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Level of disease risk knowledge among abattoir workers in Mukono and neighbouring districts, Uganda

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Abstract

A participatory disease search was conducted among abattoir workers in Lugazi abattoir in Buikwe District, Bombo abattoir in Luwero District, Kame Valley abattoir in Mukono District, and Kyengera cattle abattoir and Nakasozi-Buddo Pig Slaughterhouse in Wakiso District with the aim of assessing the level of disease risk knowledge among abattoir workers. Data collection employed PDS tools, including, key informant interviews, focus group discussions, simple ranking, proportional piling, observations, and transect walk through abattoir facilities. In addition questionnaires were administered to a selected number of abattoir workers.

Five abattoirs visited were small to medium size in terms of slaughter capacity: Lugazi abattoir (20 heads of cattle and 5 shoats per day); Bombo abattoir (10 heads of cattle and 6 shoats per day); Kame Valley abattoir (20 heads of cattle and 6 shoats); Kyengera Cattle abattoir (20 heads of cattle and 10 shoats per day and Nakasozi-Buddo pig slaughterhouse (30 pigs per day). Many had poor infrastructure, poor sanitation and poor drainage. Of the 52 abattoir workers interviewed, a substantial proportion (67.3%) was aware of zoonoses. However, a reasonable proportion (32.7%) did not know zoonoses. Awareness was on a wide range of diseases and conditions, including, Brucellosis, Tuberculosis, Tetanus, Cysticercosis, Mange, Foot and Mouth Disease, Swine Influenza, Hepatitis B, Lumpy Skin Disease, African Swine fever, Lice, *Tunga penetrans*, Anthrax, Rift Valley fever, Fasciolosis, Tick-borne infections and Salmonellosis. A reasonable proportion of abattoir workers (40.4%) were aware of consumption of meat from diseased animals, drinking of raw milk, contact, open cuts, aerosols, skin cuts, and tick bites as the mode of infection for disease. Utilization of personal protective equipment, especially boots (98%) and coveralls (90%) was highly observed and practised in the abattoirs visited. A high proportion of abattoir workers (95%) stated they normally observe hand washing in the abattoirs, with 88% practising hand washing during every task but only 40% of the respondents utilized the soap hand wash.

In conclusion, improved abattoir facilities, sanitation, drainage and improved biosafety of workers could be achieved through development support towards facilities and an awareness program for abattoir workers on health hazards, zoonotic diseases and protective clothing.

Keywords: Level, disease risk knowledge, abattoir workers, Mukono district, Uganda

1. Introduction

Abattoir workers can be categorized into transporters, slaughtermen, carcass dressers, offal cleaners, skins and hides handlers, cleaners, meat inspectors and abattoir administrators. Abattoir workers constitute a major group of people at risk of occupational and zoonotic disease due to their working environment where they come into close contact with animals or their related infectious materials at slaughter. The abattoir risks include parasitic zoonoses, infectious bacterial and viral infections, carcinogens and other potential pathogenic materials. Many studies have been conducted in many parts of the world on abattoir workers. For example, in South Sudan, a large proportion of high-risk groups such as abattoir workers have been reported to have broad knowledge of brucellosis (Madut *et al.*, 2017) ^[1]. Living in close proximity with the animals, sharing water source with animals and poor hygiene in their environment were identified as possible transmission routes for the disease (Madut *et al.*, 2017) ^[1]. In a study conducted in slaughterhouses in Western Kenya, found knowledge on zoonotic disease among abattoir workers to be low. Only 31% of workers were aware of disease being transmitted from animals to people (Cook *et al.*, 2017) ^[2]. Elsewhere in Pakistan, brucellosis seropositivity among abattoir workers was 5.1 times higher than among

livestock farmers (Ali *et al.*, 2013) [3]. Furthermore, in a study conducted in Malaysia, the majority of the workers (38.8%) had a low level of knowledge, though 91.7% had a positive attitude and 77.7% had a good practice of compliance (Abdullah *et al.*, 2016) [4]. In addition, 263 abattoir workers across five North Central (NC) states in Nigeria were evaluated on their knowledge of leptospirosis, workplace attitudinal practices and other risks that could favor spread of *Leptospira* among them. Findings showed that most workers 252 (95.8%) were ignorant of leptospirosis. Other identified risk factors for infection included age of workers, occupation, illiteracy and risks within, such as inadequate protective gear and outside the workplace, such as rodents in homes. All these factors gave a prevalence of 226 (89.7%) *Leptospira* antibodies in the abattoir workers which they probably contracted through un-mindful handling of infected animal fluids and tissues (Abiayi *et al.*, 2015) [5]. A recent study conducted in Kampala and Mbarara districts among abattoir workers, revealed 10% brucellosis seropositivity with no-use of protective gear being the main factor that increased risk (Nabukenya *et al.*, 2013) [6].

