

Effectiveness of Customized Training Programs on Knowledge, Attitudes, and Practices (KAP) Related to Antimicrobial Resistance (AMR) among Food Handlers in the Greater Manila Area, Philippines: A Quasi-experimental Study

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ABSTRACT

Background and Objectives. Antimicrobial resistance (AMR) constitutes an escalating global public health menace, intensified by the excessive utilization of antibiotics in human healthcare and agriculture. In the Philippines, the extensive misuse of antimicrobials in food production, especially in chicken, swine, aquaculture, and agriculture exacerbate AMR, presenting considerable threats to public health. Since the transmission of AMR is closely linked to food safety, food handlers play a critical role in mitigating its spread. This study evaluates the knowledge, attitude, and practices (KAP) of food handlers in the Greater Manila Area concerning AMR and the utilization of antimicrobials.

Methods. This quasi-experimental study involved developing and implementing a customized training program based on pre-training KAP questionnaires, featuring specialized training materials for fruits and vegetables sellers, meat handlers, seafood vendors, and street food vendors. The training, conducted in partnership with government entities and industry specialists, emphasized AMR awareness, food safety rules, and optimal procedures for reducing AMR hazards.

Results. The results showed statistically significant differences in pre- and post-intervention mean percentage scores in the participants' knowledge, attitudes, and practices about food handling and AMR. There was also substantial improvement observed across all four occupational groups as post-test scores increased in comparison to their baseline scores.

Conclusion. This study underscores the pivotal role of food handlers in combating AMR and stresses the necessity for a training program that is focused on AMR education within food safety initiatives. The training program should be customized, for example, according to the length of experience of the food handler, to either provide basic food safety measures or to improve and upgrade the acquired baseline knowledge and skills related to food safety. This particular study showed the importance of providing food handlers with essential knowledge and skills on food safety and proper food handling to aid in the mitigation of AMR transmission.

Keywords: AMR, food safety, food handlers, knowledge, attitudes and practices (KAP)

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INTRODUCTION

The worldwide antimicrobial resistance (AMR) issue has escalated in recent years, requiring immediate measures to mitigate its proliferation. The escalation of AMR is ascribed to multiple sources, notably the heightened utilization of antimicrobials in human healthcare and agriculture, resulting in the formation of resistant bacterial strains.¹ The excessive use of antibiotics in animal production, especially in low- and middle-income nations, has been associated with a substantial rise in antimicrobial use, anticipated to double within the next decade. This scenario is exacerbated by inadequate sanitation and healthcare infrastructure, further facilitating the spread of resistant pathogens.^{1,2} The World Health Organization has identified AMR as one of the foremost global public health issues, with approximately 1.27 million fatalities linked to bacterial resistance in 2019.^{3,4} The prevalence of AMR in the Philippines is particularly alarming due to elevated antibiotic use, misuse and extensive application of antimicrobials in food production.⁵ Research studies conducted by Belotindos et al.⁶ and Barroga et al.⁷ underscore the prevalent application of quinolone and fluoroquinolone antibiotics in chicken and swine production for growth enhancement, treatment, and prevention. This excessive use and misuse greatly foster the emergence of resistance, as resistant microorganisms can be transmitted to people via the food chain.⁸ Regulatory challenges, as highlighted by Pineda-Cortel et al. intensify these issues due to the readily available veterinary pharmaceutical treatments for farmers and their insufficient information regarding the prudent use of antimicrobials.⁵ Although AMR initiatives predominantly focus on health environments, food handlers constitute a neglected yet essential demographic in reducing AMR threats. These frontline workers are essential for upholding food safety regulations and are pivotal in disrupting the transmission of AMR within the food supply. In highly populated regions like the Greater Manila Area with a population of over 28.2 million in approximately 8,100 km², where food demand is high and sanitation standards differ among establishments, food handlers may unintentionally serve as vectors for the transmission of antimicrobial-resistant bacteria (ARB).^{9,10} Getie et al.¹¹ and Akabanda et al.¹² established that insufficient training in hygiene practices among food handlers is associated with heightened risks of contamination and foodborne diseases. Additionally, a study conducted by Lirio et al.¹³ in Metro Manila identified substantial knowledge deficiencies among food handlers concerning the consequences of antimicrobial overuse. This disparity is concerning, as food handlers often engage with meat, vegetables, and dairy items that may already have resistant bacteria due to the use of antibiotics in agriculture. Mitigating these deficiencies is essential for diminishing AMR threats and protecting public health.¹⁴⁻¹⁶ To determine why people do not adhere to the preventative health measures, the Health Belief Model (HBM) was established

by the U.S. Public Health Services. In this model, personal beliefs, perceptions about the disease, and the availability of strategies to mitigate the occurrence of the disease are determined by the health behavior. The sociodemographic and psychosocial components have been well documented to affect the individual's perception of a disease. This is the core of the HBM. For example, the likelihood of a behavior being carried out is determined by the threat perception alongside the perceived benefits, perceived barriers, and self-efficacy.¹⁷ In addition to this, participation in food safety behaviors is more likely among consumers with higher risk perception. This has been evidenced in a previous study that related proper food-handling practices to perceived severity.¹⁸

Hence, this study aims to address the knowledge gaps in food safety, specifically the roles of food handlers in ARB transmission by assessing the effect of a customized training program on the knowledge, attitude, and practices (KAP) of food handlers in Greater Manila Area about AMR. Furthermore, this seeks to describe the existing level of knowledge and behaviors, provide customized training programs designed for the specific issues encountered by food handlers, and analyze the effectiveness of these interventions.

MATERIALS AND METHODS

Study Design

This quasi-experimental study employed a before-and-after design.

Study Site

The study was implemented in the City of Manila in the National Capital Region of the Philippines. Six public markets (Figure 1) were selected in the city by their proximity to the University of the Philippines Manila. The public markets were (1) Paco Market (14°34'45.6"N 120°59'35.3"E), (2) San Andres Market (14°34'10"N 120°59'21"E), (3) Divisoria Public Market (14°36'7.9"N, 120°58'12.5"E), (4) Roxas Market (14°37'17.6"N, 120°57'41.0"E), (5) Pavia Market (14°36'40.5"N, 120°58'4.1"E), and (6) Blumentritt Market (14°37'20.9"N, 120°58'59.5"E).

Study Population

The target participants in this study were food vendors selling products in the six identified public markets in the City of Manila. For a vendor to qualify as a potential participant in the study, they should have satisfied the following inclusion criteria: (1) aged 18 years and above and (2) currently working as food vendors (fruit, vegetable, seafood, meat, or street food) in selected markets in the City of Manila. Potential participants who would be unavailable or could not attend the scheduled training period were excluded from the study. Those who satisfied the eligibility criteria as mentioned above were considered eligible participants and were recruited to participate in the study.

