

Food Safety Perceptions and Practices among Smallholder Pork Value Chain Actors in Hung Yen Province, Vietnam

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ABSTRACT

Pork safety is an important public health concern in Vietnam and is a shared responsibility among many actors along the pork value chain. We examined the knowledge, perceptions, and practices regarding food safety, disease, and health risk among selected pork value chain actors (slaughterhouse owners and workers, people living around slaughterhouses, pork sellers, consumers, and veterinary and public health staff) in three districts in Hung Yen Province, Vietnam. We randomly selected 52 pork value chain actors to be surveyed through questionnaires, observation checklists, key informant interviews, and focus group discussions. Most slaughterhouse workers acquired knowledge and experience of food safety through “learning by doing” rather than from training by a veterinary or public health professional. Both slaughterhouse worker and pork seller groups had some accurate perceptions about pig diseases and foodborne diseases; however, misperceptions of risk and, especially, of zoonoses were present. Furthermore, while workers and sellers often use cloths to dry the meat and clean equipment, they did not think this was a risk for meat contamination. Moreover, when sellers wear protective equipment, such as gloves, masks, or hats, consumers perceive that the sellers may have health issues they are trying to conceal and so consumers avoid buying from them. The perceived freshness of pork, along with trust in the seller and in the pork production process, were strong indicators of consumer preference. And yet, pork value chain actors tend to trust their own individual food safety practices more, rather than the practices of other actors along the chain. Veterinary and public health staff emphasized the gap between regulations and food safety practices. Education and training on food safety risks and proper handling are priorities, along with integrated and intensive efforts to improve food safety among pork value chain actors.

Key words: Food safety; Perception; Pig slaughterhouse; Pork; Practice; Vietnam

Food safety is an important public health concern worldwide, especially in emerging economies. In Vietnam, pork safety is of great concern to both consumers and policymakers and is a frequent topic in the media (1, 31, 32) and in policy discussions (8, 33). In 2015, pork consumption (per capita) in Vietnam was 29.1 kg, among the highest in the world. Pork is the most widely consumed meat in Vietnam, making up 56% of total meat intake (20). Up to 80% of the pork produced comes from smallholder farmers, and open wet markets are the preferred channels for purchase of pork among consumers (12). While pork production supports food security and the livelihoods of around 4 million smallholder farmers, pork production can also lead to substantial health risks. For example, raw pork marketed in Vietnam is often contaminated with high levels of foodborne pathogens, including *Salmonella* spp. (2, 7, 21, 25), *Escherichia coli* (7, 24), *Toxoplasma gondii* (in

slaughtered pigs) (10), *Taenia* spp. (in pigs) (3), and *Campylobacter* spp. (7). Moreover, many isolates of *E. coli* and *Salmonella* spp. were resistant to one or more antibiotics (25, 26). Contamination of pork by harmful microorganisms may occur at any stage from production to plate.

Pork value chain actors, including farmers, slaughterhouse workers, pork sellers, and consumers, along with three ministries in Vietnam (Ministry of Agriculture and Rural Development, Ministry of Health, and Ministry of Industry and Trade), have a shared responsibility for ensuring food safety (Food Safety Law No. 55/QH12/2010 (30)). The responsibility of food chain actors is also emphasized in a recent World Health Organization press release, stating that “Food producers, manufacturers and traders in Viet Nam need to take responsibility for the safety of food they produce and trade while consumers must take preventive measures and follow good food safety practices” (34). While pork production systems have been described previously (11, 14), other aspects, such as how pork value chain actors perceive food safety, along with risk-mitigating behaviors,

