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Knowledge Towards Food-Borne Parasitic Zoonoses and Self-Reported Hygiene Practices of Fish and Meat Vendors in the Public Market of Bay, Laguna

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Abstract

Food-borne parasitic zoonoses (FBPZs), caused by the consumption of food or water contaminated by infectious parasites, pose significant public health concerns in countries like the Philippines, where animal source foods are integral to diet and these diseases remain endemic. As they are often transmitted through food-handling practices, vendors have an important role in their prevention. With this, the study assessed the level of knowledge of the fish and meat vendors in Bay Public Market towards FBPZs and their hygiene practices. A descriptive cross-sectional study was conducted on 37 participants through the completion of a survey questionnaire on socio-demographic profile, knowledge of FBPZs, and self-reported hygiene practices. Data analyses were done through descriptive statistics, Pearson correlation, and Spearman correlation test. Results revealed that the majority (65.7%) have a good level of knowledge on FBPZs. Vendors reported that they always (median = 5) adhere to good hygiene practices and rarely (median = 2) to poor hygiene practices. Furthermore, a significant but moderate inverse correlation (r=-0.430, p=0.008) was found between vendors' age and knowledge on FBPZs. Hence, there is a need for targeted interventions to enhance understanding of FBPZs, particularly among older vendors, and to further improve hygiene practices to mitigate risk of transmission of these diseases.

Key Words: *Food-borne parasitic zoonoses, knowledge, hygiene practices, fish and meat vendors, animal source food, food-borne diseases*

Introduction

Access to an adequate supply of safe and nutritious food is essential for a sustainable life and good health. Despite this fact, many public health agencies do not completely understand the global importance of food safety. Food-borne disease (FBD) is becoming more common based on epidemiological surveillance (Käferstein & Abdussalam, 1999). According to WHO, 600 million people are reportedly becoming ill after consuming contaminated food, while 420,000 die every year. Infants, young children, the elderly, and people who are ill are particularly affected by the vicious cycle of disease and malnutrition that this creates (WHO, 2022).

Some food-borne illnesses are considered to be zoonotic. Zoonotic diseases are infectious diseases that may be transmitted from animals to humans. Unsafe farming methods, poor food handling, and contamination during production or distribution are a few of the key pathways for zoonotic illnesses to enter the food we consume (Liou, 2021). Therefore, food is an important vector for many zoonotic pathogens. However, it is important to note that food from animal sources increases the human health risk of food-borne zoonoses (Carrique-Mas & Bryant, 2013). This is because vertebrate animals are natural reservoirs for many zoonotic diseases (Leahy et al., 2022).

Food-borne zoonoses (FBZs) can be classified into three: parasites, bacteria, and viruses. Food-borne parasitic zoonoses (FBPZs) have afflicted human lives, many of which are caused by helminths. Schistosomiasis, cysticercosis, trematodiasis, and echinococcosis are prominent zoonotic parasite illnesses, and some of them have high mortality rates or long-term consequences including cancer and neurological abnormalities (Wielinga & Schlundt, 2012). An estimated 23.2 million cases and 45,927 fatalities every year have been reportedly caused by food-borne parasitic diseases (Torgerson et al., 2015).

In the Philippines, several FBPZs were documented in a study by Eduardo in 1991 and 2001. These include echinostomiasis, artyfechinostomosis, fascioliasis, heterophyiasis, carneophallosis, clonorchiasis, paragonimiasis, taeniasis, echinococcosis/ hydatidosis, diphyllobothriosis/spirometrosis and sparganosis, intestinal capillariasis, gnathostomiasis, angiostrongylosis, toxoplasmosis and sarcosporidiosis. While some of the FBPZs are now rarely observed, others remain significant concerns for public health. Many of these diseases are endemic in some regions of the Philippines, particularly where there is a tradition of eating raw or undercooked fish, snails, crustaceans, and meat (Eduardo, 1991, 2001).

A wide range of foods typically come together in markets. In Asia, public wet markets are regarded as traditional food providers and are key suppliers of everyday goods including fresh meats and produce (Carmen et al., 2020). As a source of food for human consumption, food safety is of great importance in public markets to protect consumers as well as vendors from foodborne diseases. Vendors, in particular, have significant roles in the etiology of FBZs outbreaks (Grwambi, 2020). The manner in which food is prepared and handled by vendors can cause cross-contamination and encourage the spread of FBZs. Several studies have shown how a lack of knowledge among vendors of animal-source food in low- and middle-income countries causes unsafe practices to persist (Leahy et al., 2022). Hence, understanding and improving the vendor's awareness has been a focus to address this issue. Furthermore, according to Murrell (2013), with a lack of knowledge about infection and proper hygiene, poor animal husbandry, and improper storage and disposal of human and animal waste products, the risk of people for FBPZs is at highest. This emphasizes the importance of determining vendor knowledge regarding FBPZs, especially those that handle animal source food, and their hygiene practices in their work settings. Not only are they vulnerable to the disease because of the nature of the foods that they market, but also because of their level of knowledge about these FBPZs and their compliance with hygiene practices.

This study aimed to assess the level of knowledge on FBPZs and the hygiene practices of the fish and meat vendors in the public market of Bay, Laguna. Specifically, it described the socio-demographic profile and hygienic practices of the fish and meat vendors. It also measured the level of knowledge of the fish and meat vendors about FBPZs and determined their source of knowledge about food safety. Furthermore, this study determined the relationship among the knowledge of FBPZs, hygienic practices, and socio-demographic profile of the fish and meat vendors. The findings of this study provide local data on the level of knowledge of the fish and meat vendors in the public market of Bay, Laguna regarding FBPZs and their compliance to hygiene practices. These are useful for local government units (LGUs), especially of Bay, Laguna, for developing programs, and policies, as well as for planning interventions towards improving the knowledge on FBPZs and scaling up the food safety practices of public market vendors. Such interventions are crucial to lessen the risk of consumers and vendors against food-borne diseases (FBDs) such as parasitic zoonoses and strengthen the market's competitiveness in meeting global food safety standards.

Materials and Methods

Locale of the Study

The study was conducted at the Pamilihang Bayan ng Bay or Bay Public Market, which is a central public market and biggest market of Bay located in Barangay Dila along Jose Rizal Avenue, Bay, Laguna. Bay Public Market is situated near the key municipal institutions, including the Municipal Hall and San Agustin Parish Church, public and private educational facilities, and foodservice and other business establishments. Furthermore, the public market is highly accessible to most barangays of Bay and nearby food establishments as well as nearby municipalities, making it the major source of daily food for the locals residing in the municipality and even locals from other municipalities.