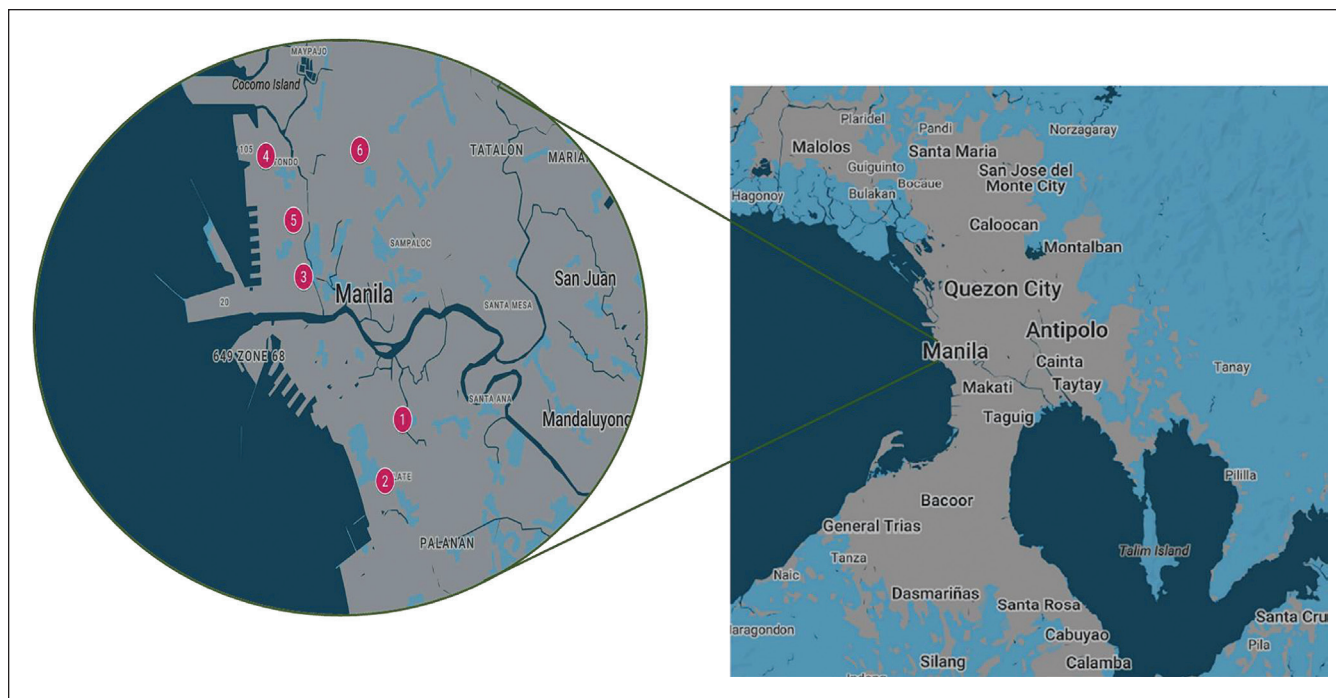


Figure 1. Locator map of the selected public markets in the City of Manila, National Capital Region, the Philippines, 2025.¹⁹

Recruitment of Participants

Recruitment of training participants was done through visits to the selected public markets during the entire month of August 2024. Market vendors were approached by convenience in their stalls and were asked if they would like to participate in a training workshop on food safety and antimicrobial resistance. Those who gave an affirmative response were assessed based on the specified eligibility criteria. Written informed consent was obtained from each eligible participant. A total of 60 recruited vendors were deemed eligible to participate in the customized training and gave written informed consent (Figure 2). Additionally, each eligible participant was informed of an incentive for their transportation to and from their residence to the customized specialized training program venue.

Sixty eligible participants were classified based on the food product that they were selling. A specific training program was scheduled for each type of market vendors (fruit, vegetable, seafood, meat, or street food). One week prior to the training, the eligible participants were reminded of the training via text message. There were three participants who were lost to follow-up. Hence, a total of 57 eligible participants were able to attend the training (Figure 2).

Research Instruments

The KAP of food handlers about AMR and food safety, and proper utilization of antimicrobials were assessed by administering the same self-administered questionnaire (SAQ) before and after the training. The KAP SAQ was designed and guided by a table of specifications that was

prepared by the research team. The table of specification laid down the distribution of items based on the learning competencies of the training program. The items were constructed based on the World Health Organization's Food Safety Key Facts,²⁰ and Food and Agricultural Organization's Antimicrobial Resistance and Food Safety page²¹. The finalized SAQ consisted of three subscales: knowledge, attitude, and practices. The knowledge subscale consisted of five multiple-choice questions. Each correct response was given a point, while an incorrect response yielded no point. Hence, the maximum score that could be obtained in this subscale was five. The attitude subscale covered recognition and development of positive attitude towards the prevention of AMR transmission. It consisted of five statements to be rated by the participants based on the degree of their agreement using a 4-item Likert scale. To facilitate scoring, agreeable statements should have been rated with strongly agree and agree, while disagreeable statements should have been rated by disagree and strongly disagree. Favorable agreement with an agreeable statement and disagreement with a disagreeable statement, regardless of the degree, yielded a point. This subscale could bring a maximum point of five. Lastly, the practice subscale consisted of five items with two categories of response, "yes" and "no." The correct response was given a point, thereby having a maximum point of five for this subscale. The overall KAP score that could be obtained from the three subscales could range from 0 to 15. From this, the overall percentage score was derived by dividing the total score with the total number of items multiplied by 100.