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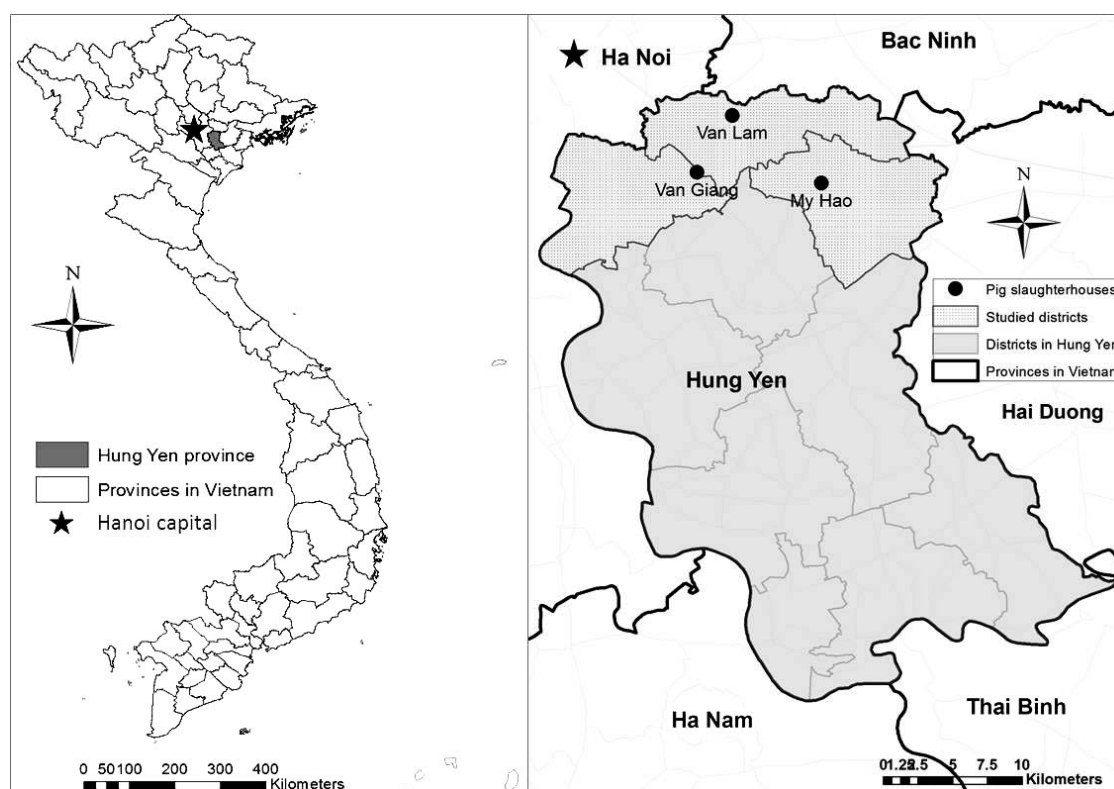


FIGURE 1. Study location, consisting of three selected districts and slaughterhouses in Hung Yen Province, Vietnam.

are not well understood. One study in Hanoi found that most consumers were aware of food safety risks but did not fear foodborne diseases greatly owing to trust in their careful purchase and preparation of food (4). Yet, on average from 2007 to 2015, there were 176 outbreaks and around 5,590 cases of foodborne disease reported per year in Vietnam (29). There is a need for understanding the perceptions of pork value chain actors, especially those closer to the start of the chain, such as slaughterhouse workers, who have a greater role in ensuring food safety (19).

Given the growing concern over pork safety, the important role of smallholder value chain actors in ensuring pork safety, and the lack of understanding of food safety perceptions, the objectives of this study were to describe food safety practices among smallholder value chain actors and explore the food safety, disease, and health risk perceptions of pork value chain actors using Hung Yen Province, Vietnam (situated 60 km south of Hanoi), as a case study. A better understanding of smallholder pork value chain actors' knowledge, practices, and perceptions of food safety will inform risk communication materials and risk management strategies, leading to a reduction in pork-related foodborne diseases in Vietnam and internationally.

MATERIALS AND METHODS

Study site. This study was conducted in three districts (Van Lam, Van Giang, and My Hao) in Hung Yen Province, Vietnam (Fig. 1). Hung Yen was selected because it is a periurban area with many livestock agriculture activities and it is in close proximity to and a major pork supplier of Hanoi, the capital city of Vietnam, where the estimated average daily pork consumption is 400 tons.

As such, Hung Yen is an important area for research on pork value chain actors.

