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# Quantitative analysis of knowledge, attitude and practice of workers in chicken slaughter slabs toward food safety and hygiene in Ouagadougou, Burkina Faso

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**Introduction:** In low- and middle-income countries, chicken serves as a cheap source of protein and an income source for many households. It is particularly important in the capital, Ouagadougou, Burkina Faso, where chicken is regularly consumed. However, hygiene standards are very low, posing a significant public health risk.

**Methods:** To better understand the food safety situation, we conducted a cross-sectional survey of the hygienic practices of 155 randomly selected chicken slaughter outlets and carcass shops with a semi-structured questionnaire.

**Results and discussion:** Of the outlets visited, 59% are not licensed, and 63% are not regularly inspected, operating in the dominant, largely unregulated informal sector. More than 80% of the chickens are sourced from village production systems, but around 6% of the birds die during transport. The monetary loss due to chicken death during transportation is around four million USD annually. Market hygiene is poor; 86% of the holding pens have no hard floor and are not washed regularly. Almost all (92%) chickens are slaughtered on bare earth floors; bleeding, plucking, and evisceration are done on a wooden table that is rarely washed. On average, the same scalding water is used for 33 birds, seven scalded at a time. Most respondents (49%) thought that plucking and evisceration were the major cause of contamination of carcasses with foodborne pathogens. Most operators only washed their hands and knives with tap water at the beginning of the slaughtering process. Some shops use refrigerators and freezers to store carcasses before selling. However, they store carcasses with other foods like fish, beef and vegetables, facilitating further cross-contamination. There were rats (26%), cats (39%) and dogs (30%) present at outlets, roaming for food, especially roadside outlets. Training schemes on hygienic food handling practices were favoured by outlets as an approach to improve matters; however, improvements in food safety will be limited without significant upgrades in infrastructure and facilities. Slaughter slabs need a standard house with stable energy, adequate airflow, clean water, toilets, detergents and freezers. Also, they need equipment like knives, tables and dishes made of high-quality, easy-to-clean materials.

## KEYWORDS

chickens, food safety, KAP, Ouagadougou (Burkina Faso), slaughter outlets

## 1. Introduction

Foodborne diseases cause a huge global socioeconomic and health burden. Each year one in 10 people get ill from contaminated food, resulting in 600 million illnesses, 420,000 deaths and the loss of 33 million healthy years of life globally, a burden comparable to tuberculosis or malaria (WHO, 2015). In Africa, with the highest foodborne disease (FBD) burden, the 31 foodborne hazards caused 1,200–1,300 DALYs per 100,000 individuals in which nearly 70% of the burden is estimated to be due to non-typhoidal *Salmonella* and Enteropathogenic and Enterotoxigenic *Escherichia coli* (Mensah et al., 2012; Makinde et al., 2020).

The burden of Foodborne diseases in low and middle-income countries is increasing. Besides health impact, food safety has become a precondition for access to global food markets and increasingly for high-value domestic markets in lower-income countries (Hoffmann et al., 2019). In Sub-Saharan Africa, the dominant informal food sector standards are absent or poor, with little regulatory oversight. Although animal products are at higher risk in terms of foodborne diseases, they are vital components of the diets and livelihoods of the undernourished majority across Sub-Saharan Africa. An improved supply of safe foods is needed to improve food security, with processing and slaughter particularly important with a high risk of microbial contamination of meat with feces and dirt or microbes from hands, equipment and surfaces (Roesel and Grace, 2014).

In urban settings, food selection is determined by availability, affordability, nutrition, and convenience (Wong et al., 2017). Chicken meat is widely consumed in Burkina Faso, especially in Ouagadougou, where it is regularly eaten in chicken restaurants (“maquis”), or cooked chicken is taken home, ready-to-eat, at the end of the working day and during celebrations and festivals (Dione et al., 2021). As well as being sold in restaurants, consumers, restaurants and hotels often buy raw chicken carcasses slaughtered and prepared at the market and roadside outlets. However, studies report high levels of bacterial contamination in these settings, with 90% of carcasses contaminated with *Campylobacter* species and 100% of carcass washing solutions being contaminated with *Salmonella* species (Kagambèga et al., 2018).

Previous studies from the same ILRI “Pull-Push project”<sup>1</sup> found consumer concerns about chicken safety (Dione et al., 2021). Disease-causing microorganisms can jump at any stage in the food chain of chicken processing. Among these stages, slaughtering is a key where microbes can be introduced from slaughterers, the environment, working equipment or washing water. Keeping the process hygiene clean at this stage is critical in ensuring chicken safety for consumers. These include clean hands, equipment like knives and containers, clean water, appropriate sanitiser and a clean working environment like a clean table and surfaces can play a paramount role in chicken safety. However, existing standards and practices are poorly described. This information is needed to understand what is required to improve the situation. In light of this, we conducted a quantitative

TABLE 1 Sample size distribution across outlet types.

Market type	Outlet type in the market	Sample size
Outlets with live birds, including those conducting slaughter ( $N = 1,331$ , 107 randomly selected)	Slaughter place in a market	66
	Slaughter place adjacent to the market (but not in the market)	20
	Roadside slaughter place not in or by a market	5
Carcass outlets ( $N = 273$ , 48 randomly selected)	Others	16
	Formal shop/supermarket	48
Total		155

knowledge, attitude and practices (KAP) survey amongst chicken slaughter points and retailers in Ouagadougou.

## 2. Methods

### 2.1. Study design and sampling approach

A cross-sectional survey with stratified sampling was carried out in Ouagadougou, the capital of Burkina Faso. First, chicken slaughter points in Ouagadougou were mapped to create a sampling frame in which the city’s main roads were georeferenced, and a route was defined for trained enumerators. The enumerator then surveyed the route and recorded the location of each eligible outlet. At the end of the mapping, 81 live chicken markets and 273 chicken carcass outlets were recorded. The official list of markets in Ouagadougou was obtained from the municipal authorities to capture more outlets providing twenty-five (25) additional live chicken markets, each with many outlets, giving 106 live chicken markets. All markets with less than two sellers and without slaughtering sites were excluded, leaving 50 markets with 1,331 outlets (including those inside and outside markets). In a separate sampling stratum, there were 273 chicken carcass outlets (shops) with no chicken slaughtering. The inclusion criteria for the sampling frame were that an outlet has to slaughter chickens or at least have a slaughtering place or have to trade chicken carcasses. Based on that, a total of 155 outlets were included (Table 1). Of the 155 outlets included, 65 slaughter chickens themselves, 46 purchase carcasses from other outlets and re-sell them, while the rest 44 were involved in live poultry trading. However, these markets have slaughtering points so that chicken buyers can hire slaughterers and get their chickens slaughtered since there are many slaughter teams in a market. Some outlets have a slaughter team (young men) in which the outlet owner is often involved. Sampling points in the city are depicted in Figure 1.

