Towards delineating butchers' knowledge base, challenges encountered, and enhancement prospects of meat inspection processes: A cattle slaughterhouse case analysis

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A b s t r a c t: There is a paucity of relevant literature about what Nigerian butchers know and challenges encountered, especially during cattle meat inspection processes. Butchers, if encouraged to put forward their suggestions so as to improve the meat inspection process, together with their advice to the veterinarians, can serve as (future) enhancement prospects. This study aimed towards delineating the butchers' knowledge base, challenges encountered, and enhancement prospects of meat inspection processes via case analysis of a cattle slaughterhouse at Nsukka urban, considered representative of many others in Nigeria. A semi-structure questionnaire via interview was administered to 54 butchers, with interview time dependent on their availability and convenience. The butchers, all male (Freq.=100.0%, n=54), largely secondary school educated, most with >5 years of work experience and delivering ≥5 days/week work patterns, were very familiar with slaughterhouse components, clearly understood what meat inspection is and appeared always prepared for the worst outcomes. Butchers (Freq.=98.15%, n=53) considered meat inspection important (p<0.0001, H-adj.=99.22) to increasingly prioritise beef meat and consumer safety. Butchers' challenges in the meat inspection process include the fear of losing the beef meat, or entire cattle carcass and the financial implications of any loss. Despite some positively (p<0.05) correlated variables, the latter obtained similar odds ratios trends based on the butchers' years of work experience. The butchers' acceptance of negative meat inspection outcomes can improve if veterinarians engage more effectively.

Keywords: meat handlers; challenges; meat hygiene; veterinarian; correlation; logistic regression.

Introduction

Globally, the demand for livestock products increases with changing consumer landscape/preferences, economic improvement/progress, as well as population growth and urbanization (*Agus and Widi*, 2018). In Nigeria, cattle have long served as an important meat source, largely under the care of nomadic rearers (*Kabir, Umoh and Umoh*, 2002). Despite being considered the most important source of animal protein, beef meat increasingly occupies a very important consumer space across various communities (*Udoh and Akintola*, 2003). As meat processing large depends on livestock production (*Tambi and Maina*, 2003; *Tambi, Maina, and Bessin*, 2003), the beef (meat) market value continually provides employment to the butchers (*Lawal-Adebowale*, 2012). The cattle used for the beef meat in Nigeria are predominantly Zebu species. Typically, the edible (meat with offals and bones) portions constitute over 70% of a slaughtered cattle carcass

(*Omole and Ogbiye*, 2013). Besides the slaughterhouse serving as the control authority with approved/registered premises for slaughtering and dressing animals such as cattle (*CAC*, 1993; *Bello et al.*, 2015), the direct purpose remains to produce beef (meat), not only through hygienic slaughtering and dressing technique(s) but importantly, through proper, humane handling of the cattle (*Bello et al.*, 2015; *Okpala and Korzeniowska*, 2021; *Veall*, 1992). In addition, slaughterhouse and its regulations are a vital aspect of the control of livestock production chain (*Raji et al.*, 2010). Despite the butchers' capacity to purchase, slaughter, and dress slaughtered (cattle) individually, the design of slaughterhouses should be such to provide the adequate facilities that sustain high-quality hygienic conditions. In many parts of Africa, slaughterhouses function largely under the administrative authority of the districts/local governments/states (*Adeyemo et al.*, 2009; *Aftab et al.*, 2012).

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As a well-established aspect of veterinary public health, meat inspection started with a visual and risk-based focus on contemporary disease panorama. Its epidemiological picture has evolved, such that current (meat) inspection techniques do not easily detect the causative agents of zoonotic diseases like salmonellosis, campylobacteriosis, and yersiniosis. Together with other classical zoonoses, these abovementioned zoonotic diseases appear no longer a significant issue in most developed industrialized countries (*EFSA*, 2011; *Alvseike et al.,* 2018). Among the food safety function of veterinarians, the meat inspection process involves looking closely at the slaughterhouse's live animals (antemortem) and carcasses (postmortem) (*Raheem and Ameen*, 2008). Specific to beef processing, veterinarians usually examine the: head, oesophagus and spleen, lungs and heart, bile duct and liver, and other accessible carcass lymph nodes, diaphragm and kidneys, carcass internal and external surfaces (*The Meat Inspection Process*, 1990). To reiterate, the primary objective of the meat inspection process is to protect the consumer and enhance good animal health/welfare. This usually involves a wide range of measures, not only within the slaughterhouses but also, throughout the meat value chain. The key focus is to reduce
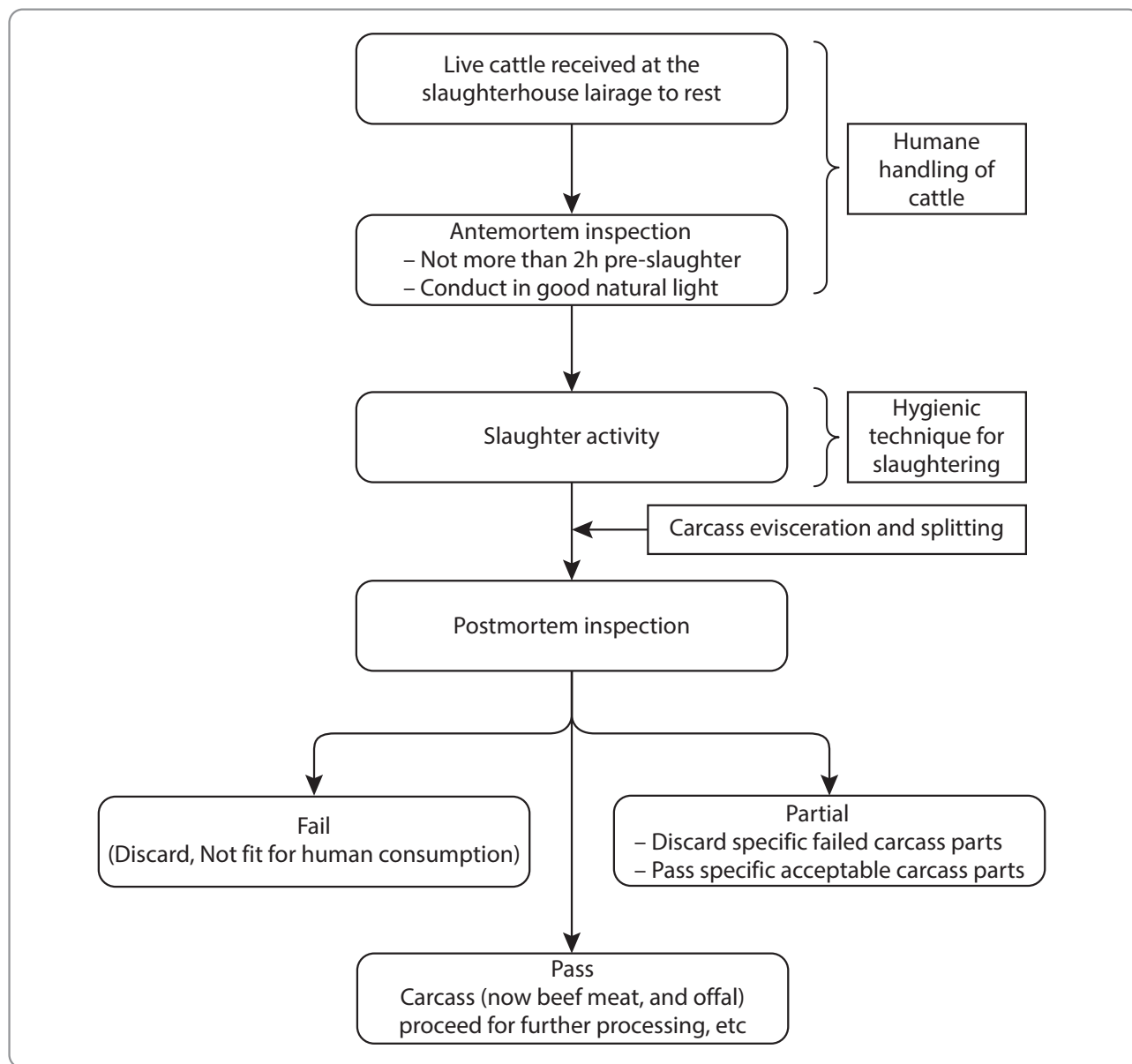