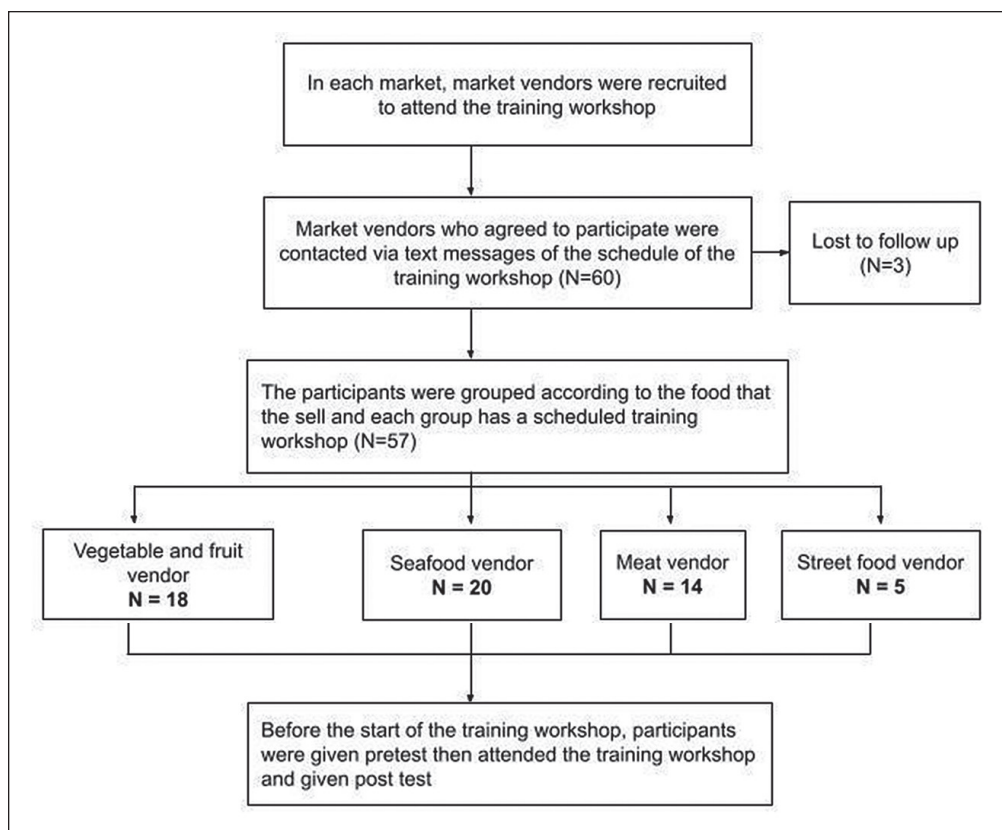


Figure 2. Flow of participants' recruitment in the study.

Aside from re-administering the SAQ as a post-test, a graded return demonstration was done to assess if the participants could apply what they learned in the training. Scenarios were simulated, and the participants were instructed to demonstrate how they would respond by applying proper techniques on food safety or translating their learning into practice. They were observed and graded by facilitators who were trained in utilizing the rubrics for evaluation.

Research Intervention: Specialized Training

Fruits and Vegetables Vendors Program

The fruits and vegetables program aimed to inform sellers about the risks of AMR and optimal procedures for handling produce to avert contamination. The session was conducted and commenced with a theoretical lecture on AMR, addressing its origins, transmission channels, and potential implications for public health. After the AMR lecture, a presentation addressed legislation and protocols about food handling procedures as stipulated by local government units (LGUs), highlighting cleanliness and food safety standards. A representative from the Bureau of Plant Industry (BPI) outlined the national policies for food handling and cleanliness, designed to mitigate the contamination of fruits and vegetables during handling and distribution. The workshop ended with an industry guest speaker who offered

experiences and best practices for managing fresh food to reduce the risk of infection and AMR.

Meat Vendors Program

For the meat seller training session, the group invited resource speakers from the Manila Veterinary Board, the National Meat Inspection Service (NMIS), and a meat processing company. The session commenced with a theoretical lecture on AMR, akin to the fruits and vegetables program. The presentation addressed the transmission of AMR by inadequate handling, storage, and processing of beef products. After the lecture, a specialist from the Manila City Sanitation Office elucidated food handling and hygiene requirements pertinent to meat vendors, detailing the local standards for meat safety and the requisite protocols to prevent contamination. The session featured a talk on national policies governing the meat industry, succeeded by a speaker who recounted practical experience and industry-specific best practices for upholding cleanliness and safety to mitigate AMR.

Seafood Vendors Program

The seafood seller training program was created in partnership with the Bureau of Fisheries and Aquatic Resources (BFAR) and the Manila City Sanitation Office. The program's structure resembled that of previous ones,

commencing with a theoretical lecture on AMR. A discussion ensued over the transmission hazards of AMR due to the inappropriate handling and storage of seafood. After the talk, a specialist from the Manila City Hygiene Office elucidated the local food handling standards pertinent to seafood merchants, underscoring the necessity of preserving cold chains and ensuring correct hygiene. A delegate from the BFAR also explained national policies about seafood handling and hygiene to mitigate contamination. The seminar ended with a speaker from the seafood business, who offered insights into optimal procedures for preserving product quality and safety, ensuring that seafood merchants comprehend the essential measures to reduce the transmission of AMR.

Street Food Vendors Program

To tackle food safety issues related to preparation and sales in the street food vendor program, a partnership with the Manila Sanitation Office and the Department of Health (DOH) was initiated. The event commenced with a talk on AMR with an emphasis on its potential effects on public health due to the inadequate handling and preparation of street food. Subsequent to the lecture, a representative from the Manila City Sanitation Office elucidated the local regulations about food safety and handling applicable to street food sellers. A lecture on national food safety policies aimed at mitigating contamination concerns, especially in street food settings, ensued. An industry expert provided insights on managing street food safety, presenting pragmatic recommendations for reducing cross-contamination and maintaining food hygiene at food stalls.

Data Collection

The study variables are the overall pre-test and post-test KAP scores, as well as the specific pre-test and post-test scores per subscale. Other study variables were demographic characteristics of participants such as age, highest educational attainment, and years of food vending experience.

Data Management and Analysis

Participants' socio-demographic characteristics, which include age, highest educational attainment, and years of experience, and their scores from the pre-test, post-test, and return demonstration were encoded in a Microsoft Excel-based data encoding form. STATA version 14²² was used in statistical data analysis.

Descriptive statistics were generated through the calculation of overall mean percentage scores and standard deviation during the pre-test, post-test, and return demonstration. These summary measures were also calculated per occupation group and KAP subscale.

The Shapiro-Wilk test was used to determine if the pre-test and post-test percentage scores in each subscale were normally distributed. Only the pre-test and post-test percentage scores in the knowledge subscale were found to be normally distributed ($p=0.929$ and $p=0.958$, respectively).

Hence, a paired t-test was used to determine if there was a significant difference between the knowledge scores during pre-test and post-test. The Wilcoxon Signed Rank test was used to compare the pre-test and post-test percentage scores for the attitude and practice subscales. All statistical tests were done at 95% confidence level.

Ethics Approval and Consent to Participate

This study was approved by the University of Philippines Manila - Research Ethics Board (UPMREB code 2024-0457-01). Written informed consents were obtained from all of the participants in the training workshop.

Data Privacy

The study adhered to the stipulations of the Data Privacy Act of 2012.

RESULTS

Demographic Profile of Participants

Sixty individuals initially agreed to participate, but three were lost to follow-up. The reasons for non-participation were not systematically recorded but may have included lack of availability, changes in work schedules, or personal circumstances that prevented attendance at the scheduled training sessions. The majority comprised seafood handlers (35.1%), fruit and vegetable handlers (31.6%), and meat handlers (24.6%). A minority (8.8%) were vendors of street food.