Due to the ever-increasing risk of zoonotic diseases such as brucellosis, leptospirosis, bovine tuberculosis, and Rift Valley fever among abattoir workers, increased awareness about occupational disease hazards and a high level of disease risk knowledge among abattoir workers is paramount in improving their biosafety. To allow for better understanding of the level of disease risk knowledge among abattoir workers in order to improve their biosafety, a study using participatory epidemiology was conducted in abattoirs in Mukono, Buikwe, Luwero and Wakiso districts.

2. Materials and Method

2.1 Study area

The study was conducted in Lugazi abattoir in Buikwe District, Bombo Town Council abattoir in Luwero District, Kame Valley Slaughterhouse in Mukono District, and Kyengera Cattle abattoir and Nakasozi-Buddo Pig Slaughterhouse in Wakiso District. The abattoirs were specialized in the slaughter of cattle, sheep, goats and pigs.

2.2 Selection of study sites

Abattoirs were selected following prior consultations with the District Veterinary Officers in Mukono, Buikwe, Kampala, Luwero and Wakiso and Proprietors of private abattoirs. Upon securing permission to access abattoir facilities, the team then went ahead and undertook the study.

2.3 Study design

The study design employed a Participatory Disease Search/Participatory Epidemiology (PDS/PE) approach (Catley & Berhanu, 2003; CAHO, 2011) [7, 8]. A team of from the Ministry of Agriculture, Animal Industry and Fisheries employed a combination of a qualitative and quantitative study design. Qualitative aspects involved informal interviews of key informants that consisted of the District Veterinary Officers, Proprietors of private abattoirs and abattoir administrators and focus group discussions with abattoir workers. Quantitative aspects involved administering questionnaires to 9-10 abattoir workers of different specialization per abattoir to assess the level of awareness regarding their knowledge on zoonoses and

health hazards that could be contracted during their work in the abattoirs. Questionnaires were administered to people working as transporters, traders, slaughtermen, carcass dressers, offal cleaners, skins and hides handlers, meat inspectors and abattoir administrators. In addition, available secondary data was collected. The team made observations on the environment around abattoirs and made transect walks across abattoir facilities during data collection.

2.4 Participatory Disease Search tools

PDS tools used included semi-structured key informant interviews guided by checklists. In addition, focus group discussions were conducted among abattoir workers. Simple ranking and proportional piling was conducted to demonstrate the level of knowledge among abattoir workers on zoonoses. Questionnaires intended to assess the level of awareness of abattoir workers on the level of disease risk knowledge were also administered to various cadres of abattoir workers in Lugazi abattoir in Buikwe District, Bombo Town Council abattoir in Luwero District, Kame Valley Slaughterhouse in Mukono District, Kyengera Cattle Abattoir and Nakasozi-Buddo Pig Slaughterhouse in Wakiso District. Observations were also made around the environment of the abattoirs and transect walks were made across abattoir facilities.

2.5 Data storage and analysis

The data obtained from the participatory methods was entered and stored in Microsoft Excel software. For data analysis, descriptive statistics was performed.

3. Results

3.1 General findings

3.1.1 Lugazi abattoir, Buikwe district

According to key informant interviews, Lugazi abattoir has been operational since 2016. Operations begin at 6:00am and end at about 8:30am daily. Average daily slaughter is 20 heads of cattle per day and 5 shoats per day. Meat inspection is done daily. Commonest lesions encountered included *Taenia* cysts, liverfluke (*Fasciola* sp), gastrointestinal nematodes, and bruises. Most abattoir workers were exposed to cysticercosis and brucellosis. Previously anthrax had been encountered by abattoir workers exposed to animals outside the slaughterhouse, especially on farms while securing animals for slaughter. Stray dogs and rodents were a common nuisance around the abattoir given its close proximity to the sugar cane plantation. Major challenges abattoir workers faced included, lack of shelter from rain, lack of a toilet, workers not fully certified even after training, lack of separate places for goats and sheep slaughters, poor drainage system, and congestion.

3.1.2 Bombo Town Council abattoir

According to key informant interviews, Bombo Town Council abattoir has an average throughput of 10 heads of cattle and 6 shoats per day. Operations begin at 5:00 am and end at about 8:15 am daily. General challenges faced at the abattoir included, lack of shelter from rain, congestion, limited numbers of taps and water tanks, rough floor which wears out cleaning brushes, a small septic tank that sometimes overflows, inadequate training on abattoir issues and exposure to animal diseases. See abattoir workers going with their day-to-day activities in the photo below.

3.1.3 Kame Valley slaughterhouse in Mukono district

According to key informant interviews, Kame Valley Slaughterhouse in Mukono district conducts an average slaughter of 20 heads of cattle and 6 shoats per day. The structure has a wooden wall but has a cemented floor and good drainage system. Mukono municipal council invested 33 million Uganda shillings to improve the abattoir floor and drainage. The abattoir shares toilet facilities with the market. The main source of water is borehole water. Cases of slaughter of sick or dead animals are rare and on many occasions are intercepted. Political interference, cases of stolen animals and issues of cattle trading licenses are the commonest challenges encounter at the Kame Valley Slaughterhouse.