Figure 1. A schematic representation of the basic meat inspection activities involving cattle slaughter in a typical slaughterhouse in Nigeria. Before and after antemortem inspection, the stages involving humane handling of cattle and hygienic techniques for slaughter are shown. Usually, the postmortem inspection would result in three major outcomes to the eviscerated/split cattle carcass/beef meat, which are either fail, partial, or pass.

the foodborne risks to consumers, with great emphasis on the prevention and control of contamination throughout the slaughtering and dressing processes (*Alvseike et al.,* 2018). A schematic representation of the basic meat inspection activities involving cattle slaughter in a typical slaughterhouse in Nigeria is shown in Figure 1. As can be deciphered, the butcher has a number of functions within the slaughter process. Some functions include assembling the live cattle into the slaughterhouse lairage, conducting the slaughter process, carcass evisceration, carcass split into desirable portions, and ensuring the latter are well prepared for sale/storage. The core of (bovine) meat inspection involves two major well-known facets, antemortem and postmortem inspection. The slaughter of cattle, regardless of any slight variations, must involve optimal hygienic techniques. In addition, the postmortem inspection outputs three major judgments: pass, partial, or fail. The importance of the butcher is best appreciated when witnessing the slaughtering activity/process. The differences in butchery practice remain fundamental to dismemberment of the carcass and its surrounding issues (*Seetah*, 2002). Besides acting as buyer to marketing the cattle, the butchers in the various slaughterhouses link both meat production and processing chain (*Musemwa et al.,* 2008; *Prabhakar et al.*, 2017).

Butchers in a typical Nigerian slaughterhouse witness the entire meat inspection process, similar to other cattle-rich nations. In addition, butchers are poised to meet the occupational health and hygiene and infrastructural requirements, in order to comply with the prerequisite food safety standards. Despite this, the meat inspection process can, at times and inevitably, get complicated. Whether the meat inspection procedures were impromptu or prearranged, such complicated meat inspection process situations could pose a wide range of challenges. In such contexts, the considerations of *Prinsen et al.* (2020) would indeed be useful, because when such butcher-meat inspection challenges emerge, there is the need to resolve them very quickly, which could be through either some form of negotiation and diplomacy, or some kind of self-regulation. Therefore, the degree/level of butchers' knowledge and understanding of the meat inspection processes is crucial, if problem-solving approaches were to be established, especially for meat inspection controversies and considering the sensitive nature of the butchers' work. Nonetheless, there is a paucity of relevant literature about what Nigerian butchers know and challenges encountered, especially during cattle

meat inspection processes. Besides, there are a wide range of challenges/problems that butchers and their slaughterhouses encounter. For example, *Adeyemo et al.* (2009) reported the cruel handling of cattle at slaughterhouses in Oyo, Nigeria. Poor sanitation practices in cattle slaughterhouses is not new, and has been reported even in Tanzania (*Komba et al.*, 2012; *Ndalama et al.* 2013). Elsewhere, *Afnabi et al.* (2014) reported on the typology of slaughterhouses in Northern Cameroon, and observed the hygiene practices of butchers, especially during production, involve poor personnel management/treatment processes of carcass.

Besides the challenges/problems butchers confront in their slaughterhouses in many parts of Nigeria, understanding the problems, as well as getting them involved in the problem-solving strategies should be useful. Butchers if encouraged to put forward their suggestions so as to improve the meat inspection process, together with their advice to the veterinarians, can serve as (future) enhancement prospects. Considering all above-mentioned, the authors herein decided to conduct a case analysis of a slaughterhouse in Nigeria, which would help establish what butchers know and understand regarding the challenges encountered during the meat inspection processes. To supplement existing information, this study aimed towards delineating the butchers' knowledge base, challenges encountered, and enhancement prospects for meat inspection processes *via* case analysis of a cattle slaughterhouse at Nsukka urban, considered representative of many others typical in other local governments/states around Nigeria. We hypothesised that the butchers' responses would generate useful information, to help make meat inspection processes less complicated and conflict-free.

Materials and Methods

Schematic overview of case study

A schematic overview of the current study, indicating the development of research instruments, study design, conducted interviews, informal discussions, data analysis, delineating results, and conducting discussions using the available relevant literature synthesis, is shown in Figure 2. Essentially, this specific slaughterhouse was selected because of the important role it plays, from receiving the cattle, slaughter, processing, and packaging, to the eventual beef meat supply to the increasingly thriving Nsukka market situated in Enugu State, Nigeria.

Ethical approval

Ethical approval was not required for the study. Moreover, this study was carried out in adherence to the code of ethics of the World Medical Association Declaration of Helsinki (WMA, 2013). Specifically, informed consent was orally obtained from all butchers who participated in this study. Also, participation was voluntary.

Study area and target population

Well-known as a university town, Nsukka urban in Enugu State, Nigeria is situated at latitude 6° 45' and 7° N and longitude 7° 12.5' and 7° 36' E with an estimated population of about 1.26 million (Nwanta,

Onunkwo, and Ezenduka, 2010). The butchers at the Nsukka slaughterhouse were the target population, who by experience, expertise, and delivery of services, are typically representative of others situated in various communities across their respective local government areas (LGAs) around the country.

