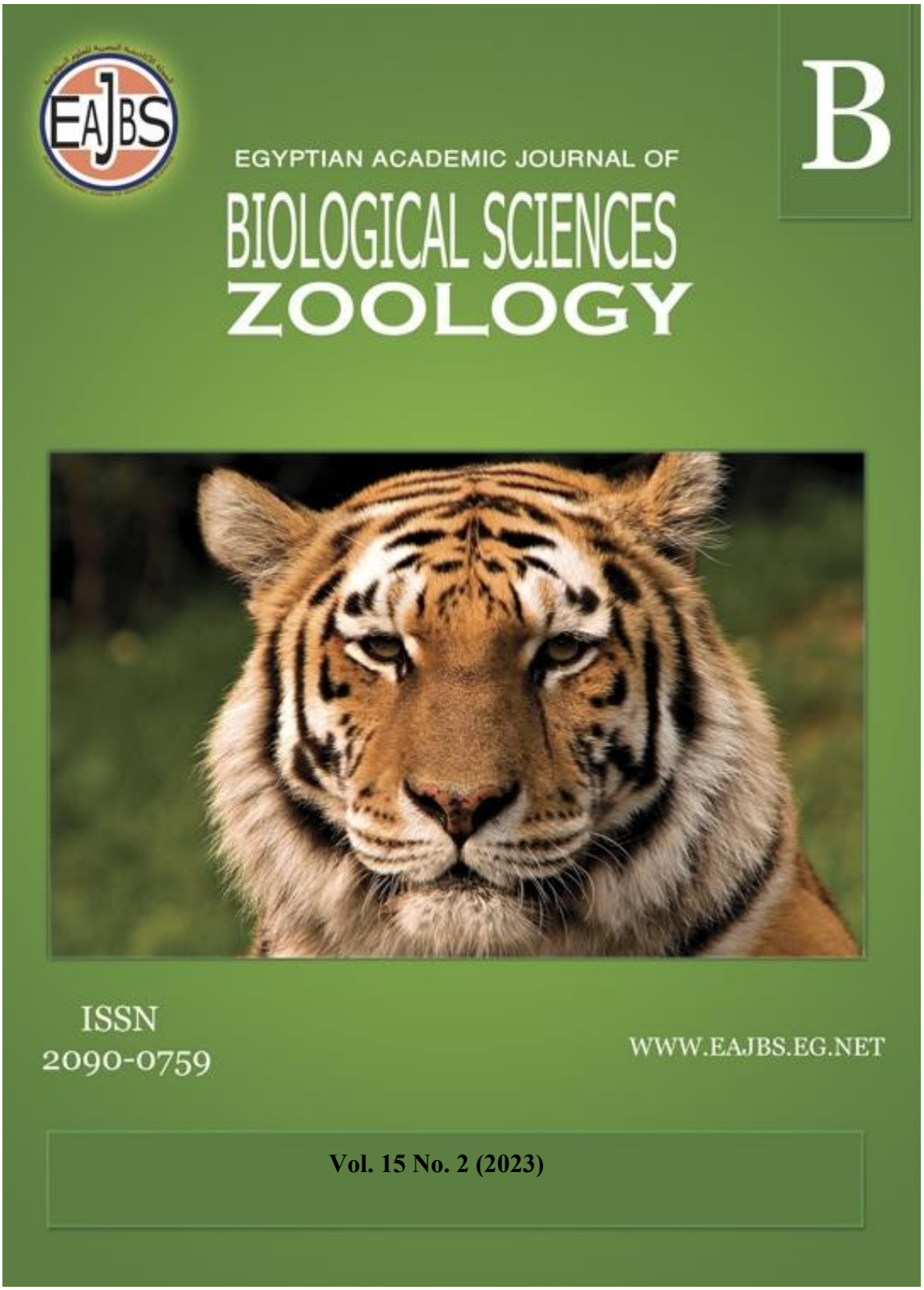

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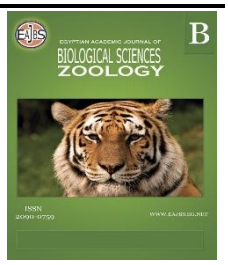