Study population. We selected seven groups along the pork value chain: slaughterhouse owners (3 participants), slaughterhouse workers (10 participants), people living in close proximity to slaughterhouses (9 participants), pork sellers (15 participants), consumers (9 participants), veterinary staff (3 participants), and public health staff (3 participants). A list of slaughterhouses was provided by district authorities, and we randomly selected one slaughterhouse in each district that met the criteria of medium scale (slaughtering 10 to 50 pigs per day) and operating every day. Medium-scale slaughterhouses commonly supply pork to open wet markets and have 5 to 10 slaughterhouse workers. Slaughterhouse workers were randomly selected from the three selected slaughterhouses. Sellers were recruited from the slaughterhouse owner's introduction, followed by snowball sampling (i.e., those sellers introduced other sellers). We selected three consumers through the seller's introduction or through direct observation of consumers buying pork at the market. To choose community members living around slaughterhouses, three households that were located within 200 m of a slaughterhouse were randomly selected. Ethical clearance and approval were obtained from the Hanoi School of Public Health's Institutional Review Board (no. 148/2012/YTCC-HD3). Written consent was obtained from all individuals participating in the study.

Data collection. Both quantitative (questionnaire or checklist) and qualitative methods (interview or focus group) were used to gather information on the knowledge, perceptions and practices of selected pork value chain actors with regard to food safety during the period of January to June 2013. An overview of the value chain actors involved, data collection tools used, and types of data collected is provided in Table 1. Two teams of researchers

TABLE 1. Number of participants, data collection methods, and key topics explored surrounding food safety for each group of pork production chain actors

Pork value chain actors	No. of participants	Data collection method	Type of data gathered
Slaughterhouse owners	3	Questionnaire	General information on pig procurement and slaughtering process
Slaughterhouse workers	10 (in 2 groups)	Focus group discussion	Perception of pig diseases, food safety, and food safety practices
Community members living around slaughterhouse	9	Key informant interview	Advantages and disadvantages of slaughterhouses in area
Pork sellers	15 (in 3 groups)	Focus group discussion	Perception of pig diseases, food safety, and food safety practices
Consumers	9	Key informant interview	Criteria for selecting pork, perceptions on pork-borne diseases, and food safety
Veterinary staff	3	Key informant interview	Responsibilities, food safety management, and collaborations
Public health staff	3	Key informant interview	Responsibilities, food safety management, and collaborations

were trained on how to use the questionnaire and checklist, as well as on conducting interviews and focus group discussions (FGDs), before the fieldwork started. The Vietnamese language was used for data collection, and notes and transcripts were later translated into English for analysis.

A structured questionnaire was used to gather basic information on slaughterhouses, slaughtering process, and procurement of pigs from slaughterhouse owners. The questionnaire was developed in Vietnamese and pretested in villages close to Hung Yen. After revision, the questionnaire was administered face-to-face by trained, experienced research assistants. Each interview lasted approximately 30 minutes. Furthermore, the hygienic practices of slaughterhouse workers and pork sellers were observed, and risks for microbial contamination were identified. Observational checklists based on sanitation guidelines (for slaughterhouse workers, circular no. 60/2010/TT-BNNPTNT (16), and for food handlers, circular no. 15/2012/TT-BYT (18)) were used to determine if slaughterhouse workers and pork sellers were operating according to food safety guidelines.

Key informant interviews were also conducted with three public health staff and three veterinary staff (one in each of the three districts) to determine the general responsibilities of staff for food safety management. Consumers were interviewed to determine perceptions of pork-borne diseases in pork quality and safety, while community members living around slaughterhouses were interviewed to determine perceptions surrounding slaughterhouses in general. Each interview was conducted face-to-face and lasted about 30 to 45 minutes. The interviewer and assistant took notes and recorded the conversation.

FGDs were conducted with slaughterhouse workers (2 groups) and pork sellers (3 groups), focusing on food safety in general. About five or six participants formed a group and were led by one facilitator with a note taker to capture the discussion. Participants reflected on perceptions and practices of food safety and ranked potential risk factors for contamination of pork. Each discussion was audio recorded after gaining permission from all participants, and the discussions lasted about 1.5 h each. FGDs were conducted in each district (with the exception of slaughterhouse workers in My Hao district).

