Food Hygiene Practices and Foodborne Disease Risks Among Students and Food Handlers in Sarawak Rural Schools

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ABSTRACT

Foodborne diseases account for millions of deaths globally. Key factors contributing to these illnesses, as well as the high incidence of food poisoning among students, include improper methods of food preparation, unhealthy lifestyles, poor sanitation, and unsafe water resources. Moreover, poor food-handling practices for food handlers, combined with insufficient food hygiene knowledge among both handlers and students, significantly increase the risk of food poisoning in school environments. This paper discusses the knowledge, attitudes, and practices (KAPs) regarding food hygiene among food handlers and students, based on findings from a quantitative study employing a non-probability quota sampling method. The sample comprised 487 students and 23 canteen food handlers drawn from eight selected schools (five primary schools and three secondary schools) in Betong, Sarawak, Malaysia. These schools were selected due to their high incidences of food poisoning. Findings indicated that the food handlers demonstrated poor personal hygiene practices, including improper handwashing technique and limited knowledge about the correct steps needed for effective handwashing. In addition, the food safety conditions associated with the canteen environment were found to be statistically significant, and differences in food hygiene knowledge were observed between male and female food handlers. Furthermore, students demonstrated low awareness of cross-contamination risks, particularly regarding the inappropriate use of the same towel for wiping hands and plates. Overall, this research provides valuable insights and highlights the need for behavioural changes that could inform national health policy revisions, particularly in the area of food safety and regulations for preventing food poisoning.

Keywords: Food hygiene, Food handlers, Knowledge, Attitude, and Practices (KAPs), Food poisoning, rural Sarawak

INTRODUCTION

Food borne disease, such as cholera, typhoid fever, hepatitis A, dysentery, and food poisoning, result from eating food tainted with harmful microorganisms or toxic substances (Sharifa Ezat, Netty & Sangaran, 2013). Among the most common causes of these illnesses worldwide are Salmonella bacteria, which are often transmitted to humans through contaminated animal products like eggs, poultry, meat and milk (World Health Organization, 2019). This study focuses on food borne diseases, particularly examining cases of food poisoning among school-aged children. It aims to study how the hygiene practices and behaviours of food handlers and students may influence the prevalence of food poisoning.

Table I shown that in 2018, a total of 13,686 food poisoning cases were reported in Malaysia, corresponding to an incidence rate of 45.25 per 100,000 people (Health Informatics Centre, 2018). During this period, Sarawak has reported a total 1,089 food poisoning cases, resulting in an incidence rate of 39.04. The cases were particularly more common in Betong, Sarawak, where Malay students experienced a higher incidence of food poisoning compared to their Iban students. Based on data from Betong District Health Office (2019), Malay students under 18 years of accounted for 113 of the 183 reported cases in 2017 and 137 of the 148 cases in 2018

(Pejabat Kesihatan Daerah Betong, 2019).

TABLE I Number of food poisoning cases reported in Betong district, sarawak from year 2014 to 2018

Years	Number of food poisoning cases reported	Malay	Iban	Chinese	Others races
2014	23	16	7	0	0
2015	89	61	28	0	0
2016	28	21	5	2	0
2017	183	113	69	0	1
2018	148	137	11	0	0

Source: Pejabat Kesihatan Daerah Betong (2019)

The data outlined above inspired the researcher to examine the food preparation process and the practices of the food handlers. In addition, the study seeks to assess the knowledge, attitudes, and practices (KAPs) related to food hygiene among both food handlers and students. One of the primary areas of concern is the physical cleanliness of kitchens and canteens. The study also considers the sociocultural factors that influence hygiene practices, aiming to support the prevention of food poisoning in the future.

The food might become contaminated during processing, cleaning, storage and preparation (Abdul-Mutalib, 2015). According to Soon (2011), most of the food poisoning cases are linked to improper food handling and inadequate cleanliness during food preparation. Past studies found that knowledge of, attitudes towards and practices regarding hygiene are the key factors in the reduction of food-borne disease (Johnson et al., 1998; Kennedy et al., 2005; Zyoud et al., 2019).