Research Design

The research design selected to address the objectives of this study was a descriptive cross-sectional. A cross-sectional study design involves gathering of data on the presence or level of one or more variables of interest as they exist in a defined population at one particular time (Aggarwal & Ranganathan, 2019). Similar studies by Alemayehu and colleagues (2021) and Otuh et al. (2023) that were conducted in the past utilized the cross-sectional method of study to assess the knowledge and practice, along with other variables, of different populations of interest on FBZs. Furthermore, cross-sectional study is relatively simple and inexpensive to carry out (Aggarwal & Ranganathan, 2019). Specifically, a descriptive cross-sectional study was selected as it can provide data for describing the status of a variable or relationships among variables at a fixed point in time (Ihudiebube-Splendor & Chikeme, 2020). This study will not only describe the socio-demographic profile, the level of knowledge on FBPZs, and the hygienic practices of the vendors but also determine the relationship among these variables. Therefore, this design was found appropriate for the aims of this study.

Study Population

The study focused on the fish and meat vendors of Bay Public Market. A list of the fish and meat business lines operating with business permit and license in the Bay Public Market was obtained from the Business Permit and License Office of the Municipality of Bay. From the list, the researcher ensured that all the stalls included in the lists still existed or operated prior to the data collection period. Fish and meat stalls that were no longer operating were excluded from the list. The total population of interest consists of vendors from the 39 stalls identified as actively selling fish and meat in the Bay Public Market based from the municipal list and actual checking. All vendors from the stalls selling fish and meats were the target participants of this study. Given the small population of the study, a complete enumeration survey was conducted. A complete enumeration method or a census is a non-

sampling method that involves studying the entire population of the study (Arnab, 2017). A census is free from sampling error, providing a true measure of the population. However, it can be difficult to enumerate all units of the population within a given time, and it can cost more and may entail more time to collect and analyze data. That is why when the number of survey units in a population is so large, the units are sampled which is more practical. However, in this study, the population is not very large for a whole population survey to be impossible to carry out. For very small populations (50 or less), one needs almost the entire population to achieve accuracy (Morris, n.d.). Considering that the population in this study was only 39, a whole population survey was done.

The study intended to conduct a whole population approach, aiming to survey every stall. However, due to practical constraints, such as closures during the data collection period, 2 stalls were not included in the survey. Hence, vendors from the 37 stalls were the final participants of this study.

Data Collection

Questionnaire Design

A self-administered survey questionnaire intended to measure the knowledge towards FBPZs and the hygiene practices of the fish and meat vendors was developed as there are no questionnaires that can be adapted from other studies for this topic and the target population. The questions and the number of questions in the survey questionnaire were revised accordingly based on the comments of the panel of experts and the pre-testing carried out. The resulting 29-item questionnaire was categorized under three (3) parts. The questionnaire that was developed was also translated in the local language, which is Tagalog, to suit the characteristics of the target population and ensure that they understood the questions.

The first part of the questionnaire covers the socio-demographic characteristics of the respondents, containing basic information on the gender, age, level of education, the number of years that they have worked as vendors, their merchandise, and whether they have attended a food safety seminar.

The second part focused on the knowledge of the vendors on FBPZs, which was further subdivided into two parts. The first part contains a question on whether the vendors knew about the FBPZs. This question aims to determine the awareness of the vendors on FBPZs. To determine the source of knowledge of the vendors about FBPZs, a question on where they have heard or read about it was included. Furthermore, the respondents were asked to provide examples of FBPZs that they have read, heard, or read to confirm that they really are aware or have knowledge about the FBPZs. The second part of part two (2) also included 10 statements revolving around concepts of FBPZs with three possible responses – true, false, and do not know. The statements were developed from the report of the Food and Agriculture Organization (FAO) and World Health Organization (WHO) about the current status of knowledge on parasites and their public health impact (FAO & WHO, 2014). Furthermore, statements were also generated based on the fact sheets on different FBPZs published by the Food and Agriculture Organization (FAO), World Health Organization (WHO), and World Organisation for Animal Health (WOAH) (2021). These resources contain necessary information about the transmission and risk factors, signs and symptoms, detection and diagnosis, treatment, and control and prevention of various FBPZs. For this 10-item part, each item that was answered correctly by the respondents bears 1 point or score. Incorrect answers, including "do not know" responses were given a 0 point.

The third section covers the hygienic practices of the vendors, which contains 10 statements with five categorical answers (1-never, 2-rarely, 3-sometimes, 4-often and 5-always) to measure the extent of application of the stated practices. The statements for this section were developed from the Codex Alimentarius book of the FAO and WHO (2022), which includes the Good Hygiene Practices (GHP) that the food business operators (FBOs) must understand and follow to oversee food safety and suitability.

Validity and Reliability

To ensure validity, the questionnaire was sent to six (6) food and nutrition experts. The panel of experts was asked whether each question or statement were valid or not. The experts were also asked to provide comments to further improve the survey questionnaire. The inter-rater agreement was analyzed through Cohen's Kappa (McHugh, 2012). The survey consisted of 29 items and the computed value for Cohen's Kappa was 0.9655, which means that there is an almost perfect agreement among the answers of the expert, ensuring that the survey questionnaire was valid.

To further assess the applicability of the survey tool to the intended population, a pre-testing was carried out among fish and meat vendors in small markets and roadside stalls around Los Baños and Bay, Laguna. A total of 18 respondents took part in the pre-testing. The administered questionnaires during the pre-testing were the revised version based on the comments and suggestions of the panel of experts.

To measure the reliability, the internal consistency of the survey tool was determined using Cronbach's alpha, wherein a value of at least 0.7 guaranteed the consistency of the questionnaire (George & Mallery, 2003). In the survey questionnaire, the knowledge (part 2B) and hygiene practice (part 3) parts were subjected to Cronbach's alpha. The part 2B, which contains 10 items of true or false statements, had a computed Cronbach's alpha of 0.7414, which means that it has an acceptable internal consistency. The part 3, containing 10 items of 5-point likert

scale statements had a computed Cronbach's alpha of 0.7217, which means that it has an acceptable internal consistency as well.

Survey Conduct

The data collection was conducted from 23 May to 25 May 2024 at the wet section of Bay Public Market. The informed consent form and questionnaire were handed out personally by the researcher to the literate participants. The respondents were required to read and understand the form, and then sign them before answering the questionnaire. After answering, the researcher collected the certificate of consent and survey questionnaire from the participants and immediately gave the incentive as an appreciation to the participants. For the participants who were illiterate or were unable to read the survey tool due to poor eyesight, the researcher read the consent form and questionnaire and recorded the answer as spoken by the participants. A thumbprint in the certificate of consent was obtained from the illiterate participants who agreed to participate in this study.

