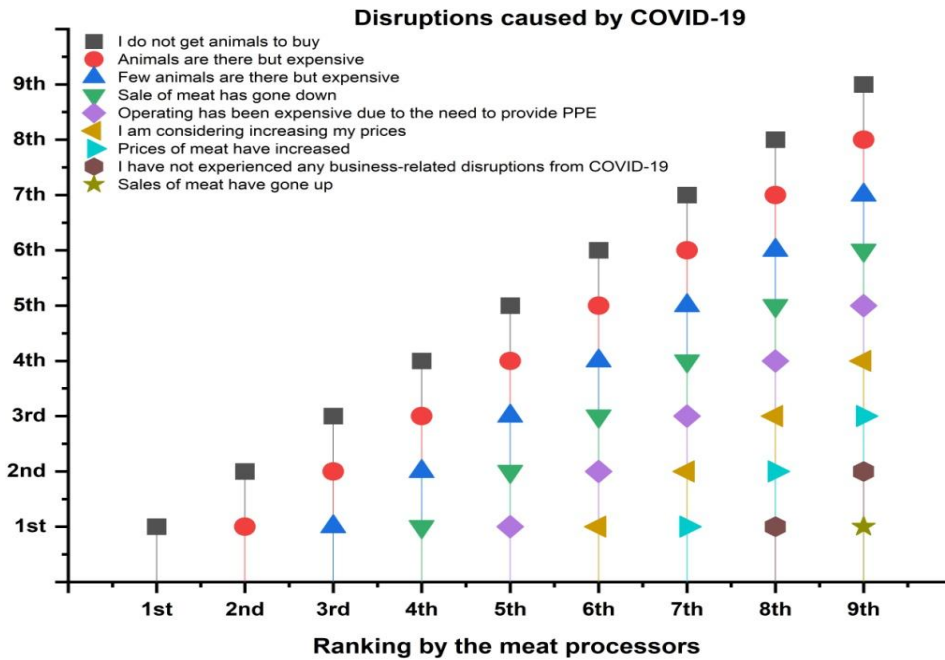


Fig. 1. The rank of disruptions caused by COVID-19 according to the meat processors

