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2900 100th Street, Suite 309, Des Moines, IA 50322-3855, USA

Stephenie Yoke Wei Wong,[1,3] Nor Ainy Mahyudin,[1] Jo Ann Ho[2] and Ungku Fatimah Ungku Zainal Abidin[1]*

[1]Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[3]Faculty of Applied Sciences, UCSI University, Cheras, 56000 Kuala Lumpur, Malaysia

Evaluation of Self-Efficacy-Based Intervention: Improving School Food Handlers' Selected Food Safety Behavior

ABSTRACT

Food safety training of food handlers is commonly used to reduce the incidence of foodborne disease worldwide. Nevertheless, studies have shown that the provision of knowledge alone may not necessarily result in a positive behavior change. Thus, this study aimed to determine the effect of a multiple-component intervention approach, comprising training and a self-efficacy building program, to improve hand washing and contamination prevention behavior among food handlers at public school canteens in Malaysia. Two groups were compared: treatment (n = 31) and control (n = 30). The treatment group received a 2-h on-site interactive training and a self-efficacy building program that incorporated verbal persuasion, role modeling, and practice time. Both groups were measured using a survey and the direct observation method, before and after a 14-day intervention period. Results show that the intervention package produced a significant increase (P < 0.001) in the behavioral compliance, knowledge, and self-efficacy scores for both behaviors. An increase in the overall frequency of soap use and adherence to the correct hand washing technique for the treatment group was recorded, although there is room for improvement in the postintervention hand washing compliance score. Findings from this study provide valuable information on possible ways to improve food safety behavior among school food handlers.

INTRODUCTION

Foodborne illness is a major public health threat worldwide. At a global level, the World Health Organization (WHO) estimated up to 600 million cases and 420,000 deaths each year due to unsafe food consumption. This estimation means approximately 1 in 10 people will fall sick due to foodborne illness *(58)*. An estimated 48 million cases, 128,000 hospitalizations, and 3,000 deaths result from such illness annually in the United States *(9)*.

In Malaysia, the number of foodborne cases has been persistent over the years. The hot and humid climate in a tropical country like Malaysia is very suitable for the growth of microorganisms in food *(2)*. Food poisoning incidences are especially significant in school foodservice operations *(24)*.

*Author for correspondence: Email: ungkufatimah@upm.edu.my

In 2018, schools in Malaysia recorded an increase of 24% in foodborne illness compared to the previous year *(34)*. In addition to affecting the vulnerable population's well-being, food safety is also an economic burden to the country *(33)*.

The U.S. Food and Drug Administration (2018) identified the three main risks from food safety behavior as improper food holding, failure to avoid contamination, and poor personal hygiene *(56)*. The literature has recommended that food safety education should focus on hand washing, adequate cooking, and avoidance of cross-contamination *(30)*. Contamination of food during handling is an important factor that may lead to food poisoning *(44)*. Contamination occurs when there is a transfer of microorganisms from one object to another, which leads to food poisoning *(20)*. Microorganisms can be transmitted from raw poultry to a food such as cold cooked meat that is to be eaten without further heating *(8)*.

Another important risk factor, poor personal hygiene, is said to have the highest incidence of foodborne illness *(30)*. Improper hand washing practices, a subset of personal hygiene *(56)*, has been identified as one of the main contributing factors to foodborne illness *(22, 43)*. Despite being well-informed about hand hygiene, most food handlers do not perform proper hand washing at work *(39, 51)*. An observation study of school food handlers in Malaysia reported that none of them carried out proper hand washing technique *(55)*. This poor hand hygiene needs to be addressed because the hands of food handlers harbor millions of microorganisms, which facilitates the spread of diseases. These risk factors are due to improper food handler behavior and are preventable through proper food safety education *(28)*.

Food safety training of food handlers is commonly used to reduce the incidence of foodborne disease worldwide. Most formal food handler training programs are considered single-component interventions, which merely emphasize supplying knowledge. Whereas some studies conclude that educational interventions do result in greater knowledge *(29, 35, 42, 52)*, improvement in attitude and actual food handling practices may not necessarily follow *(16, 32, 38)*. Still, although knowledge-based training may fail to modify behavior *(29, 35, 42, 52, 62)*, Mullan and Wong (2010) argued that formal food safety education should be encouraged because behavior change without knowledge is similarly unlikely to occur *(32)*. Besides, food safety education acts as an avenue to pass on a uniform level of knowledge to the target audience.

Thus, educational programs need to carefully target behaviors that directly impact food safety; this necessitates multiple-component interventions that combine training and other behavioral change approaches. Past studies have incorporated behavior-based training into conventional training to change food safety behavior, including such elements as motivation *(15, 21)*, role modeling *(35)*, mentoring *(49)*, provision of tools and supplies *(54)*, and managerial support after training *(46)*. The effectiveness of training is also affected by the work environment and the trainee's characteristics, which include individual ability and self-efficacy *(46)*.