Data Analysis

All the data that were collected were entered in Excel spreadsheet. Statistical coding and computation were done in the RStudio Integrated Development Environment (IDE) by a statistician.

The data were presented using descriptive statistics through frequency and percentage distribution. This analysis was used to describe the socio-demographic profile, knowledge on FBPZs, the distribution of correct and incorrect answers in the true or false statements, and the level of knowledge on FBPZs.

The level of knowledge on FBPZs was determined through the percentage of correct answers by each respondent in the part 2B of the survey questionnaire. Each statement in this part that was correctly answered by the respondents was given 1 point. The maximum score for this section was, therefore, 10 points. The cumulative score for this section was then converted to 100%, wherein interpretations were made. A score of below 70% was considered a poor level of knowledge while a score of 70% and above was considered a good level of knowledge, which was adapted from a related study on the food safety knowledge, attitude, and hygiene practices of food handlers (Tuglo et al., 2021).

For describing the hygienic practices of the vendors, the median score or answer for each statement was determined. To analyze the correlation between variables, Spearman's rank correlation and Pearson correlation tests were used (Table 1). The Pearson correlation coefficient was used to evaluate the strength and direction of the relationship between two continuous variables such as age and knowledge, and years of experience and knowledge. This correlation test has been similarly used in related studies about food safety KAP of street food vendors in Bangladesh and food handlers in Ghana (Meher et al., 2022; Tuglo et al., 2021). Pearson correlation test was also employed in a study about food safety KAP of food handlers in Indonesia which uses total population (Putri & Susanna, 2021). Spearman rank correlation, on the other hand, was used to evaluate the strength and direction of association between ordinal variables such as the level of education and hygiene practices (Schober et al., 2018). This correlation test has also been used in a study about food safety KAP of street food vendors in Bangladesh (Meher et al., 2022). To determine the significance of the identified relationship between variables, a p-value < 0.05 was considered statistically significant. Nonetheless, non-significant relationships can still be discussed (Hanover College Psychology Department, n.d.). A non-significant result does not necessarily mean that there is no relationship between variables and could be due to a small effect or low statistical power of the study (Fein et al., 2022).

Table 1. Interpretation of correlation coefficient.

Correlation Coefficient	Strength of Linear Correlation/Association
0.00 - 0.20	Very Weak
0.21 - 0.40	Weak
0.41 - 0.60	Moderate
0.61 - 0.80	Strong
0.81 - 1.00	Very Strong

Results and Discussion

Socio-Demographic Profile

The fish and meat vendors surveyed in this study were mainly female vendors (64.9%) with only 35.1% were male vendors (N=37). The youngest respondent that was surveyed was 18 years old while the oldest was 75 years old. The mean age of the respondents is around 44 years old with a standard deviation of 15.33. Hence, they are commonly around 21-65 years old. The majority (56.7%) of the vendors have attained high school level of education, including high school graduates. Some had no formal education (2.7%) and had vocational education (8.1%). Most (40.5%) of the vendors had over 10 years of working experience as fish and meat vendors (Table 2).

Table 2. Percentage distribution of the respondents according to socio-demographic characteristics, public market of Bay, Laguna.

Characteristics	Indicators	Total, n (%) n = 37
Sex	Male	13 (35.1%)
	Female	24 (64.9%)
Age group	< 21 years	2 (5.4%)
	21-35 years	12 (32.4%)
	36-50 years	11 (29.7%)
	51-65 years	10 (27.0%)
	> 65 years	2 (5.4%)
Level of Education	No formal education	1 (2.7%)
	Elementary level	2 (5.4%)
	High School level	16 (43.2 %)
	High School graduate	5 (13.5%)
	College level	6 (16.2%)
	College graduate	4 (10.8%)
	Vocational level	2 (5.4%)
	Vocational graduate	1 (2.7%)
Years of Work Experience	< 1 year	3 (8.1%)
	1-5 years	10 (27.0%)
	6-10 years	9 (24.3%)
	> 10 years	15 (40.5%)

Interestingly, many of the fish and meat vendors surveyed in this study were female, which contradicts several related studies wherein male food vendors or food handlers predominate (Jianu & Golet, 2014; Kanaan et al., 2023; Siddiky et al., 2022). The fish and meat vendors were also mostly around 21 to 65 years old, which is a wider age range than the respondents, around 21 to 50 years old and 20 to 40 years old, in related studies (Jianu & Golet, 2014; Siddiky et al., 2022). This can be due to the fact that the Philippines certainly has a wide range of working age, from 15 years old to 64 years old (PSA, 2020). The majority of the fish and meat vendors in this current study attained a high school level of education, which is comparable to the studies in western Romania and Ghana, wherein most meat handlers and street food handlers have a high school or secondary level of education (Jianu & Golet, 2014; Tuglo et al., 2021). Market vendors have often been characterized by several studies with their low level of education, especially elementary and high school levels (Adzitey et al., 2018; Amaami, et al., 2016; Khanal & Poudel, 2017; Siddiky, et al., 2022). Furthermore, most fish and meat vendors in this study have over ten years of working experience as market vendors, which was longer than the related studies wherein the majority of their food handlers or vendors have less than 5 years of work experience (Jianu & Golet, 2014; Kanaan et al., 2023; Siddiky et al., 2022).

Based on Figure 1, most of the vendors sell either fish (43.2%) or pork (40.5%), while only 21.6% sell chicken and less than 3% sell beef. Some vendors (10.8%) also sell other fish and meat products including carabao meat, shellfish like mussels and shrimps. The highest percentage of vendors selling fish could be due to the fact that the municipality is near the Laguna de Bay, where freshwater fishes are available. Furthermore, there are several local ponds in the municipality that produce tilapia and catfish (Municipality of Bay, 2022).

Majority (62.2%) of the fish and meat vendors have no experience in attending any food safety seminar. Only 37.8% of the vendors have attended seminars or training on food safety (Figure 2). This proportion was higher in a study in Bangladesh wherein none of the chicken vendors had food safety training (Siddiky et al., 2022), but somehow close to the 44% of food handlers who received a food safety training course in Ghana (Tuglo et al., 2021). The disparity could be caused by factors such as accessibility of food safety programs for vendors and varying regulations in their corresponding local governments. Nevertheless, the high proportion of vendors who never had any food safety training in this study suggests the need for the market supervisor and the LGU to prioritize training initiatives, especially given the nature of their work involving food handling. Food safety training can be given to enhance knowledge, attitude, and practices of food handlers or vendors towards food safety (Siddiky et al., 2022).