Slaughterhouse Workers' Knowledge, Attitude, and Practice towards Meat Hygiene in Al-Baha, Saudi Arabia: A Cross-Sectional Study

Osman B. O. Mohammed
Public Health Department, Faculty of Applied Medical Sciences, Al-Baha University, Al-Baha, Saudi Arabia.
E-mail : obabiker@bu.edu.sa

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ABSTRACT

Objective: The primary concern and problem revolve around food safety, particularly when it is prepared in an environment with significant contamination. Slaughterhouse workers' role in ensuring food safety includes maintaining hygiene, proper handling and inspection, adherence to regulations, quality control, equipment maintenance, and temperature control. This study aims to investigate the knowledge, attitude, and practice of slaughterhouse workers toward meat hygiene in Al-Baha, Saudi Arabia. **Methods**: This is a cross-sectional design, in which the data was collected from slaughterhouse workers in meat processing facilities in Al-Baha by questionnaires. The questionnaires included questions on demographics, knowledge, attitudes, and practices of meat hygiene. The data collected were analyzed using SPSS program to establish the knowledge, attitudes, and practice levels of slaughterhouse workers regarding meat hygiene. **Result**s: The slaughterhouse workers worked in both Al-Baha and Aqiq facilities, with the majority falling within the 20-30 years age range and having completed elementary school. They demonstrated a satisfactory level of knowledge and positive attitude towards meat hygiene practices, recognizing the potential risks and preventive measures. While most workers exhibited good practice levels, there were areas for improvement, such as avoiding eating or drinking at the workplace and ensuring proper hand hygiene after coughing or sneezing. **Conclusion:** In conclusion, the study revealed that slaughterhouse workers in Al-Baha, Saudi Arabia, demonstrated satisfactory knowledge and positive attitudes toward meat hygiene. While most workers exhibited good practices, there were areas that required improvement. Training in food safety, hand hygiene and prevention are recommended to ensure meat hygiene standards.

INTRODUCTION

The slaughtering of animals for human consumption constitutes a critical industry with significant implications for public health and safety. The potential risks associated with this practice are of utmost concern. Improper handling and processing of animals during slaughter can result in contamination with hazardous bacteria, including Salmonella, E. coli, and Campylobacter, thereby posing a substantial threat to foodborne illnesses among consumers. Moreover, the close proximity to live animals during the slaughtering process

increases the likelihood of zoonotic disease transmission, such as avian influenza and swine flu (Asare, 2020).

Concerns regarding food safety have grown globally as a result of the increasing prevalence of foodborne illnesses (Gutema *et al.*, 2021, Endale and Hailay, 2013, Bersisa *et al.*, 2019). Numerous outbreaks of foodborne illness have reportedly been linked to poor personal hygiene among those handling food (Asare, 2020). Poor sanitation and staff hygiene at the slaughterhouse may contribute to the high microbial load on the surfaces of the processing plant and tools, which may result in the contamination of meat through handlers and contaminated surfaces and equipment and pose substantial risks to the public's health (Asare, 2020, World Health Organization, 2022).

From the standpoint of public health, food safety is a major worry and issue, especially when food is handled in a highly contaminated environment (Soriyi et al., 2008). The growing frequency of foodborne disease is primarily attributed to a number of causes, including poor food handling methods, a lack of financial means to purchase safer equipment, and a lack of training for handlers in food enterprises such as slaughterhouses (Roesel *et al.*, 2019). The principal vectors of meat contamination, such as butchers operating in slaughterhouses, might also be asymptomatic reservoirs of foodborne bacteria (Sharif and Al-Malki, 2010, Todd et al., 2010).