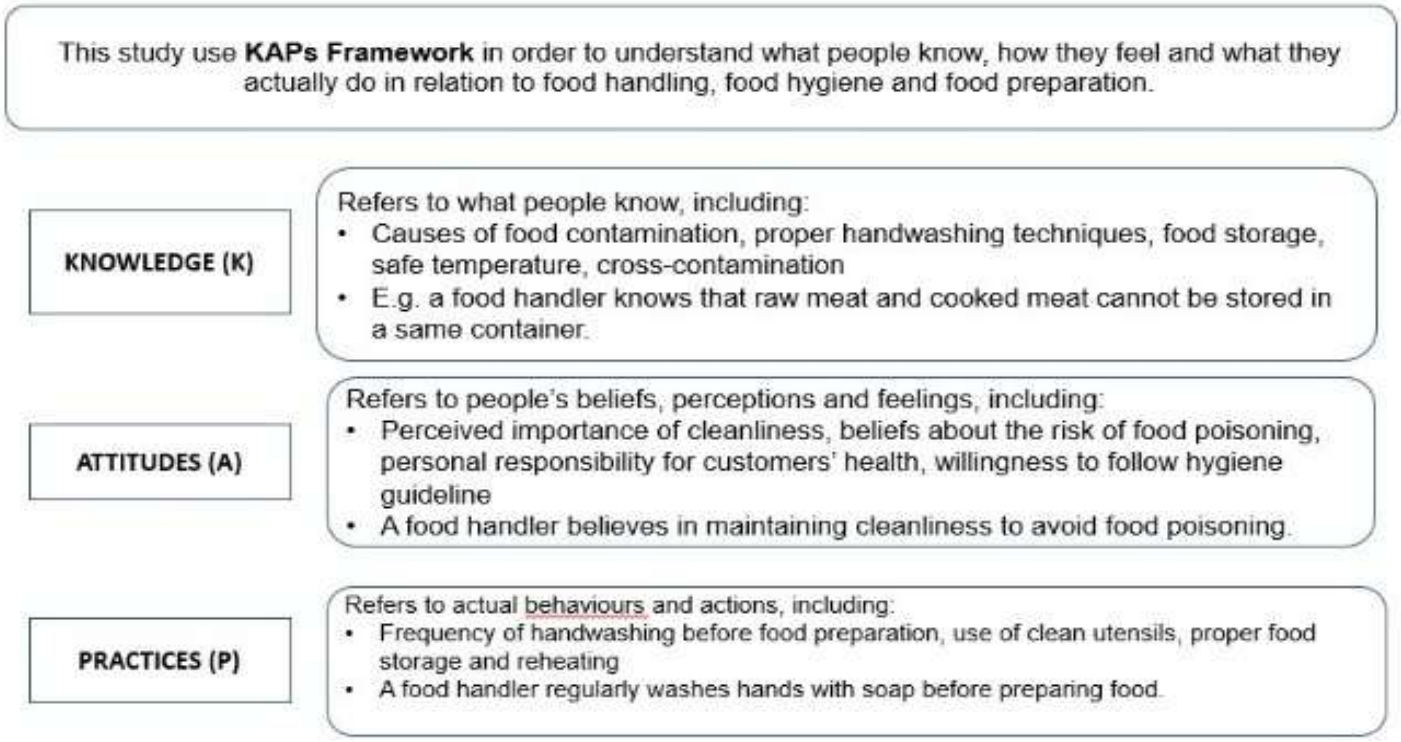
This gap in the literature and practice provide a compelling rationale for this study to explore how sociocultural beliefs and traditions influence food safety behaviours, particularly in school or community food settings, to investigates the effectiveness of current food safety training programs in multicultural context like Malaysia, to identify cultural barriers to safe food handling across different ethnic groups and to develops a culturally informed framework or a set of recommendations for improving food safety interventions and education.

METHODOLOGY AND SAMPLE SIZE

This research used a mixed-methods research design, integrating both quantitative and qualitative approaches to obtain comprehensive data. The quantitative component involved the distribution of structured questionnaires to assess respondents' knowledge, attitudes and practices (KAP) related to food hygiene and safe food handling. The KAPs framework (refer Figure 1) was selected as it systematically addresses the link between food hygiene knowledge, attitudes, and actual practices, allowing gaps between awareness and behaviours to be identified.