Knowledge of Food-Borne Parasitic Zoonoses

The majority (n=28, 75.7%) of the fish and meat vendors reported that they do not have knowledge of what a FBPZs is and only 24.3% (n=9) claim that they know what a FBPZs is (Figure 3). Among those who claimed to know about FBPZs, only two (2) had a sense answer in relation to the question of where they heard or knew about the FBPZs. Their answers were nutrition and health, the internet, and television. The very few responses and sources provided for this question may suggest that there are limited or inaccessible sources of information on FBPZs. In fact, there is little information on food-borne parasites that is widely available from various sources,

unlike other food-borne hazards such as bacteria and chemical residues, which is why their identity and characteristics are often confused with those of bacteria and viruses (Gajadhar, 2015). Nonetheless, the cited sources of knowledge can be used by the LGU as a medium for providing information on FBPZs.

On the other hand, only two (2) responses were also given with regards to the examples of FBPZs that the vendors know or heard, which include tapeworm and worms in fish and meat. These examples are actually parasites which may cause FBPZs but not the actual disease that is being asked. This may demonstrate uncertainty and a narrow scope of knowledge concerning the various FBPZs.

Based on the assessment of the level of knowledge of the fish and meat vendors towards FBPZs, the majority (65.7%) had a score of 70% and above, hence, they have a good level of knowledge. 34.3% of the vendors, on the other hand, displayed a poor level of knowledge regarding FBPZs (Figure 4). On average, respondents had a score of 6.57 with a standard deviation of 1.91.

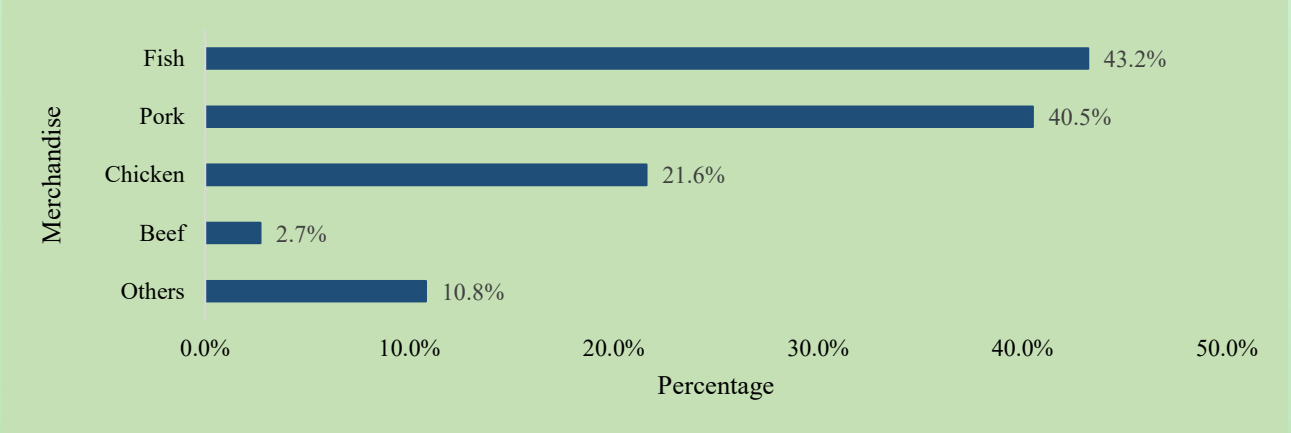

Figure 1. Percentage distribution of the fish and meat vendors' merchandise in the public market of Bay, Laguna.

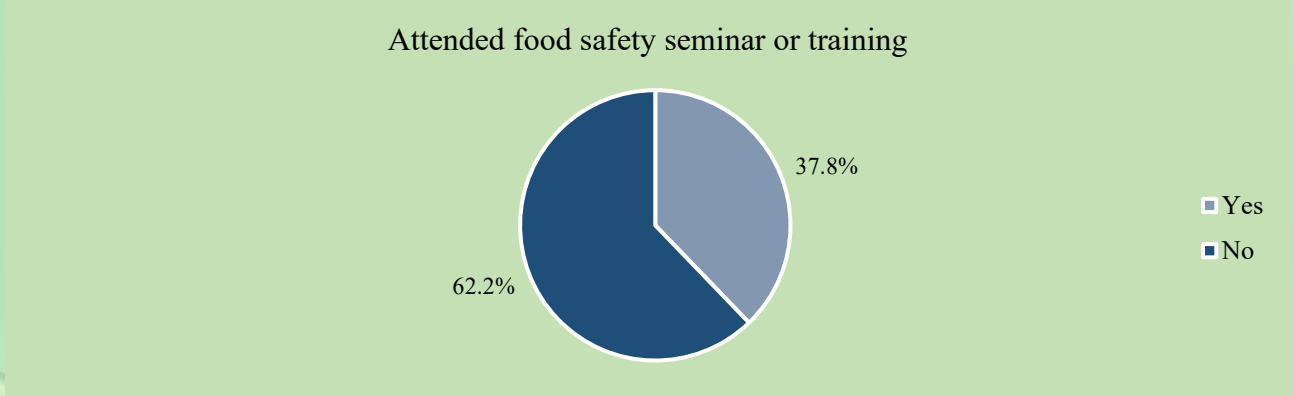

Figure 2. Percentage distribution of fish and meat vendors in the public market of Bay, Laguna who have attended food safety training or seminars.

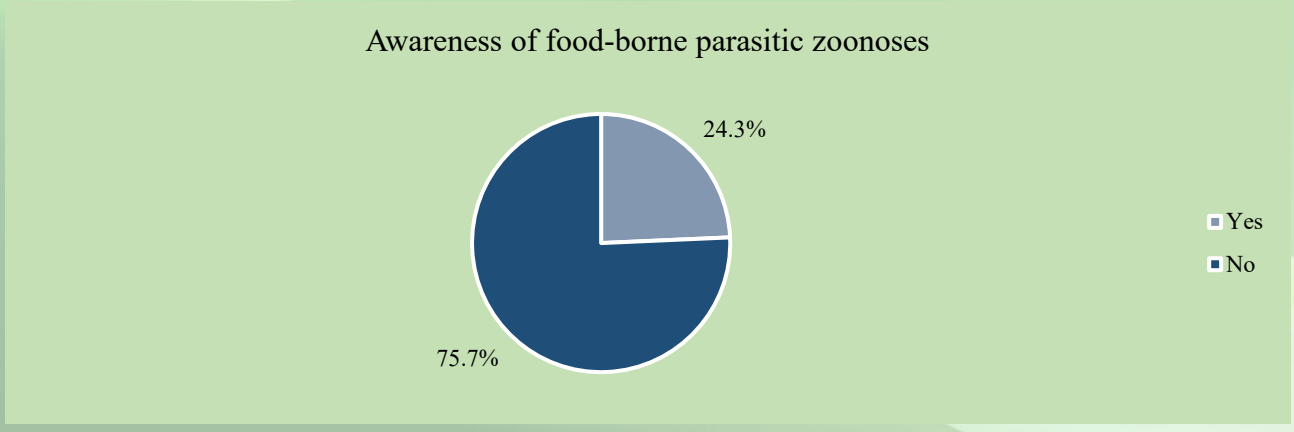

Figure 3. Percentage distribution of fish and meat vendors in public market of Bay, Laguna who knows what a food-borne parasitic zoonoses is.