Food handlers must properly wash their hands after handling food to avoid infecting other foods, other foods' surfaces, and themselves (Asare, 2020). Personal hygiene is essential in reducing food contamination and foodborne illness. Transient bacteria can be transmitted through the hands and contaminated gloves (Eljamay *et al.*, 2022).

Meat hygiene practices are of utmost importance in ensuring the safety and quality of meat products for human consumption. Slaughterhouse workers play a crucial role in maintaining hygiene standards during the meat processing chain. Their knowledge, attitudes, and practices toward meat hygiene can potentially affect the safety and quality of meat products (Gutema *et al.*, 2021, Bersisa *et al.*, 2019).

Several studies have investigated the knowledge, attitudes, and practices of slaughterhouse workers regarding meat hygiene. A study by Tadesse et al. reported that slaughterhouse workers lacked proper knowledge and understanding of meat hygiene practices and the principles of food safety (Gutema *et al.*, 2021, Haileselassie *et al.*, 2013, Roesel *et al.*, 2019). Furthermore, a study conducted by Gutema et al. revealed that the practices of slaughterhouse workers towards meat hygiene were influenced by demographic factors and individual experiences (Gutema *et al.*, 2021). Therefore, this study aims to investigate the knowledge, attitude, and practice of slaughterhouse workers toward meat hygiene in Al-Baha, Saudi Arabia.

MATERIALS AND METHODS

Study Design:

A cross-sectional survey study was conducted to gather data on slaughterhouse workers' knowledge, attitudes, and practices toward meat hygiene. This design allows for the collection of information from a representative sample of slaughterhouse workers in Al-Baha and Aqiq.

Study Setting:

The study was conducted in Al-Baha and Aqiq Slaughterhouses, Saudi Arabia, which is known for its significant meat processing industry. Al-Baha is a region located in the southwestern part of Saudi Arabia and there are two slaughterhouses and meat processing facilities in Al-Baha and Aqiq. The region is characterized by diverse cultural and socio-economic backgrounds, making it an ideal setting to capture a representative sample of slaughterhouse workers.

The study specifically focused on slaughterhouse workers in Al-Baha and Aqiq, as these areas are known to have a high concentration of meat processing facilities.

Sample Selection:

This study was conducted on all slaughter workers in both Al-Baha and Aqiq. The number of permanent staff was forty workers distributed between the two areas. A convenient sampling method was utilized to select participants from various meat processing facilities in the study area. The sample size was determined based on the estimated population of slaughterhouse workers in Al-Baha and Aqiq, ensuring a sufficient representation for meaningful analysis. The study was conducted on forty workers (twenty from Al-Baha and twenty from Aqiq).

Data Collection:

The data was collected by the researcher who visited the slaughterhouses and asked the available workers to participate in the study. The period of data collection was conducted over five days from Sunday to Thursday to ensure all workers are included. A structured questionnaire was developed to collect data on demographics, knowledge, attitudes, and practices of targets related to meat hygiene and safety in slaughterhouses. The questionnaire was administered to the participants, due to barriers of language and or communication the filling of the questionnaire was facilitated by the manager of the slaughterhouses to clarify the questions and ensure accurate completion as the whole participants were neither Arabic nor English understanding. The questionnaire was adopted from one previous study and its validity and reliability were assured through pretest of the tool.

Data Analysis:

The collected data were analyzed using appropriate statistical methods, such as descriptive statistics, chi-square tests, and regression analysis. The analysis focused on determining the level of knowledge, attitudes, and practices of slaughterhouse workers regarding meat hygiene. Subgroup analysis based on demographic factors will be conducted to identify any significant associations. Inferential statistics were used to examine associations and identify significant relationships between variables. Chi-square tests or Fisher's exact tests were employed to analyze categorical variables, such as the relationship between demographic factors (e.g., age, education) and knowledge, attitudes, and practices toward meat hygiene.