3.1.4 Kyengera Cattle abattoir, Wakiso district

According to key informant interviews, Kyengera Cattle abattoir has an average throughput of 20 heads of cattle and 10 shoats per day. Operations begin at 5:00 am and end at about 8:00 am daily. It has well established infrastructure, good sanitation and better drainage. See abattoir workers going with their day-to-day activities in the photo above.

3.1.5 Nakasozi-Buddo pig slaughterhouse

Key informant interviews on Nakasozi-Buddo Pig Slaughterhouse revealed that the facility started in 2016. Average daily slaughter is 30 pigs. The slaughterhouse mainly supplies pork to Kampala, Kyengera, Nansana, Buddo, Seeta and Mukono. Fortunately, it had never registered any incidents of zoonosis. Hot water treatment of pork was the common practice to deal with health hazards. General challenges faced by abattoir workers included Injuries through instruments, feet cracks, workers infused with smell from pork, infestation of workers by parasites from pigs, and workers contract *Tinea pedis* (foot rot). See abattoir activities in the photos below.

3.1.6 Participatory Epidemiology process and findings

At each of the abattoirs visited, abattoir workers were asked to mention the likely infections they were at risk of acquiring considering their daily routines at the abattoir. Using simple ranking, the abattoir workers were asked to rank diseases according to relative frequencies and their finding are shown in Table 1. According to the findings, Brucellosis, Rabies and Tuberculosis were the zoonoses abattoir workers had the highest likelihood of acquiring during their daily routines.

Table 1: Simple ranking by abattoir workers of the relative frequency of likely infections they were at risk of acquiring during their daily routines

Abattoir					
Rank	Lugazi-Buikwe	Kame Valley -Mukono	Bombo-Luwero	Kyengera-Wakiso	Nakasozi-Buddo-Wakiso
<i>Diseases</i>					
1	Brucellosis	Brucellosis	Brucellosis	Rabies	Brucellosis
2	Tick-related infections	Tuberculosis	Tuberculosis	Cracked feet	<i>Tinea Pedis</i> (Foot rot)
3	Tetanus	Hepatitis	Swine Influenza	Tuberculosis	Rabies
4		Elephantiasis		Mange	Mange
5		Lumpy Skin Disease		Brucellosis	Tuberculosis
6				Swine Influenza	Swine Influenza

In addition, at each abattoir visited, using proportional piling, abattoir workers were asked to use stone counters to rank diseases which severely affected human health if they got infected. The results of the ratios of the stone counts are shown in Table 2. According to the findings, Tetanus with a score of 76.7% at Lugazi abattoir, Hepatitis B with a score

of 90.0% at Kame Valley abattoir, Tuberculosis with a score of 93.0% and Rabies with scores of 30.0% and 33.0% at Kyengera Cattle abattoir and Nakasozi-Buddo Pig Slaughterhouse, respectively, were considered the diseases that caused most severe effects on human health once infected.

Table 2: Using proportional piling, ranking diseases by abattoir workers which severely affect human health if infected

Abattoirs									
Lugazi-Buikwe		Kame Valley -Mukono		Bombo-Luwero		Kyengera-Wakiso		Nakasozi-Buddo-Wakiso	
Disease	Percentage scores	Disease	Percentage scores	Disease	Percentage scores	Disease	Percentage scores	Disease	Percentage scores
Tetanus	76.7%	Hepatitis B	90.0%	Tuberculosis	93.0%	Rabies	30.0%	Rabies	33.0%
Tick related infections	13.3%	Elephantiasis	6.7%	Brucellosis	7.0%	Cracked feet	24.0%	<i>Tinea pedis</i> (foot rot)	28.0%
Brucellosis	10.0%	Brucellosis	3.3 %	Swine Influenza	0.0%	Tuberculosis	22.0%	Tuberculosis	18.0%
		Tuberculosis	0.0%			Mange	12.0%	Mange	10.0%

3.2 Questionnaire findings

Table 3 shows findings regarding information on abattoir workers interviewed. There was rather a balanced representation of views from the five abattoirs visited. Among the 52 persons interviewed, 17% belonged to Lugazi abattoir, 19% belonged to Bombo abattoir, 25% belonged to Kame Valley Slaughterhouse, 19% belonged to Kyengera cattle abattoir and 19% belonged to Nakasozi-Buddo pig slaughterhouse. Regarding animal species specialization of the slaughter, 44% of the abattoirs specialized in slaughter

of cattle and goats, 19% in pigs and 21% in cattle, sheep and goats.

The highest number of abattoir workers interviewed (33%) were traders, followed by carcass dressers (27%), then slaughtermen (15%), offal cleaners (7%), abattoir administrators (6%), transporters (4%), skin and hides handlers (4%) and lastly meat inspectors (2%). Regarding their gender, most of them were males (92%) with few females (8%).