Age Distribution

Table 1 shows that the participants aged 18-24 years were the smallest group, representing only 10.5% of the total. This age group was most represented among seafood handlers (15%) and street food vendors (20.0%), suggesting that younger individuals are more likely to engage in these roles, potentially due to lower entry requirements or informal work opportunities. Participants aged 25-34 years accounted for a relatively small percentage of the total participants at 15.8%, with fruit and vegetable handlers making up the largest proportion of the 25-34 age group (22.22%). A large proportion of the street food vendors is composed of this age group at 40%, possibly reflecting the entrepreneurial nature of this occupation. On the hand, the 45-54 age group had the second highest representation of the overall age groups at 31.6%. This age group is strongly represented by meat handlers (42.85%) and street food vendors (40.0%). Lastly, relatively small proportions of fruits and vegetable handlers and seafood handlers belong to the 35-44 age group, 33.33% and 15.0%, respectively. Participants aged 45-54 years comprised 31.6% of the total participants, making this the highest group. Seafood handlers were particularly prominent in this age category, with over half (55.0%) of the participants falling within this range. Meat handlers and fruits and vegetables handlers accounted for smaller proportions at

Table 1. Age Distribution according to Occupational Category of Participants in the KAP Customized Training Program on Food Safety and Antimicrobial Resistance from Selected Markets in the City of Manila

Age Group (years)	Fruit and Vegetable Handlers		Meat Handlers		Seafood Handlers		Street Food Vendors		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
18-24	1	5.56	1	7.14	3	15.0	1	20.0	6	10.5
25-34	4	22.22	1	7.14	2	10.0	2	40.0	9	15.8
35-44	6	33.33	6	42.86	3	15.0	2	40.0	17	29.8
45-54	4	22.22	3	21.43	11	55.0	-	0.0	18	31.6
55-60	3	16.67	3	21.43	1	5.0	-	0.0	7	12.3
Total	18	100.00	14	100.00	20	100.0	5	100.0	57	100.0

Table 2. Educational Attainment of Participants in each Occupational Category in the KAP Customized Training Program on Food Safety and Antimicrobial Resistance from Selected Markets in the City of Manila

Educational Level	Fruit and Vegetable Handlers		Meat Handlers		Seafood Handlers		Street Food Vendors		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Elementary	0	0.00	0	0.00	0	0.0	1	20.0	1	1.8
High School	12	66.67	11	78.57	15	75.0	3	60.0	41	71.9
University	5	27.78	3	21.43	3	15.0	0	0.0	11	19.3
Vocational	1	5.55	0	0.00	2	10.0	1	20.0	4	7.0
Total	18	100.00	14	100.00	20	100.0	5	100.0	57	100.0

Table 3. Years of Experience of Participants in each Occupational Category in the KAP Customized Training Program on Food Safety and Antimicrobial Resistance from Selected Markets in the City of Manila

Years of Experience	Fruit and Vegetable Handlers		Meat Handlers		Seafood Handlers		Street Food Vendors		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<1	4	22.2	4	28.57	2	10.0	1	20.0	11	19.3
1-4	3	16.7	7	50.0	13	65.0	2	40.0	25	43.9
5-9	2	11.1	2	14.3	1	5.0	1	20.0	6	10.5
10-14	2	11.1	1	7.1	2	10.0	1	20.0	6	10.5
≥15	7	38.9	0	0.0	2	10.0	0	0.0	9	15.8
Total	18	100.0	14	100.0	20	100.0	5	100.0	57	100.0

21.43% and 22.22%, respectively. Participants aged 55-60 years represented 12.3% of the total sample. This group was predominantly composed of meat handlers (21.43%) and fruit and vegetable handlers (16.67%), with minimal representation among seafood handlers (5.0%). No participants from the street food vendor were categorized within this age range, highlighting that street food vending may attract younger individuals compared to other occupations.

Educational Attainment

Table 2 indicates that the majority of participants, regardless of their occupational category, had attained at least a high school diploma, reflecting a relatively uniform educational background among food handlers. High school graduates comprised the largest proportion of participants across all groups, with an overall percentage of 71.9%. This trend was consistent within each occupational category: fruits and vegetables handlers (66.67%), meat handlers (78.57%), seafood handlers (75.0%), and street food vendors (60.0%).

A smaller proportion of participants had university-level education, accounting for 19.3% overall. This was most prevalent among fruits and vegetables handlers, where 27.78% had completed a university degree. Meat and seafood handlers had similar proportions of university graduates, at 21.43% and 15.0%, respectively. On the other hand, none of the street vendors reported to reach university-level education.

Vocational training was less common, representing 7.0% of the total sample. It was most prominent among street food vendors (20.0%) and seafood handlers (10.0%). Only one participant from the street food vendor category reported elementary education as their highest level of educational attainment, making this occupational group the only category to include a participant to have an educational attainment below secondary education.

Years of Experience in Food Handling

The majority of the participants possessed modest occupational experience, with a substantial fraction (43.9%)

having 1-4 years of experience, suggesting a potential to enhance food handling procedures. The subsequent largest proportion comprised of food handlers with less than 1 year exposure (19.3%). In terms of occupational groups, nearly 40% of fruit and vegetable handlers have over 15 years of experience, while street food vendors had a maximum of 10 to 14 years of experience. It was observed that 50% of meat handlers possessed 1 to 4 years of experience in their occupation, and this was also observed in the majority of seafood handlers in terms of years of experience (Table 3).

Knowledge, Attitudes and Practices (KAP) Before and After the Training

All 57 participants completed the pre-test, post-test, and return demonstration, and their data were included in the analysis. No missing data were reported for the outcome variables. Therefore, no imputation or other missing data handling methods were necessary.

Knowledge Subscale

Baseline scores in the knowledge subscale presented in Table 4 revealed significant gaps in food handlers' understanding of AMR. The average pre-test percentage scores across all occupation groups were below 50%. The overall average percentage score of all the food handlers had increased after attending the training. This is further supported by the result of the paired t-test, which showed that there was a statistically significant difference between the overall pre-test and post-test percentage scores in the knowledge subscale ($n=57$, $t=-10.16$, $p<0.0001$).

Among the groups, street food vendors recorded the highest baseline average percentage score (45.00%), while

meat handlers had the lowest (30.00%). These results indicate notable deficiencies in knowledge before the training.

Post-training assessments showed considerable improvements across all groups, demonstrating the training's effectiveness in enhancing AMR-related knowledge. After the training, fruit and vegetable handlers had the highest average percentage score (82.22 ± 15.17), while street food vendors recorded the lowest post-training percentage score (64.00 ± 8.94). Both meat and seafood handlers have been found to have the lowest baseline percentage scores of 30.00% and 31.00%, respectively. However, seafood handlers have higher improved percentage score of 78.00% in comparison to 65.71% of meat handlers. This improvement in the percentage scores in knowledge subscale highlights the impact of targeted education provided by the customized training program.

The data underscore the need for continued education efforts, particularly for groups with initially lower baseline scores. These findings emphasize the importance of tailored interventions to address knowledge gaps and improve understanding of AMR among food handlers. Table 4 provides a detailed comparison of pre- and post-test scores across all occupation groups.