Development of research instrument

The research instrument employed for the data collection took the form of a semi-structured questionnaire administered through an interview approach. Specifically, the interview approach was adopted to save time and enabled the butchers to have more time to attempt more, if not all questions, given the nature of their work. The questionnaire
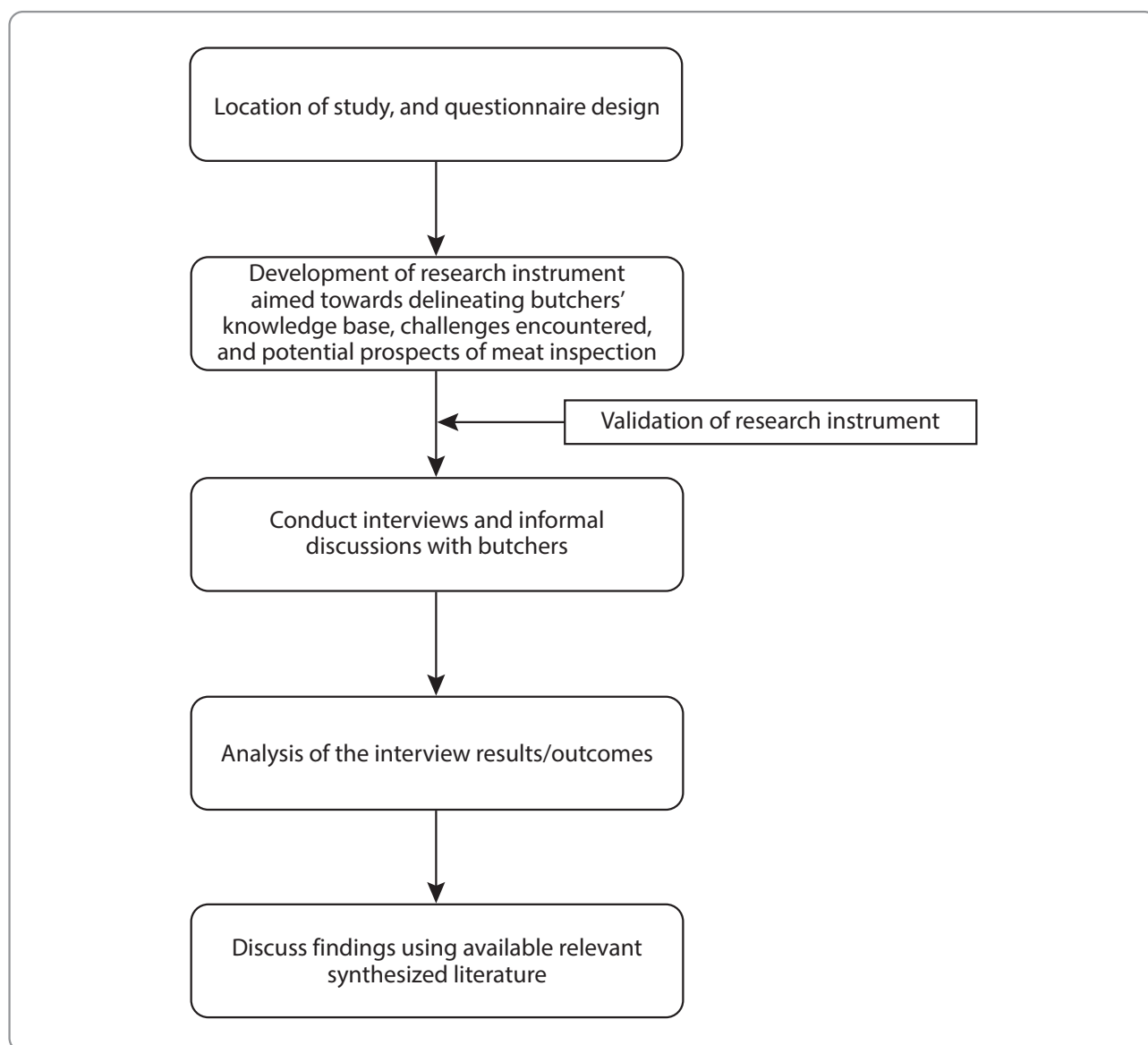

Figure 2. The schematic overview of the current study, from the design of questionnaire, conducted interviews and informal discussions, data analysis, to discussing findings using the relevant synthesized literature.

was developed *via* a combination of synthesized relevant literature and authors' experience/expertise. Content validation was conducted by a specialist veterinarian together with a lead butcher, both with substantial years of cattle slaughter and slaughterhouse experience, when combined. Specifically, content validation, as highly recommended by *Taherdoost* (2016), helps to amend the research instrument questions, with the primary purpose of strengthening their relevance and representation to the target (research) construct as well as the context of the investigated study. During the content validation process, the questions in the research instrument were critically examined based on contents and contexts, and amended where necessary, which altogether strengthened its relevance and representation to the targeted research construct/context of this current case study. Before the research instrument could be administered, it had to be approved by the lead butcher, who represented the Nsukka butchers association.

Questionnaire content and interview process

The questionnaire of this current study can be defined as a semi-structured type. Specifically, the questionnaire content comprised more open-ended rather than closed-structured items. The entire questionnaire presented the following five sections: i) Section A focused on the demographic and work experience/pattern of butchers; ii) Section B focused on the butchers' familiarity with slaughterhouse facilities; iii) Section C focused on the butchers' knowledge base regards the meat inspection process; iv) Section D focused on the butchers' challenges encountered during the meat inspection process, and v) Section E focused on the butchers' suggestions to improve the meat inspection process and engaging with the veterinarians. There were 39 items in total, which were distributed as follows: Section A = 6 items (6 structured questions); Section B = 6 items (4 open-ended and 2 structured questions); Section C = 7 items (6 open-ended and 1 structured questions), Section D = 16 items (8 open-ended and 8 structured questions), and Section E = 4 items (2 open-ended and 2 structured questions).

The entire interview activities were carried out in June 2020. During the slaughterhouse visits, face-to-face interviews were conducted, along with some informal discussions. A total of 54 butchers were interviewed. Each interview started with a brief relay of the study's objective to the butcher before the items in the questionnaire were presented.

The interview was carried out at the convenience of interviewees (butchers) and specifically, in such a way that it assured their anonymity, and encouraged their pro-active participation and willingness to provide information in a non-biased/objective fashion. To ease the interviewee's understanding of questions when difficulties arose, the use of vernacular was applied without any change of both content(s) and context(s) of the specific questionnaire item. This was carried out to enhance the butchers' understanding of the questions, and to prevent the butcher feeling any form/kind of stress, which ensured they were comfortable/relaxed throughout the interview. In addition, the interview process was such that the questions were posed to the butchers, and their responses were simultaneously written down by the interviewer (veterinarian). With this approach, the interview time would be maximized as well as optimized, to note down as much information possible. The interview time was dependent on the availability and convenience of the interviewees (butchers). In the situation where the interviews could not be accomplished/performed on the day, another time was scheduled to the agreement of both parties.

Statistical analysis

All data were subject to the Anderson-Darling normality test, which showed it as non-parametric. The Kruskal-Wallis analysis of variance (ANOVA) test was, therefore, applied to establish whether any statistical difference existed between the response variables. Analysed data were presented in terms of frequencies, percentages, and H-adjusted (H-adj) values. Where correlation was required, Spearman's test was applied and its coefficient (r) was reported. Minitab Express software (version 1.5.3, Minitab Ltd., Coventry, UK) was used to run the statistical analysis. In addition, the open-ended responses were analysed using the word-based technique described by *Ryan and Bernard* (2003). Texts, based on the butchers' responses, were sorted to develop specific statements. The frequency of occurrence was tallied, ranked and reported as percentage. Simple binomial logistic regression was used for some studied variables, to examine whether any relationships existed between any dependent and independent variables. In order to understand the outcomes, the odds ratios and Akaike Information Criteria (AIC) were determined. Specifically, the simple binomial logistic regression of data was run using the R statistical software (RStudio, PBC, Boston USA). The probability of alpha error was accepted at 0.05.