Data management and analysis. Qualitative data were carefully noted and/or tape recorded. The data were coded into

topics as the research progressed. Toward the end of the fieldwork, the main themes were formed and analyzed in depth. Descriptive statistical analysis was used to describe demographic information of participants and general processes along the pork value chain. We triangulated all data to check for consistency.

RESULTS

Characteristics of participants. A total of 52 participants were engaged in this study; most were between 40 and 60 years of age (63%). Most had completed education up to high school only (54%). Public health and veterinary staff, along with some consumers, were the most educated (many had completed some college or university), while most sellers and slaughterhouse workers were the least educated (had completed only secondary school or lower). Overall, there was a nearly equal gender balance (54% male and 46% female); however, more men worked in slaughterhouses, whereas more women were sellers. General demographic information about the participants in the three districts studied is provided in Table 2.

Pig slaughterhouses and pork markets. All three slaughterhouses studied bought pigs from one farm at a time, which were then slaughtered over the following days before pigs from other farms were bought and introduced. Some private butchers also came to these slaughterhouses to buy a live pig(s) and slaughter them using the workers there. The number of pigs slaughtered ranged from 10 to 40 pigs per day, and generally male workers (from 4 to 6) worked in the slaughterhouses. Slaughterhouses operated mostly in the early morning from 2 a.m. till 6 a.m., and slaughtering and processing were done on the floor with limited separation areas for bleeding, scalding, and dehairing. No abnormal clinical signs (e.g., thin or visibly sick pigs) were observed in the lairage at any time during the slaughterhouse visits. With regard to hygienic measures, one slaughterhouse had a separate entrance for pigs, but in all slaughterhouses selected, people could freely access the slaughter area.

TABLE 2. Demographic information, including education, age, and gender, of pork value chain actors participating in this study

Demographic information	No. of participants among:							Total no. (%)
	Slaughterhouse owners (<i>n</i> = 3)	Slaughterhouse workers (<i>n</i> = 10)	Community members living around slaughterhouse (<i>n</i> = 9)	Pork sellers (<i>n</i> = 15)	Consumers (<i>n</i> = 9)	Veterinary staff (<i>n</i> = 3)	Public health staff (<i>n</i> = 3)	
Education								
Secondary school	3	7	5	12	1			28 (54)
High school		2	4	3	2			11 (21)
College		1			4		1	6 (12)
University or higher					2	3	2	7 (13)
Gender								
Male	3	9	6	3	3	3	1	28 (54)
Female		1	3	12	6		2	24 (46)
Age (yr)								
18–30	1	2	1			1		5 (10)
31–40	2	4	1	3	1	2		13 (25)
41–50		1	4	6	3		1	15 (29)
51–60		3	3	6	4		2	18 (34)
61–70					1			1 (2)

Workers frequently wore boots, but the wearing of uniforms or aprons was not observed.

Pork markets opened daily from around 5 a.m. to 11 a.m. The amount of pork sold at pork shops varied from 20 to 300 kg daily. Those pork shops were retail (around, e.g., 20 to 80 kg) or wholesale (e.g., 80 to 300 kg) or both retail and wholesale. Approximately half the sellers transported the carcass or pork themselves, mostly by motorbike. None of the sellers stored the pork in cooled cabinets or covered the pork. Most of the sellers did not use gloves to handle pork, but they always wore aprons. During selling, all pork sellers used cloths to wipe and clean the meat, table, or equipment but also used their bare hands to handle pork and equipment.

Food safety practices of value chain actors. According to slaughterhouse workers, there are no specific regulations or standard operating procedures in the slaughterhouse. However, there are “informal rules,” where senior workers show juniors how to operate in the slaughterhouse, and the work becomes a habit and a routine within the group. Workers have a shared understanding of hygiene and try to maintain cleanliness and coordinate the slaughter process in an organized way; as one worker stated, “both slaughterhouse workers and slaughterhouse owners need to have an awareness of maintaining cleanliness and observing hygiene during slaughtering. There are no regulations or punishment, we just remind each other when one did not do something properly.” Workers reported wearing gloves and masks to protect their health and prevent contamination.