Attitude Subscale

Baseline scores in the attitude subscale, shown in Table 5, indicated notable deficiencies across all occupational groups in the range of 60.00%-75.71%. The baseline percentage scores improved post-training, supported by the results of the Wilcoxon Signed Rank test, which showed a statistically significant difference between the pre-test and post-test percentage scores of all the participants in the attitude subscale ($n=57$, $z=-5.39$, $p<0.0001$). Post-training results demonstrated

Table 4. Comparison of the Mean Percentage Scores of the Participants in the Knowledge Subscale before and after the Customized Training Program on Food Safety and Antimicrobial Resistance

Occupation Group	No.	Pretest - Knowledge Domain		Posttest - Knowledge Domain	
		Mean	($\pm$ SD)	Mean	($\pm$ SD)
<i>Fruits and Vegetables Handlers</i>	18	42.22	15.17	82.22	15.17
<i>Meat Handlers</i>	14	30.00	21.84	65.71	24.09
<i>Seafood Handlers</i>	20	31.00	22.92	78.00	19.36
<i>Street Food Vendors</i>	5	45.00	11.18	64.00	8.94
Total	57	35.53	20.13	75.09	19.74

Table 5. Comparison of the Mean Percentage Scores of the Participants in the Attitude Subscale before and after the Customized Training Program on Food Safety and Antimicrobial Resistance

Occupation Group	No.	Pretest - Attitude Domain		Posttest - Attitude Domain	
		Mean	($\pm$ SD)	Mean	($\pm$ SD)
<i>Fruits and Vegetables Handlers</i>	18	65.56	27.27	96.67	10.29
<i>Meat Handlers</i>	14	75.71	11.58	84.29	8.52
<i>Seafood Handlers</i>	20	62.00	23.31	82.00	18.24
<i>Street Food Vendors</i>	5	60.00	14.14	100.00	0.00
Total	57	66.32	22.09	88.77	14.65

significant improvements in attitude scores for all occupational groups. Among the groups, street food handlers recorded the highest improvement of the attitude percentage score from 60.00% to 100.00%. It is interesting to note that while meat vendors have the highest baseline percentage score of 75.71%, it recorded the lowest improvement in the percentage score of 84.29%, a minimal difference of only 8.58%. These findings highlight a need for interventions to improve attitudes toward food safety and AMR. In addition, the improvement in the percentage score across all occupational groups is suggestive for a targeted educational effort towards effective fostering of positive attitudes on AMR and food safety practices. However, the variations in baseline and post-training scores among the groups highlight the need for tailored interventions to address specific gaps in attitudes. Table 5 shows a comparison of pre- and post-training scores for the attitude subscale.

Practice Subscale

Baseline results in the practice subscale revealed a very low percentage score, ranging only 15.56% to 36.00% across all occupational groups. The lowest baseline percentage score was observed among fruits and vegetables vendors while the highest baseline percentage score was observed among seafood handlers. Post-training assessments demonstrated improved scores across all groups, highlighting the effectiveness of the intervention. This is further supported by the result of the Wilcoxon Signed Rank test, which showed that there was a statistically significant difference between the pre-test and post-test percentage scores of all the participants in the practice subscale domain (n=57, z=-6.58, p<0.0001). Among these occupational groups, fruits and vegetables handlers

have the highest improvement with a 70-point difference from the baseline score of 15.56% to 85.56%. This is followed by the street food vendors with a post-test percentage score of 88.00% from 20.00%, then by the meat handlers with a pre-test percentage score of 28.57% to 95.71%. While seafood handlers recorded the highest pre-test percentage score for practice subscale at 36.00%, it has the lowest post-test percentage score of 80.00%. These findings underscore the effectiveness of tailored training programs in enhancing practical food handling behaviors, particularly for groups with lower baseline scores. Table 6 provides a detailed comparison of pre- and post-training scores across occupational groups in the practice subscale.

Lastly, the overall performance of the participants has also been evaluated based on the overall pre-test and post-test percentage scores. It could be inferred from Table 7 a significant improvement in the overall percentage scores across all groups of food handlers following the training. The result of the Wilcoxon Signed Rank test further showed that there was a statistically significant difference between the overall pre-test and post-test percentage scores of all the participants (n=57, z=-17.92, p<0.0001).

The overall pre-test percentage scores across all occupational groups range from only 41.11% to 44.76%. Post-training, street food vendors have the highest average of overall percentage score at 90.00%, followed by the fruits and vegetables handlers at 88.15%. Both meat and seafood handlers recorded the lowest average of overall percentage scores at 81.90% and 80.00%, respectively. Despite the differences in baseline and post-test scores, all four occupational groups demonstrated substantial progress, with their post-test scores

Table 6. Comparison of the Mean Percentage Scores of the Participants the Practice Subscale before and after the Customized Training Program on Food Safety and Antimicrobial Resistance

Occupation Group	No.	Pretest - Knowledge Domain		Posttest - Knowledge Domain	
		Mean	(± SD)	Mean	(± SD)
<i>Fruits and Vegetables Handlers</i>	18	15.56	14.64	85.56	23.57
<i>Meat Handlers</i>	14	28.57	24.45	95.71	8.52
<i>Seafood Handlers</i>	20	36.00	23.93	80.00	24.28
<i>Street Food Vendors</i>	5	20.00	14.14	88.00	10.95
<i>Total</i>	57	26.32	22.09	86.32	20.76

Table 7. Comparison of Mean Pre-test and Mean Post-test Overall Percentage Scores of the Participants Categorized by Occupational Group in the Customized Training Program on Food Safety and Antimicrobial Resistance Conducted in the City of Manila

Occupation Group	No.	Pretest Score		Posttest Score	
		Mean	(± SD)	Mean	(± SD)
<i>Fruits and Vegetables Handlers</i>	18	41.11	12.78	88.15	9.85
<i>Meat Handlers</i>	14	44.76	12.66	81.90	10.60
<i>Seafood Handlers</i>	20	43.00	17.50	80.00	13.51
<i>Street Food Vendors</i>	5	41.43	7.82	90.00	3.91
<i>Total</i>	57	42.70	14.04	83.92	11.58

Table 8. Mean Percentage Score of the Different Occupation Groups Observed in The Return Demonstration

Occupation Group	No.	Return Demonstration	
		Mean	($\pm$ SD)
<i>Fruits and Vegetables Handlers</i>	18	72.22	13.96
<i>Meat Handlers</i>	14	78.57	29.83
<i>Seafood Handlers</i>	20	81.00	19.97
<i>Street Food Vendors</i>	5	80.00	24.49
Total	57	77.54	21.40

approximately doubling their baseline scores. This consistent improvement highlights the effectiveness of the training program in addressing key gaps in knowledge, attitudes, and practices related to food safety and AMR.