Results and Discussion

Demographics and work experience/pattern

The demographic and work experience/pattern of butchers of the current study is shown in Table 1. The butchers were all (p<0.0001, H-adj.=107.00) male (Freq.=100.0%, n=54). Male-dominated slaughterhouses are not a new phenomenon, as has been reported by other researchers (*Adzitey et al.,* 2018; *Asuming-Bediako et al.*, 2018; *Simpson et al.,* 2011; Simpson *et al.*, 2014; *Voracek et al.*, 2010). Furthermore, significantly more butchers (p<0.0001, H-adj.=28.66) had secondary level education (Freq.=55.56%, n=30), over primary (Freq.=20.37%, n=11) and tertiary (Freq.=11.11%, n=6) education levels. In their study conducted at another location, *Otupiri et al*. (2000) reported butchers had no formal training but acquired their trade exclusively from older colleagues. Previously, *Afnabi et al.* (2014) associated butchers that had primary education with the Knowledge-Attitude-Practice model, which considers the behaviour and practice dependent on the individual's knowledge, together with the new information being acquired. This specific form of knowledge acquisition can directly result in a change of attitude, and consequently, the individual's behaviour. Besides, the current study showed butchers with >5 years' experience (Freq.=66.67%, n=36) were significantly more numerous (p<0.0001, H-adj.=51.56) than those with 1–5 years' (Freq.=29.63%, n=16) work experience. Additionally, butchers mostly (Freq.=66.67%, n=36) (p<0.0001, H-adj.=17.86) indicated the studied slaughterhouse was their first workplace. From these specific butchers (n=36), those with >5 years' work experience (Freq.=48.15%, n=26) were more common (p<0.0001, H-adj.=37.89) than butchers with 1–5 years' (Freq.=16.67%, n=9) work experience. Finally, almost all butchers (Freq.=98.15%, n=53) (p<0.0001, H-adj.=103.11) delivered ≥ 5 days/week work patterns.

Butchers' familiarity with slaughterhouse components

When asked what a slaughterhouse was, almost all the butchers (Freq.=94.44%, n=51) openly responded 'a place where cattle beast brought in for slaughter, and its beef meat subsequently made available for public consumption as well as purchase'. When asked the purpose of slaughterhouse, butchers' (n=53) open responses ranked: to kill/slaughter cattle (Freq.=62.96%, n=34) > to enhance

Table 1. The demographics and work experience/patterns of butchers in the current study

Item	Category	% (n)	H-adj.	P-value
Sex	Male	100.00%(n=54)	107.00	<0.0001
	Female	0% (n=0)		
Educational status	Primary	20.37%(n=11)	28.66	<0.0001
	Secondary	55.56%(n=30)		
	Tertiary	11.11%(n=6)		
Years of work experience as a butcher	<1 year	1.85% (n=1)	51.56	<0.0001
	1–5 years	29.63%(n=16)		
	>5years	66.67% (n=36)		
Is this slaughterhouse your first workplace?	Yes	66.67% (n=36)	17.86	<0.0001
	No	25.93% (n=14)		
If yes, how long have you been here?	<1 year	0% (n=0)	37.89	<0.0001
	1–5 years	16.67% (n=9)		
	>5years	48.15% (n=26)		
Work pattern	<5 days/week	0% (n=0)	103.11	<0.0001
	≥5 days/week	98.15% (n=53)		

Legend: % = Frequency; n=Number of respondents; H-adj.= Kruskal-Wallis H-value; p-value = Statistically significant at p<0.05

slaughtered cattle hygiene/safety, make it free from contamination (Freq.=24.07%, n=13) > to prepare slaughtered cattle and transport to places of consumption/sale (Freq.=11.11%, n=6).

The numbers of butchers familiar (Freq.=48.15%, n=26) or not familiar (Freq.=51.85%, n=28) with slaughterhouse components were not significantly different (p>0.05, H-adj.=0.15). Those familiar with the slaughterhouse components openly responded with examples (where n=number of occurrences of the examples), which ranked: water source (Freq.=20.54%, n=23) > slab (Freq.=16.96%, n=19) > lairage (Freq.=9.82%, n=11) ≈ cold room (Freq.=9.82%, n=11) > drainage system (Freq.=8.93%, n=10) > veterinary office (Freq.=8.04%, n=9) > knives (Freq.=7.14%, n=8) ≈ security office (Freq.=7.14%, n=8) > light (Freq.=4.46%, n=5) > sanitation materials (Freq.=3.57%, n=4) ≈ fireplace (Freq.=3.57%, n=4). Despite their formal educational level/limitations, the knowledge butchers showed about the various components of the slaughterhouse appears very reasonable. Nonetheless, most slaughterhouses in Nigeria are guided by regulatory frameworks of local/state government, with prerequisite standards regarding construction/location, ancillary facilities, procedures for humane slaughter (of cattle), and involvement of personnel, including post-slaughter handling of the beef carcass/meat (*Annan-Prah et al.*, 2012).

Out of those familiar (Freq.=48.15%, n=26) with the slaughterhouse components, almost all (Freq.= 96.15%, n=25) markedly (p<0.0001, H-adj.=43.46) explained the use of either one or more components (where n=number of occurrence of the examples explained) and open-responses ranked: water source (water supply for washing meat, and for cleaning equipment/slaughterhouse environment) (Freq.=24.14%, n=21) > slab (where beef meat is placed, cut/dressed as well as displayed) (Freq.=19.54%, n=17) > drainage system (to ease the discharge/passage/removal of slaughterhouse fluid waste) (Freq.=11.49%, n=10) ≈ lairage: for keeping the live cattle (Freq.=11.49%, n=10) > knives (for cutting (beef meat) and slaughtering {cattle}) (Freq.=8.05%, n=7) > veterinary office (where veterinarians and officials stay) (Freq.=5.75%, n=5) ≈ security office/post (keeping the slaughterhouse safe) (Freq.=5.75%, n=5) > cold room (beef meat storage) (Freq.=4.60%, n=4) > light (to help see properly) (Freq.=3.45%, n=3) ≈ sanitization materials (used in cleaning the slaughterhouse and its environment) (Freq.=3.45%, n=3) > fireplace (for burning debris removed from slaughterhouse, as well as roasting beef meat) (Freq.=2.30%, n=2). Take for instance, the cutting implements, which are considered

very essential in the butchery practice, since their nature and shape determine the technique applied to dismember the cattle (*Seetah*, 2002). On the other hand, given that disease can occur and potentially spread in the slaughterhouse, Raji, Salami, and *Ameh* (2010) emphasized the proper burning of diseased meat as a mandatory as well as recommended practice. The availability of the fireplace in the studied slaughterhouse should, therefore, be a good plus. Additionally, improved slaughterhouses in Nigeria with modern laboratory and cold room facilities would help achieve as well as sustain the wholesomeness of beef meat, which makes it fit for human consumption. The hygiene situation of a slaughterhouse would provide a useful signal about the health status of slaughtered animals. Certainly, sustaining the hygiene situation of slaughterhouses at the optimal level will help reduce the incidence of foodborne disease spread and meat contamination.