### 2.2. Survey instrument

A semi-structured questionnaire was delivered using tablets with Open Data Kit by trained enumerators. The survey consisted

<sup>1</sup> Urban food markets in Africa: Incentivising food safety using a Pull-Push approach [www.ilri.org/research/projects/urban-food-markets-africa-incentivizing-food-safety-using-pull-push-approach](http://www.ilri.org/research/projects/urban-food-markets-africa-incentivizing-food-safety-using-pull-push-approach).

of three sections; (1) background information, including demographics, regulatory information and live bird source and trading, (2) process hygiene, including slaughtering, personal and processing practices; and (3) personal knowledge and perception of food safety.

### 2.3. Questionnaire administration

A list of outlets was developed for each enumerator to visit over 21 days (conducted in June 2021). A list of extra outlets was selected and used to replace those who did not consent to the survey. Slaughter outlets were located using GPS information from the mapping exercise and visited. The questionnaire was administered to individuals working at the outlet knowledgeable about chicken slaughter and carcass handling practices.

### 2.4. Data management and analysis

The collected data with ODK-installed tablets were stored in a centralized hub and exported to MS Excel (Microsoft, 2021), cleaned and checked before analysis started. Then it was summarized with descriptive statistics using STATA 14 (STATA, 2016) and the summary of results was presented in tables and graphs.

## 3. Results

### 3.1. Demographics of participants and regulatory information

Of the 155 participants, 128 (82.6%) were males, and most (104/155, 67%) were owners of the outlets. Only six (3.2%) participants had attended food safety related training (Table 2).

TABLE 2 Demographics of participants and outlet/market characteristics.

Background		N	%
Age category	<18	7	4.5%
	19–40	73	47.1%
	41–54	52	33.6%
	>55	23	14.8%
Interviewee role	Owner	104	67.1%
	Employee	32	20.6%
	Owners relative working at the outlet	19	12.2%
Main income source	Livestock keeping	114	73.6%
	Sale of chicken	30	19.4%
	Other	11	7.1%

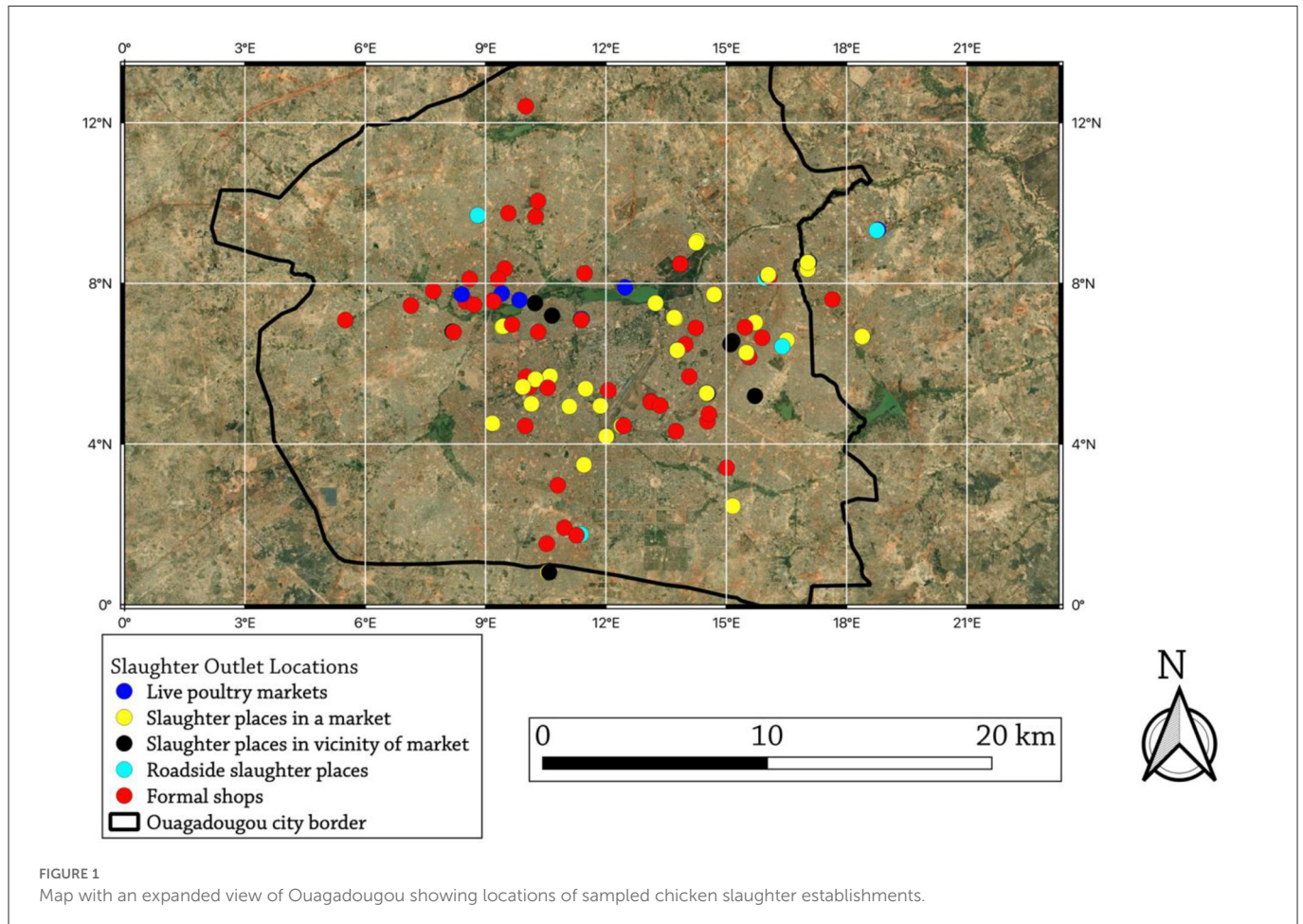


TABLE 3 Regulatory information by type of outlet (N = 155).