Regarding ages, the highest proportion of abattoir workers interviewed lay within the age-group of 40-44 years (17%), followed by 25-29 years (15%), 20-24 years (13%), 50-54 years (13%), 55-59 years (12%), then 35-39 years (10%), 45-49 years (4%) and lastly 60-64 years (4%). According to their years of experience, the highest proportion of abattoir

workers interviewed (42%) had worked for 1-5 years, followed by 6-10 years (31%), 11-15 years (12%), 16-20 years (10%), 21-25 years (4%) and lastly 26-30 years (2%). Regarding their working routine, the majority of the abattoir workers interviewed worked daily (88%) but few worked three times per week (10%) and once per week (2%).

Table 3: Information regarding abattoir workers interviewed

Variable	No. of persons interviewed	Proportion	Percentage
District/Abattoir			
Buikwe-Lugazi Abattoir	9	9/52	17%
Luwero-Bombo Town Council Abattoir	10	10/52	19%
Mukono-Kame Valley Abattoir	13	13/52	25%
Wakiso-Kyengera Cattle Abattoir	10	10/52	19%
Wakiso-Nakasozzi Buddo Pig Slaughterhouse	10	10/52	19%
Specialization of abattoir			
Pigs	10	10/52	19%
Cattle & Goats	23	23/52	44%
Cattle , Sheep & Goats	19	19/52	21%
Abattoir workers' Specialization			
Transporters	2	2/52	4%
Traders	19	19/52	33%
Slaughtermen	8	8/52	15%
Skin and Hide handlers	2	2/52	4%
Offal Cleaners	3	3/52	7%
Meat Inspector	1	1/52	2%
Carcass Dressers	14	14/52	27%
Abattoir Administrators	3	3/52	6%
Gender of abattoir workers			
Female	4	4/52	8%
Male	48	48/52	92%
Age-group of abattoir workers			
20-24	7	7/52	13%
25-29	8	8/52	15%
30-34	6	6/52	12%
35-39	5	5/52	10%
40-44	9	9/52	17%
45-49	2	2/52	4%
50-54	7	7/52	13%
55-59	6	6/52	12%
60-64	2	2/52	4%
Years of experience of abattoirs workers			
1-5	22	22/52	42%
6-10	16	16/52	31%
11-15	6	6/52	12%
16-20	5	5/52	10%
21-25	2	2/52	4%
26-30	1	1/52	2%
Working routine of the abattoir workers			
Working daily	46	46/52	88%
Working once weekly	1	1/52	2%
Working three times weekly	5	5/52	10%

Table 4 shows the responses regarding awareness of abattoir workers on knowledge of zoonoses and their mode of transmission. Generally, a substantial proportion of the abattoir workers interviewed (67.3%) were aware of zoonoses but with a reasonable proportion of abattoir workers (32.7%) not knowing about zoonoses. The highest proportion of abattoir workers were aware of brucellosis (26.9%), followed by tuberculosis (7.7%), then tetanus (3.8%), *teania* cyst (1.9%), mange (1.9%), foot and mouth disease (1.9%), Swine influenza (1.9%), hepatitis (1.9%) and lumpy skin disease (1.9%) as single diseases.

Regarding knowledge on a range of diseases, highest proportion of abattoir workers were aware of brucellosis and

tuberculosis (5.8%), followed by African swine fever, lice and *Tunga penetrans* (5.8 %), then brucellosis and hepatitis (3.8%), anthrax, Rift Valley fever, *Teania* cysts, lice and ticks (1.9%), foot and mouth disease, influenza and tetanus (1.9%), brucellosis and fasciolosis (1.9%), brucellosis and tetanus (1.9%), brucellosis and salmonellosis (1.9%), brucellosis and foot and mouth disease (1.9%), and foot and mouth disease and ticks (1.9%).

Regarding the knowledge of mode of transmission of diseases from animals and their materials to man, the highest proportion (40.4%) of abattoir workers interviewed were aware of consumption of meat from diseased animals, drinking of raw milk, contact, open cuts and aerosols,

followed by skin cuts (15.4%), then eating undercooked meat (11.5%), aerosols (5.8%), and tick bites (1.9%). Unfortunately, 25% of the abattoir workers interviewed did

not know any mode of transmission of disease from animals and their materials to man.

Table 4: Responses regarding awareness of abattoir workers on knowledge of zoonoses and their mode of transmission

Variable	No of people interviewed	Proportion	Percentage
Knowledge of zoonoses			
Yes	35	35/52	67.3%
No	17	17/52	32.7%
Diseases mentioned			
African Swine fever, lice, <i>Tunga Penetrans</i>	3	3/52	5.8%
Brucellosis	14	14/52	26.9%
Brucellosis-Fasciolosis	1	1/52	1.9%
Brucellosis-Tuberculosis	3	3/52	5.8%
Swine Influenza	1	1/52	1.9%
Brucellosis-FMD	1	1/52	1.9%
FMD	1	1/52	1.9%
FMD, Ticks	1	1/52	1.9%
FMD, tetanus, Swine influenza	1	1/52	1.9%
Hepatitis	1	1/52	1.9%
anthrax, RVF, <i>Taenia</i> , ticks	1	1/52	1.9%
Brucellosis, Hepatitis	2	2/52	3.8%
Lumpyskin Disease	1	1/52	1.9%
Mange	1	1/52	1.9%
Brucellosis Salmonellosis	1	1/52	1.9%
Tuberculosis	4	4/52	7.7%
Taenia Cysts	1	1/52	1.9%
Tetanus	2	2/52	3.8%
Brucellosis, Tetanus	1	1/42	1.9%
Not known	10	10/52	19.2%
Knowledge of mode of transmission			
Aerosols	3	3/52	5.8%
Consumption of meat from diseased animal, drinking raw milk, open cuts, aerosol	21	21/52	40.4%
Eating undercooked meat	6	6/52	11.5%
Skin cuts	8	8/52	15.4%
Tick bites	1	1/52	1.9%
not known	13	13/52	25.0%

