The Impact of Knowledge on Pathogenic Meat-borne Parasites to Food Safety Practices of Tertiary Level Students in a University in Manila, Philippines

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Abstract: Pathogenic meat-borne parasites have long been recognized as a leading public health concern worldwide. It is well-established that one of the most effective methods in preventing parasitic infection is through proper food safety practices. This study specifically aims to investigate the impact of knowledge about pathogenic meat-borne parasites on food practices. To test the hypothesis that knowledge of these parasites affects food safety practices, we distributed an online survey to selected undergraduate tertiary students in a university in Manila. Analyses carried out include Descriptive Statistics, Pearson Correlation, and Paired Samples T-test. The data revealed that the majority (59.80%) of respondents have an adequate level of knowledge based on Modified Bloom's cut-off point, wherein the internet and school were the two primary sources of information reported. It is also shown that the respondents' have positive food safety and food handling practices (mean = 4.2317, SD = 0.85545). Overall, a weak positive correlation ($r = 0.339$, $p < 0.001$) was found between knowledge on meat-borne parasites and the current practice of food safety, showing that the two variables are directly related. It was also identified that there is a statistically significant difference between allied and non-allied health students on both their knowledge ($p < 0.001$) and practices ($p < 0.001$). These findings suggest that enhancing the knowledge and awareness of meat-borne parasites among tertiary students may facilitate proper habitual health behaviors and food safety practices, leading to decreased risk of meat-borne parasitic infections.

Keywords: ***food safety practices, knowledge, meat-borne parasites, tertiary level students, parasitic infection.***

I. INTRODUCTION

The World Health Organization (2016) report noted a threat of parasitic infections among 7 million Filipinos in the Philippines after a series of food- and water-borne outbreaks in the last five years [1]. The observed increase in the trend is attributed to the continuous inclination of Filipinos to consume meat products, such as pork, beef, and poultry, including their lack of knowledge regarding the potential of these products to cause diseases. According to the Organization for Economic Cooperation and Development (OECD), Filipinos have consumed up to 490,400 tons of meat products in the half quarter of 2020 alone. Individuals have consumed at least 14.91 kilograms of pork, 13.71 kilograms of poultry, 3.15 kilograms of beef, and at least 0.52 kilograms of sheep meat [2]. The popularity of meat and its many ways of preparation in Filipino cuisine could contribute to parasitic infections acquired from mishandling and unsanitary practices involving the meat industry. *Toxoplasma gondii*, *Sarcocystis* spp., *Trichinella* spp., and *Taenia* spp. are some of the major meat-borne parasites transmitted through pork consumption [3]. To lower the risks of getting infected by these meat-borne pathogens, proper meat handling should be practiced and observed. Current practices

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regarding the storage and preparation of meat mostly revolve around refrigeration and curing.

Records show that the incidence of meat-borne parasites dates back 150 years but still constitutes an underestimated food-borne hazard [4]. Furthermore, Kirk et al. established that most diarrheal episodes were attributable to contaminated food, with Southeast Asia regions bearing the highest burden [5]. In the local setting, a study conducted from 2005 to June 2018 documenting food-borne pathogen-related outbreaks in the Philippines found that meat-containing dishes are the primary sources of outbreak occurrences [6]. Among all the prevalent food-borne parasitic infections, specifically meat-borne, some of the most important are *Taenia*, *Toxoplasma*, *Sarcocystis*, and *Trichinella* [7]. Besides affecting the day-to-day activities of the individual household setting, food-borne diseases might compromise socioeconomic development at multiple levels and extend even to the global stage [8].

The neglect of food-borne pathogens is one of the primary reasons for the occurrence of these infections [9]. As Baghlaninezhad stated, several studies have established that knowing and being aware of a certain disease can effectively contribute to its prevention and management [10]. Consumer food education frequently focuses on the nutritional advantages of foods rather than the risk of illness and how to avoid those [8]. Such limited information regarding food-related infections is influenced by the implemented food management safety systems [11].

Meanwhile, implementing food safety systems depends on the data collected and analyzed by health professionals [12]. The role of health authorities on this matter continues to grow. Previous systematic reviews favored the effectiveness of various public health involvements, including food handler knowledge and practices [13]. As reported by Viator et al. & Aik, Turner et al., it has been proven that public health interventions ameliorate food handling practices and food handler knowledge [13][14]. Being informed about the data to propagate would help the government agencies and professional health workers in addressing people's concerns regarding the prevention of food-borne pathogens rather than only focusing on how to treat those [8]. As knowledge gaps are addressed and more people become aware of the immediate significance of this issue, they will be more likely to become involved, and, as a result, more emphasis will be given to this neglected group [9]. Furthermore, the information regarding parasites is not detailed in comparison with other prevalent pathogens in the Philippines [15]; hence, gauging respondents' knowledge would be a vital point in assessing the appropriate information that needs to be disseminated.

The emergence and re-emergence of infections caused by meat-borne parasites catalyze further efforts to combat these pathogens. Concerning risk prevention, effective implementation of food safety policies is associated with how interventions are being implemented and communicated to the public. Available epidemiological data also influenced effective control measures on the incidence of parasitic intestinal infections in different areas of society [1] . In the Philippine context, the government's response towards the improvement of the country's health status was through enacting legislation about health standards. The Department of Health Food Safety Committee (DOH-FSC) has coordinated with food regulatory agencies to administer and organize an effective and extensive food control system. In 2004, the Second FAO/WHO Global Forum of Food Safety Regulators led to the founding of the Food Safety Framework in cooperation with the Department of Agriculture. One of the four key components within the framework is Household Food Consumption, which primarily focuses on the consumers, with attention to the advocacy and education of food safety and public health concerns such as environmental health and the prevention, surveillance, investigation, and management of diseases. To further safeguard and encourage people to exercise their right to health and improve the country's food safety regulatory system, the Republic Act No. 10611 (Food Safety Act of 2013) has lapsed into law. In 2003, the Republic Act No. 9296 was enacted as the Meat Inspection Code of the Philippines. This has since reinforced meat inspection systems in the country to ensure that the meat consumed by its citizens is safe and qualified. It also aims to protect consumers against the risk of meat-borne infectious diseases.

The researchers have not found studies exploring the understanding among the tertiary level students in Manila regarding pathogenic meat-borne parasites, their sources, mode of transmission, and food handling and preparation. This study sought to investigate their current information to help determine the awareness of the common concepts and misconceptions regarding meat-borne parasitic infections through an electronically distributed questionnaire. With the use of the data gathered in the study, the researchers aimed to help future policymakers and public health professionals decide on what

intervention to employ to further decrease the prevalence of meat-borne parasitic infection in the Philippines.

II. METHODS

A. Research Design

The researchers utilized a quantitative descriptive comparative design. Quantitative descriptive research examines the relationship between variables by testing objective theories and describing results through means, standard deviations, and range of scores [16]. Furthermore, Lau & Kuziemsky defines a comparative study as a descriptive research design that makes comparisons and determines whether significant differences exist for some predefined measures between groups to generate an analysis [17]. A comparative approach was chosen to meet the objectives of this study to measure and analyze the statistical relationship between knowledge regarding pathogenic meat-borne parasites to current food safety practices among the selected tertiary students.