Variable	Variable category	Outlet type <i>n</i> (%)					
		Slaughter place in a market	Slaughter place adjacent to market (but not in the market)	Roadside slaughter place not in or by market	Formal shop/supermarket	Others	Total
Gender	Male	62 (40)	18 (11.6)	4 (2.6)	29 (18.7)	15 (9.7)	128 (82.6)
	Female	4 (2.6)	2 (1.3)	1 (0.6)	19 (12.3)	1 (0.6)	27 (17.4)
Licensed to work	Yes	19 (12.3)	2 (1.3)	3 (1.9)	31 (20)	2 (1.3)	57 (3,648, 31.8)
	No	47 (30.3)	18 (11.6)	2 (1.3)	17 (11)	14 (9)	98 (63.2)
Trained in hygiene and food safety	Yes	3 (1.9)	–	–	1 (0.6)	1 (0.6)	5 (3.2)
	No	63 (40.6)	20 (12.9)	5 (3.2)	47 (30.3)	15 (9.7)	150 (96.8)
Regularly inspected	Yes	12 (7.7)	1 (0.6)	1 (0.6)	27 (17.4)	–	41 (26.5)
	No	54 (34.8)	19 (12.3)	4 (2.6)	21 (13.5)	16 (10.3)	114 (73.5)
Regularly sell cooked chicken	Yes	10 (6.5)	–	2 (1.3)	1 (0.6)	–	13 (8.4)
	No	56 (36.1)	20 (12.9)	3 (1.9)	47 (30.3)	16 (10.3)	142 (91.6)
Keep other live animals	Yes	55 (35.5)	9 (5.8)	3 (1.9)	3 (1.9)	10 (6.5)	80 (51.6)
	No	11 (7.1)	11 (7.1)	2 (1.3)	45 (29)	6 (3.9)	75 (48.4)
Keep live chickens for their business?	Yes	61 (39.4)	16 (10.3)	4 (2.6)	3 (1.9)	16 (10.3)	100 (64.5)
	No	5 (3.2)	4 (2.6)	1 (0.6)	45 (29)	–	55 (35.5)

Others are primarily involved in live poultry trading, but they have a slaughtering place near their site so that when a live chicken buyer wants it slaughtered, there are young guys to process the carcass.

TABLE 4 Slaughter outlet information, keeping live birds and other species.

Variable	Variable category	Outlet type					
		Slaughter place in a market (n, %)	Slaughter place adjacent to the market (n, %)	Roadside slaughter place not in or by market (n, %)	Formal shop/supermarket (n, %)	Others (n, %)	Total (n, %)
Slaughter own chickens	Yes	46, 29.7	12, 7.7	5, 3.2	2, 1.3		65, 41.9
	No	20, 12.9	8, 5.2		46, 29.7	16, 10.3	90, 58.1
Sell fruit or vegetables	Yes	1, 0.6			2, 1.3		3, 1.9
	No	65, 41.9	20, 12.9	5, 3.2	46, 29.7	16, 10.3	152, 98.1
Purchase chicken carcasses for retail	Yes	3, 1.9	1, 0.6		42, 27.1		46, 29.7
	No	63, 40.6	19, 12.3	5, 3.2	6, 3.9	16, 10.3	109, 70.3
Slaughter sick chicken and sell the meat	Yes	34, 21.9	9, 5.8	3, 1.9	2, 1.3	–	48, 73.8
	No	12, 7.7	3, 1.9	2, 1.3	–	–	17, 26.2
Holding pen where birds stay before slaughter has a hard floor	Yes	8, 5.2		1, 0.6	–	–	9, 13.8
	No	38, 24.5	12, 7.7	4, 2.6	2, 1.3	–	56, 86.2
Holding pen ever been washed	Yes	2, 1.3				–	2, 3.1
	No	44, 28.4	12, 7.7	5, 3.2	2, 1.3	–	63, 96.9
Source of carcass purchase	Direct from the farm to you	3, 1.9	–	–	4, 2.6	–	7, 12.7
	From another market	6, 3.9	2, 1.3	–	4, 2.6	1, 0.6	13, 23.6
	From a middle man who has kept them for up to a few days	16, 10.3	2, 1.3	1, 0.6	10, 6.5	1, 0.6	30, 54.5
	From a middle man who brings them directly from farm to you	2, 1.3	1, 0.6	–	1, 0.6		4, 7.3
	Other	–	–	–	1, 0.6	–	1, 1.8



TABLE 5 Information on live bird price, health and transport.

Variables	Minimum	Maximum	Most likely (mean)
Sale price of improved live chicken (XOF)	1,982	3,410	2,328
Journey times for live chickens to reach slaughter outlet in hours	7	22	12.5
Percentage of birds that die during transport or within 24 h of arrival	3	12	6
Percentage of birds that die of disease that you own	2	5	2
Percentage of birds that you own become sick or weak but not die	3	9	5
Number of chickens slaughtered per day	31	106	54
Days chickens stay at outlet before slaughter	1	4.5	2

Only 57 (36.8%) participants held a license to trade chicken or an appropriate health certificate, while the rest were not authorized or licensed to work; also, only 41 (26.4%) reported that the authorities regularly inspected them. Outlets that slaughtered chickens kept live chickens for some time [1–5 days, average (mean) of 2 days] before slaughter. Besides, 80 (36.8%) kept other live animals at their slaughter slab or shop (Table 3), most commonly guinea fowl, turkey and ducks (Supplementary Table 1).

Outlet types were stratified by their involvement in chicken slaughter and trade. Based on this, most participants were from slaughter places in the market or adjacent to the market. Of the total outlets visited, 65 slaughtered chicken themselves, 46 purchase carcasses for retail, while the rest, 44, were involved only in live chicken marketing and hence not included in the slaughtering section (Table 4).