In Table 5 are shown responses regarding abattoir structures and practices. A substantial proportion (63%) of the respondents confirmed abattoirs had roofs, cemented floors, Solid walls, toilet and hand washing facilities though a reasonable proportion (37%) of respondents stated the abattoirs did not have required structures and facilities.

Rodents and dogs around abattoirs (50%), sleeping in the abattoirs (42%) and slaughtering of sick animals within abattoir facilities (12%) were unacceptable issues and

practices revealed by respondents. Fortunately, a high proportion of respondents revealed sleeping in the abattoir (58%) and slaughtering of sick animals (88%) were prohibited in the abattoirs.

Regarding standard practices of meat inspection and ante-mortem inspection, 100% of the respondents revealed meat inspection was performed in the abattoirs daily. In addition, 73% of respondents stated ante-mortem inspection was conducted daily in the abattoirs.

Table 5: Responses regarding of the abattoir structure and practices

Variable	Responses	No. of respondents	Proportion	Percentage
Abattoir structure				
Roof, cemented floor, Solid walls, toilet and hand washing facilities	Yes	33	33/52	63%
	No	19	19/52	37%
Unacceptable abattoir Practices				
Rodents and Dogs around the abattoir Sleeping in the abattoir Slaughter of sick animals	Yes	26	26/52	50%
	No	26	26/52	50%
	Yes	22	22/52	42%
	No	30	30/52	58%
	Yes	7	7/52	12%
	No	46	46/52	88%
Required standard abattoir practices				
Meat Inspection daily Ante-mortem Inspection daily	Yes	52	52/52	100%
	No	0	0/52	0%
	Yes	38	38/52	73%
	No	14	14/52	27%

Table 6 shows responses regarding PPE, handwash, eating practices and smoking within the abattoir facilities. PPE practices commonly used were Boots (98%) and Coveralls (90%). Otherwise, other PPE such as Gloves (12%), Eye protection (10%), Lab coat overalls (6%) Dust Musks (4%) and Respirators (2%), were rarely used among abattoir workers.

Regarding handwash, 96% of the respondents stated they normally observe hand wash in the abattoirs, with 88% practising hand wash during every task. Unfortunately, only 58% of the respondents utilized the soap hand wash, and 19% of the respondents observed hand wash only at bathroom times, while 15% of the respondents observed

hand wash only at meal times, and 12% of the respondents observed hand wash only at the beginning and end of the day.

Normally eating and drinking in the abattoir is not recommended. However, 60% of the respondents stated that they usually eat and drink in the abattoir with 31% of the respondents eating and drinking daily, while 15% do eat and drink every three days per week and 8% do eat and drink once a week in the abattoir.

Smoking in the abattoir is never recommended. Accordingly, 100% of the respondents stated they did not smoke in the abattoir at all.

Table 6: Responses regarding Personal Protective Equipment (PPE), Handwash, eating practices and smoking within the abattoir facilities

Variable	Response	Proportion of responses	Percentage of response	
PPE Practices	Gloves	yes	6/52	12%
		No	46/52	88%
	Coveralls	Yes	48/52	90%
		No	4/52	8%
	Dust Masks	Yes	2/52	4%
		No	50/52	96%
	Boots	Yes	51/52	98%
		No	1/52	2%
	Respirators	Yes	1/52	2%
		No	51/52	98%
	Eye Protection	Yes	5/52	10%
		No	47/52	90%
	Lab coat overall	Yes	3/52	6%
		No	49/52	94%
Handwash		Yes	50/52	96%
		No	2/52	4%
	Handwash mealtimes	Yes	8/52	15%
		No	44/52	85%
	Handwash at Beginning and End of day	Yes	6/52	12%
		No	46/52	88%
	Handwash bathroom times	Yes	10/52	19%
		No	42/52	81%
	Handwash during all task	Yes	46/52	88%
		No	6/52	12%
	Soap handwash	Yes	30/52	58%
		No	22/52	42%
Eat and Drink in abattoir	Abattoir eat drink daily	Yes	31/52	60%
		No	21/52	40%
		Yes	16/52	31%
		No	36/52	69%
	Eat drink every 3 days	Yes	8/52	15%
		No	44/52	85%
	Eat and drink weekly	Yes	4/52	8%
		No	48/52	92%
Smoking in abattoir	Smoking in abattoir daily	Yes	0/52	0%
		No	52/52	100%
	Smoking in abattoir every 3 days	Yes	0/52	0%
		No	52/52	100%
	Smoking in abattoir weekly	Yes	0/52	0%
		No	52/52	100%