Self-efficacy, the belief that one has the ability to attain the desired result *(18)*, is said to have a positive influence on behavior *(23)*. Self-efficacy enhancement has mainly been used in health-related intervention programs and has shown promising results. Among many positive results, these programs have exhibited positive outcomes for improving foot self-care behavior among older diabetic adults *(48)*, increasing physical activity among older adults of varying health conditions *(4, 26, 41)*, encouraging exclusive breastfeeding *(11)*, and improving fruit and vegetable consumption *(27)*.

In terms of food safety, past studies that examined the role of self-efficacy in explaining food safety intention and behavior have shown conflicting results *(1, 7, 12, 13)*. In a survey study to investigate whether the Health Action Process Approach can be used to predict food safety behavior, self-efficacy was found to be the strongest predictor of intention to carry out food hygiene practices *(13)*. Self-efficacy was also reported to correlate positively with behavior in a self-administered survey study to measure knowledge, perceptions, and behaviors among middle school students *(23)*. In contrast, young adults with high food safety self-efficacy exhibited poor food handling practices due to poor knowledge *(1)*. In addition, to date there have been no published intervention studies targeting self-efficacy to change school food handlers' behavior. Thus, the effectiveness of programs to enhance self-efficacy in foodservice to improve food safety practices has been unclear.

To the authors' knowledge, this is the first intervention study to incorporate self-efficacy enhancement in the intervention program to improve food safety behavior in school foodservice. This study looked at the effect of the intervention program on two food safety behaviors: (i) hand washing and (ii) contamination prevention. Knowledge, self-efficacy, and behavioral compliance scores were measured before and after treatment for both control and treatment groups.

MATERIALS AND METHODS

Study design

The intervention study, comprising a treatment group (n = 31) and control group (n = 30), was conducted among food handlers working in school canteens in Greater Kuala Lumpur, Malaysia. The effectiveness of the intervention was measured before and 14 days after the intervention program. The study was approved by the Ethics Committee for Research Involving Human Subject, Universiti Putra Malaysia, the State Education Department, and the Ministry of Education Malaysia. Before the actual study, the intervention program was pretested in a school not included in the study.

Sampling and sample size

Food handlers that fulfilled the following selection criteria were recruited for the study: (1) 18 years of age or older, (2) directly involved in food handling, and (3) able to communicate in either the English, Malay, or Indonesian language. To encourage participation, the study provided a monetary incentive and complimentary hand washing facilities.

The sample size for this study was calculated using G*Power version 3.1.9.2 software. Before sample size calculation, the effect size was first determined using Cohen's *d* effect size formula. M_1 and M_2 were the means for the treatment and control group, respectively, obtained from previous literature *(61)*. The calculated Cohen's *d* effect size was 0.829.

$$\text{Cohen's } d \text{ effect size} = \frac{M_1 - M_2}{SD_{pooled}} = 0.829$$

where M_1 is the mean for the treatment group (52.16), M_2 is the mean for the control group (31.50), and SD_{pooled} is the pooled standard deviation (24.92) *(61)*.

Based on a sample size calculation using G*Power version 3.1.9.2 software, where $\alpha = 0.05$, Power = 0.8, allocation ratio $N_2/N_1 = 1$, and Cohen's *d* effect size = 0.829, a minimum sample size of 48 respondents (24 per group) was obtained. Factoring in an additional 20% of the calculated value to account for possible attrition rate *(3)*, the final minimum sample size was 60 (30 per group).

A total of 66 food handlers from 10 nationally funded schools in Greater Kuala Lumpur, Malaysia, were recruited using the convenience sampling method. However, five participants withdrew during the study. In the end, 61 participants (treatment group [$n = 31$]; control group [$n = 30$]) completed the program. To minimize sample contamination, participants from control and treatment groups were from different districts, A and B, respectively. Sample contamination refers to sharing of information related to the intervention among participants in the control group of an intervention study *(24)*. Selecting participants from different districts may reduce the chance that they would discuss the study with each other, which could affect the outcome of the intervention. Between-group comparisons were made to ensure that the participants from the districts were similar.

Intervention

The intervention was implemented for 14 days prior to the posttest. The treatment group was provided with the following:

On-site interactive training

A 2-h on-site training using an iPad digital device (Apple, Cupertino, CA) and informational posters was conducted in each school by the main researcher assisted by a data enumerator. The main researcher, a certified food handler training instructor, conducted the training consistently in each school in a treatment group. The data enumerator assisted in the setting up and managing of teaching tools during each session. Small-group training (four to nine participants per session) was conducted in each school to ensure training effectiveness. To keep participants engaged, iPad digital devices (one to two participants per iPad), posters, hands-on demonstrations, and activities were used. Each session was conducted at the students' dining area during nonpeak hours.