Most pork sellers prefer to use wood surface tables, even if the government had helped them to build tables with enamel tiles, steel, or a granite surface. Pork sellers explained that wood is easier to clean than other surfaces and that “wood table surface can help pork stay dry and keep pork fresher” by absorbing water. Sellers mentioned

the use of cloths to dry pork, clean equipment, and clean hands and tables, emphasizing “it is necessary to have dried cloth to wipe pork and table to avoid wetness, so the pork will be less pale and rancid.” For personal protective equipment, sellers reported wearing aprons and sometimes thin gloves but rarely used masks or protective hats. Masks or protective hats were avoided because they thought that consumers would think that sellers who covered their face or head had health problems that they were trying to conceal.

Retailers said that if pork was left over, they would sell it to restaurants or canteens at a relatively lower price or process it into products such as *nem chao* (boiled pork skin with roasted rice powder) and *gio thu* (mixed pork and ham) and sell them to consumers. For consumers, the most important criteria for selecting pork were “bright red, soft and sticky,” followed by “fresh looking and good smell.” Consumers also emphasized trust in pork sellers and cleanliness of seller stalls as factors that strongly influenced their pork purchasing. In contrast, price and accessibility were less important.

All three public health officers interviewed stated that their responsibilities were for “cooked food,” while raw meat was under the veterinary authorities’ responsibilities. Indeed, public health officers inspect finished pork products, whereas veterinary staff inspect raw pork products. Public health officers are responsible for compliance with regulations on management of foodborne diseases and zoonoses, including inspecting food centers, restaurants, food processing shops and plants for compliance with regulations and guidelines on food safety, ensuring food handlers have health certification, and training food handlers and processors on food safety and hygienic practice.

Veterinary staff mentioned a gap between existing legislation and inspection practices for pork safety surrounding transportation, slaughterhouses, markets, and raw meat handling and processing. Inspection legislation mainly

applied to the big or medium slaughterhouses or markets, whereas small or private butchers or retailers were not frequently inspected. At the slaughterhouse, one veterinary staff member reflected, “it cannot be 100% guaranteed that all pigs were inspected at the slaughterhouse, 80 to 90% is a good number. The government still has difficulties in taking care of this duty.”

Food safety risk perceptions. During FGDs with slaughterhouse workers, risks for microbial contamination of pig carcasses were discussed and ranked in terms of risk level. Although there were varying responses between the two FGDs, both groups emphasized that feces on skin of live pigs, punctured intestines, and the water source were likely sources of contamination. In contrast, using cloths for dry wiping carcasses and transporting carcasses were ranked as not a source of contamination. One worker explained that cloth is safe “because everyone has to wash it and keep it clean every day. So there is no problem. After selling and working all day, they wash and dry it for the following day.” Slaughterhouse workers also perceived that pork-borne diseases impaired pork quality and safety, including foot and mouth disease (FMD), porcine reproductive and respiratory syndrome (PRRS), liver flukes, helminths, and pig diarrhea. FMD and PRRS were emphasized as main causes of poor pork quality and safety. Some of the slaughterhouse workers perceived cysticercosis and leptospirosis as uncommon; as one worker explained, “there have been cases of leptospirosis or cysticercosis, but this was observed a long time ago (4 to 5 years). Now these are fewer than before and every year there may be only 1 to 2 cases reported.” In general, workers perceived that pig diseases are more important to food safety than zoonotic diseases.