4. Discussion

The study reports on a participatory disease search that was conducted among abattoir workers in Lugazi abattoir in Buikwe District, Bombo abattoir in Luwero District, Kame Valley abattoir in Mukono District, and Kyengera cattle abattoir and Nakasozi-Buddo Pig Slaughterhouse in Wakiso District with the aim of assessing the level of disease risk

knowledge among abattoir workers. Key PDS tools used included key informant interviews, simple ranking, proportional piling, observations, and transect walk through abattoir facilities. In addition questionnaires were administered to a selected number of abattoir workers.

Abattoirs visited were small to medium size in terms of slaughter capacity. Nakasozi-Buddo pig slaughterhouse had

an average daily slaughter of 30 pigs. Others had average daily slaughter ranging from 10 heads of cattle and 6 shoats per day (Bombo abattoir), to 20 heads of cattle and 5 shoats per day (Lugazi abattoir), and 20 heads of cattle and 6 shoats per day (Kame Valley abattoir) and 20 heads of cattle and 10 shoats per day (Kyengera cattle abattoir). Whereas the slaughterhouse visited lie within urban areas, the majority were as small in slaughter capacity as slaughterhouses found in rural areas normally referred to as slaughter slabs (Cook *et al.*, 2017) [2]. Studies conducted elsewhere found these facilities to be privately owned and normally rented to butchers who employ their own team of slaughter workers (Clotey, 1985, FAO, 2010) [9, 10].

Whereas Kyengera Cattle abattoir, Kame Valley abattoir and Nakasozi-Buddo Pig Slaughterhouse had good infrastructure, good sanitation and improved drainage, Lugazi abattoir and Bombo Town Council abattoir had poor infrastructure, poor sanitation and poor drainage. These aspects are known to be among multiple failings in the slaughter process that result in meat contamination that allow the transmission of pathogens: inadequate infrastructure, poor hygiene, lack of ante and postmortem inspection, and inadequate training (FAO, 2010, Herenda *et al.*, 1994; Cook *et al.*, 2017) [10, 11, 2]. It is recommended that the floor of the slaughterhouse should be hard concrete and impervious, to reduce dirt in the slaughterhouse and allow drainage and ease of cleaning (Herenda *et al.*, 1994) [11]. Equally important, a roof is important to protect the carcass from the weather and to reduce the temperature in the slaughterhouse (Mann, 1984, Bengtsson & Whittaker, 1988) [12, 13]. Lugazi abattoir did not have good toilet facilities. Moreover, lack of toilets often leads workers to regularly defecate in the open, a behaviour that may promote the persistence of zoonotic diseases such as cysticercosis (Cook *et al.*, 2017) [2]. As a result of noncompliance such slaughterhouses with poor sanitation, poor drainage, lack of toilets and handwash facilities normal face closure by the Veterinary Regulatory Authorities (Cook *et al.*, 2017) [2].

Simple ranking indicated brucellosis, rabies and tuberculosis were the zoonoses abattoir workers had the highest likelihood of acquiring during their daily routines. Key informant interviews revealed most abattoir workers were exposed to cysticercosis, brucellosis and anthrax. Proportional piling revealed that Tetanus with a score of 76.7% at Lugazi abattoir, Hepatitis B with a score of 90.0% at Kame Valley abattoir, Tuberculosis with a score of 93.0% and Rabies with scores of 30.0% and 33.0% at Kyengera Cattle abattoir and Nakasozi-Buddo Pig Slaughterhouse, respectively, were considered the diseases that caused most severe effects on human health once infected. In line with these findings, 10% brucellosis seropositivity has been reported among abattoir workers in Kampala and Mbarara districts (Nabukenya *et al.*, 2013) [6]. Elsewhere in South Sudan, a large proportion of high-risk groups such as abattoir workers have been reported to have broad knowledge of brucellosis (Madut *et al.*, 2017) [1]. In a study conducted in Nigeria, 90.3% (102/113) of abattoir workers were aware of bovine tuberculosis being contracted from cattle (Sa'idu *et al.*, 2015) [14]. In addition, cysticercosis prevalence in pigs at slaughter in this region has been reported to be 37.6% (Thomas, 2016) [15]. Moreover, hepatitis E is considered a potential emerging zoonotic disease risk to pig slaughterhouse workers [Wertheim *et al.*,

2009; Holt *et al.*, 2016; Cook *et al.*, 2017) [16, 17, 2]. At regional level, brucellosis, rabies and tuberculosis are considered important zoonoses, given their human health impact (Magona *et al.*, 2016) [18].