Sixty percent of the outlets transported chickens to the place of slaughter by motorbike, with tricycles and wooden cages used by 32 and 30% of outlets, respectively. The mean price of a live bird sold by an outlet is 2,328 XOF, equivalent to 3.5 USD (1 USD = 664.56 XOF as of September 2022 exchange rate); chicken sale prices varied between 1982 XOF to 3410 XOF (Table 5). The journey time from the bird's place of purchase to the outlet where it is slaughtered takes more than 12 h on average (mean) (7 h on the minimum and 22 h on the maximum) with a mean travel distance of 100 km. On average, 6% of the birds die during transport or within 12 h of arrival at their market and more than 3% of the birds become weak or sick after arrival (Table 5). Chickens typically stay at the outlet for 2 days before slaughter. From the 155 outlets, 65 (42%) slaughter chickens themselves, while 46 (30%) obtain carcasses from other slaughter slabs. The rest, 44 (28%), were involved only in live chicken trading but not slaughtering and carcass trading. On average, they slaughter 54 chickens per day (31–106). The majority (73.8%) (48/65) of outlets slaughter birds even if they are sick. They use various medicines to treat sick birds. Among the common medicines, antibiotics 30% and vitamin 10% are their favorites to treat sick birds (Table 6).

## 3.2. Process hygiene (hygienic practices from slaughter to sale of chickens)

### 3.2.1. Chicken slaughter

Sixty/sixty-five (92%) of the participants slaughter chickens on a bare earth floor (Table 6). Most slaughter slabs bled birds on the floor or in barrel containers (Figure 2A). The bleeding surfaces were mainly made of metal, plastic, or bare earth (Figure 2B). Most

respondents said they dispose of blood and blood washings on-site or throw them away on the floor without proper disposal.

### 3.2.2. Scalding, plucking and evisceration of chickens

On average, 33 birds use the same scalding water, while seven birds are scalded at once in the scalding tank. The scalding water is changed once a day at most outlets. Outlets estimated that 25 L of water is used in the scalding tank; on average, nearly 20 outlets share the slaughtering site. Most of the respondents use a table as a plucking surface 48 (73.8%), which is made of wood 53 (70.7%) (Table 6). After removing the feathers (plucking), most slaughterers (23%) dispose of them in a bin or dump them, e.g., on the street or in the market (20%) or a combination of the two (17%) (Supplementary Table 3).

### 3.2.3. Cross-contamination sites

After plucking, the next stage in carcass processing is evisceration. Most respondents (49%) do pluck and eviscerate in the same place; scalding and plucking were done at the same location in 12.3% of outlets. Among the concerning practices reported in this study was that 50% said that they just drop solid slaughter and processing waste on the ground, followed by outside the market and down the drain (Table 7).

### 3.2.4. Equipment, hand washing, and waste disposal

Most 22/65 (33.8%) of the respondents wash knives at the beginning of slaughter and the end of the day, while some 6/65 (9%) wash after each batch of chickens. A quarter of slaughterers wash their hands at the end of slaughtering, with fewer washing at the start (16%) (Supplementary Table 3). Most respondents (31%) use tap water to wash knives, followed by carcass rinse water (15.4%) and then store wash water (17%). Most respondents (52%) said they throw solid slaughter waste outside the market (not in a specified waste disposal site). Only seven (11%) prepare the waste material to be taken by waste collection services (Table 7).

### 3.2.5. Carcass purchase and sale

#### 3.2.5.1. Carcass purchase

Sixteen percent of outlets sell frozen chicken. For shops that purchase, freeze and resell carcasses, the mean transport time from

**TABLE 6** Slaughtering, plucking and surface type and materials used to construct the surface ( $N = 65$ ).

Surface type per slaughter stage	Materials to make the surface	$N$ (%)
Slaughter surface type	Floor	60 (92)
	Table and other	2 (3)
	Table	1 (2)
	Other	2 (3)
Materials used to make the slaughter surface	Bare earth	50 (77)
	Others	8 (12)
	Wood	4 (6)
	Non-corrosive metal (stainless steel or aluminum)	1 (2)
	Bare earth and Wood	1 (2)
	Non-corrosive metal	1 (2)
Chicken plucking place type	Floor	48 (73.8)
	Wood	4 (6)
	In a basin	4 (6)
	Table and other	3 (4.6)
	Table, in basin and floor	3 (4.6)
	Other	3 (4.6)
Material types used to make plucking surface	Wood	52 (80)
	Metal	7 (11)
	Plastic	4 (6)
	Bare earth	2 (3)
Evisceration place type	Table	54 (83)
	Table and a basin	4 (6)
	Basin	3 (4.5)
	Other	3 (4.5)
	Floor and table	1 (1.5)
Material types used to make evisceration surface	Wood	54 (83)
	Others	4 (6)
	Metal and plastic	3 (5)
	Plastic and wood	2 (3)
	Plastic	2 (3)
Medicines use to treat sick birds ( $N = 100$ )	Antibiotics only	22 (22)
	Vitamin	4 (4)
	Antibiotic and antiparasitic	4 (4)
	Antibiotics and vitamin	4 (4)
	Do not use medicine	66 (66)

place of purchase to their shop was 30 min. On average, they sell 77 chicken carcasses per week. They keep frozen chicken carcasses for about 35 days before selling them (Table 8).

Only 22% said carcasses are individually packed when receiving them (Table 9). They use plastic bags followed by sacks and cardboard boxes to transport carcasses to households and street restaurants (“maquis”) (Figure 3A).

Only 40% of the participants said they washed carcasses before selling. Most respondents put the carcass on a wooden table before and after washing. They use the main water supply to wash the carcass. Carcasses are typically stored in refrigerators or freezers if kept for a prolonged period (37 and 35%, respectively). However, they keep fish and other meat together with the chicken carcass in the same refrigerator/freezer, and power cuts are frequent (Table 9).

### 3.2.5.2. Carcass sale

Households are the leading customers of fresh chicken carcasses. Local breeds are the most commonly sold frozen chicken type, followed by imported broilers and locally reared improved breeds. Furthermore, households are the leading buyers of frozen chicken, followed by restaurants. Most (70%) of outlets said there is no refrigerated transportation mechanism for carcasses; 54% of the respondents said that carcasses come in contact with other carcasses during transportation (Table 9).

### 3.2.5.3. Hygiene at retail shops

Out of the 46 carcass retailers, 17 (37%) wash carcasses immediately after receiving them, washing on-average 20 carcasses at a time. The majority (61/155, 39.5%) of the respondents frequently wash their hands with soap. However, 3% of participants admitted they never or rarely wash their hands (Figure 3B).