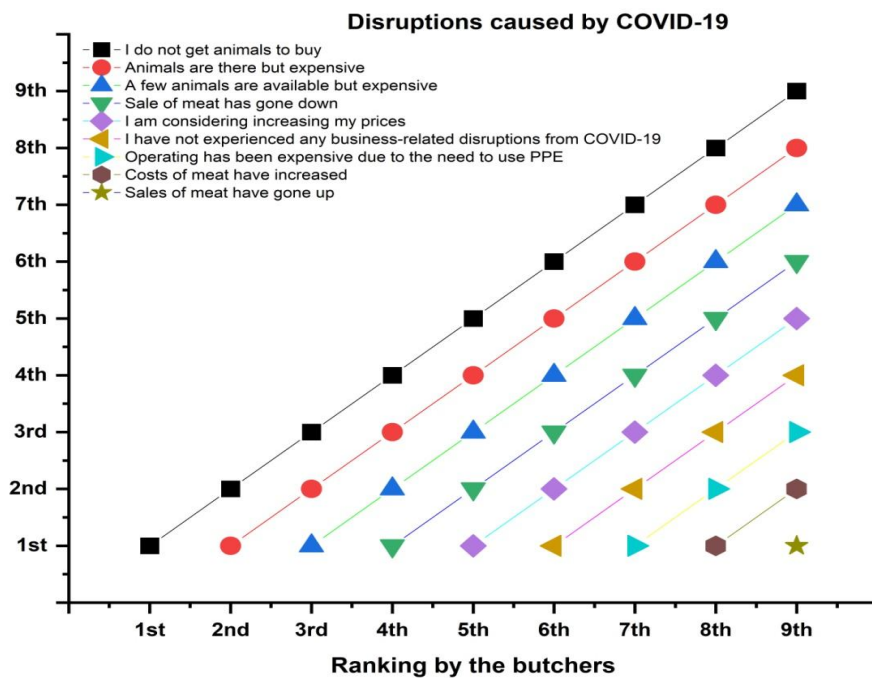


Fig. 2. The rank of disruptions caused by COVID-19 according to the butchers

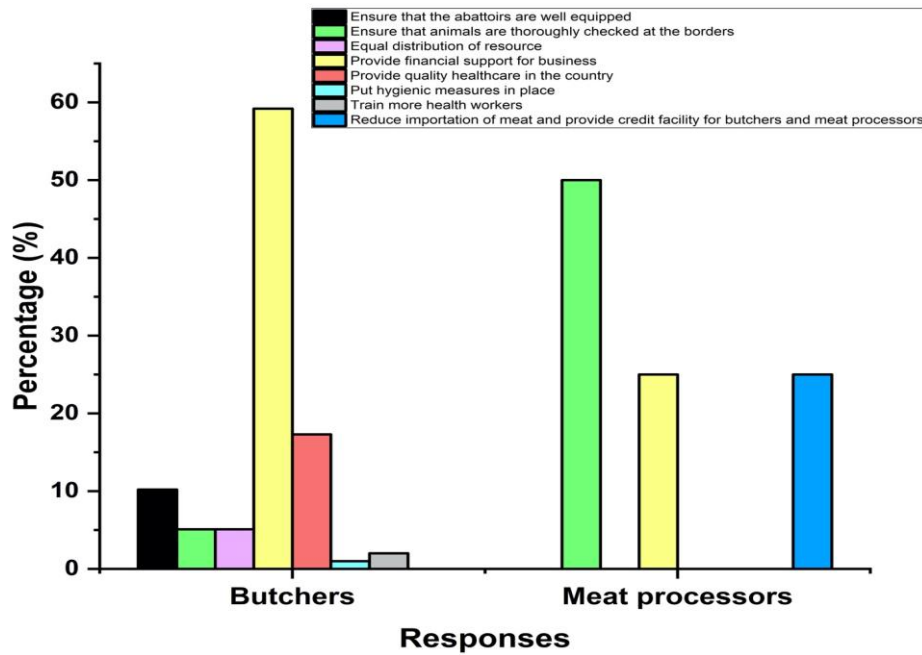


Fig. 3. Potential government interventions to ensure the survival of meat production and processing in Ghana after COVID-19

Table 3. Preparedness for COVID-19 of butchers and meat processors in the Tamale metropolis

Variable	Butchers		Meat processors	
	No. of respondents	Percentage	No. of respondents	Percentage
Were you prepared for COVID-19?				
No	48	49	0	0
Yes	50	51	4	100
If yes, how?				
Purchased animals in advance	9	9.2	2	50
Stored meat for my clients	6	6.1	1	25
Already had safety measures in place	35	35.7	1	25
Not prepared	48	49	0	0
If no, why?				
Did not know that it would enter Ghana	7	7.1	0	0
Did not know that it would get to Tamale	4	4.1	0	0
Did not expect it to cause such a crisis	36	36.7	0	0
Thought it was not a black disease	1	1	0	0
Prepared	50	51	0	0
Potential government intervention during the COVID-19 period				
Make farming resources available	89	90.8	1	25
Provide transportation service	7	7.1	2	50
Assist in buying animals by providing credit	0	0	1	25
Compensate for lost income	2	2	0	0

Fig. 3 shows government interventions suggested by the butchers and meat processors to ensure meat production and processing survival after COVID-19. The meat processors proposed that to ensure the survival of the meat industry and food bio-security post-COVID-19, the Government should 1) ensure that animals are thoroughly checked for evidence of disease at the borders before entering the country (50.0%), 2) provide financial support for the meat business (25.0%), and 3) reduce the importation of meat and meat products while lending them money for them to increase their operations (25.0%). Butchers thought that if the Government 1) provides financial support (59.2%), 2) provides quality health care (17.3%), 3) equips and biosecure the abattoirs in the country (10.2%), 4) ensures that animals are thoroughly checked at the borders (5.1%), 5) ensures even distribution of resources (5.1%), 6) trains more health workers (2.0%), and 7) puts hygienic measures in place (1.0%); the meat industry will recover from the shocks and disruptions suffered because of COVID-19 to ensure food biosecurity. The Government of Ghana needs to put various control and combating measures in place to ensure the survival and growth of the animal and meat industry during and after COVID-19 and against future pandemics have been suggested [18,42,50,51]. They include the provision of financial services, providing education on personal hygiene for farming communities, butchers, and meat processors, provision of facilities for large scale production of animals and processing, provision of refrigerated storage facilities, engaging supermarkets and entrepreneurs in animal and meat production, integrating livestock and crops, one health approach to livestock production, the establishment of a national laboratory and regular surveillance services, backyard and home rearing of animals among others.