B. Subjects and Study Site

The study was carried out in a university in Manila during the second semester of A.Y. 2020-2021. The sampling size was determined using the Raosoft Calculator with a 5% margin of error and 95% confidence interval to arrive at a definite number of respondents representing the existing population at the time of conducting the study. According to the Varsitarian, the university's student population was 40,375 as of A.Y. 2019-2020; therefore, using the said calculator, the sampling size was computed to be a minimum of 381 students [18]. At the end of the data gathering, however, a total of 490 respondents were gathered, increasing the confidence interval to 97.4%. The respondents were chosen from different colleges of the university with the approval of the corresponding Deans. Students may not represent a significant risk group in general, but some broader consequences must be considered. In the near future, some would be in charge of their households, while the majority would be responsible for vulnerable populations [19]. Therefore, students were selected as the subject source for this research. The respondents must have the following inclusion criteria: (a) they must be 18 to 25 years old; (b) must be a bona fide tertiary level student in the particular university; (c) have a staple diet of meat which includes chicken, beef, or pork; (d) know common food handling practices. Hence, these criteria ensure that reliable and relevant data will be acquired.

Furthermore, to select the respondents of the study, a non-probability sampling method was applied. Purposive sampling is the deliberate selection of participants according to their ability to explain a certain idea [20]. Through this technique, a sample that can be logically assumed to be an eligible representative of the population will be drawn. To develop a sample with maximum variation, the researchers collaborated with the student council representatives of specific colleges or faculty to distribute the survey forms to students of their respective colleges. The respondents were also divided into two distinct groups, namely, the allied health and non-allied health. The classification of the students under allied health is based on the programs listed by the University of Santo Tomas, which included respondents from the Faculty of Pharmacy and those taking up Medical Biology under the College of Science [21]. Moreover, the distinction among the programs was further identified using the definition of biology given by the Commission on Higher Education (CHED), wherein biology is defined as a subject closely related to the fields of agriculture, fisheries, forestry, nutrition, allied health care sciences such as medicine, nursing, pharmacy, veterinary medicine, animal and plant sciences, and environmental science. Hence, programs closely related to the said definition were categorized under allied-health.

C. Data Instrumentation

Surveys are useful in generating a quantitative assessment of tendencies, attitudes, and beliefs of a population. It can also test for relationships across variables within a population by using sample studies from that population [16]. This study utilized a cross-sectional survey, which sought information from a sample at one point in time [22], and was prepared through a web-based software called Google Forms. The survey instrument used to collect data was primarily adopted from existing related journal articles with permission to use from their authors and was modified or adapted by the researchers to align with the present study. The validity and reliability of scores on these instruments demonstrated established and acceptable results from past uses.

The questionnaire was divided into three sections, where each part aimed to answer the study's specific objectives. The first part of the questionnaire was tailored to gauge the respondents' knowledge on pathogenic meat-borne parasites and is targeted to identify (a) which sources do the respondents acquire their knowledge about parasitic infection from, (b) their knowledge about meat-borne parasites, including modes of transmission,

symptoms and clinical manifestations, and (c) their attitudes and beliefs as to how prevention and treatment are ought to be done given the risk of parasitic infection from eating meat is present and/or disease has taken place. The second part of the questionnaire, on the other hand, aimed to gauge the respondents' knowledge and practices regarding food safety and food handling. Lastly, the third part of the questionnaire evaluated the future food safety practices of the respondents concerning meat-borne parasitic infections.

The respondents' overall knowledge of pathogenic meat-borne parasites was assessed using 23 items with a total of 57 points, with a higher score indicating sufficient knowledge on the topic. Modified Bloom's cut-off point was employed to determine good, moderate, or poor scores. The food safety and food handling practices section, on the other hand, included 10 items, and the responses were assessed using a 5-point Likert scale ranging from 1 for "Strongly Disagree" to 5 for "Strongly Agree". Lastly, the future practices category of the questionnaire was also in the form of a Likert scale, consisting of 5 items, with the same parameters as the food safety practice section.

Furthermore, a pilot test using Cronbach's alpha was done to assess the reliability and consistency of the instrument before the actual data gathering. The acquired score of the test was 0.720, which indicated an acceptable consistency for the scale of the data gathered. It should be noted that the value of > 0.700 in Cronbach's alpha is acceptable [23].

D. Data Gathering Procedure

The researchers submitted the research proposal to the Faculty of Pharmacy Review Ethics Committee. Upon approval, a letter of request was sent to the college deans individually to ask permission to collect data from their students. The approved colleges included the Faculty of Pharmacy, College of Education, College of Science, College of Commerce and Business Administration, Conservatory of Music, College of Accountancy, and the College of Tourism & Hospitality Management. After receiving consent from the respective deans, data was collected by collaborating with the student council representatives of the approved colleges, who disseminated the questionnaires to students of their respective colleges. The geographical distance between the researchers and the respondents was an issue due to current social situations, particularly the COVID-19 pandemic. Rather than personally distributing the survey forms, online distribution was administered for safety, efficiency, and accessibility. Data gathering was conducted from the 6th of April to the 3rd of May, 2021.

Moreover, the students were asked to access the questionnaire using only their university e-mail addresses to verify that they were eligible as a respondent. Additionally, a short introductory caption covering the research title, objectives of the study, and target respondents were included in disseminating survey questionnaires. A consent form was also incorporated at the beginning of the survey form, which allowed the respondents to exercise their autonomy and consent in participating in the study. The electronic survey was modified to allow only one submission entry from each respondent, thereby reducing the risk of multiple responses from one individual. Likewise, the respondents were allowed to answer the survey form at their convenience. After submitting the survey forms, the responses were automatically sent to a designated survey response sheet using the web-based software Google Sheets. The researchers then tabulated, summarized, and tallied the responses for data analysis. All data acquired were double-checked to ensure completeness, accuracy, and reliability. Finally, the gathered data was subjected to statistical treatment.

E. Ethical Considerations

As the internet evolves as a platform for social interaction and information dissemination, a challenge to develop a coherent ethical approach for internet-mediated research is emergent. To gather data directly from online surveys, ethical concerns may arise with regard to obtaining informed consent, maintaining privacy and confidentiality of the data, and the right to withdrawal or omission of items.

*Informed consent***:** Individuals who choose to participate in the study must do so based on informed consent [24]. Further, owing to the distance between the researcher and the respondent in online settings, it was challenging to ascertain if they fully understood what they were consenting to. Thus, the researchers ensured that all information in the consent was informed and knowledgeable. Another issue that may arise is the verification of the respondent's ability to give informed consent. It was arduous to judge the extent to which individuals in the sample were competent to impart informed consent in an online setting.

Privacy and Confidentiality: Concerns regarding the ability of online survey tools to facilitate privacy and confidentiality have

been evident. The researchers ensured that there was an explicitly provided statement mentioning the purposes for which the data used, the rights of the respondents, and strategies for data protection.

*Right to withdraw consent***:** The survey forms were deployed electronically, and the respondents were asked to only complete the survey once they have agreed to informed consent. Should the respondents have changed their decision and wanted to withdraw from the study, they were allowed to do so by (a) not submitting the survey form and (b) contacting the study proponents using the contact information found in the first part of the survey form. The researchers were also available to answer or clarify any queries regarding the survey.

*Data Privacy***:** As specified by the Republic Act 10171 (Data Privacy Act of 2012), Chapter 1, Section 2, "It is the policy of the State to protect the fundamental human right of privacy, of communication while ensuring a free flow of information to promote innovation and growth. The State recognizes the vital role of information and communications technology in nation-building and its inherent obligation to ensure that personal information in information and communications systems in the government and the private sector are secured and protected." Conforming to this, the researchers valued the importance of information and its confidentiality. All sensitive information gathered using the survey form was not released to the public, protecting the privacy of respondents and the confidentiality of information shared. To safeguard their data, only the researchers using their university email addresses can access the survey forms and their responses.