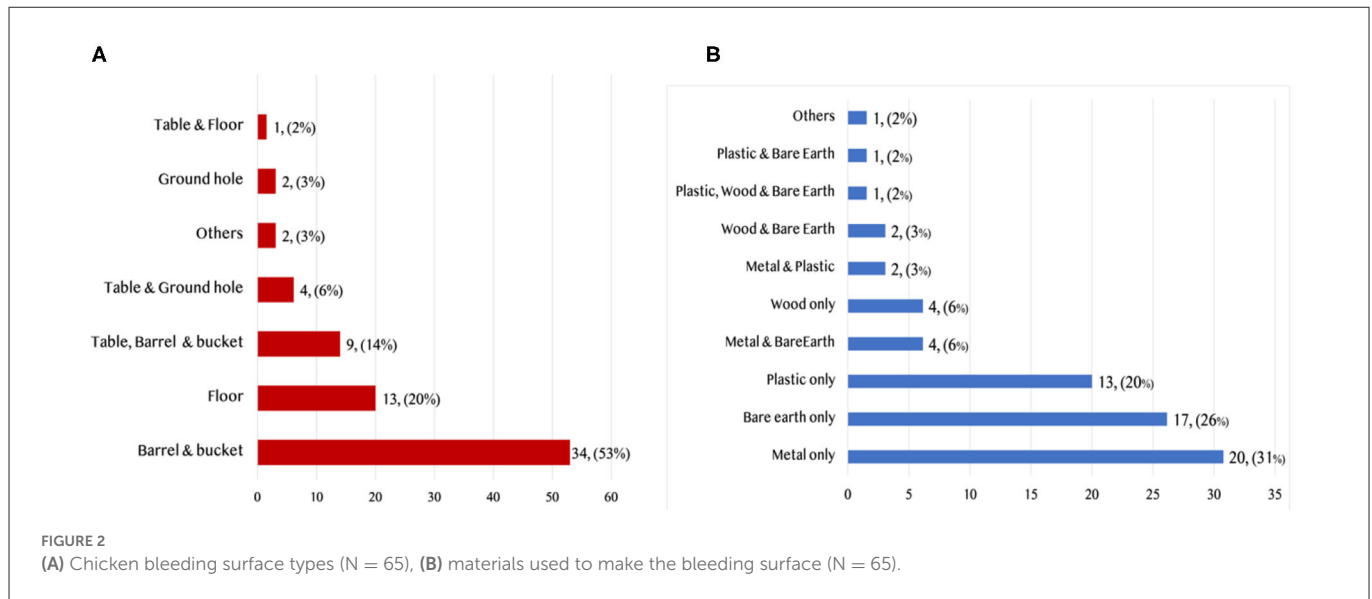
### 3.2.6. Contamination

There were rats, cats and dogs roaming around certain outlets searching for food; from roadside outlets, 40/155 (26%) reported rats, 61/155 (39%) reported cats, and 47/155 (30%) reported that most of the time dogs will come close to food preparation surfaces. However, only 17, 17, and 10% have control measures for these pests, respectively. Poisons are the most common control method, followed by traps and other approaches like covering the carcasses tightly to prevent access. Also, they use fly sprays and other insect killers (Table 10). However, slaughter places in the market were free from rats, cats and dog visits, with zero reports of these animals from the informants (Supplementary Table 4).

Interviewers observed several animals during their visits. Among the animal species observed, sheep, cats, dogs, and goats were most often seen wandering around the outlets. Most informants had access to toilets and water, often in the market or a public toilet; 63% reported the toilet was adequate and 85% reported they had access to water at the toilet (Table 10).

## 3.3. Food safety perception and knowledge

Ninety percent of interviewees stated that they had not heard of food poisoning incidents from chicken consumption and knew that temperature is important for the safety of carcass storage. Furthermore, 98% know water hygiene is important for food safety (Figure 4).



**TABLE 7** Cross-contamination possibilities through multiple steps performed at the same point, equipment washes and waste disposal methods (N = 65).

Questions	Response categories	N (%)
Cross-contamination (activities done at the same point)	Plucking and evisceration	32 (49)
	Scalding and plucking	8 (12)
	Scalding and evisceration	6 (9.2)
	Scalding, plucking and evisceration	19 (30)
Solid slaughter waste disposal places	Outside market	34 (52)
	Taken by waste collection service	7 (11)
	Throw outside market or taken by waste collection service	5 (7.7)
	Throw in the market	3 (5)
	Throw in pond or lake	2 (3)
	Combination of all the above	14 (21)

**TABLE 8** Information on frozen carcass transport and selling.

Variables	Most likely	Minimum	Maximum
Carcass transport time in minutes	32	26	64
Number of carcass purchases per week	77	50	122
Carcass storage days before selling	36	11	82

### 4. Discussion

Chicken is a highly consumed animal source of food in Ouagadougou, Burkina Faso. However, the hygienic practice in slaughtering outlets and carcass shops is very poor (Figure 5). Among the risky sanitary practices and perceptions observed in this study,

most participants were not licensed to work and were not regularly inspected by authorities; almost all workers have no training on food safety and related topics. Most outlets keep live chickens and other birds like guinea fowl, turkey, and ducks in and around outlets. Also, rodents and other mammals, such as cats, dogs and goats, many stressed and in poor health, are near food preparation areas creating a favorable environment for disease transmission. The house where birds stay before slaughtering is rarely washed or sanitized, exacerbating risks of transmission of zoonotic disease pathogens like avian influenza that could affect people and birds. The unhygienic handling practices in live markets before slaughtering can be a hotspot for the possible emergence of new pathogens that can cause local or global pandemics unless there is improvement in housing, marketing and transportation of birds in the city.