4. CONCLUSIONS

The butchers and meat processors were all males, mostly young, married, and Muslim. Education had a significant influence on the impact of and preparedness for COVID-19 among butchers. Both butchers and meat processors were negatively affected by COVID-19. Most of the butchers and meat processors' businesses could collapse if COVID-19, with its associated lockdown, lasts for more than 5 months. The meat processors were all prepared for COVID-19 but not all the butchers. As a long-term help during the COVID-19 pandemic,

butchers requested the government to provide them with financial assistance, whilst meat processors require animals to be thoroughly checked at the borders before entering the country to ensure food (meat) bio-security.

SIGNIFICANCE STATEMENT

The sudden surge of the global COVID-19 pandemic did affect the butchers and meat processing businesses in Tamale, coupled with challenges associated with the access to purchase meat protein from sales points for nourishment by the consumers during the lockdown period. Assessing the impact of COVID-19 on butchers will give data for areas the government and stakeholders have to intervene in. It will also provide an idea about meat production, protein availability, and challenges involved in assessing the same to safeguard the present and future, especially during pandemics. This study results recommend government assistance in the meat production and processing sector for economic relief as far as the impact of COVID-19 on meat processors, butcher, and meat consumers in the Tamale metropolis, Ghana is a concern.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

CONSENT

The purpose of the study was initially explained to the participants, and they were interviewed based on their consent. The confidentiality of each respondent's answers was guaranteed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hatab AA, Cavinato MER, Lagerkvist CJ. Urbanization, livestock systems and food security in developing countries: A systematic review of the literature. *Food Sec.* 2019;11:279-299. Available:https://doi.org/10.1007/s12571-019-00906-1.
2. Beyene T. Veterinary Drug Residues in Food-animal Products: Its Risk Factors and Potential Effects on Public Health. *J Veterinar Sci Technol.* 2016;7:285. Available:https://doi.org/doi:10.4172/2157-7579.1000285
3. Adzitey F. The prevention and control of bacterial foodborne hazards in meats and meat products-an overview. *J. Meat Sci. Tech.* 2016;4:01-10.
4. Adzitey F. Incidence and antimicrobial susceptibility of *Escherichia coli* isolated from beef (meat muscle, liver and kidney) samples in Wa Abattoir, Ghana. *Cogent Food and Agriculture.* 2020; 6: 2-10. Available:https://doi.org/.10.1080/23311932.2020.1718269.
5. Pesewu GA, Quaynor EB, Olu-Taiwo MA, Anim-Baidoo I, Asmah RH. Bacterial contaminants of raw broiler meat sold at Korle-Gonno, Accra, Ghana. *Int. Food Res. J.* 2018;25:1758-1762.
6. Sulleyman KW, Adzitey F, Boateng EF. Knowledge and practices of meat safety by meat sellers in the Accra Metropolis of Ghana. *International Journal of Veterinary Science.* 2018;7:167-171.
7. Yafetto L, Adator EH, Ebuako AA, Ekloh E, Afeti FY. Microbial quality of raw beef and chevon from selected markets in Cape Coast, Ghana. *J. Biol Life Sci.* 2019;10:1. Available:https://doi.org/:10.5296/jbls.v10i1.14022.
8. Adzitey F, Teye GA, Amoako D.G. Prevalence, phylogenomic insights, and phenotypic characterization of *Salmonella enterica* isolated from meats in the Tamale metropolis of Ghana. *Food Sci Nutr.* 2020;8:3647-3655. Available:https://doi.org/:10.1002/fsn3.1647.
9. Hui DS, Azhar EI, Madani TA, Ntumi F, Kock R, Dar O, Ippolito G, Mchugh TD, Memish ZA, Drosten C, Zumla A, Petersen E. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health-The latest 2019 novel coronavirus outbreak in Wuhan, China. *Int J Infect Dis.* 2020;91:264-266. Available:https://doi.org/10.1016/j.ijid.2020.01.009.
10. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W, China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *The New England Journal of Medicine.* 2020; 382(8):727-733. Available:https://doi.org/10.1056/NEJMoa2001017.
11. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, Hu Y, Tao ZW, Tian JH, Pei YY, Yuan ML, Zhang YL, Dai FH, Liu Y, Wang QM, Zheng JJ, Xu L, Holmes EC, Zhang YZ. A new coronavirus associated with human respiratory disease in China. *Nature.* 2020;579(7798):265-269. Available:https://doi.org/10.1038/s41586-020-2008-3.
12. Verma P, Dumka A, Bhardwaj A. Ashok A, Kestwal MC, Kumar P. A Statistical Analysis of Impact of COVID19 on the Global Economy and Stock Index Returns. *SN Comput. Sci.* 2021;2:27. Available:https://doi.org/10.1007/s42979-020-00410-w.
13. World Health Organization (WHO). WHO Coronavirus Disease (COVID-19) Dashboard. Accessed 6 May 2020. Available:https://covid19.who.int/?gclid=EA1aIQobChMIwKKOgd3g6QIVQu7tCh1SGgbSEAAAYASABEGl2gPD_BwE, 2021.
14. Ghana Web. Coronavirus pandemic: Impact on livestock sector in Ghana. Accessed 6 May 2020. Available:https://www.ghanaweb.com/GhanaHomePage/features/Coronavirus-pandemic-Impact-on-livestock-sector-in-Ghana-932707, 2020.
15. Akufo-Addo NAD. Address to the nation by the President of the Republic, Nana Addo Dankwa Akufo-Addo, on updates to Ghana's enhanced response to the coronavirus pandemic, on Sunday;2020.
16. Hatab AA, Krautscheid L, Boqvist S. COVID-19, Livestock Systems and Food Security in Developing Countries: A Systematic Review of an Emerging