F. Data Analysis

The collected data were analyzed by a consulting statistician using Microsoft Excel and Statistical Package for the Social Sciences (SPSS). A pilot testing of the survey form was done, and the initial data underwent Cronbach's Alpha for reliability testing. After passing the reliability test, the researchers proceeded to the actual gathering of data for the study. Analysis carried out included descriptive statistics, Pearson product-moment correlation, and Paired Samples T-tests.

The respondents' overall knowledge was categorized using a 57-point questionnaire. It was graded using the modified Bloom's cut off point as "good" if the score is between 80% and 100% (46 to 57 points), "moderate" if the score is between 50% and 79% (29 to 45 points), and "poor" if the score is less than 50% (28 points and below). These scores were subsequently interpreted as "high", "adequate", or "low" levels of knowledge, respectively. For the assessment of food handling practices, a 5-point Likert scale was utilized, the derived mean and standard deviation of the given answers were employed for evaluation. The practice of the respondents was based on the overall all mean score, ranging from 1 to 5, and was categorized as "positive" if ≥ 4 points, "neutral" if < 4 but > 3, or "negative" if < 3 points. The same psychometric scale was used for the analysis of the respondents' future food safety practices.

Frequencies and percentages of the responses from each question were determined. Moreover, descriptive statistics were done to summarize the data collected in a simple numerical form, where the mean and standard deviation were calculated. In testing the hypothesis, inferential statistics were used to analyze the correlations between the variables in the whole data set. As such, Pearson's product-moment correlation, a parametric test, was done to assess the relationship between knowledge on meat-borne parasites and the current food practices of the students. On the other hand, Paired Samples T-test was performed to compare the means between two related groups and determine if there is a significant difference between the allied and non-allied health students in terms of their knowledge on pathogenic meat-borne pathogenic parasites, as well as their current food safety practices. The acquired data were then presented using corresponding tables and figures.

III. RESULTS AND DISCUSSION

This chapter includes the presentation of results, followed by a detailed discussion and interpretation of findings concerning the aim of the study in determining the impact of knowledge on pathogenic meat-borne parasites on the current food safety and food handling practices of selected tertiary students in a university in Manila. This chapter also addresses the study's specific objectives, including determining the level of knowledge and sources of information on pathogenic meat-borne parasites of the respondents, their food safety practices, the relationship between these two variables, and the comparison of allied and allied non-allied health students included in the population.

The discussion and interpretation of findings are subdivided into categories: (a) knowledge regarding meat-borne parasites,

(b) current and future food safety and food handling practices, (c) relationship between the respondents' knowledge on meat-borne parasites and their current food safety practices, and (d) comparison between allied health and non-allied health students' knowledge on parasites and current food safety practices.

A. Demographic profile of the respondents

A total of 490 respondents consented to participate in this study. Table 1 presents the number of students at each respective college department. The demographic variables showed that the majority of the respondents belong to the allied health courses (Faculty of Pharmacy & College of Science). The remaining respondents belong to other academic disciplines.

Table.1. *Demographic Profile of the Respondents who participated in the Study.*

Category	**Frequency** (N= 490)	**Percentage**
Faculty of Pharmacy	123	25.31
College of Science	180	36.73
Conservatory of Music	9	1.84
College of Tourism & Hospitality Management	109	22.24
College of Accountancy	34	6.94
College of Commerce and Business Administration	17	3.47
College of Education	18	3.67
Total	**490**	**100**

B. Assessment of Knowledge on Pathogenic Parasites

The respondents' knowledge about pathogenic meat-borne parasites, graded using the modified Bloom's cut-off point, is shown in Table 2. It is seen that most of them have moderate scores, from 29 to 45 points. Furthermore, 126 respondents had a good mark ($\geq$ 46 points), while only some attained poor scores ($\leq$ 28 points). With this, it can be interpreted that the majority (59.80%) of the respondents are considered to have adequate knowledge, while the remaining either have a high level of knowledge (25.71%) or a low level of knowledge (14.49%).

Table.2. *Overall knowledge of the respondents regarding pathogenic meat-borne parasites.*

Bloom's Cut-off point	**Frequency** (N= 490)	**Percentage**	**Cumulative Percent**
Good (80% to 100%)	126	25.71	25.71
Moderate (50% to 79%)	293	59.80	85.51
Poor (<50%)	71	14.49	100.00
Total	**490**	**100.00**	

The abovementioned findings of this study reveal that the students who participated had some familiarity with meat-borne parasites and the dangers of parasitic infections, with the majority of them (59.80%) having an adequate overall level of knowledge. In comparison, approximately one-third (25.71%) have a high level of knowledge, and some still have a low level of knowledge (14.49%). The combined percentages of high and adequate levels of knowledge were substantially greater than other related research, including a study conducted by [25], wherein only 43.35% of their student population had basic knowledge about intestinal parasites. Such findings are favorable because adequate knowledge on the subject matter suggests a positive effect on preventing parasitic infections, as it translates to behavioral changes that may reduce the risk of infection [26].

Their knowledge of meat-borne parasites may also have contributed to the low occurrence of infection among the respondents. The majority (71.4%) reported that they have no history of parasitic infection.

Meanwhile, Table 3 displays the respondents' different sources of information about parasites and the subject areas in which they were knowledgeable. The findings from these multiple-select questions below show that the majority of the respondents gain information from the internet (90.20%), while from those respondents who learn about meat-borne parasites in school (86.12%), some have taken up courses such as Biology (83.47%), and Microbiology (44.29%).

Table.3. *Sources of information regarding meat-borne parasites among selected tertiary students in a university in Manila*.

Category		**Frequency** (N= 490)	**Percentage**
Where do you hear or read about meat-borne parasites? (Select all that apply.)	Internet	442	90.20
	Television	252	51.43
	School	422	86.12
	Newspaper	38	7.76
	People	224	45.71
	Other	140	28.57
Which subject areas do you have background knowledge on? (Select all that apply.)	Biology	409	83.47
	Microbiology/Parasitology	217	44.29
	Food technology	39	7.96
	Food service system	64	13.06
	Not applicable	55	11.22

The current study illustrated that most students have gained such information primarily from the internet (90.20%) and school (86.12%). According to Guarner & Niño, students review textbooks, articles, and other learning materials downloaded online; thus, having the internet as the primary source of information about parasites comes as no surprise [27]. The second most frequently identified source, on the other hand, is information learned from school, which coincides with the fact that university courses such as the ones stated in this study are integrated within the curriculum of both allied health and non-allied health programs [28]. Most of the students were also found to have background knowledge on subject areas such as Biology (83.47%), a fundamental course during high school. In comparison, only 4.97% of the respondents have a background in Food Technology. In a similar study by Nisha et al., other means for students to get information about infectious diseases were via television/radio, news, social media networks, and newspapers; however, these largely focus on virus- and bacteria-related diseases [25]. According to Santos et al., students' primary sources of information on parasites were television, home, and school, while Carvalho et al. pointed out that school remains to be the main source of information on parasites and related diseases among students they've surveyed [29][28]. Therefore, it can be deduced that school and its curricula have an impact on students' knowledge on parasites and the diseases they cause and that incorporating this information into their courses would facilitate the development of safe habitual food handling practices [30].