Butchers' knowledge base about the meat inspection process

When asked 'what do you understand about meat inspection', butchers' (n=40) responses ranked: when veterinarians check the health status (i.e., any challenging problems in the liver, lungs, etc.) of cattle to be killed/slaughtered (Freq.=31.48%, n=17) ≈ the process to carefully examine the beef meat after slaughter (Freq.=31.48%, n=17) > the process veterinarian employs to check the killed cattle so as to obtain wholesome meat, very safe for consumption, and if bad, to condemn it (Freq.=22.22%, n=12) > when veterinarian checks if the cattle being slaughtered has any infection, sickness or, is just healthy enough for the public consumption (Freq.=11.11%, n=6). Almost all butchers significantly (p<0.0001, H-adj.=99.22) considered the meat inspection 'important' (Freq.=98.15%, n=53). When asked why, butchers' (n=49) open-responses ranked: to check and ensure the beef meat is safe before it is sold to the consumer (Freq.=22.45%, n=11) > to stop the distribution and remove bad (contaminated/diseased/infected) beef meat that should not be consumed (Freq.=20.41%, n=10) > to make sure only quality safe meats of good health status are sold (Freq.=18.37%, n=9) > to detect/identify the foodborne disease and prevent its spread/transmission from cattle to consumer public (Freq.=16.33%, n=8) > if beef meat is not properly checked, the public will consume contaminated beef meat (Freq.=14.29%, n=7) > help to separate off sick cattle that may not be with good/healthy beef meat (Freq.=8.16%, n=4).

When asked which area(s) of meat inspection was/were most important, butchers' (n=25) open-responses ranked: all aspects of meat inspection are important (Freq.=60.0%, n=15) > checking the dead/killed cattle first before the live ones (Freq.=20.0%, n=5) ≈ checking head, liver, muscle, and intestines of slaughtered cattle (Freq.=20.0%, n=5).

Generally, the Nigerian populace believes that butchers know their duties and responsibilities. Butchers, therefore, have to make the best effort to grow their expected and prerequisite knowledge and skills in meat inspection procedures and processes, which they acquire through their routine exposures to pre-slaughter, slaughter, and post-slaughter (cattle) activities. Whereas some earlier slaughterhouse surveys have focused on the entire organs of the animal body, some others have done so only on one or two organs. The incidences of abnormalities obtained in such surveys, even across different geographical locations, have widely varied. Factors like the degree of veterinary inspection/supervision, and the critical appraisal of the identified abnormalities by the person conducting the survey, have affected the findings of such surveys (*Raji et al.*, 2010; *Al-Dahash and David*, 1977; *Okoli*, 2001). In this current study, when asked specifically whether inspecting the cattle either 'before' or 'after' slaughter was more important, the butchers' (n=50) open-responses ranked: 'after' slaughter (Freq.=72.0%, n=36) > 'before' slaughter (Freq.=20.0%, n=10) > both (Freq.=8.0%, n=4). When asked what meat inspection 'before' and 'after' slaughter was called, one butcher came close to calling 'before' a 'physical examination' whereas another was correct to call 'after' as 'postmortem'. However, almost all butchers were unable to name 'antemortem', and 'postmortem' inspection, which should not be surprising. This is because there is published evidence of butchers unable to identify/name essential aspects closely related to the meat inspection process. For example, *Otupiri et al.* (2000) reported that butchers in a Kumasi slaughterhouse in Ghana were unaware of common/frequent foodborne diseases, such as salmonellosis and or anthrax. A way out of this challenge could follow *Raji et al.* (2010), who proffered the need for a committed effort to educate butchers (and cattle traders) thoroughly about meat inspection of cattle. This would help the butchers appreciate the meat inspection process much more. In addition, as butchers have close contact with cattle destined to be slaughtered (*Otupiri et al.*, 2000), their capacity to acquire additional meat inspection knowledge should not be underestimated.

Delineating butchers' challenges encountered during the meat inspection process

An attempt to delineate butchers' challenges encountered during the meat inspection process is shown in Table 2. When asked if they were 'comfortable' with any aspect of meat inspection, the number of butchers who indicated 'yes' (Freq.=46.30%, n=25) did not significantly differ (p>0.05) from those who indicated 'no' (Freq.=46.30%, n=25). The butchers (n=25) who indicated 'yes' to 'comfortable' openly shared their thoughts, which ranked: inspection considered important parts like head, lungs, liver and intestine (Freq.= 56.0%, n=14) > comfortable at all aspects of the meat inspection process (Freq.= 36.0%, n=9) > veterinarians empower the butchers with calmness, confidence, and trust during the meat inspection process (Freq.=8.0%, n=2). When asked if they were 'uncomfortable' with any aspect of meat inspection, butchers who indicated 'no' (Freq.=81.48%, n=44) were significantly more numerous (p<0.0001, H-adj.=42.42) than those who indicated 'yes' (Freq.=18.52%, n=10). The butchers (n=10) who indicated 'yes' to 'uncomfortable', openly shared their thoughts, which ranked: liver if bad signals a big problem because of the anticipated loss (Freq.= 60.0%, n=6) > the manner in which veterinarians speak about the condemned meat oftentimes is not pleasant (Freq.=10.0%, n=1) > there are situations when butchers did not believe the veterinarians (Freq.=10.0%, n=1). Although a significant (p<0.0001, H-adj.=77.64) majority of butchers agreed the inspectors were well engaged during the meat inspection (Freq.=92.59%, n=50) (Table 4), the few who indicated 'no' (Freq.=7.41%, n=4) openly shared their thoughts, which ranked: the veterinarians sometimes make it so difficult to be well engaged with (Freq.= 5.6%, n=3) > veterinarians sometimes do not elaborate on why the meat being condemned is bad (Freq.=1.8%, n=1).

The financial implications of condemned beef meat for the butchers have been well reported (*Antia and Alonge*, 1982; *Halle,* 1998; *Raji et al.*, 2010). A significant (p<0.0001, H-adj.=99.22) majority of butchers (Freq.=98.15%, n=53) agreed that the meat inspection process added value to their profession (Table 4). One butcher (Freq.=1.89%, n=1), who indicated the meat inspection process did not add value, openly shared that the process sometimes confuses them (butchers). Clearly, the butchers greatly depend on the veterinarians, who provide quality checks for the beef meat product and for cattle health status. In this context, butchers (and cattle traders) should be encouraged to seek the assistance of

veterinarians, particularly for their sick cattle, in order to reduce meat contamination (*Raji et al.*, 2010). Besides strengthening how the meat inspection process adds value, butchers of this current study called for a greater well-engaged (meat inspection) process, which would allow veterinarian's decision making to be further explained, considering that the butchers' professional existence equally depends on it. Despite this, the butchers recognize the meat inspection process, either directly or indirectly, provides (some) inspiration and protects their profession.