Return Demonstration

After the training, a return demonstration was done. Table 8 shows the mean percentage score in each occupation groups. It could be observed that the majority of the mean percentage score was high with the highest score of 81% observed among seafood handlers, while the lowest percentage score of 72.22% observed among fruits and vegetable handlers. Additionally, the performance of the participants was also categorized based on the percentage score range in the return demonstration activity. It could be inferred in Table 9 that while there were five participants categorized within the low percentage score range represented by 40.00-59.99 percentage score range (4 participants) and 0.00-39.99 percentage score range (1 participant), most of the participants performed well in the return demonstration activity. This is demonstrated by the 19 participants, who were categorized within the 100.00 percentage score range followed by 19 participants within the 80-99.99 percentage score range. It is important to note that the participant within the 0.00 percentage score range was given a remedial class for the return demonstration.

DISCUSSION

Middle-aged Participants Involved in Food Handling

The data highlighted a strong presence of middle-aged participants within the age range of 35-54 years, who likely have more established careers in food handling. Younger participants within the range of 18-34 years were more represented among street food handlers and seafood handlers, reflecting the accessibility and informal nature of these roles.⁵ The absence of older participants (55-60 years) in street food vending suggest that this occupation may be physically demanding or less appealing for older individuals. These findings can guide the development of age-appropriate training materials and interventions, ensuring that all age groups are effectively engaged in food safety and AMR education.

Table 9. Distribution of Participants according to Performance Percentage Score Attained in the Return Demonstration

Range of Percentage Score	No.	(%)
0.00 - 39.99	1	1.75
40.00 - 59.99	4	7.02
60.00 - 79.99	14	24.56
80.00 - 99.99	19	33.33
100.00	19	33.33
Total	57	100.00

Diversity in Educational Levels among Food Handlers

While most food handlers possess foundational education levels, there is diversity in educational attainment.²³ In general, higher levels of education are associated with greater knowledge of food hygiene safety.²⁴ In this study, majority of the participants attained secondary school education. This scenario is similar to the result of a recent study wherein majority of the respondents have lower educational level.²⁵ Additionally, in the study of Mwove et al.²⁶, a significant 38.1% of street food vendors had completed secondary school education, while approximately 93% lacked any formal training in food hygiene and safety. This scenario of a lack of training in food safety is closely associated with poor food hygiene.^{25,27} The lower educational attainment specifically secondary and elementary education highlights a potential area for targeted educational interventions to ensure comprehension and compliance with food safety practices.²⁵ Furthermore, street food vending, being a low-cost and accessible business to establish, offers a viable pathway for them to start their entrepreneurial journey.

Varied Years of Experience in Food Handling

The analysis of work experience among participants reveals a varied distribution of expertise highlighting opportunities for targeted interventions to enhance food handling practices. Participants with less than one year of experience (19.3%) are a notable demographic for introductory and capacity-building interventions. These individuals are likely to be more receptive to new food safety concepts and behaviors. On the other hand, there were also participants with extensive experience, particularly those in the over 15-year category. These individuals may require strategies to improve and update the food safety knowledge and practices that they have been applying over the years. In this study, the varied years of experience in food handling across the different occupational groups were described; however, it has not been indicated whether the participants have taken previous food safety training other than this customized training program. Interestingly, considering that the street food vendors exhibited a maximum of 10-14 years of experience, with some working close to 15 years, and that most of these participants are within the 25-44 years age group, this indicates that the

participants have started working as early as 20 years old. This group appears to operate largely outside the regulatory oversight of government food safety guidelines, often relying on their informal methods of food handling. These practices may not align with updated food safety regulations and pose potential risks.²⁸ This scenario underscores the importance of extending regulator outreach and offering tailored training programs to street food vendors to integrate them into formalized food safety systems. On the other hand, the distribution of work experience highlights the necessity of flexible training methods tailored to the participants' varying experience levels. Additionally, based on previous studies conducted, hygienic food handling practices have a close correlation with the number of years of food handling.²⁹ For those with less than one year of experience, training should prioritize the introduction of foundational concepts and basic practices to establish a solid groundwork. Participants with 1-4 years of experience require reinforcement of best practices, with an emphasis on habit formation to ensure consistency and compliance. For individuals with over 15 years of experience, training should focus on incremental updates to modernize their practices while leveraging their expertise to serve as role models and mentors for others. The findings underscore the need for mandatory basic and advanced training programs to effectively enhance food handlers' knowledge, attitudes, and practices in food safety.²³ Understanding the diversity in experience levels across occupational groups allows for designing interventions that effectively address varying needs that will ultimately lead to the enhancement of food safety practices and mitigation of risks associated with AMR.

Improved Knowledge in AMR

The pre-test findings indicated a deficient comprehension of AMR among food handlers, especially with its transmission routes and public health ramifications. Post-training evaluations demonstrated a significant enhancement in awareness. Participants exhibited an enhanced understanding of AMR ideas, encompassing the dangers linked to antibiotic abuse and its capacity to jeopardize food safety. This enhancement corresponds with the findings of Malavi et al., which underscores the effectiveness of educational programs in augmenting food workers' comprehension of essential food safety concerns.³⁰ The participation of specialists from the Manila Health Department, Bureau of Plant Industry, and other pertinent organizations enhanced the training by integrating academic knowledge with actual applications. Moreover, Sjarif et al.³¹ emphasized that interactive and customized educational programs, like the methods employed in this study, are superior in promoting knowledge retention relative to conventional lecture-based methods.

The statistically significant difference between the pre-test and post-test percentage scores in the knowledge sub-scale clearly revealed that participants demonstrated a better grasp of AMR concepts, including the risks associated with antibiotic misuse and its potential to compromise food safety.

This improvement aligns with the findings by Malavi et al., which emphasized the efficacy of educational interventions in enhancing food handler's understanding of critical food safety issues.³⁰

Enhanced Attitudes toward Food Safety

Workshops facilitated favorable changes in participants' perceptions of food safety and hygiene. Before the training, some food handlers voiced doubts about the significance of cleanliness practices in mitigating AMR. Post-training evaluations revealed the participants gained a heightened understanding of their responsibilities in protecting public health. This has also been shown in a recent study in Negros Oriental, indicating that tailored training sessions enhanced the participants' attitudes toward hygiene behaviors.³² Participants' attitudes on food safety were further influenced by the lectures delivered by representatives from the industry and relevant government agencies, which conveyed real-life experiences. The workshops reiterated and emphasized the concrete repercussions of inadequate food handling, prompting the participants to embrace safer techniques.