Table.4. *General Knowledge on pathogenic meat-borne parasites among selected tertiary students in a university in Manila.*

Category		**Frequency** (N= 490)			**Percentage**		
		Yes	**No**	**Don't know**	**Yes**	**No**	**Don't know**
Do you know which disease is a parasitic disease?	Ascariasis	343	6	141	70.00	1.22	28.78
	Balantidiasis	258	12	220	52.65	2.45	44.90
	HIV	48	386	56	9.80	78.78	11.43
	Hepatitis	99	324	67	20.20	66.12	13.67
	Trichinellosis	316	13	161	64.49	2.65	32.86
	Toxoplasmosis	271	24	195	55.31	4.90	39.80
	Influenza	69	349	72	14.08	71.22	14.69

Do you know which are the modes of transmission (MOT) of parasitic diseases?	Animal contact	430	21	39	87.76	4.29	7.96
	Soil contact	412	32	46	84.08	6.53	9.39
	Sexual contact	211	183	96	43.06	37.35	19.59
	Air droplets	124	263	103	25.31	53.67	21.02
	Dirty hands	425	33	32	86.73	6.73	6.53
	Uncooked meat and vegetables	476	4	10	97.14	0.82	2.04
	Sweet food						
	Sneezing	46	291	153	9.39	59.39	31.22
	Untreated water	122	274	94	24.90	55.92	19.18
		462	7	21	94.29	1.43	4.29
Which are the symptoms of a parasitic disease?	Diarrhea	469	3	18	95.71	0.61	3.67
	Abdominal Pain	433	16	41	88.37	3.27	8.37
	Anemia	191	139	160	38.98	28.37	32.65
	Weight loss	361	44	85	73.67	8.98	17.35
	Sore throat	89	218	183	18.16	44.49	37.35
Which of the following is/are meat-borne parasite/s?	*T. spiralis*	307	20	163	62.65	4.08	33.27
	T. gondii	269	33	188	54.90	6.73	38.37
	Sarcocystis spp.	206	51	233	42.04	10.41	47.55
	Tapeworm	374	23	93	76.33	4.69	18.98
	T. vaginalis	62	253	175	12.65	51.63	35.71
Which are the possible ways of acquiring meat-borne parasitic infection?	Meat stored in a high-temperature environment	422	18	50	86.12	3.67	10.20
	Spoiled meat	475	3	12	96.94	0.61	2.45
	Contaminated meat	479	3	8	97.76	0.61	1.63
	Uncooked meat	427	3	0	87.14	4.69	8.16
	Handwashing	76	366	48	15.51	74.69	9.80
Which are the early/onset signs and symptoms of meat-borne parasitic infection?	Diarrhea	467	3	20	95.31	0.61	4.08
	Abdominal Pain	387	34	69	78.98	6.94	14.08
	Vomiting	456	6	28	93.06	1.22	5.71
	Fever	141	213	136	28.78	43.47	27.76
	Skin rashes	277	63	150	56.53	12.86	30.61
Which complications may develop due to meat-borne parasitic disease?	Malnutrition	427	12	51	87.14	2.45	10.41
	Anemia	277	68	145	56.53	13.88	29.59
	Growth retardation	232	88	170	47.35	17.96	34.69
	Heart attack	135	145	210	27.55	29.59	42.86
Do you know that close contact with cats may cause human infection and increase the risk of abortion in pregnant women?		120	233	137	24.49	47.55	27.96
Abdominal pain is a symptom of meat-borne parasitic illnesses.		425	10	55	86.73	2.04	1.22
Diarrhea is a symptom of meat-borne parasitic illnesses.		474	1	15	96.73	0.20	3.06
Vomiting is a symptom of meat-borne parasitic illnesses.		466	6	18	95.10	1.22	3.67

Nausea is a symptom of meat-borne parasitic illnesses.	388	29	73	79.18	5.92	14.90
Headache is not a symptom of meat-borne parasitic illnesses.	234	104	152	47.76	21.22	31.02
Hypertension is a symptom of meat-borne parasitic illnesses.	100	181	209	20.41	36.94	42.65
Hypoglycemia is a symptom of meat-borne parasitic illnesses.	107	120	263	21.84	24.49	53.67
Pain in the bone is a symptom of meat-borne parasitic illnesses.	75	196	219	15.31	40.00	44.69
Coughing or sneezing is a symptom of meat-borne parasitic illnesses.	110	226	154	22.45	46.12	31.43

Table 4 presents the questions asked to assess the respondents' general knowledge regarding pathogenic meat-borne parasites. It includes the identification of parasitic organisms and diseases, meat-borne parasites, mode of transmission, signs, and symptoms, as well as preventive measures. The comprehensive set of questions below will help gauge the respondents' level of knowledge about the important aspects of meat-borne parasitic infection.

The respondents accurately identified pathogenic meat-borne parasites that are prevalent in the Philippines, including *Taenia* spp. [31] and *T. gondii* [32]. Although *Trichinella* has a lower prevalence in the country [33], the respondents in the current study still categorized it correctly as a pathogenic meat-borne parasite. However, almost half of the respondents (47.55%) failed to identify *Sarcocystis* spp., which is also found to be common in the country [34]. As these parasites show endemicity in some regions of the Philippines, knowledge regarding them would be beneficial in terms of developing targeted preventive measures against diseases they may cause, including Taeniasis, Toxoplasmosis, Trichinellosis, and Sarcocystosis.

To delve further into the respondents' knowledge, questions regarding the modes of transmission, signs, symptoms, and complications of meat-borne parasitic infections were asked. The majority were able to correctly distinguish that meat stored in a high-temperature environment, uncooked, contaminated, or spoiled meat was a possible way to acquire meat-borne parasitic infections, among others. Unfortunately, the respondents were not aware of the increased possibility of abortion in pregnant humans once they are exposed to cats or the ones infected, especially. It is a known fact that cats are essential in the survival and the life cycle of some meat-borne parasites because cats are the ones that shed the oocysts that would be left on soil and would then make contact with humans [35]. Nayeri et al. have specifically mentioned that there is a significant seroprevalence of Toxoplasma gondii antibodies in women who have spontaneous abortions in their study [36]. They were also well-aware of the signs and symptoms related to such infections, with diarrhea, vomiting, and abdominal pain having the highest percentages. Even though each parasitic disease would manifest varied symptoms at the different stages of infection (or none at all), according to a study conducted by Chalmers et al., most of the time, mild symptoms presented mostly by parasitic infections such as diarrhea, abdominal pain, vomiting and nausea stated before would commonly be noted [37]. However, since they are general symptoms that can easily be overlooked, these symptoms are often disregarded and not given much attention, therefore lengthening the time before the parasitic disease can be properly identified.

The respondents were also asked about the possible complications from meat-borne parasites. Most of them (87.14%) answered yes to malnutrition. This is supported by a study in 2015 by Duedu et al., who found that malnutrition and parasitic infection have a significant association. It has also been shown that parasitic intestinal infections compromise the nutritional status of the infected since parasites compete for nutrition, leading to the malabsorption of essential nutrients [38]. The same authors also noted that nutrients are wasted when infected patients experience loss of appetite, vomiting, and diarrhea, common symptoms of meat-borne parasitic infection. As for anemia, although 29.59% or about one-third of the participants were unsure of it being a complication of parasitic infection, there are, in fact, documented cases of parasitic infection especially, intestinal ones, which induce decreased hemoglobin concentration via intestinal bleeding.

Eventually, this may lead to anemia [39]. For instance, Harpavat et al. presented a documented case of chronic iron deficiency anemia in an adolescent patient with taeniasis [40].