Using an iPad, the trainer gave a PowerPoint presentation introducing five topics that incorporated some important concepts from the literature *(Table 1)*: (i) real case stories *(59)*, (ii) the use of disgust *(45)*, and (iii) error-based training *(59)*. In topic 1, the training started with story telling accompanied by a video clip of an actual food poisoning incident that led to the death of a 5-year-old child in Kuala Terengganu, Malaysia *(5)*. Telling about a real case is much more effective than showing statistics on foodborne outbreaks because people are more likely to feel compassion *(59)*. For topic 2 there were slides showing sources of germs and the microbial plate counts from different locations, e.g., hands, tabletop, toilet, etc. In topic 3, "how germs are transmitted," images of feces and fecal-oral routes were shown to create the feeling of disgust among participants *(45)*. The training was strengthened by the use of GloGerm powder (Marlatek, Inc., Brockville, ON, Canada) and a handheld UV light to demonstrate how germs can transfer from different places due to cross-contamination and inadequate hand washing practices. The last two topics (4 and 5) used error-based training to cover contamination prevention and hand washing. Food handlers were shown a food preparation video clip and were asked to identify the errors made by food handlers in the video. Lastly, this was followed by a hand washing demonstration and practice among the participants. Training accompanied by activities, visuals, and hands-on practice helps to create an informal, clear, and realistic learning experience that can stimulate food handlers' interest *(52)*. All training and educational materials were delivered in the Malay language. At the end of each session, participants answered a short questionnaire to evaluate the trainer's effectiveness and the training content (results not shown). After training, the posters used for the training session were also mounted at strategic locations in the food preparation and service area.

Self-efficacy building program

Following training, participants were asked to follow a 14-day intervention program to enhance their self-efficacy. The self-efficacy building program consists of the following: (i) verbal persuasion from canteen owner, (ii) role modeling, and (iii) daily practice time. The program was based on

TABLE 1. Outline of the educational material used for the treatment group

Delivery approach	Video	Game	Demo	Hands-on	Concept (reference)
Topic 1: Introduction					Storytelling of a real case is more effective *(56)*
Storytelling of a real case	√				
Topic 2: Germs, germs everywhere					
Activity 1: Microbial plate count			√		
Topic 3: How are germs transmitted?					Use of disgust *(42)*
Image of feces & fecal-oral route					
Activity 2: GloGerm kit				√	
Topic 4: Preventing contamination of food					Error-based training *(56)*
Activity 3: "Spot the dirty food handling practices" video	√	√			
Topic 5: Hand washing					Error-based training *(56)*
Activity 4: Hand-washing video	√				
Activity 5: "Spot the correct time to wash hands" video	√	√			
Activity 6: Hand-washing activity			√	√	

Bandura's (2004) principal sources of information for self-efficacy, which are mastery of skill, verbal persuasion, and vicarious experience *(6, 21)*. Based on personal mastery experiences, efficacy can be strengthened through repetitive successes of a particular task, such as the allocated practice time in this study. Verbal persuasion refers to the action of inducing people to believe that they are able to cope with a particular task. Thus, the verbal persuasion from the canteen owner in this study helped the food handlers believe that they were capable of performing a given task. On the other hand, vicarious experience, i.e., seeing others perform activities successfully, can generate the belief that the viewers themselves are also able to achieve behavioral improvement. Therefore, when selected participants were recognized as role models during the intervention program, peers that observed had a high tendency to follow suit.

Verbal persuasion

On a daily basis throughout the intervention period, canteen owners were required to provide encouragement and verbal persuasion to their respective food handlers, following a researcher's script. The script was designed to enhance food handlers' belief that they were capable of performing the two selected food safety behaviors. Here are examples of verbal persuasion: *"Hand washing only takes 20 seconds. When washing your hands, sing the 'Happy Birthday' song twice—that will give you 20 seconds!"* and *"this practice is more or less the same as what we usually do, please make sure ready-to-eat foods are covered at all times."* When food handlers were seen carrying out the behavior, canteen owners were asked to give realistic positive appraisal such as, "Yes, that's the correct way to wash your hands. Good job and keep it up!" Providing positive appraisal can encourage initiation and maintenance of a particular behavior *(6)*.

Role modeling

In each school, one food safety champion was selected among the participants to act as a role model, based on recommendations from the canteen owner. Selected role models were positive, confident, and respectful. Each canteen owner encouraged the selected candidate to perform the food safety behavior consistently throughout the intervention period. According to Yiannas (2015), when food safety champions are used to model proper food safety behavior regularly, peers who are observing have a high tendency to follow suit *(59)*.

Practice time

Canteen owners were asked to allocate a 10-min practice time daily for food handlers to perform the two selected food

safety behaviors. A reminder was sent to canteen owners twice a week through mobile phone text messages, via the WhatsApp Messenger application. Canteen owners were reminded to allow food operators to perform the practice daily and to send photos of staff members performing the particular behavior.