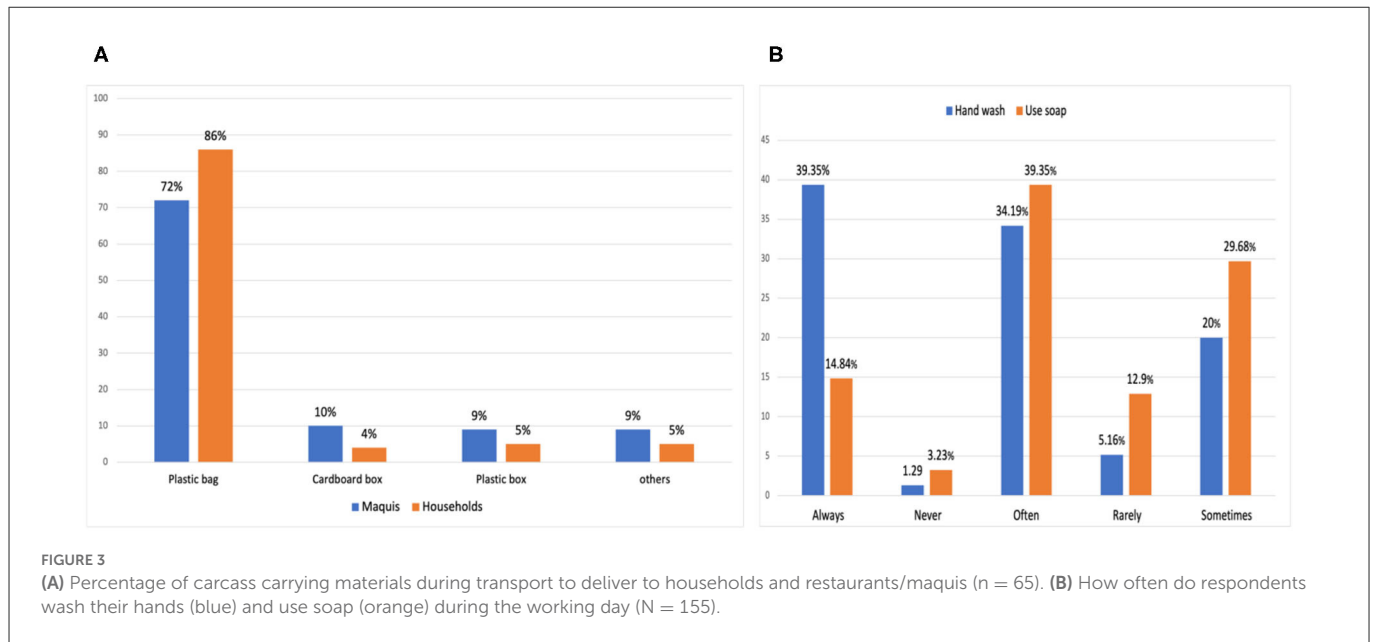
Various studies in chicken slaughtering, processing, and consumption in sub-Saharan African countries indicated below-standard chicken handling practices, in line with this study. [Ovai et al. \(2022\)](#) reported in Gahanna that consumers transport chicken meat with other items, store it in the same refrigerator, and have low hand and equipment washing habits. [Birgen et al. \(2020\)](#) have also discussed that chicken consumers in Kenya had a medium hygienic practice level. Also, many similar unhygienic practices were reported in street-vended chicken, and loads of bacterial contamination of chicken carcasses were found to be high due to poor handling practices. Also, the presence of pests and flies, contaminated vending places, lack of appropriate clothing and the use of unclean water to wash carcasses are the main malpractices that are causing cross-contamination in chicken slaughtering, vending and consumption chains ([Hessel et al., 2019](#); [Mpundu et al., 2019](#); [Musawa et al., 2020](#)).

Most slaughter outlets get chickens from local markets. On average, chickens travel more than 12 h to reach the city’s market. During transportation, a large number of birds die due to stress-associated diseases. The mode of transport of the chickens to the slaughter point with birds hung together from motorbikes or other vehicles not only stresses the birds but also contributes to increased pathogen shedding and animal suffering; the close contact between the birds increases cross-contamination with fecal microbes such as *Campylobacter* species ([Neri et al., 2019](#)). Also, long-distance



TABLE 9 Carcass storage, packaging, transport means and storage surfaces before and after washing and storage facilities.

Items/questions	Response category	N	%
During transport, carcasses are packed in	Plastic bag and Sac	13	28.3
	Plastic bag	8	17.4
	Cardboard box	6	13.0
	Others	5	10.9
	Sac and card box	4	8.7
	Sack	3	6.5
	Plastic bag and card box	3	6.5
	Sack and plastic box	1	2.2
	Sac plastic box and card box	1	2.2
	Sac and other	1	2.2
	Plastic box and other	1	2.2
Carcasses are individually packaged when you receive them	Yes	10	22
	No	36	78
Outlet sells frozen chicken	Yes	25	16
	No	40	84
Wash chicken carcasses after purchasing them	Yes	18	39
	No	28	61
Carcasses placed temporarily before washing	Table	45	54.2
	Container	26	31.3
	Table and container	9	10.8
	Other	2	2.4
	Floor	1	1.2
Carcasses placed temporarily after washing	Container	35	42.17
	Table	28	33.73
	Floor and table	13	15.64
	Floor	2	2.41
	Floor and other	2	2.41
	Table and others	2	2.41
	Other	1	1.2
Carcass washing water sources	Main water supply	79	89.8
	Borehole	4	4.5
	Rainwater collection	3	3.4
	Spring/well	2	2.3
Chicken carcass storing facilities	Refrigerator	17	37
	Freezer	16	35
	Refrigerator and freezer	12	26
	Refrigerator, freezer and open-air at ambient temperature	1	2
Other foodstuffs stored with chicken	Fish	20	76.9
	Other meat	4	15.4
	Other	2	7.7



transportation is associated with an increased mortality rate of birds (Caffrey et al., 2017; Dos Santos et al., 2017, 2020). Around 6% of the birds die during transport or within 24 h of arrival. To have an intuitive of the loss due to death, we used a simple calculation to estimate the amount of the monetary loss in the city alone. According to Somda et al. (2018), 50,000 chickens are consumed daily in Ouagadougou. Eight per cent loss of this amount is around 3,000 chickens with an average estimate of chicken price of 2,328 XOF per bird; the daily loss in the city is XOF 7 million per day, equivalent to more than four million USD per year that instead have to contribute to the national economy. Not all of this loss is preventable—but it can easily be reduced with better transport, which will also reduce cross-contamination of birds with FBD pathogens like non-typhoidal *Salmonella* and *Campylobacter*, reduce stress which precipitates pathogen shedding and improve animal welfare.