In order to ensure clarity, relevance and content validity, the questionnaire was reviewed by a panel of healthcare professionals, including a health education officer, a public health officer, and two academicians from a local university. Prior to the main data collection, pilot testing was conducted at a number of selected schools. The pilot study involved administering the questionnaire to a small, representative group of students and food handlers. This helped to determine whether the respondents understood the questions as intended, and to identify whether any items in the questionnaire are ambiguous or redundant. It is also to ensure whether the response options are adequate for capturing the desired information. Feedback gathered during the pilot study was used to refine the structure and content of the instrument, thereby enhancing its validity, reliability, and overall respondent engagement.

Figure 1 Knowledge, Attitudes & Practices (Kaps) Framework



Data were collected using Google Forms. The questionnaire was structured into three modules: Module A focused on respondents' demographic information; Module B covered hygiene practices, physical facilities, and the environment; and Module C examined students' awareness, knowledge, attitudes, and behaviours related to food hygiene. Responses were measured using a 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree".

Quantitative data were processed and analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics, such as frequency and percentage, were used to summarise demographic characteristics and to assess knowledge, attitude and practices (KAPs) related to food hygiene among food handlers and students. Analysis of Variance (ANOVA) was used to examine associations between hygiene practices and selected demographic variables. In total, 70 variables for food handlers and 50 variables for students were analysed. Findings were presented in tables and interpreted using frequency distributions, descriptive statistics, and ANOVA results based on significance values.

For the qualitative component, data were collected through interviews and observations. Interview transcripts were analysed using thematic analysis. Recurring ideas were coded, and themes were developed to capture key findings related to food hygiene practices. Direct quotations from food handlers and students were included to support the identified themes.

The study involved 487 students and 23 canteen food handlers from eight selected primary and secondary schools. The comparatively smaller number of food handlers reflects the actual staffing structure of school canteens, where each school typically employs only a limited number of operators and assistants. In contrast to the large student population, the pool of available food handlers within the selected schools was inherently limited. Thus, the number of food handlers included in the study was determined by the accessible population rather than by sampling constraints, and it sufficiently represents the food handler workforce in the participating schools.

A non-probability sampling technique, specifically quota sampling, was employed. Respondents were selected based on predetermined characteristics such as age, race and gender to ensure representation of relevant sub-groups. The selection of food handlers was determined by the respective school management. Students who met the study criteria, including being below 18 years old and having been affected by food poisoning incidents were identified and grouped accordingly. The table below shows the distribution of respondents included in this study.

Table II Number Of Respondents By School

No.	School	Number of respondents (students)
1.	SK Maludum	78
2.	SK Tambak	41
3.	SK Tui	32
4.	SK Samarang	35
5.	SK Kalok	45
6.	SMK Pusa	121
7.	SMK Ulu Layar	51
8.	SMK Beladin	84

LITERATURE REVIEW

According to Soon (2011), the majority of food poisoning incidents are linked to improper food handling and inadequate cleanliness during food preparation. Additionally, food hygiene is important for food preparation and food handling as the food might become contaminated during processing, cleaning, storage and preparation (Abdul-Mutalib, 2015). Food-borne diseases and death might have occurred due to a lack of adequate food hygiene (Abdul-Mutalib, 2015). More than 50 per cent of food poisoning cases in Malaysia are caused by insanitary food handling procedures (Sharifa Ezat, Netty & Sangaran, 2013).

In addition, Soon (2011) argued that majority of food poisoning cases are linked to improper food handling and inadequate cleanliness during food preparation. On the other hand, Cowan (2019) highlighted that poor personal hygiene among food handlers also contributes significantly to these incidents. Studies found that knowledge of, attitudes towards and practices on hygiene are the key factors in the reduction of food-borne diseases (Zyoud et al., 2019).