While they stated that it is rare in the US, they also noted that it is more common in South America, Africa, and Asia. As for growth retardation, 47.35% of the participants identified it as a complication of meat-borne parasitic disease. To support this, growth retardation has been considered an early clinical manifestation of congenital toxoplasmosis along with hydrocephalus, microcephaly, and chorioretinitis [41]. This is because pregnant women can be exposed to the soil where cats, a host of *T. gondii*, deposit their feces. For heart attack, the majority of respondents answered with uncertainty (42.86%). Nevertheless, the risk for heart attack has been encountered among patients with taeniasis and muscular cysticercosis [3]. The aforementioned authors also stated that myocarditis progresses in about 5-20% of infected individuals. They may present chest pain, tachycardia, and impaired electrocardiogram reading. Other cardiovascular complications include intraventricular thrombus, thrombophlebitis, and pulmonary embolism, all of which can be fatal.

Looking at the participants' knowledge of the symptoms of meat-borne parasitic illness, most respondents (86.73%) correctly identified abdominal pain while fewer did on coughing and pain. In instances of trichinellosis, along with abdominal pain and cough, muscle pain is established to be its common symptom rather than pain in the bone [42]. Meanwhile, hypertension and hypoglycemia turned out to be among the least agreed symptoms of meat-borne parasitic illness, with the majority of the answers being "Don't know", 42.65%, and 53.67%, respectively. However, patients infected with meat-borne parasitic infections can manifest elevated blood pressure and blood sugar, not because of the parasites themselves but because of the drugs used to treat those [43]. Campbell and Soman-Faulkner studied the adverse effects of various antiparasitic drugs like praziquantel, a typical anthelminthic drug used to treat parasitic infections such as taeniasis [44].

In some cases, it has been shown to also induce hypertension, nausea, and vomiting. Another drug on their list was pentamidine, which has been demonstrated to cause hypoglycemia. Alternatively, hyperglycemia rather than hypoglycemia is the more common symptom of the meat-borne parasites themselves, such as *Toxoplasma gondii*, particularly when the parasite inhabits the pancreas, the organ responsible for insulin regulation [45]. Following this, the same parasite can also cause the majority of headaches experienced by individuals infected with meat-borne parasites. Here, 47.76% of the participants answered "Yes" to headache being a symptom of meat-borne parasitic illness. Headaches being a symptom of parasitic infections is reflected in a study by Prandota et al. wherein they studied children in the Department of Pediatric Neurology in a hospital for three years [46]. They found out that some recurrent headaches among the patients are actually caused by cerebral toxoplasmosis since the cyst of the parasite can, in fact, reside in the central nervous system.

On the assessment of the respondents' knowledge relating to their attitude toward prevention and treatment of meat-borne parasitic infection, three questions were given, as shown in Table 5. It was found that the majority of the respondents would consult a doctor to treat a parasitic disease. Likewise, cooking meat (96.94%) remains to be the primary prevention mechanism. In comparison, proper sanitary (95.71%) and washing of raw meat (93.88%) were believed to be the most effective ways to prevent the spread of meat-borne parasitic diseases.

Table.5. *Attitude toward treatment and prevention of pathogenic meat-borne parasites among selected tertiary students in a university in Manila.*

Category		**Frequency (Yes)**	**Percentage (Yes)**
If you suffer from a parasitic disease, which one do you choose for treatment?	Consult a doctor	481	98.16
	Self-medication	4	0.82
	Traditional medicine	2	0.41
	Don't take seriously	0	0.00
	Don't know	3	0.61
Which one prevents meat-borne parasitic diseases?	Deworming of livestock (e.g., cow, pig, etc.)	437	89.18

	Cook meat	475	96.94
	Wearing a face mask in public	151	30.82
Which of the mechanisms are done to prevent transmission of meat-borne parasitic diseases*?*	Following proper sanitary protocol	469	95.71
	Cooking meat using the minimum core temperature	327	66.73
	Washing raw meat	460	93.88

In dealing with parasitic infections, it is necessary to immediately seek different interventions for the treatment of the underlying causes to avoid the progression of their pathogenesis. Given the situation that when suffering from a parasitic disease, the majority of respondents (98.16%) would immediately consult a doctor, while only four (0.82%) would resort to self-medication. These findings are comparable to a study by Chaisiri et al., wherein patients would consult or ask for advice from a physician in case of a parasitic disease or illness [47]. The information provided by nutritionists and physicians is deemed trustworthy and reliable by consumers rather than other sources such as food manufacturers [48]. This may imply that most people still rely on doctors' prescriptions rather than self-medicating with over-the-counter drugs and/or herbal remedies.

The respondents' knowledge about prevention mechanisms was also assessed, wherein approximately 89.18% of them agreed that caretakers must deworm their livestock as a preventive measure for pathogenic meat-borne parasites. According to Labiaga et al., gastrointestinal parasite species found in swine, cattle, and poultry farms, such as those emphasized as meat-borne parasites in this study, have zoonotic tendencies that can infect humans, posing a public health concern [49]. As livestock are threatened by such parasites, implementation of proper deworming and anti-parasitic treatment and management programs would be beneficial in reducing the occurrence of meat-borne parasitic infection in humans. Properly cooking meat is another process agreed upon by the majority (96.94%) of the respondents to prevent pathogenic meat-borne parasites. This suggests that the respondents are aware that inactivating and/or terminating one or more stages from the parasite's life cycle would be vital in preventing the transmission of parasitic infections. A study by Fransseen et al. indicated that cooking food of animal origin has a core temperature reaching 60–75 °C, and should be done for at least 15-30 minutes [50]. However, it is still important to take note that some parasites are not labile from the temperature range specified; thus, alternative methods of meat handling and preparation might be necessary.

When the respondents were asked if a face mask must be worn to prevent meat-borne parasitic infections, there are 30.82% that have agreed to the statement, while 20.61% did not know. The common pathogenic meat-borne parasites would normally have to take the route of entry through the host's mouth, medically known as the fecal-oral route, so that their cysts would ultimately end up in the intestinal tract, where they would benefit the most [51]. This implies that the respondents may have a lack of knowledge on the transmission of meat-borne parasitic infections since they were not able to distinguish that the use of masks in public can only prevent airborne diseases [52] that can be caused by certain bacteria and viruses [53].

Moreover, among the respondents, 95.71% knew that following safety protocols implemented by the National Meat Inspection Service (NMIS) ensures that meat would be safe to consume and ultimately reduces the risk of contamination and meat-borne diseases. The majority of the respondents have also identified washing meat as one of the mechanisms to prevent meat-borne parasitic infections. Labiaga et al. (2018) have mentioned that the public, as a part of the consumers of meat, must be made more aware that it should be thoroughly washed and properly cooked to prevent the transmission of meat when preparing meat products parasites [49].

C. Assessment of Current Food Safety and Food Handling Practices

Table 6 shows the significant factors of food safety practice that were grouped into four categories: proper hygiene on handling meat, meat preparation, meat preservation, and meat storage.

This is to efficiently assess the knowledge of the respondents on said practices.

Table.6. Descriptive Statistics and Interpretation for current meat handling, preparation, preservation, and storage practices of selected tertiary students in a university in Manila.