Pork sellers have some familiarity with the slaughtering process (e.g., from observing the process or having worked in a slaughterhouse previously), and all pork sellers mentioned that pork quality was strongly related to the slaughtered pig’s condition and the manner of slaughtering. One seller explained, “when restraining pigs for slaughtering, if we struggle with the pig for a long time, the pork would not have a good quality.” Sellers mentioned pig diseases affecting pork quality and safety, including cysticercosis and leptospirosis (both zoonoses), PRRS and FMD, classical swine fever, and pasteurellosis. Sellers did not perceive zoonotic diseases as a major food safety concern. During FGDs, sellers ranked potential risk factors that may lead to pork contamination. Although there were some differences among the FGDs, in general, uncleanness of table or surface, wastewater drain next to the shop, and uncleanness of the surrounding shop area were ranked as high risk factors. Both groups ranked the clothes and shoes of sellers as low risk factors for microbial contamination in pork.

Consumers assumed that less-safe pork may originate from sick or dead pigs, explaining that less-safe pork “is less fresh, has a bad smell, rancid,” and the pork “is pale, has a strange smell, and has a wet feel when touched.” The majority of consumers mentioned at least one pig disease affecting pork safety and quality, such as cysticercosis,

streptococcal infection, or pig diarrhea. One consumer explained “cysticercosis causes taenia disease in human due to eating infected cysticercosis pork. For prevention, when buying, check the pork, it should not have dots that look like white rice seed.” Another consumer explained “‘*Lien cau khuan*’ (in Vietnamese; the name for *Streptococcus suis*) can cause illness via eating. To prevent, do not eat raw pork, blood, or not-well-cooked internal organs, and do not touch raw pork if you have a scratch on your skin or hand.”

Community members living around slaughterhouses emphasized some advantages to having a slaughterhouse near their residence, such as providing jobs, creating business opportunities, and the convenience of buying fresh pork nearby. Community members explained “Slaughterhouse here provides pigs and pork sources for butchers and pork sellers, no need to go far. Slaughterhouse creates work for some workers.” Some disadvantages, such as noise, were reported; however, all respondents mentioned that they have become accustomed to the presence of the slaughterhouse and so the noise is not much of a disturbance. One community member remarked, “no disadvantage, do not know since I sleep deeply, the environment around is normal. The noise is negligible.” A few community members said that the presence of the slaughterhouse can result in odor, polluted water, and the spread of animal diseases. Most community members mentioned potential impacts on human health, for example, “sometimes in summer when the weather is hot and humid, the smell might spread and then get inhaled, or heavy rain could stagnate the dirty water, which may cause itchiness on people’s hands and feet.”

The participants mentioned that information about pig disease and pork-borne diseases came from mass media, such as newspapers, the internet, local radio, or television. Veterinary or public health sources were not mentioned as sources of information. Some slaughterhouse workers gained knowledge about food safety or hygienic practices from following their fellow workers’ work habits, or “learning by doing.” Other slaughterhouse workers had attended some training programs on food safety which were organized by the province.

Diarrheal illness. Slaughterhouse workers and pork sellers reported no cases of illness or diarrhea among themselves over the last 6 months and were also not too worried about diseases because they perceived that the pork production process was safe and control measures were applied. In addition, workers reported wearing masks, gloves, and boots to protect their health and to limit risks in case of suspected diseases in pigs. However, based on the researchers’ own observations, the workers did not wear any masks or gloves during slaughter. For pork sellers, neither they nor their family members reported being affected with pig-related diseases or had symptoms after consuming pork within six months or even one year in the past. Consumers also stated that no cases of illness or diarrhea were observed from eating pork or pork products in their family within the last 12 months; however, one consumer mentioned that her

3-year-old daughter got diarrhea once after pork consumption, but was unsure about the cause.

DISCUSSION

Our study captured valuable insights into practices and perceptions of pork safety and quality among smallholder pork value chain actors. Subtle but important differences in perceptions of pig diseases and food safety among smallholder pork value chain actors were noted. For instance, slaughterhouse owners knew more about pig diseases affecting food safety and quality than pork sellers and consumers, perhaps because they had more frequent and direct encounters with pigs and were motivated to learn more. However, there were considerable misperceptions surrounding zoonotic and foodborne disease among these three groups. This study also demonstrated that slaughterhouse workers and pork sellers knew about some food safety risks associated with their pork handling practices but might not be aware of the degree of risk. For instance, slaughterhouse workers often use a clean cloth to dry pig carcasses. Workers assumed there was little risk for microbial contamination of carcasses as they reported washing the cloth every day, despite the possibility for contamination of the cloth through drying multiple carcasses throughout the day. Incorporating value chain actor's perceptions surrounding safe food safety practices can better inform education and communication intervention efforts to improve food safety (23).