- Literature. Pathogens (Basel, Switzerland). 2021;10(5):586. Available:<https://doi.org/10.3390/pathogens10050586>.
17. Kakati LJ, Deka RJ, Das P. Impact of covid-19 on livestock sector. *The Science World*. 2021; 1(2):49-52.
 18. FAO. Guidelines to mitigate the impact of COVID-19 pandemic on livestock production and animal health. Rome;2020. Available:<https://doi.org/10.4060/ca9177en>.
 19. Vorotnikov V. Poland's poultry sector suffers because of the Covid-19. Accessed 6 May 2020. Available:<https://www.poultryworld.net/Meat/Articles/2020/5/Polands-poultry-sector-suffers-because-of-the-Covid-19-584063E/>, 2020.
 20. Biswal J, Vijayalakshmy, K, Rahman H. Impact of COVID-19 and associated lockdown on livestock and poultry sectors in India. *Veterinary world*. 2020;13(9):1928-1933. Available:<https://doi.org/10.14202/vetworld.2020.1928-1933>.
 21. Anderson J. The (beef, pork and chicken) protein sector. Accessed 6 May 2020. Available:https://www.uaex.edu/life-skills-wellness/health/covid19/COVID_19_Impacts_on_Ag_and_Rural_Economy.pdf, 2020.
 22. FAO. Mitigating the impacts of COVID-19 on the livestock sector. Rome;2020. Available:<https://doi.org/10.4060/ca8799en>.
 23. Azevedo D. Covid-19: Impact on the global poultry sector. Accessed 6 May 2020. Available:<https://www.poultryworld.net/Meat/Articles/2020/5/Brazil-Covid-19-cases-spike-among-processing-plant-workers-589566E/?dossier=42157&widgetid=0>, 2020.
 24. Bogart N. COVID-19 to have 'immediate and drastic' impact on Canadian meat supply: industry group. Accessed 6 May 2020. Available:<https://www.ctvnews.ca/health/coronavirus/covid-19-to-have-immediate-and-drastic-impact-on-canadian-meat-supply-industry-group-1.4894557>, 2020.
 25. Financial Post, Coronavirus closes meat plants in Canada and the United States as world's largest pork producer warns of shortages. Accessed 6 May 2020. Available:<https://business.financialpost.com/news/retail-marketing/coronavirus-spread-closes-north-american-meat-plants>, 2020.
 26. Marchant-Forde JN, Boyle LA. COVID-19 Effects on Livestock Production: A One Welfare Issue. *Front. Vet. Sci*. 2020;7:585787. Available:<https://doi.org/10.3389/fvets.2020.585787>.
 27. Ghana Statistical Service, 2010 Population and housing census. Accessed 6 May 2020. Available:http://www2.statsghana.gov.gh/docfiles/2010_District_Report/Northern/Tamale%20Metropolitan.pdf, 2012.
 28. Ministry of Food and Agriculture. Livestock development in Ghana policies and strategies. Accessed 6 May 2020. Available: <http://agricinghana.com/wp-content/uploads/>, 2004.
 29. Adzitey F. Animal and meat production in Ghana-An overview. *J. World's Poult Res*. 2013;3(1): 01-04.
 30. Calculator.net, Sample size calculator. Accessed 6 May 2020. Available:<https://www.calculator.net/sample-size-calculator.html?type=1&cl=95&ci=5&pp=50&ps=5&x=64&y=12>, 2020.
 31. Dyal JW, Grant MP, Broadwater K, et al., COVID-19 among workers in meat and poultry processing facilities-19 States. *MMWR Morb Mortal Wkly Rep*. 2020; 69:557-561. Available:<https://doi.org/10.15585/mmwr.mm6918e3>.
 32. Adzitey F, Abu A, Teye GA, Weyire A, Issahaku A, Boateng EF. Handling and storage of leftover meat by butchers in the Tamale Metropolis and Bolgatanga Municipality of Ghana. *J. Meat Sci. Tech*. 2018;6:30-35.
 33. Jianu C, Goleț I. Knowledge of food safety and hygiene and personal hygiene practices among meat handlers operating in western Romania. *Food Cont*. 2014;42:214-219. Available:<https://doi.org/10.1016/j.foodcont.2014.02.032>
 34. Mahaboubil-Haq M, Adzitey F. Meat production and consumption in the Wa Municipality of Ghana. *International Food Research Journal*. 2016;23(3):1338-1342.
 35. Ojokoh BA, Makinde OS, Fayeun LS, Babalola OT, Salako KV, Adzitey F. Impact of COVID-19 and lockdown policies on farming, food security and agribusiness in West Africa. *DS-COVID-19-2020: Book: Data Science for COVID-19 (Accepted)*;2020.