Adoption of Improved Practices

Unsafe practices occur among food handlers due to the lack of knowledge acquired from training programs. These training programs mainly focus on the assumption that unsafe behavior will change with an increase in knowledge of food safety. However, most often, applying the new knowledge is unsuccessful due to the difficulty of transferring the knowledge into practice. A model that has been proposed recently is knowledge-sharing, which includes the adoption and implementation of the acquired knowledge³³; hence, this study had a return demonstration. Majority of the participants in the study performed well in the return demonstration activity, except for one participant who had a percentage score in the range of 00.00-39.99. In this study, the training program notably enhanced food handling practices. Post-training assessments, which are composed of the return demonstration and the post-test, indicated increased adherence to hygiene measures, including appropriate handwashing, preservation of cold chains for seafood, and compliance with local food safety regulations. These results correspond with Mana-Ay, who recorded analogous enhancements in cleanliness behaviors after focused training sessions.³² Practical demonstrations and interactive workshops emphasized the implementation of food safety principles. This method was especially advantageous for street food vendors encountering distinct difficulties in upholding cleanliness standards. This strategy's success corresponds with the findings of Abdelwahed et al. which underscore the efficacy of experiential learning techniques in enhancing food safety measures.²

Broader Implications of AMR Mitigation

The success of the training conducted among food handlers in selected markets within the Greater Manila Area

underscores the critical need for integrating tailored AMR education into food safety initiatives. By enhancing food handlers' knowledge and skills, this program contributes significantly to the broader effort of mitigating AMR risks in the Philippines. As Belotindos et al. highlighted, addressing AMR in food production and processing is crucial to curbing its transmission along the food chain.⁶ Moreover, the collaborative approach was key to the program's success, which brought together experts from academia, government agencies, and the private sector. The partnership serves as a potential model for similar interventions in other high-risk regions within the Philippines and globally. Such initiatives provide valuable guidance for policymakers, public health organizations, and industry stakeholders, emphasizing the importance of AMR-focused training within the food sector. By improving food handlers' understanding and practices concerning AMR, this research supports national and international efforts to combat AMR. It also lays the groundwork for developing standardized AMR education programs that could be deployed in other high-risk areas and comparable urban environments. Ultimately, this study aims to foster a safer food supply chain, reduce community-level AMR transmission, and strengthen AMR management strategies in Manila and beyond.

Limitations of the Study

The generalizability of the findings of the study may have been affected by selection bias due to the recruitment by convenience. Furthermore, participants were not asked if they have attended other food safety training in the past. However, the research team implemented measures to minimize the introduction of bias that may affect the internal validity of the study. The items were constructed based on the learning outcomes of the training program as specified in the table of specifications. The evaluators in the return demonstration were trained in utilizing the rubrics to standardize their ratings.

CONCLUSION

This study highlights the effectiveness of customized training program in significantly improving food handlers' KAP related to AMR. By addressing critical gaps in food safety practices and fostering behavioral changes among food handlers, the initiative contributes to the broader goal of mitigating AMR risks in the Greater Manila Area. The findings that emphasize the value of integrating AMR education into food safety training programs with the inclusion of a return demonstration as simulation of the acquired learning from the training program underscore the importance of ongoing efforts to enhance awareness and promote adherence to best practices that will eventually lead to reduction of AMR transmission through proper food handling and preparation. This approach provides a

foundation for adoption of similar interventions in other high-risk areas, supporting global efforts to combat AMR and ensuring a safer food supply chain.

Recommendations

The outcomes of the workshop highlight several key recommendations for sustaining and expanding its impact. First, periodic refresher courses should be conducted to reinforce knowledge and ensure the continuity of best practices among food handlers. Second, integrating AMR education into mandatory food safety training programs is essential to institutionalize its significance and promote consistent learning. Third, training initiatives should be extended to include informal food handlers and underserved areas through community-based outreach, ensuring inclusivity and broader reach. Finally, regular monitoring and evaluation should be implemented to assess adherence to improved practices and measure the long-term impacts of these interventions, fostering continuous improvement in food safety standards.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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REFERENCES