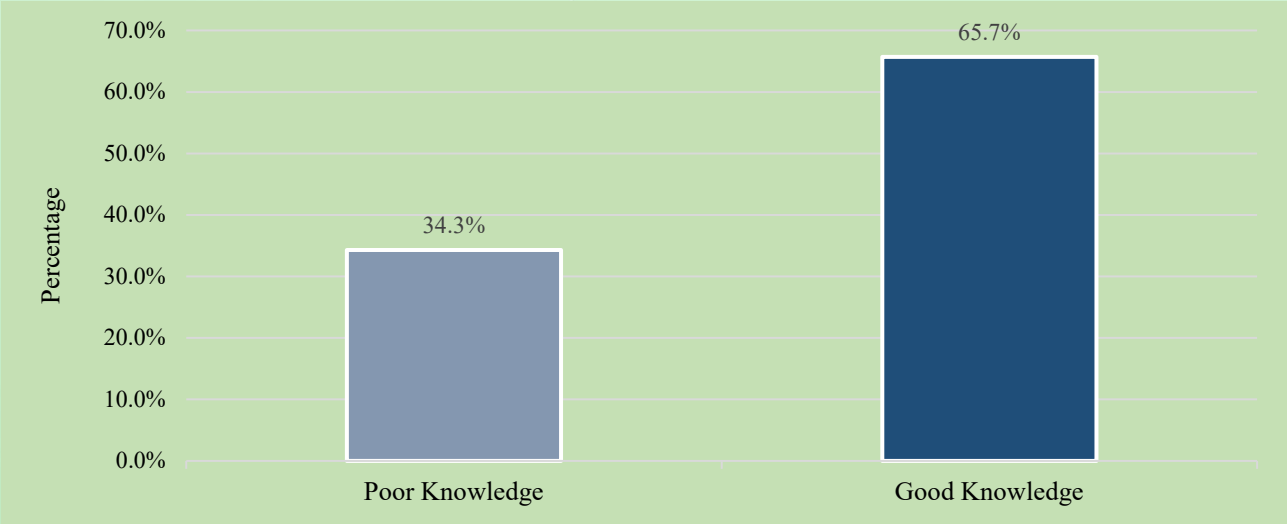

Figure 4. Level of knowledge on FBPZs of fish and meat vendors in the public market of Bay, Laguna.

Despite the low initial recognition, the surveyed fish and meat vendors may have demonstrated a good level of practical knowledge of the key concepts related to FBPZs, including transmission, associated symptoms, and preventive measures. The low proportion of vendors who were aware of what a FBPZs is, may be due to the lack of recognition of the specific term or academic terminology, which is the food-borne parasitic zoonoses. It can be that vendors possess practical knowledge about food-borne parasites but may not identify them under specific academic or technical terms. The simplicity of the examples of food-borne parasites that was also provided may be evidence for this, as tapeworms and worms are some common names. In a pilot study in Nigeria, it was found that the majority of the respondents had good knowledge of zoonoses, FBZs, preventive methods, and associated health risks, but had poor knowledge of the types of FBZs. The reason was attributed to the technical/medical nomenclature of the types of diseases in the questionnaire (Otuh et al., 2023).

The relatively good level of knowledge about FBPZs in this study may be attributed to several factors, including the years of work experience and the level of education of the fish and meat vendors. Many vendors in this study have over ten years of working experience. This extensive work experience likely gave them exposure to various aspects of food safety and the risks associated with some FBDs. According to Teferi (2022), food handlers with longer work experience may have accumulated better knowledge and skills associated with food safety. Hence, in this study, the vendors may have gained knowledge related to food safety and FBZs through observations or personal experience while working. Moreover, despite the fact that the majority of the vendors have a high school level of education, the basic education that they received may still provide them with foundational knowledge on food safety. Here in the Philippines, part of the curriculum for grade 7 or 8 is the home economics cookery course in technology and livelihood education (TLE). It includes discussion on some biological hazards or risks (DepEd, 2016b). Moreover, the health subject in grade 4 includes topics on food safety principles and food-borne diseases (DepEd, 2016a). Hence, the foundational education that the vendors have may contribute to their understanding of food safety and FBDs, despite lacking in technical terms, such as the FBPZs.

The observed good level of knowledge among vendors is encouraging from a public health perspective, as it indicates some foundational understanding of key aspects related to food safety and zoonotic diseases, especially parasitic zoonoses. Such knowledge is crucial for implementing effective hygiene practices and preventive measures to minimize the risk of foodborne illnesses, particularly FBPZs, within the market setting. A related study found that a good knowledge in the manner of transmission, prevention, and acquisition of meat-borne parasites has been directly correlated with proper food safety practices, which may lower the risks of parasitic infection (Camacho, et al., 2021). This finding of the study was inconsistent with other related studies on knowledge of food handlers specifically on zoonoses. A study on Nigeria found that the overall level of knowledge and awareness among suppliers of bushmeat was low (Ozioko et al., 2018). Similarly, a study in wet markets in Dhaka, Bangladesh found that although chicken vendors have satisfactory levels of knowledge on food safety in general, they had unsatisfactory knowledge on zoonoses and food-borne pathogens (Siddiky et al., 2022). Nonetheless, a survey in India had consistent results with this study, wherein the majority (60%) of butchers showed awareness of the commonly occurring zoonotic diseases (Prabhakar et al., 2017).

While this study found that the majority of the fish and meat vendors had a good level of knowledge regarding FBPZs, certain areas in the survey highlighted significant gaps in the understanding. Table 3 summarizes the vendors' answers about FBPZs. Most of the fish and meat vendors displayed poor knowledge on the source of some food-borne parasites as only 42.9% of them knew that lung flukes can originate from dogs and cats. Lung fluke infection, or *paragonimiasis*, is known to be endemic in eight of the 17 administrative regions in the

Philippines (WHO et al., 2020). This can originate from dogs and cats, passed on to and infect freshwater crustaceans that are foods of humans, causing diseases upon eating raw or undercooked (WHO et al., 2021). However, less than half (48.6%) of the respondents only knew the risks of FBPZs associated with consuming raw or undercooked fish and meat, highlighting a crucial gap in knowledge regarding the transmission of parasitic infections through food. This underscores the importance of knowing the source and transmission of lung fluke infection and other parasitic zoonoses among vendors for implementing appropriate preventive measures such as practicing safe food handling, towards mitigating the risks against FBPZs.