Respondents' Demographic Profiles

Based on Table III & IV, a total of 487 students from rural schools in Betong and 23 food handlers were interviewed. This study involved eight schools that had reported high cases of food poisoning: Sekolah Kerajaan (SK) Maludam, SK Tambak, SK Tui, SK Semarang, SK Kalok, Sekolah Menengah Kerajaan (SMK) Pusa, SMK Ulu Layar, and SMK Beladin. The demographic profiles of the respondents are summarized in the following Table III and Table IV.

TABLE III Students' Demographic Profiles

Gender	Frequency	Percentage (%)
Male	307	63.0
Female	180	37.0
Ethnic Background	-	-
Malays	355	72.9
Iban	110	22.6

Bidayuh	2	0.4
Chinese	10	2.1
Others	10	2.1

TABLE IV Food Handlers' Demographic Profiles

Gender	Frequency	Percentage (%)
Male	18	78.3
Female	5	21.7
Ethnic Background	-	-
Iban	15	65.2
Malays	5	21.7
Others	3	13.0

Knowledge, Attitude and Practice of Food Hygiene among Food Handlers

Table IV above shows that the majority of food handlers have pretty good knowledge regarding the statement that food kept for more than four hours may not be safe for consumption. Approximately 60.9% (14 out of 23) correctly recognized that food held beyond four hours should not be consumed. The mean score for this item was 4.174, and the standard deviation (SD) was 1.1541. This reflects a generally high level of awareness. This finding is consistent with established food safety guidelines, which emphasise that food kept in the temperature danger zone for more than four hours should be discarded to prevent foodborne illness (Abdul-Mutalib et al., 2015). When food is inadequately cooked or reheated, harmful bacteria may survive, as this critical control point (CCP) fails to effectively eliminate pathogens. Prolonged exposure to unsafe temperatures further promotes bacterial growth and replication, thereby increasing the risk of contamination and food poisoning.

In contrast, a study conducted among food handlers at Universiti Putra Malaysia reported only moderate knowledge levels regarding temperature control, cross-contamination, food poisoning, and personal hygiene. Compared to those findings, the present study suggest a relatively better understanding among the school canteen handlers on the importance of time-temperature control in ensuring food safety.

TABLE V Knowledge, attitude and practice of food hygiene among food handlers

Variables	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Food has exceeded 4 hours may be allowed for consumption	1 (4.3%)	7 (30.4%)	1 (4.3%)	-	14 (60.9%)
I do not need to wash my hands using 7 correct hygiene steps if busy serving customers	9 (39.1 %)	5 (21.7%)	5 (21.7%)	1 (4.3%)	3 (13.0%)
Towel used to wipe hands can be used to wipe a dish and a bowl	4 (17.4%)	1 (4.3%)	1 (4.3%)	1 (4.3%)	16 (69.6%)

Raw foods and cooked foods should not be stored in the same containers	11 (47.8%)	4 (17.4%)	3 (13.0%)	-	5 (21.7%)
I must always wash my hands after touching raw materials	16 (69.6%)	3 (13.0%)	1 (4.3%)	1 (4.3%)	2 (8.7%)

The findings also indicate a concerning attitude towards proper hand hygiene practices among food handlers. A total of 14 respondents (60.8%) agreed with the statement, "I do not need to wash my hands using 7 correct hygiene steps if busy serving customers." This item recorded a mean score of 2.304 (SD = 1.3959. A P-value of 0.044), suggesting a tendency to compromise proper handwashing procedures during busy periods. The ANOVA results indicated a statistically significant association between gender and hygiene knowledge ($F = 4.576$, $p = 0.044$), indicating that gender may influence differences in hygiene-related knowledge and attitudes among food handlers.

These findings are similar with studies by Dora-Liyana et al. (2018) and Abdul-Mutalip et al. (2012), which reported inadequate personal hygiene among food handlers, including improper handwashing and limited knowledge of correct handwashing procedures. In particular, many food handlers were unfamiliar with the seven recommended steps for effective hand hygiene. A research that was conducted in Kelantan, for instance, found that hands were the primary source of cross-contamination during food handling (Zin et al., 2017). Food handlers were often unaware of unconscious hand movements, such as touching their face or other body parts, which can facilitate the transfer of pathogens. The study concluded that cross-contamination during food preparation is always a potential risk. Therefore, proper hand hygiene remains one of the most critical and controllable measures in preventing foodborne illnesses.