Significantly (p<0.0001, H-adj=24.81), many butchers appeared not worried about the final outcome of the meat inspection process (Freq.=74.07%, n=40) (Table 4). On the other hand, those who indicated they were worried (Freq.=25.93%, n=14) shared their thoughts, which ranked: destruction of condemned meat (Freq.=7.41%, n=4) > loss of money from condemned meat portions (Freq.=5.56%,

n=3) > personal feeling about (sick) cattle's health when it is condemned (Freq.=3.70%, n=2) ≈ loss of borrowed/loaned funds used to purchase cattle, now condemned, so it is double loss (Freq.=3.70%, n=2). Clearly, the butchers invest a lot into achieving a strong health status for the cattle especially pre-slaughter. It is, therefore, not a good situation when either an animal and/or its beef meat is condemned, based on the inspection verdict of a severe nature infection, which renders the beef meat unfit for human consumption. Such meat inspection outcomes, if not upheld, would definitely lead to public health implications and when upheld, on the other hand, poses immense financial implications for the butchers. A previous report about beef retail in Zaria, Nigeria, indicated the cost of 1 kg of cattle liver, lung, and heart as of 2010 to be around $1. So, if an animal had been struck by disease, and beef meat were to be condemned, one could only but imagine the significant

Table 2. An attempt to delineate butchers' challenges encountered during meat inspection process

Item	Category	% (n)	H-adj.	P-value
Any aspect of meat inspection 'comfortable'?	Yes	46.30% (n=25)	0.00	>0.05
	No	46.30% (n=25)		
Any aspect of meat inspection 'uncomfortable'?	Yes	18.52% (n=10)	42.42	<0.0001
	No	81.48% (n=44)		
Well engaged with vet. officers at meat inspection process?	Yes	92.59% (n=50)	77.64	<0.0001
	No	7.41% (n=4)		
Do vet. officers and meat inspection process add-value?	Yes	98.15% (n=53)	99.22	<0.0001
	No	1.85% (n=1)		
You worry about meat inspection process outcome?	Yes	25.93% (n=14)	24.81	<0.0001
	No	74.07% (n=40)		
Do you see the meat inspection process as time-consuming?	Yes	7.41% (n=4)	77.64	<0.0001
	No	92.59% (n=50)		
Do you have a voice during the meat inspection process?	Yes	83.33% (n=45)	47.56	<0.0001
	No	16.67% (n=9)		
Any other meat inspection process challenges to share?	Yes	9.26% (n=5)	71.04	<0.0001
	No	90.74% (n=49)		

Legend: % = Frequency; n=Number of respondents; H-adj.= Kruskal-Walis H-value; p-value = Statistically significant at p<0.05

financial loss such would bring to the livestock industry (*Raji et al.*, 2010). Besides the clear financial and public health implications, there is also the quality management implication for the beef meat product. If the meat inspection is not thorough enough, the quality management output will be compromised. In the current work, almost all the butchers (Freq.=92.59%, n=50) significantly (p<0.0001,H-adj.=77.64) considered the meat inspection not time-consuming. However, those who indicated the meat inspection was time consuming (Freq.=7.41%, n=4) (Table 4), openly responded that more hands were needed to make the process faster, especially in the situations when increased quantities of cattle were being slaughtered. To reiterate, the meat inspection process requires veterinarians' objectivity, consistency, and thoroughness to assure consumer protection and safety.

Many butchers (Freq.=83.33%, n=45) significantly (p<0.0001, H-adj.= 47.56) indicated they have a voice during the meat inspection process (Table 4). On the other hand, those who believed they have no voice during the meat inspection process (Freq.=16.67%, n=9) openly shared their thoughts, which ranked: veterinarians know better, so we have to adhere to what they say (Freq.=7.41%, n=4) > veterinarians cannot be questioned because they follow well established regulatory framework/guidelines (Freq.=3.70%, n=2) ≈ one cannot do anything about bad/condemned meat, but to discard it (Freq.=3.70%, n=2) > sometimes, the meat inspection process brings fear, and the butcher is unable to do or say anything (Freq.=1.85%, n=1). From these open responses, the butchers believe the veterinarians have a role to play in empowering them to have a voice, especially in the meat inspection process. When asked if there were any other challenges encountered during the meat inspection process, butchers who indicated 'yes' (Freq.=9.26%, n=5) were significantly fewer in number (p<0.00001, H-adj.=71.04) than those who indicated 'no' (Freq.=90.74%, n=49). The few who indicated 'yes' to any other challenges encountered during the meat inspection openly shared their thoughts, which ranked: at times, some beef meat, not entirely bad in our opinion and that ought not to be condemned, is condemned (Freq.=7.41%, n=4) > sometimes, the veterinarian makes the meat inspection procedure very complicated for the butchers to follow/understand (Freq.=1.85%, n=1). Indeed, we can deduce the butchers are strongly attached to both the cattle and emergent beef meat. By streamlining the meat inspection process, the butchers could become more persuaded to accept the eventual decision/outcome reached by the veterinarian(s).

Enhancement prospects for the meat inspection process

When asked if there were suggestions to improve the meat inspection processes, butchers who indicated 'yes' (Freq.=42.59%, n=23) appeared not significantly different in number (p>0.05, H-adj.=1.80) from those who indicated 'no' (Freq.=57.41%, n=31). Some of those who indicated 'yes' openly shared their suggestions, which ranked: the meat inspection process should be a source of encouraging the veterinary officials despite the challenges (Freq.=16.67%, n=9) > the meat inspection process should not only focus on beef meat and cattle but also, the slaughterhouse, its environment, hygiene as well as sanitation (Freq.=7.41%, n=4) ≈ the meat inspection should remain a detailed process especially when there are many (cattle) being slaughtered (Freq.=7.41%, n=4) > the meat inspection process should be consistent throughout, especially in adherence to the established regulatory guidelines/framework (Freq.=3.70%, n=2) > the meat inspection process should enable the veterinary officials to make themselves more accessible and available (Freq.=1.85%, n=1). Clearly, it can be deduced that the butchers herein strongly believe in the meat inspection process, and equally understand that it can be very challenging. Despite this, butchers still desire more from (and beyond) the meat inspection process.

When asked if they had any general advice to the veterinarians, the number of butchers who indicated 'yes' (Freq.=57.41%, n=31) appeared not significantly more (p>0.05, H-adj.=2.35) than those who indicated 'no' (Freq.=42.59%, n=23). Some of those who indicated 'yes', openly shared their advice, which ranked: veterinarians should increase their consistency, diligence and objectivity, with no favouritism during the meat inspection process, for the public good (Freq.=25.93%, n=14) > veterinarians should not be aggressive, but should treat the owner of cattle/beef meat with some regard/respect (Freq.=7.41%, n=4) ≈ veterinarians should find a way to compensate/placate the butchers whose meat has (now) been condemned (Freq.=7.41%, n=4) > veterinarians should see the (meat) inspection process as a means to further educate/equip the butchers (Freq.=3.70%, n=2) ≈ veterinarians should show empathy, especially for the loss borne by the butcher of a condemned cattle/beef meat, and discuss amicably, and calmly (Freq.=3.70%, n=2) ≈ veterinarians should help add to the voice of butchers, especially in seeking the assistance of local/state government towards improving the meat inspection process/slaughterhouse facilities (Freq.=3.70%, n=2). In offering

their advice, butchers herein seem critical and at the same time somewhat objective, yet, cognisant of the importance of the meat inspection process, and desirous to learn more. Indeed, the butchers demand increased empathy from the veterinarians. Essentially, the butchers also believe veterinarians have a crucial role to play, not only in the meat inspection process, but also, in the progress of the slaughterhouse.