The majority of the vendors displayed poor knowledge of the proper storage temperature for preventing FBPZs, as approximately one-fourth (25.7%) knew that it is not right to store fish and meat at high temperatures to prevent diseases from food-borne parasites. This was somehow consistent with the result of a study, wherein it was found few vendors and consumers correctly indicated that protein foods, including fish and meat, should be discarded if exposed to non-refrigerated temperature for 2 hours (Nkosi & Tabit, 2021). This lack of knowledge in proper temperature handling for fish and meat could be because market settings often lack refrigeration and vendors usually display their goods on a display table and are exposed to open air (GAIN, 2020). Moreover, few (40%) of the vendors knew that directly drinking raw water or water from rivers, lakes, and springs does not prevent FBPZs, with more than half (51.4%) of the respondents displaying incorrect knowledge about this. This result of the study disagrees with studies from Iraq and Ghana, which found that most food handlers displayed good knowledge of the use of treated water for cooking and consumption (Kanaan et al., 2023; Tuglo et al., 2021). The disagreement could be because this statement was negatively structured in this study. The lack of knowledge on the correct temperature for storage and safe water to use is an issue of food safety. Hence, this emphasizes the need for training or education on safe food handling temperature and safe water consumption among the fish and meat vendors. This is important as keeping food at a safe temperature and using safe water and raw materials are included in the WHO's five keys to safer food, which, when applied, can mitigate the risk of many FBZs (GAIN, 2020).

Nonetheless, in this study, the majority of the vendors showed good knowledge on some preventive measures to minimize risk of FBPZs, as almost all (97.1%) knew about washing hands and utensils and 91.4% knew about separating raw and cooked foods. The majority also have good knowledge of the possible effects of the parasites to an individual as 88.6% knew that parasites in fish and meat can make people sick if not handled or cooked properly and that they can present several symptoms to an individual. Most (74.3%) vendors even knew food or water contaminated with pork tapeworm can cause disease in various organs.

Table 3. Distribution of the respondents' answers about knowledge on FBPZs.

Knowledge Questions	Responses, n (%)		
	Correct	Incorrect	Don't know
Meat and fish can be sources of food-borne parasitic zoonoses.	21 (60%)	1 (2.9%)	13 (37.1%)
Lung flukes that affect human lungs can originate from dogs and cats.	15 (42.9%)	4 (11.4%)	16 (45.7%)
Parasites in fish and meat can make people sick if not handled or cooked properly.	31 (88.6%)	1 (2.9%)	3 (8.6%)
Parasites present in fish and meat products can cause fever, diarrhea, nausea and vomiting, headache, body ache, and stomach pain.	31 (88.6%)	0	4 (11.4%)
Consuming raw or undercooked meat and fish does not have risks in acquiring parasitic infection.	17 (48.6%)	13 (37.1%)	5 (14.3%)
Consuming food or water contaminated with pork tapeworm may cause disease involving the brain, heart, or eyes.	26 (74.3%)	3 (8.6%)	6 (17.1%)
Storing meat and fish at high temperature helps in preventing diseases from food-borne parasites.	9 (25.7%)	23 (65.7%)	3 (8.6%)
Separating food items such as raw meat and fish from cooked items during preparation, storage, and production can lessen the risk of having diseases from food-borne parasites.	32 (91.4%)	2 (5.7%)	1 (2.9%)
Drinking water directly from rivers, lakes, and springs helps in preventing diseases from food-borne parasites.	14 (40%)	18 (51.4%)	3 (8.6%)
Washing hands and utensils used for handling fish and meat can help minimize diseases from food-borne parasites.	34 (97.1%)	0	1 (2.9%)

Self-Reported Hygiene Practices

Table 4 displays the median self-reported rating of the fish and meat vendors regarding the various statements on hygiene practices. The median scores for various practices indicate the frequency with which vendors engage in these practices.

Overall, the fish and meat vendors reported that they always (median = 5) engage in good hygiene practices but rarely (median = 2) engage in poor hygiene practices. This finding somehow agrees with the result of the study in western Romania and Ghana, wherein most of the meat handlers and street food handlers, respectively, have good hygiene practices (Jianu & Golet, 2014; Tuglo et al., 2021). Personal cleanliness during food handling including wearing clean clothes and aprons, proper hand washing, and keeping nails clean and short had a median score of 5, indicating that vendors always adhere to these practices. Similarly, the practices of using safe water for washing utensils and keeping waste containers covered received a median score of 5, which means that the fish and meat vendors always adhere to these hygiene practices. These findings were comparable to a study in Ecuador wherein most street food vendors reported that they always wear appropriate and clean clothes, keep their nails short and clean, use potable water to wash utensils and raw materials, and keep a covered waste container (Rosales et al., 2023). Studies among street food vendors and chicken vendors showed that the majority of them wash their hands before and after processing and handling foods and dressing chicken, respectively (Hossen et al., 2021; Siddiky et al., 2022). Furthermore, the vendors also reported that they never (median = 1) sneeze and cough over food nor handle food products when sick, which corresponds with the answer of most the meat handlers and street food vendors surveyed in Romania and Ecuador, respectively (Jianu & Golet, 2014; Rosales et al., 2023).

While there is strong adherence in personal hygiene and cleanliness and waste management, there are practices that hold opportunities for improvements. The fish and meat vendors reported that they rarely (median = 2) wear jewelry and carry a cellphone while selling food, and handle food products after touching money. This finding disagrees with the result of a survey in Ecuador, wherein most street food vendors claimed to never wear jewelry during their work, but agrees with their result that only few vendors always practice not handling money and food simultaneously (Rosales et al., 2023). This may be because, in many food service locations, including a public market, food workers simultaneously handle money and prepare food, hence, handwashing is often neglected between these two separate tasks (Michaels, 2002). Although the handling practices mentioned were rarely done by the fish and meat vendors in this study, these practices still need to be improved as they can promote cross-contamination. In order to improve the current hygiene practice of the fish and meat vendors, the LGU should impose safety policies and provide them with proper training on food safety and hygiene practices. Proper food safety practices are important as they may lower the risks of parasitic infection (Camacho et al., 2021).

Table 4. Median rating of the hygiene practices of the fish and meat vendors.