Category	Mean	Std. Dev.	Interpretation*
Proper Hygiene on Handling Meat			
Lack of hygiene is the cause of meat-borne parasitic infections.	4.641	0.6503	Strongly Agree
Use of soap while washing hands or face can prevent meat-borne parasitic infections.	4.622	0.6816	Strongly Agree
Meat Preparation			
Raw food consumption is the cause of worm infestation.	4.482	0.7240	Agree
Do not use the same knife to cut raw meat.	4.457	1.0308	Agree
Wash the knife used to cut meat with hot water before using it to cut another meat.	4.451	0.8572	Agree
Meat Preservation			
If raw meat has been stored at a room temperature that is too warm but then is properly cooked to the correct internal temperature, it is not safe to eat.	2.686	1.2198	Neutral
The temperature has a significant effect on the spoilage of food.	4.804	0.4458	Strongly Agree
Food drying is a method of meat preservation.	4.200	0.9094	Agree
Meat Storage			
Meat should be stored for 3-5 days in the fridge.	3.696	0.9904	Agree
Do not store leftovers on countertop tables.	4.278	1.0452	Agree
Overall	**4.2317**	**0.85545**	**Positive****

**Mean interpretation per item: ≥ 4.5 = Strongly Agree, 3.5 to 4.4 = Agree, 2.5 to 3.4 = Neutral, 1.5 to 2.4 = Disagree, 0 to 1.4 = Strongly Disagree*

***Overall mean interpretation: ≥ 4 = Positive, < 4 but > 3 = Neutral, < 3 = Negative*

The general knowledge of food safety and food handling practices of the consumers has posed a crucial question in food-borne disease outbreaks [19]. In developing countries, households significantly contribute to food-borne disease outbreaks due to "cross-contamination of raw food with prepared food, lack of food safety awareness, poor personal hygiene, improper food handling, and preparation at home" [54].

Food, including meat-based dishes, that are prepared, handled, and stored through unhygienic practices are susceptible to contamination as it encourages the proliferation and transmission of disease-causing organisms [55]. Our data showed that most of the respondents strongly agree with the statement "lack of hygiene is the cause of meat-borne parasitic infections" (mean = 4.641, SD = 0.6503) and that using soap while washing hands or face can prevent meat-borne parasitic infections (mean = 4.622, SD = 0.6816). This finding suggests

that there is a positive effect on the respondents' practices concerning proper hygiene on meat handling, attributing to their existing knowledge about the pathogenesis of meat-borne parasites. Proper handwashing before, during, and after food preparation can help in significantly reducing the risk of diarrhea, a primary symptom of parasitic infections. The respondents' awareness regarding these hygienic practices is essential because as food-handlers of their present and future households, their hands can serve as vehicles in disseminating food-borne diseases due to poor personal hygiene and cross-contamination [55].

Cross-contamination between food handlers, equipment, and utensils is another factor that is significant in the spread of food-borne disease outbreaks [56]. In the category of meat preparation, the respondents agree with using a different knife to cut raw meat (mean = 4.457, SD = 1.0308) and washing the knife with hot water before using it for another meat (mean = 4.451, SD = 0.8572). Several studies found that cross-contamination may be a result of unsafe practices in household kitchens, including the "inefficient use of cutting surfaces and applied cleaning methods" [57]. Meanwhile, the study also mentioned that the prevalent cause of cross-contamination is when raw food comes into contact with cooked food or even ready-to-eat ones. Our data showed that the respondents have agreed that consuming raw food is one of the causes of worm infestation (mean = 4.482, SD = 0.7240). According to Dbouk et al. (2021), cases of Taeniasis or worm infestations are most commonly observed in countries or societies where raw beef is common [58]. This solidifies the fact that the respondents have prior ideas about how parasitic infections are transmitted and how they can be prevented.

Improper practice in household kitchens associated with the time and temperature conditions of food is one of the major components contributing to outbreaks of food-borne disease [56]. In terms of meat preservation, the respondents strongly agree (mean = 4.804, SD = 0.4458) that "temperature has a significant effect on the spoilage of food." In the Philippines, the ambient temperature varies from 25 °C to 35 °C. This range is within the "danger zone" (4 °C to 60 °C), which is favorable to the growth and multiplication of pathogenic microorganisms (e.g., parasites) that can cause food-borne disease outbreaks [59]. The relatively high humidity, high mean temperature, and abundant rainfall in the country favor the presence of moisture and, consequently, the development of food spoilage. Food spoilage can be defined as any circumstances that make food unacceptably consumed and can be microbiological, attributing to the proliferation of microorganisms producing enzymes that may result in spoilage [60]. Accordingly, the activity of spoilage-causing microorganisms can be reduced using food preservation methods, including food drying (removal of water content). Our data showed that the respondents are aware of the aforementioned preservation method since the majority agreed (mean = 4.200, SD = 0.9094) with the statement, "food drying as a method of meat preservation."

Conversely, the respondents showed an overall neutral response (mean = 2.686, SD = 1.2198) to the statement "if raw meat has been stored at a room temperature that is too warm, but then is properly cooked to the correct internal temperature, it is not safe to eat." Cooking meat in proper temperature conditions can prevent meat-borne parasitic infections. The USDA-FSIS (2017) recommends using a food thermometer to measure the internal temperature in the thickest part of cooked meat [61]. A temperature of at least 63°C and 71°C must be measured for whole cuts of meat and ground meat (excluding poultry), respectively. It is important to remember that, unlike ground meat, whole cuts of meat require a rest time of three minutes before carving or consuming. Once these recommendations are followed before cooking, meat is then considered safe to eat. However, it is advised not to consume cooked meat if it has been left in the "danger zone" for too long since the growth of pathogenic microorganisms may produce heat-resistant toxins which cannot be destroyed by cooking. These findings support the fact that having existing knowledge about the development of pathogenic microorganisms, such as parasites, will further allow the consumers to be mindful of the basic principles in meat preservation.

In delaying the growth of pathogenic microorganisms, it is also important to maintain the storage requirements of meat. Controlling temperature conditions by refrigeration may reduce activity and growth, as opposed to temperature conditions within the "danger zone" of meat. According to the Food and Agriculture Organization of the United Nations (2021), *Taenia solium* can be killed by freezing pork for ten days at a temperature of less than or equal to -10 °C [62]. The same organization has also noted that some species of *Trichinella* and Toxoplasma gondii may be killed by freezing meat for at least 3 days at -20 °C. However, the respondents only had a certain degree of agreement (mean = 3.696, SD = 0.9904) on storing meat in the fridge for 3-5 days.

Further, they also agreed that leftovers should not be left on countertop tables (mean = 4.278, SD = 1.0452). As recommended by the USDA-FSIS, leftovers must be stored in appropriate containers and refrigerated within 2 hours. With these results, it can be inferred that the majority of the respondents practice proper meat storing interventions. Thus, this may give them the advantage of having a lower risk of meat-borne infections.

D. Assessment of Future Food Safety and Food Handling Practices

Table 7 shows the descriptive statistics and interpretation for the respondents' future practices when it comes to food safety and food handling practices for the prevention of parasitic infections.

Table.7. Descriptive Statistics and Interpretation for the Respondents' Future Practice on Food Safety

Category	**Mean**	**Standard Dev.**	**Interpretation***
I would read more journals about food safety and meat-borne parasitic infections in order to enhance my knowledge.	4.36	0.873	Agree
I would attend a food safety and sanitation seminar/s to gain more knowledge regarding this matter.	4.16	0.973	Agree
I would attend a cooking or service competition to improve my professional knowledge.	3.59	1.309	Agree
I would maintain a clean cooking environment to control food safety and prevent parasitic infections.	4.83	0.465	Strongly Agree
Self-checking of food safety is important to restaurants and institutions.	4.81	0.500	Strongly Agree
Overall	**4.35**	**0.8096**	**Positive****

**Mean interpretation per item: ≥ 4.5 = Strongly Agree, 3.5 to 4.4 = Agree, 2.5 to 3.4 = Neutral, 1.5 to 2.4 = Disagree, 0 to 1.4 = Strongly Disagree*
***Overall mean interpretation: ≥ 4 = Positive, < 4 but > 3 = Neutral, < 3 = Negative*

As previously discussed, most respondents have adequate knowledge on pathogenic meat-borne parasites with an overall positive practice toward food safety. In line with this, the respondents were also evaluated on how they will apply their knowledge on meat-borne parasites, specifically their prevention mechanisms, to their food safety practices. Most of them have strongly agreed (mean = 4.83, SD = 0.465) that they would "maintain a clean cooking environment to control food safety and prevent parasitic infection". Their conscious practice of keeping their cooking environment clean can decrease the possibility of meat-borne parasitic infection, unlike in cases where people are oblivious to the risk of food-borne illnesses present at home [63].