Correlation and logistic regression outcomes

The correlation tests can reveal how strongly one variable brings about some change in and or movement of another (*Mat Roni et al.,* 2020). Whether such change in, and/or movement of, is negative (inversely related) or positive (directly related), the correlation tests remain depicted by way of coefficient (r) and probability (p) values (*Okpala and Bono*, 2016). In an attempt to deduce whether butchers' knowledge base is associated with any potential challenges, correlation tests were performed. The correlation coefficients obtained between significant elements of frequent responses from butchers' knowledge base and challenges encountered of meat inspection processes

is shown in Table 3. A total of five positive significant correlations were found. Butchers who indicated 'yes' that veterinarians engaged well, strongly correlated with the meat inspection process (and veterinarians) adding value (r=0.485643, p=0.0002). Interestingly, butchers familiar with and able to explain the slaughterhouse components strongly associated with those who did not worry about the final outcome of the meat inspection process (r=0.316736, p=0.0196). The butchers who indicated 'no' to any aspects of the meat inspection process considered 'uncomfortable', strongly associated with the meat inspection process 'not' being time-consuming (r=0.411262, p=0.0020). The butchers who did not worry about the final outcome strongly associated with the meat inspection process 'not' being time-consuming (r=0.316736, p=0.0196). Unsurprisingly, butchers who indicated the meat inspection process/veterinarians add value to their profession strongly associated with not having any other (meat inspection) challenges to share (r=0.430007, p=0.0012). Moreover, butchers should be considered as full-fledged professionals in their right, despite the rather repetitive and routine nature of their activities in the slaughterhouse.

Table 3. Correlation coefficients obtained between significant elements of frequent responses from butchers' knowledge base and challenges encountered in meat inspection processes.

	A1	B1	C1	C2	C3	C4	C5	C6
B1	−0.038851 [1] 0.7803 [2]							
C1	0.047194 0.7347	−0.065484 0.6380						
C2	−0.080000 0.5653	−0.038851 0.7803	−0.134840 0.3310					
C3	−0.038851 0.7803	−0.018868 0.8923	−0.065484 0.6380	*0.485643* *0.0002**				
C4	*0.316736* *0.0196**	−0.081264 0.5591	0.153106 0.2690	−0.167332 0.2265	−0.081264 0.5591			
C5	−0.080000 0.5653	−0.038851 0.7803	*0.411262* *0.0020**	−0.080000 0.5653	−0.038851 0.7803	*0.316736* *0.0196**		
C6	0.063246 0.6496	−0.061430 0.6590	0.042640 0.7597	0.063246 0.6496	−0.061430 0.6590	0.188982 0.1711	−0.126491 0.3621	
C7	−0.090351 0.5159	−0.043878 0.7527	−0.152286 0.2716	0.153596 0.2675	0.430007 0.0012*	0.102590 0.4604	−0.090351 0.5159	0.028571 0.8375

Legend: [1]Correlation coefficient, [2]Probability Level; *Correlation data (also presented in italics) significantly different at p<0.05; A1 = Butchers familiar with slaughterhouse components and able to explain it; B1 = Butchers who indicated 'yes' to meat inspection as important; C1 = Butchers who indicated 'no' to finding aspects of meat inspection 'uncomfortable'; C2 = Butchers who indicated 'yes' that they were well engaged with veterinarians during the meat inspection process; C3 = Butchers who indicated 'yes' that meat inspection process+veterinarians added value to their profession; C4 = Butchers who indicated 'no' to worrying about the final outcome of the meat inspection process; C5 = Butchers who indicated 'no' to meat inspection process being time-consuming; C6 = Butchers who indicated they have a 'voice' during the meat inspection process; C7 = Butchers who had no other challenges concerning the meat inspection process.

To interpret logistic regression outcomes, and less depend on the probability levels, the use of odds ratios can help to measure the unique effect of predictor on outcome, given its ability to be scaled-up without confrontation of boundary points of between 0 and 1 (Gelman and Hill, 2007). Excluding sex and work pattern, the butchers' years of work experience (<1 year, 1–5 years, and or >5 years) by obtaining a reasonable H-adj value of 51.56, was deemed suitable as the predictor in the logistic regression test. The influence of butchers' years of work experience on the studied meat inspection slaughterhouse variables using simple logistic regression analysis is shown in Table 4. Despite the obtained non-significant (p>0.05) probability results, the butchers' years of work experience produced three odds ratios trends on the meat inspection slaughterhouse (output) variables. Firstly, those who indicated 'yes' to being familiar with slaughterhouse components, are comfortable with aspects of meat inspection, and worry about the final outcome of the meat inspection process obtained similar odds ratios trend (<1 year: odds ratios=1; 1–5 years: odds ratios= >1; >5 years: odds ratios= >1). Secondly, those who indicated 'yes' to considering meat inspection important, and that veterinarians and the meat inspection process add value, obtained similar odds

Table 4. Influence of butchers' years of work experience on the studied meat inspection slaughterhouse variables using simple logistic regression analysis

Variables	Years of work experience	Odds Ratio	Level of Probability*	AIC
Indicated 'yes' to familiar with slaughterhouse components	<1 1–5 >5	1 >1 >1	p>0.05	79.73
Indicated 'yes' to consider 'meat inspection' important	<1 1–5 >5	1 1 <1	p>0.05	17.14
Indicated 'yes' to comfortable with aspects of meat inspection	<1 1–5 >5	1 >1 >1	p>0.05	76.97
Indicated 'yes' to uncomfortable with aspects of meat inspection	<1 1–5 >5	1 >1 >1	p>0.05	58.91
Indicated 'yes' to well engaged with veterinarians at meat inspection process	<1 1–5 >5	>1 >1 >1	p>0.05	28.65
Indicated 'yes' that veterinarians and meat inspection process add value	<1 1–5 >5	1 1 <1	p>0.05	17.14
Indicated 'yes' to worry about final outcome of meat inspection process	<1 1–5 >5	1 >1 >1	p>0.05	68.54
Indicated 'yes' the meat inspection process as time consuming	<1 1–5 >5	1 1 >1	p>0.05	33.12
Indicated 'yes' to have a voice during the meat inspection process	<1 1–5 >5	1 1 >1	p>0.05	55.88
Indicated 'yes' to other meat inspection challenges to share	<1 1–5 >5	1 1 >1	p>0.05	37.01

Legend: Key: AIC = Akaike Information Criterion; *Level of significance set at <0.05

ratios trend (<1 year: odds ratios=1; 1–5 years: odds ratios= 1; >5 years: odds ratios= <1). Thirdly, those who indicated 'yes' to meat inspection process being time consuming, who have a voice during the meat inspection process, and who had other meat inspection challenges to share, obtained similar odds ratio trend (<1 year: odds ratios=1; 1–5 years: odds ratios= 1; >5years: odds ratios= >1).