Good Hygiene Practices			Poor Hygiene Practices		
Statement	Median	Interpretation	Statement	Median	Interpretation
Wear clean clothes and an apron.	5	Always	Wears jewelry while selling food.	2	Rarely
Wash hands with soap and water before and after handling food products.	5	Always	Carries cellphone while selling food.	2	Rarely
Keep nails clean and short.	5	Always	Handles food products after touching money.	2	Rarely
Use safe water for washing utensils used for food products.	5	Always	Sneeze and cough over food products.	1	Never
Waste containers are kept covered.	5	Always	Handles food products when sick.	1	Never
Overall	5	Always	Overall	2	Rarely

Figure 5 depicts some observations on the hygiene practices of the fish and meat vendors in Bay Public Market. One observation was that while the vendor was wearing an apron, the clothing of the vendor, which includes sleeveless shirt, shorts, and slip-on footwear, was inappropriate for their work, especially since they handle food products. This contradicts with the vendors' reported practice of always wearing clean clothes and aprons. Figure 5 also shows the exchange of money and food products between the customer and the vendor. During this activity, it was observed that the vendor did not wash hands before and after handling food products nor after handling money, which does not agree with the reported practice. Additionally, it can be observed in figure 8 that there are buckets with drippings of animal blood on its surface, which the vendors used to store water for washing equipment and hands. Notably, there were no dedicated handwashing facilities in the public market, and only faucets were available nearby (Figure 6). This observation does not support vendors' reported practice of always washing their hands and using safe water for washing utensils. According to Chapter 5, Section 24 of the municipal ordinance

mandating the laboratory test requirements in securing health cards for food handlers and non-food handlers in different establishments in the Municipality of Bay, wash hand basins shall be installed in convenient places in all food establishments, food manufacturing establishments, and public and private markets equipped with adequate supply of water and, in proper cases, with soap, cloth or paper towels and/or hand drying equipment. The absence of proper hand washing facilities at the market indicates non-compliance with this requirement.

Figure 5. Observed hygiene practices of fish and meat vendors in Bay Public Market

Figure 5 also depicts the lack of proper waste containers, with vendors using only plastic bags and sacks for waste disposal. Disposed wastes are therefore exposed to the market environment, which does not align with vendors' reported practice of always keeping waste containers closed. Figure 9 shows an overflowing garbage container near the fish and meat section, creating unhygienic conditions that could harbor pathogens. The abovementioned ordinance specifies in chapter 7, section 32 that refuse should be separated to recyclable, non-recyclable and food materials. Section 33 states that all marketplaces shall have holding bins or refuse storage area containers maintained to be vermin and rodent proof, and that individual stalls in public and private markets shall provide garbage plastic bags for their refuse. This explains why the fish and meat stalls only have plastic bags or sacks for their wastes. However, based on figure 5, stalls seem to have only one garbage bag which may not support waste segregation as ordained by the municipality. Moreover, the overflowing garbage container in figure 6 may indicate failure to maintain a vermin or rodent proof refuse storage container.

Figure 6. Hygiene observations in Bay Public Market

Aside from the mentioned sanitary requirements, section 19 of the ordinance enumerated required proper hygiene practices for food establishment personnel in processing food, including wearing of clean working garments, hairnets, caps, and apron, especially for cooks; observing good personal hygiene; proper hand washing; not allowing food handlers with long fingernails and active skin infection to work; and avoiding wearing pieces of jewelry during work duty. While ordinance for proper hygiene practice exists, it must be implemented properly, strictly, and consistently, to improve adherence among vendors. Especially in the public market, the municipality must take proactive measures, such as placing convenient hand washing facilities and having proper refuse containers, and improving or strengthening ordinances, to facilitate good hygiene practices among vendors.

Correlation between Knowledge, Hygiene Practices, and Socio-demographic Profile

Based on the correlation analysis detailed in Table 5, only age and knowledge have a significant correlation with each other. With a Pearson correlation coefficient of -0.430 and a p-value of 0.008, age has a significantly moderate inverse linear relationship with the knowledge scores of the vendors. This indicates that younger vendors tend to have higher knowledge regarding FBPZs than older vendors. This was comparable in a study in China, wherein younger vendors and consumers, particularly of age group of 26 to 35 years old had higher levels of knowledge towards food safety (Ma et al., 2019). However, the result of this current study was inconsistent with a study in Ghana which found no significant association between age and knowledge of vendors (Tuglo et al., 2021). Nonetheless, the findings of this suggest that younger vendors may benefit from more recent educational opportunities or greater exposure to information through online channels or internet, which are critical in enhancing their understanding of food safety practices, especially on FBPZs. In fact, statistics show substantial online users among younger demographics worldwide (Petrosyan, 2024). Further, a study in Indonesia demonstrated that individuals exposed to food safety information through educational institutions and social media had 2.3 times and 1.6 times higher likelihood of possessing good food safety knowledge when dining out, respectively (Nurhidayati et al., 2022). Internet and social media even ranked 1st and 2nd, respectively, as information sources about food safety and food-borne illness during a crisis (Abdulsalam & Bakarman, 2021).

In contrast, the inverse correlation between education level and knowledge scores was very weak and not statistically significant ($r = -0.107$, $p = 0.529$). This suggests that while formal education is important, it does not solely determine the level of understanding of the vendors on FBPZs. This finding agrees with a previous study indicating that other factors such as being a registered food handler, significantly impact the food safety knowledge beyond formal education (Tuglo et al., 2021).

Regarding years of working experience, a weak positive linear relationship with knowledge scores was observed, although it did not reach statistical significance ($r = 0.301$, $p = 0.07$). This indicates that fish and meat vendors with more vending experience tend to have slightly higher levels of knowledge on FBPZs, although not statistically significant. Vendors with more years of experience may have encountered various circumstances related to food safety and parasitic zoonoses, gaining related knowledge over the years. In this study, the majority of the vendors had more than ten years of working experience and had a good level of knowledge. Food handlers with longer experience may have acquired better knowledge and skills concerning food safety in their years of working (Teferi, 2022). In fact, a study found that vendors with longer working experience have significantly higher levels of food safety knowledge (Siddiky et al., 2022). In this study, this correlation did not reach statistical significance, which could mean that other factors beyond the years as a vendor may influence the vendor's understanding of FBPZs more. Nonetheless, this suggests that fish and meat vendors, despite their years of working experience, need exposure to information on FBPZs to shape their knowledge in this matter.

Similarly, attendance to food safety seminars or training showed a very weak positive correlation with knowledge scores, but this relationship was not statistically significant ($r = 0.137$, $p = 0.418$). This indicates that participating in seminars related to food safety may not substantially increase the knowledge levels of the fish and meat vendors, especially on FBPZs. This finding aligns with the studies in Nigeria and Ghana, which did not find a significant correlation and effect of receiving food safety training with knowledge of vendors or food handlers (Madaki & Bavorova, 2019; Tuglo et al., 2021). Other factors, including the quality of food safety training received, the retention of knowledge learned from the training or seminar, the relevance of the information provided, and others, may have influenced the knowledge of the vendors.