On the other hand, the food handlers had good knowledge regarding proper towel usage. Approximately 16 respondents (69.6%) strongly disagreed with the statement that the same towel can be used for both hands and bowls/plates. This item recorded a mean score was 4.043 (SD = 1.6090), indicating a generally strong awareness of the risks associated with improper towel practices. Overall, the food handlers showed a positive attitude towards appropriate towel usage and recognized its potential role in preventing cross-contamination and foodborne illness.

This finding is encouraging, particularly in the context of previous research. Dora-Liyana et al. (2018) reported that some food handlers lacked adequate knowledge of equipment hygiene and frequently reused dish towels to wipe plates, a practice that is discouraged due to cross-contamination risks. Similarly, Saipullizan et al. (2018) found that 76.9% of food handlers acknowledged that dirty dishcloths increase the risk of food contamination. Supporting this statement, Gerba et al. (2014) and Duane et al. (2022) highlighted towels used repeatedly without proper washing can accumulate high bacterial loads. Damp towels, in particular, provide an ideal environment for bacterial growth, making them a significant source of cross-contamination.

In addition, the food handlers demonstrated good knowledge regarding the need to separate raw and cooked foods to prevent cross-contamination. A total of 15 food handlers (65.2%) agreed that raw and cooked food should not be stored in the same containers, with a mean score of 2.304 and a standard deviation (SD) of 1.6078. These findings are consistent with past studies (e.g., Abdul-Mutalib et al., 2015; Dora-Liyana et al., 2018; Nur Izyan et al., 2019), which highlight that food contamination often occurs when raw meat comes into contact with animal skin, fur, or intestines during food preparation due to improper handling practices. Nur Izyan et al. (2019), for instance, reported that in their study, the majority of respondents (88.3%) ensured that raw and cooked foods were kept separate to minimise the risk of cross-contamination. Maintaining this separation, including using different containers and cutting boards for raw meat and vegetables is essential for safe food handling (Dora-Liyana et al., 2018). This finding aligns with other studies, which found one-third (33.3%) of food handlers were unaware that using the same utensils for both raw and cooked foods could lead to foodborne illnesses (FDs) (Errico et al., 2022).

The food handlers demonstrated a positive attitude toward the practice of washing hands after handling raw materials. Approximately 82.6% agreed that they must wash their hands after touching raw ingredients, with a

mean score of 1.696 and a standard deviation of 1.2946. This indicates a generally good attitudes towards personal hygiene, particularly after handling high risk items such as raw meat and fresh chicken. The majority of respondents also agreed that hands should be thoroughly cleaned and washed before food preparation and that handling food with dirty hands should be avoided. These findings are consistent with previous studies conducted by Abdul-Mutalib et al. (2012) and Al-Shabib et al. (2017), which reported that nearly all food handlers recognised that hand washing is a critical practice in food handling. In contrast, inadequate hand hygiene has been shown on significantly contribute to food contamination. Jalani et al. (2021). For example, identified poor hand hygiene practices and other unsafe behaviours as key factors contributing to food poisoning in school canteens. These include touching food with bare hands, refreezing defrosted foods, failing to separate raw and cooked foods, and smoking in food preparation areas. These negative attitudes and practices increase the risk of food contamination and foodborne illnesses.

Knowledge, Attitudes and Practices (KAPs) towards Food Hygiene among Students

TABLE VI knowledge, attitude and practices towards food hygiene among Students

Variables	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Food poisoning, such as stomach pain and squealing can be avoided if you eat with clean hands	344 (70.6%)	59 (12.1%)	38 (7.8%)	8 (1.6%)	38 (7.8%)
There are three (3) basic steps to handwashing	230 (47.2%)	77 (15.8%)	91 (18.7%)	31 (6.4%)	58 (11.9%)
A dirty environment does not cause food pollution	85 (17.5%)	23 (4.7%)	23 (4.7%)	34 (7.0%)	322 (66.1%)
Hot kitchen or chamber temperature will increase germ breeding rates	166 (34.1%)	80 (16.4%)	130 (26.7%)	34 (7.0%)	77 (15.8%)
Cutting raw fruit and fresh meat using separate cutting boards	306 (62.8%)	75 (15.4%)	52 (10.7%)	15 (3.1%)	39 (8.0%)