Several practices to prevent contamination of pig carcasses, such as avoiding puncturing the gut and washing the pig and carcass thoroughly, were observed at the slaughterhouse. Indeed, pig skin can have high rates of *Salmonella* (27), and efforts appear to be made to prevent contamination; however, the same cloth is often used to dry multiple carcasses during the day, which can be problematic if the cloth is contaminated with bacteria. Workers also stated that they used gloves and masks to protect their health and limit contamination, but these practices were not observed during visits. Our simultaneous study on *Salmonella* contamination (data not presented) showed that there is a high chance of finding *Salmonella* on workers' hands. Encouragement of the use of protective equipment such as gloves to prevent carcass contamination is recommended.

Slaughterhouse workers stated that they "learn by doing" and follow informal rules of the slaughterhouse rather than getting trained by relevant authorities. Furthermore, the source of food safety information for slaughterhouse workers was mainly through mass media, as opposed to public health or veterinary services. And yet, training can be and is provided by public health and veterinary staff. Based on the food safety law of 2010 (no. 55/2010/QH12), a national strategy for food safety from 2011 to 2020 has been approved by the Prime Minister, with the objectives, among others, to improve the knowledge and practice of food safety for different groups and strengthen the management system for food safety (5, 30). We suggest the organization of further training and incorporating the needs and perceptions of slaughterhouse workers in training materials to ensure that good slaughterhouse hygiene is recommended (2).

Vietnamese food safety regulations emphasize the importance of good hygienic practices through regulations and guidelines (including hazard analysis and critical control point principles); however, at small- and medium-scale pig slaughterhouses, regulations or guidelines are often not applied. For example, according to the Vietnamese regulations, slaughterhouses have to be separated from residential areas (at least 100 m) and have to use appropriate waste treatment systems (17). All three slaughterhouses used biogas systems for slaughterhouse waste management. However, because of the limited land area and the initial start point from a traditional household-based slaughterhouse, all three slaughterhouses were not able to follow the regulation surrounding residential distance. Furthermore, limited financial capacity and land may constrain building a new and separate slaughterhouse in another location. Interestingly, however, some community members living around slaughterhouses seemed to be accustomed to the slaughterhouse presence and to feel minimally or not at all disturbed. On the other hand, some veterinary staff, public health staff, and community members expressed interest for slaughterhouses to be relocated to more suitable areas and follow existing requirements and regulations.

Another concern raised by veterinary and public health staff was the limited capacity for inspecting slaughterhouses and markets owing to lack of human resources. Inspections are mainly implemented for large- or medium-scale slaughterhouses (more than 10 to 20 pigs per day), and are not frequent for small-scale slaughterhouses, private butchers, or retailers. There is a need to strengthen the capacity for inspections (15).

Our findings demonstrated that pork sellers use wooden tables because of the perception that wood makes meat look fresh for longer periods of time than do other surface types; the preference for a fresh appearance is driven by consumer demand. The seller groups preferred a wooden table surface over other surfaces, such as enamel, granite, or steel. They explained that the water absorption capacity of wood seems better than that of enamel, granite, or steel, so it makes pork look drier and less rancid. However, in terms of food safety, the wood surface is more prone to bacterial contamination. For example, when comparing materials to reduce *E. coli* contamination (e.g., laminate, wood, tile, and granite), granite has been shown to perform the best in reducing *E. coli* contamination, with less of the bacteria remaining after simply cleaning with soap, while wood performed quite poorly (22). Finding a suitable material that is affordable, prevents contamination, and makes the pork appear appealing to consumers is challenging but needed.