In terms of hygiene practices, the study found a weak positive linear relationship with education level, which was not statistically significant ($r = 0.269$, $p = 0.108$). This suggests that vendors with higher education levels tend to report slightly better hygiene practices, although not statistically significant. In other studies, a significant relationship was found between these variables (Siddiky et al., 2022; Tuglo et al., 2021). A higher level of education gets better knowledge, which affects their attitude and consequently reflects in their hygiene practice (Tuglo et al., 2021). However, the result of this study suggests that hygiene practices may be influenced by other factors beyond formal education. Nonetheless, a study in Ghana revealed that food safety practices of food handlers remain an issue in many nations, regardless of their educational background (Akabanda et al., 2017).

Moreover, the vendor's years of working experience showed a weak inverse linear relationship with their reported hygiene practices, but also did not reach statistical significance (r = -0.283, p = 0.09). This suggests that vendors with more working experience tend to report lower adherence to hygiene practices, although not statistically significant. This finding was inconsistent with a study in Bangladesh, wherein chicken vendors with longer working experience exhibit significantly higher practices (Siddiky et al. 2022). In contrast, a study in Ghana found no significant association between these variables, which somehow supports this current study (Tuglo et al., 2021). The disparity could be caused by differences in study population and size. However, the inverse correlation between the variables found in this study may indicate that vendors with longer experience may have become satisfied with their practice over time, feeling less important to maintain standards of hygiene practices. Therefore, LGU must be consistent and strict in implementing hygiene standards in the market that must be followed by the vendors.

Additionally, attendance to food safety seminars and reported hygiene practices of the vendors have an inverse linear correlation that is very weak and not statistically significant (r = -0.017, p = 0.919). The correlation coefficient is very close to zero, which means that there is almost no correlation between these two variables. This disagrees with a study in Ghana which significantly found that food handlers who have undergone training courses focused on food safety are more likely to exhibit good practices in food safety and hygiene (Tuglo et al., 2021). This disparity could be a result of the difference of the food safety training received and the research population. Nonetheless, food safety training in vendors is important in improving their practice as well as their knowledge and attitudes to prevent the spread and contamination of food-borne pathogens in their working environment (Siddiky, et al., 2022). While food safety training is aimed at improving the hygienic practices of the vendors, this study found near to no correlation between these variables. Therefore, LGUs should focus on providing the fish and meat vendors with food safety training that will translate into good hygiene practices.

Lastly, knowledge scores and hygiene practices of the vendors have a positive linear relationship that is also very weak and not statistically significant (r = 0.066, p = 0.699). The correlation coefficient of these two variables is also very close to zero, indicating almost no correlation between them. This is supported by two studies in Ghana and a study in Malaysia which found no significant relationship between knowledge and hygiene performance among food vendors or handlers (Amegah et al., 2020; Sani & Siow, 2014; Tuglo et al., 2021). However, several studies also suggest that a good level of knowledge on food safety translates to good hygiene practices (Siddiky, et al., 2022; Teferi, 2022). However, the result of this study may indicate that good knowledge does not always affect hygiene practices. Therefore, regardless of the level of knowledge of the fish and meat vendors, the LGUs need to encourage them to adhere to good hygiene practices as a preventive measure against FBPZs.

Table 5. Correlation matrix of knowledge of FBPZs, hygiene practices, and socio-demographic characteristics of the fish and meat vendors of the public market of Bay, Laguna.

Variables	Knowledge of FBPZs		Hygiene Practices	
	Correlation Coefficient	*p-value*	Correlation Coefficient	*p-value*
Sex	0.114	*0.502*	-0.003	*0.985*
Age	-0.43*	*0.008*	0.008	*0.962*
Education Level	-0.107	*0.529*	0.269	*0.108*
Years of Working Experience	0.301	*0.07*	-0.283	*0.09*
Food Safety Seminar or Training	0.137	*0.418*	-0.017	*0.919*
Knowledge of FBPZs	—	—	0.066	*0.699*

*Correlation coefficient is significant (p-value < 0.05).

Conclusion

This study demonstrated that the majority of the fish and meat vendors have a good level of knowledge regarding FBPZs. However, only a few vendors were familiar with the FBPZs, which may demonstrate practical knowledge about it, but may have a lack of understanding of academic or technical terms. Furthermore, gaps in understanding about FBPZs were identified including source and transmission routes of parasitic zoonoses, safe food handling temperature, and the use of safe water for prevention. The study also revealed that the fish and meat vendors have strong adherence to hygiene practices as they always adhere to good hygiene practices and rarely to poor hygiene practices. However, practices including handling cellphones and money and wearing pieces of jewelry while handling food simultaneously can still be improved. Interestingly, this study found that younger vendors tend to have higher knowledge of FBPZs than older vendors, which may be caused by the greater exposure of younger individuals to information through the internet. This medium is even one of the sources of information on FBPZs that were cited by the vendors along with television and nutrition and health. While this provides an idea of possible

mediums to use for the dissemination of information, this also reveals the limited or inaccessible sources of information about FBPZs. This highlights the importance of widely disseminating information on FBPZs as well as proper hygiene practices through various communication channels including posters, leaflets, digital platforms, and television, ensuring that it can be accessible to all vendors, especially older vendors. This will be a collective effort of the LGU, Municipal Nutrition Action Office (MNAO), and Municipal Health Office (MHO). They could also initiate targeted educational and training programs for the fish and meat vendors, which cover identification of zoonotic parasites and their transmission routes, symptoms of FBPZs, preventive measures, and demonstrations on proper hygiene practices. The LGU should also take necessary steps to implement suitable food and personal hygiene policies or ordinances that must be followed by the market vendors to increase their adherence towards good food handling practices. These efforts aim to provide awareness towards FBPZs and prevent or mitigate risks against them.

This study is the first study to investigate fish and meat vendors' knowledge of FBPZs and their hygiene practices. Therefore, further studies still need to be conducted to fill the gaps in this area. Future research could explore a broader range of markets and vendors across different places to provide a more comprehensive understanding of their FBPZs knowledge and practices. Future research could also evaluate the effectiveness of various interventions in improving vendors' knowledge of FBPZs and hygiene practices. Lastly, for future studies adopting the methods of this research, it is recommended for the researcher to observe and rate hygiene practices rather than have them rated by the vendors themselves to reduce response bias due to social desirability. This may also provide more accurate results.

Declarations

Author Contribution Statement

Mary Angelar De Miguel: data collection, data analysis, constructing the questionnaire, writing the manuscript

Aimee Sheree Barrion: supervision, conceptualization, constructing the questionnaire, expert validation, review, refine, and proofread the manuscript

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Conflict of Interest

The authors declare no conflict of interest.

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