If a bird is diseased during transport, they administer medications like antimicrobials, vitamins and antiparasitic drugs at the site. Inappropriate antimicrobial use without considering the withdrawal period poses a significant public health risk in terms of drug residue. Studies indicated that tetracyclines, aminoglycosides and fluoroquinolones are commonly used antimicrobial classes to treat various diseases in poultry in sub-Saharan Africa (Azabo et al., 2022). Various organisms that have veterinary and public health importance have been reported to develop antimicrobial resistance to these drugs mainly due to irresponsible use (Economou and Gousia, 2015). There were numerous diabolical practices with little to no concept of hygiene. Many outlets slaughter and sell sick chickens, a practice that poses significant risks to consumers. Food preparation surfaces were not food-grade; if they were cleaned, mostly they were not, they would still harbor high microbial loads. When there is cleaning, they rarely use detergents. Tap water alone will not eliminate microbes at an acceptable level. Strong detergents that have low residual risk to public health, like Lactic Acid, Acetic Acid, and Trisodium Phosphate sprays, must be used to

effectively kill most pathogens from the surface, utensils and meat (Sallam et al., 2020; Nkosi et al., 2021).

Almost all of the tables used to slaughter, bleed, scald, and eviscerate chickens were made of either bare earth or wood. Many stages of slaughter and dressing, such as plucking and evisceration, were conducted in the same place or by the same person, with no cleaning of surfaces, equipment or hands. Slaughtering and dressing are the main sources of contamination (Althaus et al., 2017; Emanowicz et al., 2021). Plucking, which is removing the feather, can contaminate the worker's hand and, when done together with evisceration, can contaminate the carcass. Scalding and other activities should be segregated from evisceration to reduce cross-contamination because most contamination with pathogens like *Salmonella* spp., *E. coli* and *Campylobacter* species are introduced at the evisceration stage (Mpundu et al., 2019; Zeng et al., 2021). On average, twenty outlets share the same scalding water. Mixing different chickens will promote cross-contamination between birds, and the non-standardized approach to heating the scalding water would not ensure a consistently high temperature that would inactivate microbes. Certain disease causing agents are known to spread in scalding tanks unless additives are used to sterilize the water (Projahn et al., 2018; Mpundu et al., 2019). Scald additives like sodium hydroxide significantly reduce the bacterial load by creating an unsuitable alkaline environment in the tank, which must be practiced in slaughtering outlets visited and elsewhere (McKee et al., 2008). Most workers wash their hands and knives at the beginning of the day with only tap water, contributing to massive cross-contamination. Given the tenacity of some microbes, tap water alone cannot eliminate all pathogens unless standardized detergents are used. There was also an issue of environmental contamination with blood and feathers dumped near the site or in the market, exposing the public and animals to diseases and attracting vermin. Humans and free-ranging urban livestock can get infected from the inappropriately disposed waste and keep the disease transmission cycle alive (Cook et al., 2017).

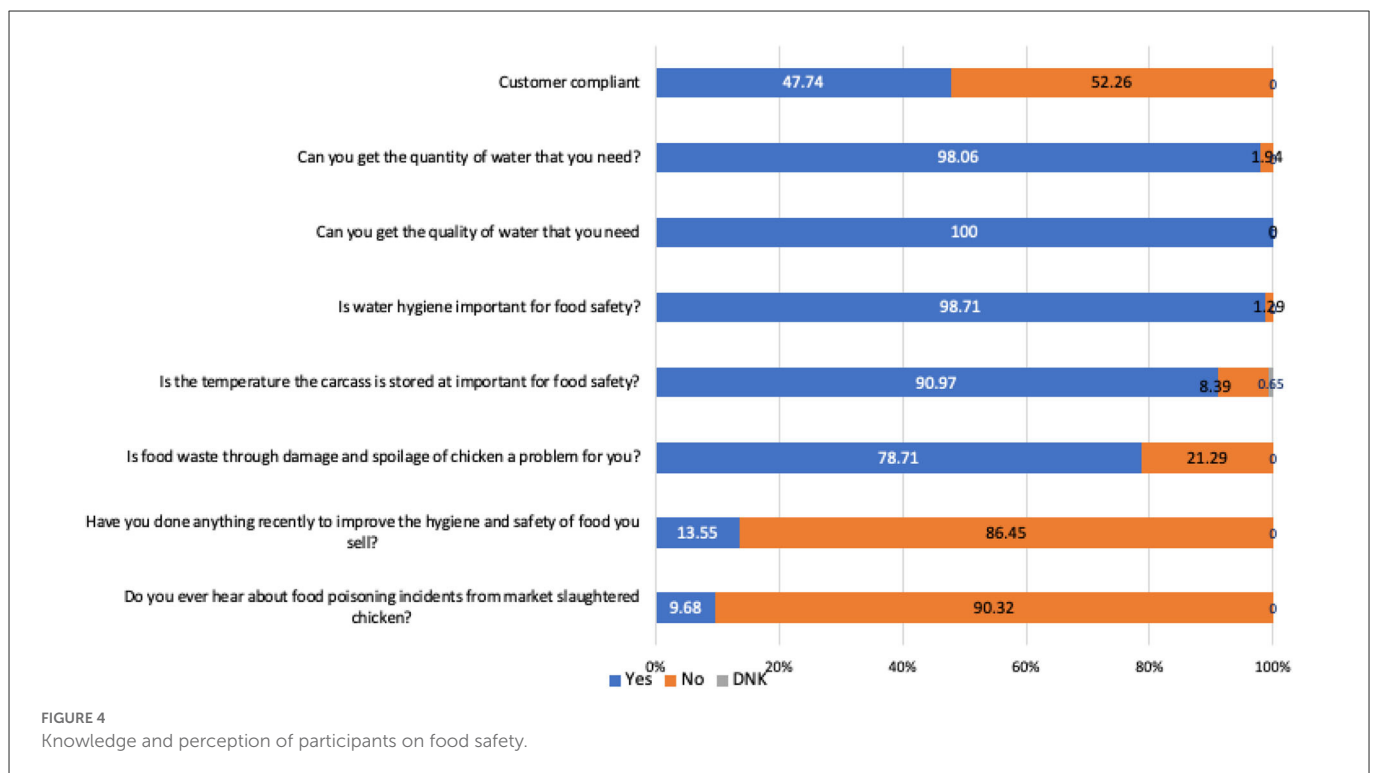
TABLE 10 Carcass contact, frequency of using refrigerator, animal control methods, and animals observed during the interview.