Sellers at almost all pork shops used cloths to wipe pork dry or to clean hands or equipment, a practice similar to that of slaughterhouse workers. The cloths may be possible carriers of contaminants, and yet, they are perceived to be low risk by the sellers. This misperception should be specifically addressed in future training activities. In addition, the use of masks, gloves, or hats by sellers gave some consumers the impression that the seller may have been concealing health problems (such as skin or respiratory disease), and thus, buyers are hesitant to buy pork from them. Sellers also mentioned that pork quality was related to

the manner of restraining and slaughtering pigs, which can lead to pale, soft, and exudative meat. Research has shown that pale, soft, and exudative meat has a strong correlation with preslaughter animal handling, stunning, dehairing, and carcass chilling (13). As such, it appears that sellers are more knowledgeable and concerned about aspects relating to food quality rather than food safety.

The consumer groups focused on sensorial or physical characteristics of pork (perceived freshness, color, smell, or texture) as indicators for pork purchasing behavior, pork quality, and safe pork (6). In our study, the color and smell of pork were determined to be the most important selection criteria when purchasing pork, while price was least important. For consumers, “wet” looking pork was an indicator for low quality of pork, hence the sellers’ practice of continuously drying the meat using cloth. Accessibility of pork was less important for consumer preference, since the mobile shops or vendors sell pork widely at villages or communes. Moreover, trust in sellers, butchers, and the pork production process was also mentioned as an important criterion in selecting pork. And yet, consumers and other value chain actors emphasized trust in their own food safety practices rather than the practices of others along the pork value chain. Integrated efforts, along with traceability along the pork value chain, are recommended.

A cross-cutting synthesis of our findings related to zoonoses revealed that slaughterhouse workers and pork sellers have little knowledge and some misperceptions about zoonoses. Limited knowledge on zoonoses may be owing to concern over other issues, such as severe and contagious pig diseases (FMD and PRRS), consistent with a consumer study that found that pig diseases, along with growth promoter residues, were the main concerns (9). Information on pig diseases is usually related to urgent or reemerging zoonoses, such as avian influenza and *S. suis*. This information was also gathered from discussions and interviews in our study. Participants’ mention of zoonotic diseases, including leptospirosis and cysticercosis, could be because they remembered cases of cysticercosis that occurred a few decades ago in Vietnam (28). And yet, respondents viewed zoonotic diseases as less of concern for food safety than pig diseases. Clarifying the degrees of risk for food safety should be emphasized in education initiatives.

There are some limitations inherent in this study. First, our sample size per research group was small; as such, quantitative analytical methods are not appropriate. Furthermore, our sample came from three districts in Hung Yen and, thus, might not be representative of other regions in Vietnam. However, this study provides important insights into perspectives on food safety among slaughterhouse owners, workers, sellers, consumers, and authorities responsible for pork safety in the area (veterinary staff and public health staff). Second, our study did not explore the food safety perceptions and practices of other actors along the pork value chain (e.g., farmers and traders), who also have a role in ensuring food safety. Future research may consider the roles and perceptions of such actors.

In this study, the food safety practices and perceptions of pork value chain actors were explored. Pig slaughtering practices, along with pork handling practices by sellers, are

often performed without using adequate protective equipment. Sellers prefer to use wood tables over other materials to maintain perceived “freshness” of pork, despite the high risk of wood tables for microbial contamination of pork. Both slaughterhouse workers and pork sellers often use the same cloths for cleaning equipment and drying meat, presenting risks for cross-contamination. Misperceptions of slaughterhouse workers and pork sellers surrounding the risks of zoonoses for pork safety were observed. These findings suggest that more education and training interventions to promote appropriate food safety practices are needed. They also suggest that incorporating the perceptions and actual practices of pork value chain actors into the training should be a priority. Furthermore, an emphasis on pig disease, food safety risks, and zoonoses in food safety interventions is warranted. However, training alone is unlikely to change behavior unless there are some additional motivations in place. Finally, integrated efforts among all pork value chain actors, along with traceability in the chain, are needed to ensure pork safety. Future research to substantiate the findings could include examining the risk perceptions and practices of pork value chain actors in other communities (in Vietnam and other countries), exploring interventions to improve risk perceptions, risk communication, and safe handling practices on food safety or determining risks for other meat categories such as chicken or beef.

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