Table VI shows that the majority of students demonstrated excellent knowledge regarding the statement, “Food poisoning, such as stomach pain, queasiness, can be avoided if you eat with clean hands”. A total of 403 students (82.7%) agreed with this statement. This indicated a strong awareness of the role of hand hygiene in preventing foodborne illness. The mean score was 1.639 (SD = 1.1936), reflecting a high level of agreement. The ANOVA results revealed a statistically significant relationship between students’ level of education and their knowledge of food poisoning prevention ($F = 2.414$, $p = 0.026$). This suggests that educational level influences students’ understanding of how proper hand hygiene can reduce the risk of symptoms such as stomach pain and nausea.

These findings are consistent with previous studies. Smigic et al. (2021) reported that 95% of students practised hand hygiene before preparing food. However, only 52.5% washed their hands for at least 20 seconds**,** which is the recommended duration (Smigic et al., 2021). Similarly, Myshelia at al. (2022) found that good preventive practices, particularly handwashing with soap before eating, significantly reduce the risk of foodborne illnesses. In their study, 79.7% of the students reported that they always washed their hands until clean before eating. Furthermore, a significant association was identified between students’ attitudes and preventive practices ($p = 0.004$), highlighting that those with a better understanding of food safety risks were more likely to engage in proper hygiene behaviours (Mshelia et al., 2022). Despite generally good awareness of hand hygiene, gaps in food safety knowledge remain. Smigic et al. (2021) highlighted that only 12.5% of students knew that bacterial contamination in food cannot be detected through sight, smell, or taste, showing the need for continued food

safety education.

The findings showed that students had poor knowledge regarding the statement, "There are three (3) basic steps to handwashing". Only 89 students (18.3%) knew there were three basic steps for handwashing. This highlights a considerable gap in their understanding of proper hand hygiene procedures. The mean score was 2.199 (SD = 1.3964), further reflecting limited knowledge in this area. These results suggest that many students are not only unaware of the basic steps but also lack familiarity with the recommended seven-step handwashing procedure outlined in national health guidelines.

This finding is particularly significant because handwashing is widely recognised as one of the most effective measures for preventing food poisoning. Unclean hands can keep harmful bacteria that contaminate food and increase the risk of infection. A lack of emphasis on personal hygiene and inadequate use of sanitisers have been identified as major contributors to the rising burden of infectious diseases in developing countries (Vivas, 2011). Similarly, Kar et al. (2018) highlighted poor hand hygiene among poor handlers and schoolchildren as a persistent public health concern.

Although a positive attitude towards handwashing has been shown to reduce the risk of foodborne illness, knowledge does not always translate into safe behaviour. Jeffree and Mihat (2016) noted that school food poisoning outbreaks are also associated with cross-contamination from water storage tanks, consumption of undercooked food, and the use of untreated water. For example, Garayoa et al. (2005) demonstrated that even students with better food safety knowledge may still engage in high-risk food choices. International evidence reinforces these concerns: Thailand's Global Student-based Health Survey reported that 15.7% of students seldom washed their hands before meals (World Health Organization, 2017), while a study in Seoul and Ulsan found that 67% of students were unaware of the correct handwashing techniques (Yoon & Yoon, 2007).

The findings showed that the students had a mild attitude toward "*Hot kitchen or chamber temperature will increase germ breeding rates***"**. 246 or 50.5% students said that a hot kitchen or chamber temperature will increase germ breeding rates. The mean was 2.540 and 1.4222 for the standard deviation. Based on the ANOVA test on the level of education among the students, there was an F-value of 2.248 and a P-value of 0.038; this result is significant. Therefore, there was a statistically significant difference between the level of education of the students and the attitude that hot kitchen or chamber temperature will increase germ breeding rates. The findings aligned with the observation that children were involved in food preparation despite having limited experience. There was a noticeable lack of knowledge about the importance of proper temperature control to ensure food safety from microbes. The study took place in 26 primary schools in the Ljubljana district and nearby areas in Slovenia (Ovca et al., 2014). Moghaddam et al. (2020) reported that high school students in Khorramdarreh, Zanjan, Iran, demonstrated limited understanding of how temperature affects food, with only 35% showing adequate knowledge in this area.