Bolek (2020) points out that because people of different ages obtain their information on food safety from a wide range of sources, including television shows, talk shows, seminars, and scientific journals, the information would become more varied over time. As a result of this occurrence, consumers develop misconceptions about the safety precautions required to assist them in properly handling their food. In the same study, the majority of the respondents agreed that scientific journals have the utmost reliability among all other sources of information on food safety. This is consistent with the findings of our study, in which the majority of respondents, with a mean score of 4.36, agreed to read more journals to better their understanding of food safety and to prevent meat-borne parasite infections. Moreover, the respondents' overall expectation to improve knowledge by reading journals or participating in activities that highlight proper food handling is validated by the findings of a study in Italy [64]. The researchers aimed to enhance knowledge on food-borne diseases on a consumer scale.

Health professionals advise that food safety and sanitation seminars be conducted as this will help consumers trust their sources of information, allowing them to begin changing their

behavioral approach toward food preparation into a more beneficial one [65]. In a study conducted by Lally, Chipperfield, & Wardle (2008), after immersing their participants in eight seminars of lecture and training about food safety, their mean score increased to 60.5% from 45.3% prior to the seminars [66]. Hence, educating consumers would yield improved knowledge. However, the authors noted that obtaining knowledge alone does not necessarily lead to behavioral modification. It was mentioned that repetition of the desired behavior is crucial and must take place to truly improve one's practices.

Accordingly, people who have adequate background knowledge on parasitic infections would be more inclined to avoid eating raw or undercooked food and are more open to expand their knowledge on the said topic [67]. This would go hand-in-hand with how the majority of the respondents would want to attend different cooking competitions to further improve their knowledge. In essence, these professional cooking shows are not just present to give out new ways on how to cook new recipes, but they are also meant to give proper hygiene practices to a greater audience with ease [68]. This idea is also solidified by the statement made by Geppert et al. that cooking shows or even cooking competitions conducted by professional chefs comply with the personal safety hygiene protocols [69]. This proves the fact that consumers respond positively to the authority that professional chefs hold. They take it as a sign to imitate what they do, therefore striking a change in their behaviors when it comes to food handling and observing more hygienic food practices.

Consumption of food bought from establishments or restaurants alike has always been a trait of the current standard of living [70]. However, consumers also believed that pre-cooked meals outside of their homes pose a greater risk of food-borne infection [63][71]. This is further supported by the study cited by Liu (2018), in which food served in restaurants is first among the causes of food-borne outbreaks [72]. In addition to this, the same author also cited that food safety has proved to be the most basic standard for food quality evaluation which consumers tend to pay more attention to. With this in mind, being concerned about food safety when eating outside the comfort of homes has always been a standard among customers [73][72]. It is also important to note that some meat-borne parasite cysts, including that of *Taenia solium*, may be seen with the naked eye. Hence, making the strong agreement (mean = 4.81, SD = 0.500) of most of the respondents to the statement "self-checking of food safety is important to restaurants and institutions" justified.

E. Assessment of the Relationship between Knowledge on Pathogenic Meat-borne Parasites and Current Food Safety Practices

Table 8 shows the descriptive statistics of the overall knowledge and current food safety practices of all the respondents. A Pearson's Product-Moment Correlation revealed a weak positive correlation between the two variables ($r = 0.339$, $p < 0.001$), showing that overall knowledge is directly proportional to the respondents' current food safety practices.

Table.8. Descriptive statistics and Pearson Correlation of the Overall Knowledge and Current Food Safety Practices of the respondents.

	Mean	**Std. dev**	**Pearson Correlation**	***p*-value**	**N**
Overall Knowledge	38.573	9.3430	0.339*	<0.001	490
Food Safety Practice	4.232	0.3405			

**Note:* Correlation is significant at the $p < 0.01$ level (2-tailed).

Understanding meat-borne parasites, including their modes of transmission, is of great public health importance, as Torgerson et al. stated that the incidence of parasitic infections worldwide was determined at 407 million cases annually, wherein 91.1 million cases (22%) and an estimated 52 thousand deaths are of food origin [74]. In the Philippines, the most common vehicle for food-borne disease outbreaks was meat-based dishes [59]. The higher risk of infection caused by these meat-borne parasites may be attributed to the lack of knowledge on their pathogenesis and related food handling practices. This supports the results obtained in this study, which implies that there is a significant and direct relationship ($r = 0.339$, $p < 0.001$) between the respondents' knowledge of meat-borne parasites and their current food safety practices. This reaffirms that the two variables follow the same pattern, wherein a high or adequate level of knowledge translates to a positive current food safety practice, while a low level of knowledge results in a negative one. Other similar studies lend credence to these findings, as they also show positive correlations between students' awareness of food-borne parasitic diseases and the

development of right health behaviors, as well as food handlers' knowledge on intestinal parasites and food safety [75][76].

In accordance with this established relationship, it is widely noted that in areas where food-borne disease outbreaks are rampant, people would like to know more about their causes, how they occurred, and how they may prevent those pathogens from infecting them [77]. In a study by Alexander et al., residents in a community with high rates of taeniasis were made aware of the specific details on what this parasitic disease is and how they might avoid contracting it by deploying pre- and post-tests to the responders through public dissemination systems and school campaigns [78]. Because of the improvement in their knowledge of the parasite's physical properties and mode of transmission, there was an increase in the reported practice of handwashing with soap. It is, therefore, essential that students or people, in general, are enlightened on the need for increased knowledge on meat-borne parasites and associated infections, as it is shown that there is a link between awareness of these parasites and enhanced food safety practices.

F. Assessment of the Differences between Allied Health and Non- Allied Health Students' Knowledge on Meat-borne Parasites and Food Safety Practices

Allied health and non-allied health students' knowledge on meat-borne parasites were graded using the modified Bloom's cut-off point, as seen in Table 9. In both groups, the majority have moderate scores, translating to an adequate level of knowledge. However, it is evident that allied health students have a higher percentage of good scores (38.94%) in comparison to students from non-allied health programs (4.28%). Evidence of a low level of knowledge on pathogenic meat-borne parasites and related infections, shown by the frequency of poor scores, was greater to much extent with non-allied health students (29.95%) than that of allied health students (4.95%).

Table.9. Comparison of the knowledge scores of the subgroups, Allied Health (N = 303) and Non-Allied Health students (N =187), on pathogenic meat-borne parasites.