Ethical Considerations:

This study adheres to ethical guidelines to ensure the protection of participants' rights and privacy. Informed consent was obtained from all participants, and confidentiality of their responses is strictly maintained throughout the study. Ethical approval was obtained from the Deanship of Scientific Research, Al Baha University, Saudi Arabia.

RESULTS

Table 1 presents the demographic characteristics of slaughterhouse workers in Al-Baha, Saudi Arabia. The data shows that 50% of the workers are in Al-Baha, while the other 50% are situated in Aqiq. Most of the workers (80%) fall within the 20-30 years age range, with only 20% being aged between 30-40 years. In terms of education, 75% of the workers have completed elementary school, while 20% have a secondary school education, and only 5% hold a university degree. The majority of workers (62.5%) have temporary employment, while 37.5% have permanent positions. The majority of workers (95%) are directly involved in the slaughter process, with a small percentage (5%) holding Veterinarian positions. Most workers (85%) have less than 5 years of experience, 10% have 5-10 years of experience, and only 5% have over 10 years of experience. Regarding training, 37.5% of the workers have received training, while 62.5% have not undergone any specific training.

Table 1: Slaughterhouse demographic characteristics in Al-Baha, Saudi Arabia (n=40)

Variables		Freq.	Percent
Slaughter place	Al-Baha	**20**	**50**
	Aqiq	**20**	**50**
Age	20-30 years	**32**	**80**
	30-40 years	**8**	**20**
Education	Elementary school	**30**	**75**
	Secondary school	**8**	**20**
	University	**2**	**5**
Type of work	Temporary	**25**	**62.5**
	Permanent	**15**	**37.5**
Job	Slaughter	**38**	**95**
	Veterinarian	**2**	**5**
Experience	< 5 years	**34**	**85**
	5- 10 years	**4**	**10**
	>10 years	**2**	**5**
Training	Yes	**15**	**37.5**
	No	**25**	**62.5**

Table 2 presents the knowledge of slaughterhouse workers in Al-Baha, Saudi Arabia, regarding meat hygiene practices. The data indicates that the majority of workers have a good understanding of the potential risks and preventive measures related to meat contamination. They are aware that hand touching, coughing/sneezing during slaughtering, improper handling of meat, and eating/drinking during the process can pose risks. The workers also recognize the importance of regular hand washing, the use of gloves, proper cleaning and sanitization of tools, and the potential contamination from insects and pests.

Table 2: Slaughterhouse Workers' Knowledge of Meat Hygiene in Al-Baha, Saudi Arabia (n=40)

Variables	Yes	No	I do not know
Hand touching is a risk for contamination of meat.	85	15	0
Coughing/ sneezing during slaughtering is a risk for contamination of meat .	97.5	0	2.5
Improper handling of meat could pose contamination of meat	90	5	5
Regular washing of hands before and during meat handling could reduce the risk of meat contamination.	100	0	0
Eating/drinking during slaughtering increases the risk of meat contamination .	77.5	22.5	0
Using gloves while handling meat reduces the risk of contamination	80	10	10
Microbes are on the skin, nose, and mouth of healthy meat handlers.	75	20	5
Proper cleaning and sanitization of knives and hooks reduce the risk of meat contamination.	95	2.5	2.5
Wearing hand gloves during handling carcasses reduces the risk of contamination of meat.	75	15	10
Insects and pests could be a source of contamination in raw meat.	95	0	5
Cross-contamination is when microorganisms from contaminated meat are transferred by the meat handler's hands to another.	70	20	10
Overall level of knowledge (Mean + SD) = 85±2.14			

Table 3, presents the attitudes of slaughterhouse workers in Al-Baha, Saudi Arabia, towards meat hygiene practices. The data shows that the majority of workers have a positive attitude and understanding of the importance of maintaining hygiene standards in the slaughterhouse. They acknowledge that meat handlers with wounds or injuries should not handle meat, and they believe that the necessity of wearing protective clothing and masks

is necessary during slaughtering operations. The workers also understand the significance of hand washing, area cleaning, and safe meat handling to reduce the risk of contamination. Additionally, they are aware of potential sources of contamination, such as knives, hooks, and cutting boards, and the need for proper sanitization.