This result supports the importance of temperature control in food handling areas to minimise bacterial contamination risks. Keeping kitchen environments below 20°C significantly slows bacterial reproduction, reducing foodborne illness risks (Membré et al., 2005). This finding is consistent with the study, which found that improper temperature management in food preparation and storage is one of the leading causes of foodborne illnesses. Pathogenic bacteria, including E. coli and B. cereus, showed significant growth when food was stored at unsafe temperatures (Ricci et al., 2020). In line with current finding, which suggest that improper temperature management can contribute to bacterial proliferation, especially in food storage and preparation areas. Keeping food below 4°C significantly slows bacterial reproduction, reducing the risk of foodborne illnesses (De Silvestri et al., 2018).

The findings showed that the students had good practice on *"Cutting raw fruit and fresh meat using separate cutting boards".* There were 381 students, or 78.2%, who said they used separate cutting boards for raw fruit and fresh meat to prevent cross-contamination during food preparation. The mean score was 1.780, and the standard deviation (SD) was 1.2385. According to the Food Acts (2009), Bill 35 1(g), separate cutting boards should be used for raw and cooked foods to prevent cross-contamination. This practice is a key aspect that should be emphasised in school health promotion programs. Improper food handling, such as using the same cutting board for both raw and ready-to-eat foods, can significantly increase the risk of cross-contamination (Carrasco et al., 2012). Similar findings were reported by another study, where cross-contamination during food preparation

was linked to the use of unwashed cooking utensils, sharing chopping boards for wet and dry ingredients, and poor maintenance of the school canteen (Osaili et al., 2021). The study revealed that 58.1% of respondents were aware that using the same chopping board for vegetables after cutting raw meat could lead to cross-contamination (Osaili et al., 2021).

Temporary Worker, Food Handlers Training Programme and Home-based Food Vendors

Based on interviews conducted in schools, more than 50 per cent of food handlers were found to be temporary workers. These temporary workers may not be officially registered and may not have undergone any food handling training or received the required anti-typhoid vaccination. This situation highlights a significant gap in food safety and hygiene practices, particularly in rural schools in Betong Sarawak.

Furthermore, studies found that over half of the food handlers had not participated in any food handling training, highlighting a critical weakness in preventive food safety measures. This lacks of training raises concerns about the level of awareness and compliance with food hygiene standards among those responsible for preparing and serving food in public school settings. Food safety training plays a crucial role in minimizing the risks of foodborne illnesses and improving the overall hygiene practices of food handlers.

CONCLUSIONS

In conclusion, this study identified significant gaps in food hygiene practices and food handling behaviors that may contribute to foodborne disease risks among students and food handlers in rural schools in Betong, Sarawak. The findings highlight poor hand hygiene, unsafe food handling, and limited food safety knowledge as key concerns. These issues highlight the need for structured food safety training and health education initiatives in rural school settings. Addressing these gaps is vital to reducing foodborne disease risks and promoting a safer school food environment.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical guidelines established by the Research Ethics Committee of Universiti Malaysia Sarawak (UNIMAS). Ethical approval for data collection was obtained from the Economic Planning Unit (Reference number: (16) JKM/SPU/608-8/2/1 Vol.3), the Ministry of Education Malaysia (Bil. KPM.600-3/2/3-ERAS (8886), and the relevant State Education Department (Reference number: JPNSW.SKPP.LAT.600-1/1/1 Jld.9(68)). In addition, the UNIMAS Research Committee approved the data collection process (UNIMAS/NC-17.04/04-01 Jld.1(4)). All procedures involving human participants were conducted in accordance with established institutional ethical standards. As this study involved participants below 18 years of age, special ethical considerations were applied, including informed consent procedures and safeguards aligned with internationally recognized ethical principles for research involving minors, including those outlined in the Nuremberg Code.

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