There was rather a balanced representation of views from the five abattoirs visited during the questionnaire interviews given similar proportions of abattoir workers sampled from the various abattoirs. The proportions among the 52 abattoir workers ranged from 17% to 25% per abattoir. In each abattoir visited, people were selected for the questionnaire interview by the Abattoir Administrators and Abattoir Chairperson in compliance to the objectives of the study. In a similar study conducted in Nigeria, personnel selection from each abattoir included in the study was based on compliance with the interviewer and punctuality in daily abattoir activities (Sa'idu *et al.*, 2015) [14].

In regard to animal species specialization for slaughter, of the five abattoirs visited 44% of the abattoirs specialized in slaughter of cattle and goats, 19% in pigs and 21% in cattle, sheep and goats. This was similar to an abattoir study conducted in Western Kenya in which out of 142 slaughterhouses visited, 37.3% (53/142) specialized in slaughter of only cattle, 40.8% (58/142) in pigs and 21.8% (31/142) in cattle, goats and sheep (Cook *et al.*, 2017) [2].

According to different job groups among abattoir workers interviewed, 33% were traders, then 27% carcass dresser, 15% slaughtermen, 7% offal cleaners, 6% abattoir administrators, 4% transporters, 4% skin and hides handlers and 2% meat inspectors. Other studies have reported different proportions of different job groups among abattoir workers. Cook *et al.* (2017) [2] reported 11% slaughtermen, 75% flayers, 4% Cleaners, 8% offal cleaners and 2% forepersons or owners in a study conducted in Western Kenya. In terms of responsibility, traders supplied the animals for slaughter and distributed and sold meat to consumers. Carcass dressers were responsible for skinning and sectioning the carcass. Slaughtermen were responsible for cutting the animals throats. They were practising Muslims in the mixed ruminant or cattle slaughterhouse to allow all meat products be sold as Halal. Offal cleaners were responsible of cleaning offals, often ensuring minimal contamination of meat. Abattoir administrators were responsible for overall management of the slaughterhouse and its daily activities. Transporters were responsible for providing transport for delivery of animals to the slaughterhouse. Skins and hides handlers were responsible for cleaning, drying and sorting out skins and hides. Meat inspectors were professionals that conducted meat inspection, ante-mortem inspection and ensured meat complied to required standards, including prevention of slaughter of sick animals.

The abattoir workers ranged in age from 20 to 64 years with a highest proportion (24%) lying within the age-group 50-54 years and highest proportion (38%) having worked for 1 to 5 years. Other studies have reported older workers up to 82 years and more experienced workers (mean experience 9.35 years) (Cook *et al.*, 2017) [2]. Most abattoir workers interviewed worked daily (86%) and were males (92%) with few females (8%). Elsewhere studies have reported males constituting 97% and females 3% of the slaughterhouse workers (Cook *et al.*, 2017) [2].

Regarding awareness of abattoir workers on knowledge of zoonoses, a substantial proportion of abattoir workers interviewed (67.3%) were aware of zoonoses but with a

reasonable proportion of abattoir workers (32.7%) not knowing zoonoses. Poor awareness and knowledge of zoonosis combined with food consumption habits and poor animal husbandry are likely to expose abattoir workers to an increased risk of contracting zoonosis. Low knowledge regarding zoonotic infection was also reported in a KAP survey among the abattoir workers in Malaysia (Abdulahi *et al.*, 2016) [4].

It was interesting to note that the substantial proportion of abattoir workers that were aware of zoonoses, knew a wide range of diseases, including, brucellosis, tuberculosis, tetanus, *teania* cyst, mange, foot and mouth disease, swine influenza, hepatitis, lumpy skin disease, African swine fever, lice, *Tunga penetrans*, anthrax, Rift Valley fever, fasciolosis, tick-borne infections and salmonellosis. In line with this, 61% of the respondents reported awareness on brucellosis, with 30% being aware of its mode of transmission in a study conducted among abattoir workers in Kampala and Mbarara (Nabukenya *et al.*, 2013) [6].

A reasonable proportion of abattoir workers interviewed were aware of consumption of meat from diseased animals, drinking of raw milk, contact, open cuts, aerosols, skin cuts, and tick bites as mode infection for zoonoses. Ingestion of undercooked meat and drinking raw milk have been reported to be the commonest known modes of transmission of brucellosis in previous studies conducted among abattoir workers in Kampala and Mbarara (Nabukenya *et al.*, 2013) [6]. Elsewhere in a study conducted in western Kenya 42% of the abattoir workers knew that meat could be a source of disease (Cook *et al.*, 2017) [2]. Unfortunately, a reasonable proportion (23.8%) of the abattoir workers interviewed did not know any mode of transmission of disease from animals and their materials to man. Other studies have also shown a proportion of abattoir workers not having awareness on zoonoses (Cook *et al.*, 2017) [2]. In addition, a lack of knowledge regarding the process of meat contamination is considered the biggest hindrance to improving conditions in the meat industry (Mann, 1984) [12]. Training personnel in meat hygiene has been recommended for improving conditions in slaughterhouses and to reduce bacterial contamination of meat and disease exposure in workers [FAO, 2010; Wamalwa *et al.*, 2012] [10, 19].