Table 3: Slaughterhouse Workers' Attitude towards Meat Hygiene in Al-Baha, Saudi Arabia (n=40)

Variables	Yes	No	Not sure
Meat handlers with wounds or injuries on their hands must not touch or handle meat.	80	15	5
Wearing protective clothing during slaughtering is a must.	85	10	5
Wearing a mask during slaughtering operations is a must.	80	15	5
Hand washing before handling meat reduces the risk of contamination.	90	7.5	2.5
Washing slaughter area before slaughtering operations reduces the risk of contamination.	87.5	7.5	5
Safe meat handling to avoid contamination and diseases is part of meat handler job responsibilities.	82.5	10	7.5
Sneezing or coughing without covering our noses or mouths could contaminate the meat.	77.5	12.5	10
Using watches, earrings and rings will increase the risk of meat contamination.	70	12.5	17.5
Wearing protective clothing and shoes could help improve work safety and hygiene practices.	70	15	15
Knives, hooks and cutting boards can be a source of food contamination.	87.5	5	7.5
Knives and cutting boards should be properly sanitized to prevent cross-contamination.	77.5	10	12.5
Overall level of attitude (Mean + SD) = 80±3.6			

Table 4, presents the practices of slaughterhouse workers in Al-Baha, Saudi Arabia, regarding meat hygiene. The data reveals that the majority of workers exhibit positive practices in various aspects of meat hygiene, such as using hand gloves, wearing protective clothing, and washing hands properly. However, there are areas where improvement is needed, as some workers reported engaging in practices that could pose risks, such as eating or drinking at the workplace, handling meat with cuts or injuries on their hands, or not washing hands after smoking, sneezing, or coughing.

Table 4: Slaughterhouse Workers' Practices Towards Meat Hygiene in Al-Baha, Saudi Arabia (n=40)

Variables	Yes	No
washing of hands before and during meat handling or while handling carcasses.	75	25
Do you drink or eat at your workplace.	77.5	22.5
Do you wear protective clothing during slaughtering operations/while handling carcasses.	82.5	17.5
Do smoke inside meat processing areas?.	70	30
Do you wear a mask during slaughtering operations.	72.5	27.5
Do you wash your hands properly before or after using gloves?.	85	15
Do you eat/drink during slaughtering operations.	82.5	17.5
Do you wash your hand after smoking, sneezing, or coughing.	67.5	32.5
Do you wash hands/cover wounds with water-proof dressing before handling carcasses.	92.5	7.5
Do you wear a hairnet or a cap while working?.	80	20
Do you wash the abattoir/facilities before slaughtering operations.	65	35
Do you handle/process meat when you have cuts, wounds, bruises, or injuries on your hands?.	77.5	22.5
Do you use potable water for washing the abattoir/facilities before slaughtering operations.	70	30
Do you remove your personal stuff such as rings, necklaces, watches, etc. while handling meat .	90	10
Do you wash your hand after sneezing or coughing?.	80	20
Overall level of practice (Mean + SD) = 78±2.1		

Table 5, presents the relationships between slaughterhouse demographic characteristics and the levels of knowledge, attitude, and practices toward meat hygiene in Al-Baha, Saudi Arabia. The analysis explores the impact of demographic variables on these three aspects. Regarding the relationship between demographic variables and knowledge, the results indicate that age, education level, type of work, job, experience, and training have significant associations with the level of knowledge. Workers aged 20-30 years exhibit higher knowledge levels compared to those aged 30-40 years. Additionally, workers with higher education levels, permanent employment, working as slaughterers, having more than 10 years of experience, and receiving training demonstrate greater knowledge about meat hygiene. In terms of the relationship between demographic variables and attitude, the results show that only the type of work and job have significant associations. Workers with temporary employment and those working as slaughterers display more favorable attitudes towards meat hygiene compared to their counterparts. Regarding the relationship between demographic variables and practice, several significant associations are observed. The slaughter place, age, education level, type of work, job, experience, and training are related to workers' practices.