Moreover, AIC has been deemed useful to determine the authenticity, and validity of regression (models) outcomes, even when the sample size of a given study is small (*Hurvich and Tsai*, 1989). Table 7 shows the AIC value was least (AIC=17.14) for those butchers who indicated 'yes' that veterinarians and the meat inspection process add value, and greatest (AIC=79.73) for those butchers who indicated 'yes' that they were familiar with slaughterhouse components. Through their years of work experience, butchers could develop a better appreciation and understanding about how veterinarians and meat inspection process could add value to their profession. Deducing from *Tyre et al*. (2003), the AIC would be the estimate of constant with the relative distance between the unknown true likelihood function of data, and fitted likelihood function of model, wherein the lower AIC depicted the model considered as closer to the truth.

Limitations of study

In the implementation process of this current work, a number of limitations, in our opinion, were delineated. Firstly, the small sample size of the current study, that is, 54 butchers, as well as that it focused on one slaughterhouse, might be considered a limitation to this study. The small sample size might also limit the detectability of years of work experience predictor to logistically regress any influence on the studied meat inspection slaughterhouse variables. Moreover, there is a possibility that a study investigating the same specific objective, but capturing more butchers, and to a large extent, more slaughterhouses, could provide a different outcome. Secondly, even though the slaughterhouse in the current study resembles others in various LGAs in Nigeria, the discussion herein might not be adequately/fully representative of Nigeria's butchers'/slaughterhouses' circumstances. Nigeria being a multicultural and multi-ethnic nation, both butchers' work terrain and slaughterhouse circumstances in the various local governments would differ. Thirdly, although any conducted meat inspection procedure/process largely coordinated by any veterinarian in Nigeria would

typically adhere to and be consistent with the prescribed format learned through Doctor of Veterinary Medicine (DVM) training as delivered across the veterinary schools, how the butchers associate and connect with one (or more) veterinarian(s) has a fair chance to differ within and across slaughterhouses. Fourthly, there were some questions posed to the butchers that required either 'yes' or 'no'. The butchers providing such answers could be perceived as a limitation. According to *Okpala, Nwobi and Korzeniowska* (2021), such responses might not necessarily reveal the truth. Additionally, the various attributes of knowledge base, challenges encountered, and enhancement prospects of meat inspection process studied herein might be perceived to appear rather preliminary. Howbeit, we hold the opinion that this current work lays a robust foundation for future studies. Considering all the above-mentioned limitations, nonetheless, the database the current study has created serves great benefit to all the involved parties, that is, from butchers, slaughterhouse management, consumers, government/policy makers, to researchers.

Conclusions

Through this current slaughterhouse case analysis, a strong attempt has been made towards delineating the butchers' knowledge base, challenges encountered, and enhancement prospects for meat inspection processes. The butchers, male-dominated, largely secondary level educated with over five years of work experience, delivered mostly ≥5 days/week work patterns. Besides their great familiarity with the slaughterhouse components, butchers undoubtedly know what the meat inspection process entails and appear always prepared for the worst of the outcomes.

Almost all butchers considered the meat inspection important, greatly prioritizing checking and ensuring the beef meat is safe before it is sold to the consumer. Besides some positively correlated variables, the latter obtained resembling odds ratios trends in butchers' years of work experience. Butchers' greatest challenge in the meat inspection process is the fear of losing their beef meat. The meat inspection process requires veterinarians' objectivity, consistency, and thoroughness to assure consumer protection and safety. It is clear the butchers need more help in the meat inspection process so as to become more persuaded to accept the eventual decision/outcome reached by the veterinarians. Despite this, the butchers still believe in the meat inspection process, with the understanding that it is equally very challenging.

The butchers' acceptance of negative meat inspection outcomes could improve if veterinarians engage more effectively. Nonetheless, the butchers desire more from the veterinarians, and beyond the meat inspection process. For instance, they demand empathy from the veterinarians, and to enable butchers to add a voice in order to help improve the slaughterhouse's progress for the public good. Clearly, the repetitive nature of the butchers' daily routines is reflected in their capacity to develop and grow in their profession through years of work experience. The butchers yearn for both local and state governments of Nigeria to fund the improvement of their knowledge base. Additionally, butchers yearn for more cooperation and understanding from veterinarians, especially during the meat inspection processes, so that it becomes less complicated, more motivating, and conflict-free. Future work should be directed on the financial and public health implications of meat inspection outcomes, and this can be achieved through more robust case studies.

Razgraničenje baze znanja mesara, izazovi i perspektive za poboljšanje postupka inspekcije mesa: primer klanice goveda

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A p s t r a k t: Postoji relevantna literatura o onome što nigerijski mesari znaju i izazovima sa kojima se susreću, posebno tokom procesa inspekcije mesa goveda. Mesari, podstaknuti da iznesu svoje predloge za poboljšanje procesa inspekcije mesa, zajedno sa savetima veterinara, mogu poslužiti kao (budući) faktori poboljšanja. Ova studija imala je za cilj da razgraniči bazu znanja mesara, izazove sa kojima se susreću i perspektive za poboljšanje postupka inspekcije mesa, kroz analizu slučaja/primera klanice goveda u Nsukka urbanu, koja se smatra predstavnicom mnogih drugih u Nigeriji. Polustrukturalni upitnik je distriviuran putem intervjua mesarima, ukupno 54 osobe, a vreme intervjua zavisilo je od njihove dostupnosti i pogodnosti. Mesari, muškarci (frekv. = 100 %, n = 54), uglavnom srednješkolsko obrazovani, većina sa> 5 godina radnog iskustva i radnom nedeljom od ≥ 5 dana, bili su vrlo dobro upoznati sa komponentama klanica, jasno su razumeli šta je inspekcija mesa i činilo se da su uvek bili pripremljeni za najgore ishode. Mesari (frekv. = 98,15%, n = 53) su bili mišljenja da je inspekcija mesa važna (p <0,0001, H-adj. = 99,22) kako bi se prioritet dao goveđem mesu i bezbednosti potrošača. Izazovi mesara u postupku inspekcije mesa uključuju strah od gubitka goveđeg mesa ili celog trupa stoke, kao i finansijske implikacije bilo kakvog gubitka. Uprkos nekim pozitivnim (p <0,05) promenljivim vrednostima u korelaciji, kasnije dobijeni slični trendovi odnosa kvota na osnovu radnog iskustva mesara. Prihvatanje negativnih rezultata inspekcije mesa od strane mesara može se poboljšati ako se veterinari efikasnije angažuju.

Ključne reči: rukovaoci mesom; izazovi; higijena mesa; veterinar; korelacija; logistička regresija.

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