A substantial proportion (57%) of the respondents confirmed abattoir structures had roofs though a fairly large proportion (43%) of respondents stated the abattoir structures did not have roofs. Other studies in region reported only 65% of slaughterhouses to have good infrastructure: roof, cement floor, and solid walls (Cook *et al.*, 2017) [2].

Sixty percent of the abattoir workers reported observing rodents and dogs around abattoirs. Close proximity of the abattoir to sugar cane plantations was cited by abattoir workers as a likely risk factor. Presence of pests and roaming animals in the slaughterhouse has been reported as a factor contributing to transmission of infectious disease, either through contamination of meat or eating of meat scraps by dogs or rats, which lead to persistence and spread of diseases such as echinococcosis and leptospirosis (Mann, 1984; Bengtsson *et al.*, 1988; Brown *et al.*, 2011; Cook *et al.*, 2017) [12, 13, 20, 2]. In a study conducted in western Kenya, a large number of slaughterhouses (78%) reported seeing dogs around the facility with a smaller percentage seeing rats (12%) (Cook *et al.*, 2017) [2].

A high proportion of respondents revealed sleeping in the abattoir (60%) and slaughtering of sick animals (86%) was a prohibited practice. Sleeping in the abattoir facilitates disease transmission to abattoir workers. Slaughtering infected animals has been shown to be a risk factor for direct infection with zoonotic diseases such as anthrax, brucellosis, and leptospirosis [Cook *et al.*, 2017] [2].

All abattoir workers interviewed (100%) revealed meat inspection was performed in the abattoirs daily. This was desirable since all abattoirs supplied meat sold to consumers. Other studies have reported 90% of slaughterhouses having daily meat inspections, with meat inspector at times visiting butcheries to inspect the meat if they were too late to perform meat inspection at the slaughterhouses (Cook *et al.*, 2017) [2]. A substantial proportion (67%) of abattoir workers revealed that ante-mortem inspection was conducted daily in the abattoirs. This was much higher than 7% reported in other studies in region (Cook *et al.*, 2017) [2]. It has been observed that where meat inspection is commonly performed at the butchery, ante mortem inspection, which is essential for preventing the slaughter of sick animals, and detailed carcass and organ examination for signs of disease is hindered (Cook *et al.*, 2017) [2].

Utilization of personal protective equipment was highly observed and practised in the abattoirs visited. Boots (98%) and Coveralls (90%) were personal protective equipment commonly used while Gloves (5%), Dust Musks (0%), Respirators (2%), Eye protection (5%) and lab coat overalls (2%) were rarely used by abattoir workers. On the contrary, limited utilization of protective equipment has been reported in slaughterhouses in studies elsewhere, with only 27% of the slaughterhouses using PPE (Cook *et al.*, 2017) [2]. It is likely that abattoirs visited normally provide workers with basic protective equipment such as rubber boots and coverall, while in other regions very few slaughterhouses do provide protective equipment for workers, with workers having to provide their own protective coats in 78% of slaughterhouses and workers providing their own rubber boots in 84% of slaughterhouses (Cook *et al.*, 2017) [2]. Under such an arrangement, cost of protective equipment limits its utilization by abattoir workers. Protective clothing is necessary within the slaughterhouse to primarily protect the meat product from contamination but has also been shown to protect meat handlers against directly transmitted zoonoses such as leptospirosis and brucellosis [Nabukenya *et al.*, 2013; FAO, 2004; Brown *et al.*, 2011; Cook *et al.*, 2017] [6, 21, 20, 2].

A high proportion of abattoir workers (95%) stated they normally observe hand washing in the abattoirs, with 88% practising hand washing during every task. Unfortunately, only 40% of the respondents utilized the soap hand wash. Hand washing is predominantly used to protect meat from contamination, but also protects workers against directly transmitted bacterial pathogens such as *Salmonella* sp [Brown *et al.*, 2011; Gomes-Neves *et al.*, 2012] [20, 22]. The lack of soap for hand washing contravenes international guidelines (Codex-Alimentarius-Commission, 2005; FAO 2004) [23, 21] and may lead to public health implications to abattoir workers and a wider consumer community (Cook *et al.*, 2017) [2].

Sixty-two percent of the abattoir workers interviewed consumed food and drank alcohol in the abattoir while none smoked. Normally smoking, eating and drinking in the

abattoir is not recommended. Smoking and consuming food at the slaughterhouse have been associated with increased risk of zoonotic diseases such as leptospirosis [Campagnolo *et al.*, 2000; Cook *et al.*, 2017) ^[24, 2]. In addition, alcohol consumption has been reported to be a risk factor for injury at work (Stallones L, Xiang H. 2003; Cook *et al.*, 2017) ^[25, 2]. In conclusion, improved abattoir facilities, sanitation and drainage and improved biosafety of workers could be achieved through development support towards facilities and an awareness program for abattoir workers on health hazards, zoonotic disease and protective clothing.



Fig 1: Kyengera Cattle abattoir, Wakiso district, Uganda

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6. Competing interests

Authors of this manuscript declare that they have no competing interests.

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