Category	**Frequency** (N=490)	**Percentage**
Allied Health Students (N = 303)		
Good (80% to100%)	118	38.94
Moderate (50% to 79%)	170	56.11
Poor (<50%)	15	4.95
Non-Allied Health Students (N = 187)		
Good (80% to100%)	8	4.28
Moderate (50% to 79%)	123	65.78
Poor (<50%)	56	29.95

Allied health students, such as those taking up to the Bachelor of Science in Medical Technology, Pharmacy, and Biochemistry under the Faculty of Pharmacy and Bachelor of Science in Biology, major in Medical Biology, Microbiology, and Psychology under the College of Science, are known to study and use scientific principles and evidence-based practices for the identification, evaluation, and prevention of diseases. Educational courses offered to these students seek to prepare them to become competent professionals across healthcare settings. In this study, the data show that allied health students primarily obtain their knowledge on pathogenic meat-borne parasites from their subject courses, including Biology, Microbiology, and Parasitology. Some also acquire such information from the internet, books, and medical journals. Non-allied health students, on the other hand, get information regarding pathogenic meat-borne parasites from the internet or learn from people with the background knowledge they are acquainted with. The availability of information regarding related topics about parasitic infection and food safety on the internet may be the reason why some non-allied health students yielded moderate scores. These students who participated in the study belong to programs like the Conservatory of Music, College of Accountancy, and College of Commerce and Business Administration. Further, some students under this category also have familiarity with proper food safety practices, like in College of Tourism & Hospitality Management and College of Education, as food technology and food service systems are included in their respective curricula.

Based on the results shown in Table 9, the majority of students from each group were found to have adequate levels of knowledge; however, it is evident that more students from non-allied health courses (29.95%) have low levels of knowledge than those of allied health students (4.95%). The same argument holds true for students with a high level of knowledge regarding pathogenic meat-borne parasites, wherein allied health students (38.94%) greatly outnumbered non-allied health students (4.28%). These findings are comparable to the study

by Xing-Da et al., who concluded that the level of awareness of food-borne parasitic infections among college students in various majors was different, with non-medical students having a lower level of awareness than medical students who had received medical parasitology education [79].

In Table 10, Pearson Correlation was also used to separately analyze the relationship between the knowledge and current food safety practices of allied and non-allied health students. The analysis indicates that there is a statistically significant relationship between the two variables on both the allied health students and non-allied health students.

Table.10. *Descriptive statistics and Pearson Correlation of the Knowledge on pathogenic meat-borne parasites and Current Food Safety Practices of Allied Health and Non-Allied Health students.*

	Mean	**Std. dev**	**Pearson Correlation**	**p-value**
Allied Health Students (N = 303)				
Allied_Knowledge	42.416	7.6083	0.303*	< 0.001
Allied_Practices	4.270	0.3278		
Non-Allied Health Students (N = 187)				
NonAllied_Knowledge	32.348	8.5139	0.324*	< 0.001
NonAllied_Practices	4.169	0.3521		

**Note:* Correlation is significant at $p < 0.01$ level (2-tailed).

The relationship found between the knowledge and the current food safety practices among allied health students is statistically significant (r = 0.303, $p < 0.001$). This finding is parallel to other studies that have found evidence of a significant difference in students' food safety knowledge in accordance with their difference in the department, food-related training, and year of education [80]. This correlation is further supported by several journals, including a study by Abolhassani (2018), where knowledge and attitude of medical science students on health and food safety also indicated a relationship between the level of education and attitude towards health and food safety. Xing-Da et al. also stated that the development of a correct attitude regarding food consumption in relation to knowledge on parasites was relatively high for medical students [79]. Hence, literacy level or competence in the specified topic helps these students be more mindful and develop proper food practices, thereby decreasing their risk of acquiring parasitic infections.

Further, data analysis of the results also shows a statistically significant relationship (r = 0.324, p < 0.001) between the knowledge and the current food safety practices of non-allied health students. Thus, the same correlation with allied health students was seen; that is, knowledge has an impact on how they handle food. Carvalho et al. reported that students belonging to technical courses like Agriculture, Information Technology, and Management had limited knowledge of parasitic infections and a lower rate of preventive attitudes, such as proper food practices, increasing their susceptibility to such infections [28].

Paired Samples T-test was also performed and showed that the *p*-value is < 0.001 ($\alpha = 0.05$), indicating that there is a significant difference in the knowledge between the allied and non-allied health students with t (186) = 15.219. It also shows that there is a significant difference between the practices of allied health and non-allied health students with $p < 0.001$, t (186) = 3.914.

Table.11**.** *Paired Samples Descriptive Statistics and T-test of the Knowledge on Meat-borne Parasites and Current Food Safety Practices of Allied Health and Non-Allied Health students.*

		Mean	**N**	**SD**	**t**	**df**	***p*-value**
Pair 1	Allied_Knowledge	44.535	187	6.5256	15.219	186	< 0.001
	Non-Allied_Knowledge	32.348	187	8.5139			

Pair 2	Allied_Practices	4.311	187	0.3115	3.914	186	< 0.001
	Non-Allied_Practices	4.169	187	0.3521			

Note: α = 0.05

These notable differences found between allied health and non-allied health students are supported by other related studies which indicated that there were also statistically significant differences among or between the socio-demographic characteristics of students [80], and whether or not they are receiving health education [81]. On the contrary, they found that there was no difference between the level of food safety practice and demographic variables like educational level among their respondents [82].

IV. CONCLUSION

This study aimed to determine the impact of knowledge regarding pathogenic meat-borne parasites on current food safety practices among selected tertiary students in a university in Manila using a quantitative descriptive comparative design as a research method. A Google form questionnaire survey was utilized and distributed through online platforms such as social media groups, and a total of 490 respondents were obtained. It was discovered that overall, most of the students (59.80%) have a moderate level of knowledge on pathogenic meat-borne parasites, while some have good (25.71%) and others have poor (14.49%). The respondents have access to a variety of sources of information about parasites, with the majority accounting for the internet and school, as shown in the data. Some of them also took courses such as Biology, Microbiology, Parasitology, and Food Technology. The results also indicate that the respondents' food safety and food handling practices were favorably positive, with a mean score of 4.23. Pearson

Correlation analysis revealed that overall, knowledge regarding pathogenic meat-borne parasites has a significant relationship with the current food safety practices of the selected tertiary level students. This weak positive correlation ($r = 0.339$, $p < 0.001$) between the two variables indicates that the knowledge is directly proportional to food safety practice. Paired Samples T-test, on the other hand, demonstrated that there is a statistically significant difference between both the knowledge ($p < 0.001$) and the current food safety practices ($p < 0.001$) of two subgroups, allied health, and non-allied health students. This is also supported by the results wherein a greater percentage of students from allied health courses have a higher level of knowledge than those of the non-allied health students.

Millions of Filipinos are at risk of parasitic infections, with the majority of this owing to their continued preference for meat products such as pork, beef, and poultry. The lack of information about their propensity to cause disease and improper food handling are other factors that may contribute to this risk. It was found that the majority of the respondents obtained knowledge scores that were moderate and interpreted as having an adequate level of knowledge, with only some having a high level of knowledge. Good knowledge of the mode of transmission, prevention, and acquisition of meat-borne parasites directly correlates to proper food safety practices. As universities/schools were found to be one of the primary sources of information on pathogenic meat-borne parasites and related diseases, they must be able to provide opportunities to increase students' knowledge and awareness in order to improve their food safety practices. Enhancing the knowledge on meat-borne parasites among tertiary students through health education seminars regarding meat-borne parasitic infections, integration of food safety education in any form in the school curricula, and establishment of food safety policies in the university may facilitate and increase the probability of the development or adaptation of habitual health behaviors and food safety practices, leading to a decreased risk of meat-borne parasitic infections.

The current COVID-19 pandemic situation constrained many variables in this research. Further studies revolving around broader demography such as respondents from different social standing would reveal new insights. Approaching this research with qualitative technique would also give a wider and clearer perspective of consumers' standpoint regarding meat-borne parasites and food handling practices.

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