- Available: <https://easychair.org/cfp/DS-COVID-19-2020>, 2020 [Accessed 6 May 2020].
36. Oguniela YI, Mukhtar AA. Gender Issues in agriculture and rural development in Nigeria: The role of women. *Humanity and Social Sciences Journal*. 2009; 4(1): 19-30.
 37. GlobalData Healthcare. The impact of big pharma on Covid-19. Accessed 6 May 2020.
Available: <https://www.pharmaceutical-technology.com/comment/covid-19-pharmaceutical-companies-impact/>, 2020.
 38. Rahman Md. S, Das GC. Effect of COVID-19 on the livestock sector in Bangladesh and recommendations, *Journal of Agriculture and Food Research*. 2021;4:100128.
Available:<https://doi.org/10.1016/j.jafr.2021.100128>.
 39. International Labour Organization (ILO). COVID-19 and its impact on working conditions in the meat processing sector. Sectoral Brief;2021. Accessed 27 July 2021.
Available:https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/briefingnote/wcms_769864.pdf.
 40. Ijaz M, Yar MK, Badar IH, Ali S, Islam MS, Jaspal MH, Hayat Z, Sardar A, Ullah S, Guevara-Ruiz D. Meat Production and Supply Chain Under COVID-19 Scenario: Current Trends and Future Prospects. *Front. Vet. Sci*. 2021;8:660736.
Available:<https://doi.org/10.3389/fvets.2021.660736>.
 41. The Guardian, three food factories in England and Wales close over coronavirus. Accessed 5 June 2020.
Available:<https://www.theguardian.com/business/2020/jun/19/three-meat-factories-in-england-and-wales-closed-over-coronavirus>, 2020.
 42. Tasiame W, Soku Y, Thompson EE, Sasu BK, Bediako EN, Bentum KE, Boateng E, Boakye O, Yeboah O. Covid-19: effect on livestock industry and animal protein accessibility in Ghana. Accessed 6 May 2020.
Available:<https://www.myjoyonline.com/opinion/covid-19-effect-on-livestock-industry-and-animal-protein-accessibility-in-ghana/>, 2020.
 43. Obese FY, Osei-Amponsah R, Timpong-Jones E, Bekoe E. Impact of COVID-19 on animal production in Ghana. *Animal frontiers : the review magazine of animal agriculture*. 2021;11(1): 43-46.
Available:<https://doi.org/10.1093/af/vfaa056>.
 44. Marzoli F, Bortolami A, Pezzuto A, Mazzetto E, Piro R, Terregino C, Bonfante F, Belluco SA. Systematic review of human coronaviruses survival on environmental surfaces. *Science of Total Environment*. 2021;778:146191.
Available:<https://doi.org/10.1016/j.scitotenv.2021.146191>.
 45. Heil H. Meat plant must be held to account for Covid-19 outbreak, says German minister. Accessed 5 June 2020.
Available:<https://www.theguardian.com/world/2020/jun/22/meat-plant-must-be-held-to-account-covid-19-outbreak-germany>, 2020.
 46. Lillist B. Chaotic and crazy': meat plants around the world struggle with virus outbreaks Accessed 5 June 2020.
Available:<https://www.theguardian.com/environment/2020/may/11/chaotic-and-crazy-meat-plants-around-the-world-struggle-with-virus-outbreaks>.
 47. Meat and Livestock Australia, The impacts of COVID-19 on livestock and red meat markets. Accessed 6 May 2020.
Available: <https://www.mla.com.au/news-and-events/industry-news/the-impacts-of-covid-19-on-livestock-and-red-meat-markets/#>, 2020.
 48. Sharma N. Coronavirus crisis triggers layoffs, pay cuts, and hiring freeze across Indian industries. Accessed 6 May 2020.
Available:<https://qz.com/india/1837566/coronavirus-triggers-layoffs-across-indian-it-startup-aviation/>, 2020.
 49. Adrian T, Natalucci F. COVID-19 crisis poses threat to financial stability. Accessed 6 May 2020.
Available:<https://blogs.imf.org/2020/04/14/covid-19-crisis-poses-threat-to-financial-stability/>, 2020.
 50. Adzitey F, Abu A, Teye GA. Impact of COVID-19 on livestock and meat production in northern Ghana, In: *Impact of COVID-19 on Food Production, Nutrition Security and Hospitality in Northern Ghana: Mitigation Action against the Pandemic*. (Editor) Kugbe, J.X., Chapter 4. 2020;49-64.
 51. Monten SKK, Adzitey F. The impact of COVID-19 on frozen meat business operations in the Tamale Metropolis of