Questions	Response categories	N	%
Carcasses' physical contact with other carcasses	Never	3	12.5
	Rarely	2	8.3
	Sometimes	2	8.3
	Often	4	16.7
	Always	13	54.2
Carcasses refrigerated during transport	Never	17	70.8
	Rarely	2	8.3
	Often	3	12.5
	Always	2	8.3
<b>Animal control method</b>			
Rat ( <i>n</i> = 27)	Rat poison	14	51.9
	Trap	10	37
	Other	3	11
Cat ( <i>n</i> = 27)	Rat poison	13	48
	Trap	9	33
	Other	5	18.5
Dog ( <i>n</i> = 17)	Rat poison	3	23.
	Trap	3	23
	Other	7	53.85
Fly ( <i>n</i> = 36)	Fly spray	15	41.7
	Other insect killers	19	52.8
	Fly tape	2	5.6
Animals observed during the interview wandering around the outlet	No animals observed	69	44.5
	Sheep	21	13.6
	Cat and dog	18	11.6
	Dog	8	5.2
	Goat	8	5.2
	Cat	7	4.5
	Sheep and goat	8	5.2
	Cat, dog and pig	3	2.6
	Wandering hens	3	1.9
	Combinations of the above animals	9	5.8
Toilet place used by the outlet workers	Market or public toilet	63	41
	Others private toilet	33	21
	Private toilet at stall/shop	29	19
	Outside (open air)	14	9
	Another private toilet	14	9
	Private or public	2	1
Action when a worker has stomach upset (e.g., diarrhea)	Do not go to work	52	34
	Wash hands more thoroughly	45	29
	Wash hands more thoroughly and minimize handling of produce	28	18

(Continued)

TABLE 10 (Continued)

Questions	Response categories	N	%
	Do not go to work, wash hands more thoroughly and minimize handling of produce	22	14
	Minimize handling of produce	6	4
	Do not go to work and other response	2	1
Toilet reported as adequate	Yes (%)	98	63
	No (%)	57	37
Water is available	Yes (%)	132	85
	No (%)	23	15
Have to pay for toilet	Yes (%)	78	50.3
	No (%)	77	49.7



From chicken carcass shops visited, a limited number of the outlets receive individual-packed carcasses, while most receive carcasses mingled. After receiving, less than half of the outlets wash before selling, contributing to cross-contamination between carcasses from single or multiple sources. They keep the cold chain by storing the carcass in refrigerators and freezers but with other foodstuffs, which can cause cross-contamination among foods. Even though cooking may kill most organisms, cross-contamination will happen without proper storage protocol. Rodents and pests could access food storage and preparation areas. Unhygienic and unmanaged places are likely to be visited by animals and insects carrying nasty zoonotic pathogens. The first line measure must manage the outlet by making it neat and hygienic, which is unfavoured by rodents and flies. However, they prefer to use unsafe approaches like poisons and insecticides, increasing the public health risk with active poisoning and long-term residual effects.

Although many described toilets as adequate, they are, in fact, little more than holes in the ground that are not cleaned, and given that most have to pay to use these toilets, open excretion is likely. Clean water with detergents is definitely among the easiest yet most effective measures to reduce foodborne diseases, but water is not available in most toilets, contributing to the poor hygiene of the working environment of the outlets. 34% do not go to work when workers feel sick, which is good practice. However, a significant number (29%) continue to work, posing risks to consumers through contamination with pathogens the sick worker may be shedding, which is exacerbated by the shortage of clean water in most outlets.

Even though most food safety practices were exceptionally poor, participants had some knowledge of basic food safety and hygiene requirements. They understood the importance of the cold chain, although carcasses were often kept at ambient temperatures. Chicken eaten in restaurants is typically thoroughly cooked, killing foodborne



FIGURE 5

Typical carcass processing work environment. (As it can be observed from the picture, the working area has substandard hygiene levels; worker is not properly dressed (at least no gloves, shoes and mask), and the table is unclean and messed with different equipment and garbage. The washing water is not changed with an imminent probability of contaminating the carcasses. The ground is polluted and contaminated with visible dirt).

microbes. Given the poor upstream hygiene, this microbial kill-step before consumption is critical. However, massive microbial loads will be introduced into the food preparation area on the carcass, contaminating other foods stored or prepared with the chicken, such as salads commonly eaten with chicken. Cooked carcasses may also become re-contaminated through unwashed hands, utensils and surfaces. This is a problem in homes, where preparation practices will be highly variable, and children, the most vulnerable to foodborne disease, routinely eat at restaurants, where food poisoning can impact many customers.

Low income and lack of resources could account for the poor standards. However, some improvements could be made with little to no investment, such as processing in sequential, linear steps with separation of clean and dirty areas and wiping clean surfaces. However, the impact of such measures on food safety may be limited, given the lack of food-safety prerequisites, such as clean water, pest control, and clean and cleanable environments. Given that preventing cross-contamination of cooked and ready-to-eat food prepared at home and in restaurants and adequate cooking of meat are the main control points that will limit the impact of poor hygiene upstream, it is advisable to promote awareness of measures to ensure appropriate practices at these control points. The focus on reducing this risk is not on what the average person does but on reducing the percentage that does not apply appropriate measures or utilize particularly hazardous approaches.

## 5. Conclusions

Massive and preventable loss of birds was observed, through poor handling and transport, resulting in undue economic loss for the outlet and supply chain, and appalling animal welfare, in turn exacerbating zoonotic disease risks, including foodborne. Concerning food safety, standards are so poor and infrastructure so limited that major improvements would require massive investment to improve facilities and train slaughterers and other value chain actors, combined with an appropriate level of regulation. There are,

in fact, many stages that intervention can be done to safeguard consumers from foodborne illnesses. The easiest and possibly cheapest measure can be awareness creation for workers because most faulty practices can be reverted with simple educational campaigns. Importantly there needs to be much greater consumer awareness of the dangers of eating unhygienically prepared food. This may create consumer demand for safer food, with market forces beginning to drive improvements and sustaining investments in improved food safety and infrastructure.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

AA: cleaned the data, performed analysis, and wrote the manuscript's draft. MD: developed survey tools and supervised the surveys. GI: trained enumerators and supervised and conducted the surveys. VL: trained enumerators and conducted the surveys. BG: participated in data analysis and commented on the first draft of the manuscript. DG: conceptualized the project. TK-J: conceptualized and supervised the overall project. All authors contributed to the article and approved the submitted version.



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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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