Table 5: Relationships between slaughterhouse demographic characteristics and level of knowledge, attitude and practices toward Meat Hygiene in Al-Baha, Saudi Arabia (n=40)

Variables		Knowledge	p-value	Attitude	p-value	Practice	p-value
Slaughter place	Al-Baha	85	>.05	80	>.05	60	<.05*
	Aqiq	70		75		80	
Age	20-30 years	88	<.05*	81	>.05	75	>.05
	30-40 years	63		75		60	
Education	Elementary school	75	<.05*	87	>.05	67	>.05
	Secondary school	80		88		100	
	University	100		100		100	
Type of work	Temporary	75	>.05	92	<.05*	80	<.05*
	Permanent	80		73		67	
Job	Slaughter	80	<.05*	84	<.05*	82	<.05*
	Veterinarian	100		100		100	
Experience	< 5 years	80	>.05	91	>.05	88	<.05*
	5- 10 years	75		50		50	
	>10 years	100		100		100	
Training	Yes	87	<.05*	80	<.05*	90	<.05*
	No	48		56		52	

DISCUSSION

Investigating the knowledge, attitudes, and practices of workers involved in the slaughterhouse industry is crucial in understanding the hygiene practices that contribute to the safety of carcasses and protect consumers from various foodborne infections. This study aims to explore the behavior and understanding of workers regarding hygiene protocols during the slaughtering process. By examining their knowledge, attitudes, and actual practices, valuable insights can be gained to identify potential areas for improvement. The findings of this study can inform interventions and training programs aimed at enhancing worker compliance with hygiene standards, ensuring the safety of carcasses and reducing the risk of foodborne illnesses among consumers.

Improper handling of carcasses and inadequate hand hygiene practices are widely recognized as significant risk factors in the transmission of meat contamination, resulting in foodborne diseases. When carcasses are not handled properly, there is an increased likelihood of cross-contamination, allowing pathogens to spread from contaminated surfaces to the meat. Moreover, poor hand hygiene, such as inadequate handwashing or the lack of proper sanitization measures, can contribute to the transfer of harmful bacteria and viruses onto the meat during the handling process. These practices pose a substantial threat to public health, as consuming contaminated meat can lead to the development of various foodborne illnesses in consumers. To mitigate these risks, strict adherence to proper carcass handling procedures and rigorous hand hygiene protocols is essential in the meat industry to ensure the production of safe and wholesome products for consumers.

The study revealed a satisfactory overall level of knowledge regarding the role of personal hygiene, and cross-contamination as potential risks of meat contamination and transmission of meat-borne infections, as most respondents answered the knowledge questions correctly including hand touching, coughing/sneezing during slaughtering, improper handling of meat, the use of gloves, proper cleaning and sanitization of tools, and eating or drinking during the slaughtering processes (Mean + SD) = 85±2.14. Food handlers

should constantly wash their hands at every stage of food production to protect the customer from diarrhea and other food-related infections, according to findings made by the Codex Alimentarius Commission in 2003. It's especially important for meat handlers to wash their hands before handling meat, after eating, smoking, coughing, sneezing, touching trash, and visiting the restroom (Alimentarius, 2003).

The study demonstrates that (75%) of respondents' educational level is elementary school, 20% completed secondary level the rest (10%) represent veterinary inspectors or doctors who complete university education. This education profile of meat handlers was statistically found associated with the overall meat hygiene Knowledge(p-value <.05), but does not have a significant role in improving the attitudes and the practices of respondents towards meat hygiene aspects (p-value >.05), despite this positive correlation between the educational level of meat handlers in the target areas, many studies conducted in other countries Ghana, Iraq have reflected that the education has no significant influence on the knowledge of food workers regarding food hygiene (George Amponsah and Ekua Anamoaba, 2011, Aldosky *et al.,* 2016).