Ghana. Al-Nahrain J. Sci. (Special Issue:
COVID-19). 2020;0:13-20.

Available:<https://doi.org/10.22401/ANJS.00402>.

APPENDIX

SUPPLEMENTARY DATA

QUESTIONNAIRE FOR IMPACT OF COVID-ON BUTCHERS AND MEAT PROCESSING.

OPERATION IN TAMALE

Kindly Tick in the box [] or state accordingly

1. Gender: a. Male [] b. Female []
 2. Age (years): a. below 21 [] b. 21- 40 [] c. 41 - 60 [] d. above 60 []
 3. Marital status: a. Married [] b. Single [] c. Divorced [] d. In a relationship [] e. Other []
 4. Religion: a. Christianity [] b. Islamic [] c. Traditional [] d. Other []
 5. Educational background: a. None [] b. Basic [] c. Secondary [] d. Tertiary []
e. Others (specify).....
 6. Tribe: a. Dagomba [] b. Bulisa [] c. Kasena d. Manprusi e. Other
 7. How can you describe the current impact of COVID-19 and lockdown policies on your business?
 8. How do you rate the impact of COVID-19 on your business revenue?
a. Very Negative [] b. Negative [] c. Neutral [] d. Positive [] e. Very Positive []
 9. Why is it so?
 10. Are you engaged in butchering as
Full-time [] Part-time []
 11. I do butchering as
a. Business [] b. Tradition [] c. Pleasure [] d. others (specify).....
 12. How many people did you employ before the covid crisis?
a.1-5[] b. 6-10[] c.11-15[] d.16-20[] e. others (specify).....
 13. How many people did you lay off as a result of COVID-19?
 14. How best would you describe the effect of COVID-19 on your business. Rank from highest to lowest (1-9)
- What number question is this?

Description	Ranking (1= lowest to 9 = highest)
I do not get animals to buy	
Animals are there but expensive	
Few animals are there but expensive	
Sale of meat has gone down	
Sales of meat have gone up	
I have increased the prices I charge for meat	
I am considering increasing my price	
Operating has been expensive due to the need to buy PPE	
I have not experienced any business-related disruption due to COVID-19	

15. Were you prepared to handle the situation with the current COVID-19 crisis?

a. Yes [] b. No []

16. If yes, what measures did you put in place?

17. If not, why?

18. If lockdown continues for more than 5 months, how do you think this will affect your business?

19. What would you have wanted the government to do for your business during this period?

a. Provide transportation service [] b. Buy farm produce []
c. Make farming resources available [] d. Others (specify).....

20. What do you want the government to do for your business after this period to ensure that you survive future pandemics?

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