- Mulchandani R, Wang Y, Gilbert M, Van Boeckel TP. Global trends in antimicrobial use in food producing animals: 2020 to 2030. *PLOS Glob Public Health*. 2023 3(2):e0001305. doi.org/10.1371/journal.pgph.0001305.
- Abdelwahed AY, Metwally SM, Ahmed AM, Alkotb Alagamy Z. Knowledge, attitudes and practices of food handlers about safety at Fayoum restaurants. *Tanta Sci Nurs J*. 2022. 24(1): 356-379. doi:10.21608/tsnj.2022.221609.
- Iera J, Seghieri C, Tavoschi L, Isonne C, Baccolini V, Petrone D, et al. Early Warning Systems for Emerging Profiles of Antimicrobial Resistance in Italy: A National Survey. *Int J Res Public Health*. 2023;20(9):5623. doi:10.3390/ijerph20095623.
- Lawry LL, Konduri N, Gitonga N, Kiggundu R, Mbaye M, Stergachis A. Gaps in data collection for sex and gender must be addressed in point prevalence surveys on antibiotic use. *Front Antibiot*. 2023;2. doi.org/10.3389/frabi.2023.1154506.
- Pineda-Cortel MRB, del Rosario EH, Villaflores OB. Use of veterinary medicinal products in the Philippines: regulations, impact, challenges and recommendations. *J. Vet. Sci*. 2024; 25(2):e:33. doi:10.4142/jvs.23134. PMID: 38568834.
- Belotindos L, Villanueva M, Miguel J, Jr., Bwalya P, Harada T, Kawahara R, et al. Prevalence and Characterization of Quinolone-Resistance Determinants in *Escherichia coli* Isolated from Food-Producing Animals and Animal-Derived Food in the Philippines. *Antibiotics (Basel)*. 2021;10(4). doi:10.3390/antibiotics10040413. PMID: 33918946. PMCID: PMC8068814.
- Barroga TRM, Morales RG, Benigno CC, Castro SJM, Caniban MM, Cabullo MFB, et al. Antimicrobials Used in Backyard and Commercial Poultry and Swine Farms in the Philippines: A Qualitative Pilot Study. *Front Vet Sci*. 2020;7. doi.org/10.3389/fvets.2020.00329.
- Nelson DW, Moore JE, Rao JR. Antimicrobial resistance (AMR): significance to food quality and safety. *Food Qual. Saf*. 2019 March, 3(1):15-22. doi.org/10.1093/fqsaf/fyz003.
- Vicar EK, Alo DB, Koyiri C, Opere-AsaIoha K, Obeng-Bempong M, Mensah GO. Carriage of antibiotic resistant bacteria and associated factors among food handlers in Tamale Metropolis, Ghana: Implications for food safety. *Microbiol Insight*. 2023 Jan 16: 11786361221150695. doi.org/10.1177/11786361221150695. PMID:36726578. PMCID: PMC9885032.
- Das M, Ojha AK, Dolma KG, Majumdar T, Sarmah P, Ramamurthy T. Monitoring the potential dissemination of antimicrobial resistance in foods, environment, and clinical samples: a one health prospective. *Food Sci Biotechnol*. 2024 Aug;34:803-813. doi:10.1007/s10068-024-01676-z. PMID: 39958177. PMCID: PMC11822141.
- Getie M, Abebe W, Tessema B. Prevalence of enteric bacteria and their antimicrobial susceptibility patterns among food handlers in Gondar town, Northwest Ethiopia. *Antimicrob Resist Infect Control*. 2019 July;8(1):111. doi.org/10.1186/s13756-019-0566-7.
- Akabanda F, Hlortsi EH, Owusu-Kwarteng J. Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. *BMC Public Health*. 2017 Jan;17(1):40. doi.org/10.1186/s12889-016-3986-9.
- Lirio GAC, Labana RV, Bernardo IRA, Bernarte RP, Dungca JZ, Nissapatorn V. Survey of Intestinal Parasites Including Associated Risk Factors Among Food Vendors and Slaughterhouse Workers in Metro Manila, Philippines. *KnE Soc Sci*. 2018 Jun;3(6):493-505. doi:10.18502/kss.v3i6.2400.
- Amaiaich R, Lalami AEO, Fadil M, Bouslamti R, Lairini S. Food safety knowledge, attitudes and practices among food handlers in collective catering in central Morocco. *Heliyon*. 2024 Nov; 10(23):e40739. doi:10.1016/j.heliyon.2024.e40739. PMID: 39687091. PMCID: PMC11648122.
- Freivogel C, Lehmann SH, Visschers HM. Tailoring can improve consumers' hygienic food-handling behavior to reduce the transmission risk of antimicrobial-resistant bacteria through food. *Eur J Invest Health Psychol Educ*. 2022 Feb. 12(2):169-192. doi:10.3390/ejihpe12020014. PMID: 35200236. PMCID: PMC8871282.
- Flores ARC, Angbengco JM. Assessment of Knowledge, Attitude, and Practices of food handlers on food safety in selected tertiary hospitals in Metro Manila, Philippines. *Int J Nutr Sci*. 2024 Mar; 9(1):39-47. doi 10.30476/IJNS.2024.100091.1265.
- Werthmann D, Rabito FA, Reed C. Knowledge, attitudes, and practices concerning cockroach exposure among caregivers of children with asthma. *BMC Public Health*. 2021 July. 21:1485. doi.org/10.1186/s12889-021-11497-y.
- Wang M, Huang L, Pan C, Bai L. Adopt proper food-handling intention: An application of the health belief model. *Food Control*. 2021 Sep. 127:108169. doi:10.1016/j.foodcont.2021.108169.
- Google. [SEAOHUN KAP Study Site: Location of the six selected public markets in the City of Manila for the SEAOHUN KAP study]. Retrieved May 21, 2025, available from URL [https://www.google.com/maps/d/u/0/edit?mid=1BVJM3B2jq9LidsidU-nVZsf9pylJ4s&usp=sharingGoogle My Maps.
- World Health Organization. World Health Organization. Food safety Key Facts. <http://www.who.int/news-room/fact-sheets/detail/food-safety>. 2017. Cited 2024 March. Available from <http://www.who.int/news-room/fact-sheets/detail/food-safety>.
- Food and Agriculture Organization of the United Nations. Antimicrobial Resistance, Food Safety 2024 cited 2024 March. Available from <https://www.fao.org/antimicrobial-resistance/key-sectors/food-safety/en/>.
- StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LLC.
- Ncube F, Kanda A, Chijokwe MG, Nyamugure T. Food safety knowledge, attitudes and practices of restaurant food handlers in a lower-middle-income country. *Food Sci Nutr*. 2020 Feb;8(3):1677. doi.org/10.1002/fsn3.1454.
- Ma L, Chen H, Yan H, Wu L, Zhang W. Food safety knowledge, attitudes, and behavior of street food vendors and consumers in Handan, a third tier city in China. *BMC Public Health*. 2019 Aug;19(1):1128. doi.org/10.1186/s12889-019-7475-9.
- Hossain Nur M, Jony Md E, Bakshi P, Rana J, Ferdoush Z, Shomrat Md GM, et al. Food safety knowledge, attitude and hygiene practices (KAP) and microbial quality of meat in slaughterhouses: a study in gopalganj, Bangladesh. *J Agric Food Res*. 2025 Jun; 21:101914. doi.org/10.1016/j.jafr.2025.101914.
- Mwove J, Imathiu S, Orina I, Karanja P. Food safety knowledge and practices of street food vendors in selected locations within Kiambu County, Kenya. *Afr J Food Sci*. 2020 Jul;14(6), 174-185. doi.org/10.5897/AJFS2020.1929.
- Huynh-Van B, Vuong-Thao V, Huynh-Thi-Thao T, Dang-Xuan S, Huynh-Van T, Tran-To L, et al. Factors associated with food safety compliance among street food vendors in Can Tho city, Vietnam: implications for intervention activity design and implementation. *BMC Public Health*. 2022 Jan, 22(94). doi.org/10.1186/s12889-022-12497-2.
- Subedi I, Baral R, Rai S. Knowledge, Attitude and Practice (KAP) of Street Food Vendors in Kathmandu. *Act Sci Nutr Health*. 2024 Oct; 8(10):12-21. doi:10.31080/ASN.H.2024.08.1439.
- Siddiky NA, Khan MdSR, Sarker MdS, Mahmud A, Tanvir Rahman Md, Ahmed, MM, et al. Knowledge, attitude and practice of chicken vendors on food safety and foodborne pathogens at wet markets in Dhaka, Bangladesh. *Food Control*. 2022 July;. 131:108456. doi:10.1016/J.FOODCONT.2021.108456.
- Malavi DN, Abong' GO, Muzhingi T. Effect of food safety training on behavior change of food handlers: A case of orange-fleshed sweet potato purée processing in Kenya. *Food Control*. 2021 Jan;119: 107500. doi.org/10.1016/j.foodcont.2020.107500.
- Sjarif DR, Yuliarti K, Wahyuni LK, Wiguna T, Prawitasari T, Devaera Y, et al. Effectiveness of a comprehensive integrated module using interactive lectures and workshops in understanding and knowledge retention about infant feeding practice in fifth year medical students: a quasi-experimental study. *BMC Med Educ*. 2016 Aug;16(1):210. doi.org/10.1186/s12909-016-0705-2.
- Mana-ay A. Evaluation of a Training of Trainers Program on Food Safety and Nutrition Security. *Philipp Soc Sci J*. 2020 Jun;3(1):82-92. doi.org/10.52006/main.v3i1.111
- Yeargin TA, Gibson KE, Fraser AM. New Approach to Food Safety Training: A Review of a Six-Step Knowledge-Sharing Model. *J. Food Prot*. 2021 Nov;84(11):1852-1862. doi.org/10.4315/JFP-21-146.