The study also confirmed an insignificant influence of working experience on meat handlers' knowledge (P > 0. 5), at the same time working experience was statistically confirmed to have a positive impact on improving their sanitary meat practices (p-value <.05), Similar findings by M.Webb, and A. Morancie, 2015 **(**Webb and Morancie, 2015) as they found a modest correlation between food handlers' work experience and their understanding of food safety.

Training is statistically confirmed to be the major factor in improving knowledge, attitudes and practices concerning carcass safety and sanitation as well as the effect of educational level. This finding supports the assertion made by Gillespie I, et al. in 2000 that training and education may be an effective technique to raise food handlers' awareness of food safety and, as a result, improve food safety procedures (Gillespie *et al.*, 2000).

Another study from 2012 in Malaysia found that the majority of food handlers (94.3 percent) had attended one or more food safety training sessions and that 73.4 percent of them had appropriate knowledge of food-borne pathogens (Abdul-Mutalib *et al.,* 2012). The study looked at twelve attitudes, classified as agree or disagree. The participants' overall attitude was found to be between (Mean + SD) = 803.6, and 90% of them agreed that workers should not touch or handle meat if they have wounds or injuries on their hands. This finding is consistent with Akabanda F, *et al.* (2017).'s observation that hand washing before handling meat lowers the risk of contamination. There is a strong correlation between having a positive outlook and upholding safe food handling procedures, as evidenced by the fact that (98.9%) of meat handlers concur that anyone with cuts, bruises, or other injuries on their hands should not touch or handle meat, and (75.8%) believe that safe meat handling helps prevent disease and contamination (Akabanda et al., 2017).

The majority of participants (75%) use hand gloves during slaughtering operations or while handling carcasses, (82.5%) wear protective clothing during slaughtering operations or while handling carcasses, (92.5%) wash hands/cover wounds with water-proof dressing before handling carcasses, and (80%) wear a hairnet or a cap while working, putting the overall level of personal hygiene practices at around (Mean SD) = 782.1. According to WHO (2014), these generally good personal hygiene habits are essential for preserving the safety of meat and protecting consumers from food-related illness and intoxication (Organization, 2014).

This satisfactory level of personal hygiene practices was found to be positively correlated with many demographic variables including age, type of work, Job, experience, and training.A study in Moroccan slaughterhouses conducted by Mohammed Amine Bahir, *et al.* in 2023 revealed almost similar results, including that 77.5 percent of participants perfumed their hands before handling meat and the majority of slaughterers adhered to best

practices when it came to cleaning the slaughter area and equipment both before and after the slaughter process (Bahir *et al.,* 2023).

This study highlights the importance of maintaining good standards of food safety in slaughterhouses and sheds light on the knowledge and practices of workers in Al-Baha, Saudi Arabia. The results underscore the significance of targeted training initiatives and continuous monitoring to uphold meat hygiene standards and protect public health. By addressing areas that require improvement, stakeholders can work towards ensuring consistent adherence to food safety regulations in the meat processing industry. The study has several limitations, such as the potential for self-report bias in the questionnaires, which may limit causal inferences, another limitation is the small sample size as the study was conducted in one region of Saudi Arabia with over forty workers which limits its generalizability.

Conclusion:

The findings revealed that many meat handlers possess a fundamental understanding and positive attitude towards personal hygiene, particularly in terms of hand hygiene practices such as regular washing before and during meat handling, as well as the utilization of protective clothing and masks during slaughtering operations. The insights gained from this study can be leveraged to develop targeted interventions and policies aimed at enhancing meat hygiene practices. By implementing these measures, the safety and quality of meat products for human consumption can be improved, ensuring the well-being of consumers.

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