In turn, the control group did not receive any treatment. Nevertheless, a copy of the educational material was given to the control group at the end of the study for ethical reasons.

Measuring the effects of multiple-component intervention

The study used a multiple-component intervention approach; thus, effectiveness was measured based on the total intervention package. Both the control and the treatment groups were measured before and after the 14-day intervention, using a combination of direct observation and survey. The direct observation method was used to measure actual behavior, whereas the survey approach was used to measure food handlers' knowledge and self-efficacy. Participants were also asked to fill out a sociodemographic form on day 1 of the intervention period.

Direct observation *(behavior)*

The direct observation method was used to assess the participants' hand washing (compliance to the 7-step hand washing technique recommended by the Ministry of Health Malaysia) *(31)* and contamination prevention behavior (preventing the contamination of ready-to-eat (RTE) food with potential contaminants, i.e., raw foods, dirty hands, pests, detergents, etc.) Actual behavior was observed before respondents filled out the questionnaire so that participants did not have a clear idea of which behaviors were being observed. All enumerators were trained by the main researcher (first author of this study) before actual data collection, following the method of York et al. (2012) *(60)*. During training, the researcher and enumerators observed the same food handlers (up to three people), who were not included in the final data collection. The observation notes and score from each observer were compared to determine the number of similarities. This step was repeated until satisfactory reliability was reached among observers.

During actual data collection, the first half-hour observation was taken as a warm-up session for participants to be comfortable with the researchers' presence. This step was followed by a 2-h observation during food preparation, service, and cleaning. To minimize the Hawthorne effect, the following steps were taken: (i) the first 30-min observation period was not recorded, (ii) researcher and data enumerators were dressed casually, (iii) small talk with respondents was initiated (when appropriate) to reduce nervousness, and (iv) participants were not aware which particular behaviors were being observed *(14)*.

Hand-washing behavior was manually recorded on a hand washing observation form adopted from Paez et al. (2007) and Strohbehn et al. (2008) *(37, 53)*, with minor modification. A total of 15 tasks that require hand washing were observed, which can be grouped into four categories: personal hygiene, food preparation, cleaning, and other. The number of times respondents "should wash hands" and "did wash hands" were recorded. A similar form was also used for "contamination prevention of RTE food" but was modified based on Food Act 1983 [ACT 281] and Regulations (2013) *(19)*. The form consists of three main categories: food is covered during service, food handlers are not engaging in any behavior that may contaminate food, and food is not in contact with any material that may contaminate food. The observation forms are shown in the supplementary material.

To suit the population of the study, the hand washing method used was benchmarked against the 7-step hand washing practice recommended by the Ministry of Health Malaysia (2013) *(31)*. However, it was found that none of the respondents washed hands following the 7-step hand washing technique and that the use of hand soap was rare. Thus, researchers observed the number of occasions when the selected practice was performed, regardless of whether it complied with the recommended procedure. The number of times respondents should have performed the behavior and when they did perform the behavior were recorded. The behavior compliance score (%) for each practice was then calculated using the following formula:

$$\frac{\textit{The number of times the behavior was performed x100}}{\textit{The number of times the behavior should have been performed}}$$

Survey

Before administration of the survey questionnaire, an A4 poster was shown to participants; the poster defined the two selected behaviors, (i) hand washing (7-step hand washing technique) and (ii) contamination prevention of RTE food. This step was done to ensure that all the respondents had the same level of awareness of what was being asked in the survey. Respondents were then required to complete a set of questionnaires measuring their knowledge and self-efficacy before and after the intervention.

Knowledge

Respondents were required to complete a set of knowledge questions, assessing their knowledge about the two selected behavior. Each question had three response options (True, False, and Unsure). An item that was correctly answered was coded as 1. If the answer given was incorrect or the response was "unsure," the item was coded as 0.

The hand-washing knowledge questions were adapted from Roberts et al. (2008) *(42)*. An example of a question for hand-washing practice was "After hand washing, hands should be dried with a single-use paper towel" (True, False, and or Unsure). After content validation, the final instrument for hand washing consisted of 15 true or false items.

TABLE 2. Profile of participants in the intervention study

Characteristics		Treatment group	Control group	t/χ^2	*P*-value
Age[†]		36 ± 11	36 ± 12	0.020	0.984
Gender[§]	Male	7 (23)	10 (33)	0.877	0.349
	Female	24 (77)	20 (67)		
Nationality[§]	Malaysian	14 (45)	5 (17)	5.772	0.016*
	Indonesian	17 (55)	25 (83)		
Marital status[§]	Single	10 (32)	9 (30)	0.036	0.849
	Married and others	21 (68)	21 (70)		
Educational level[§]	Primary and below	5 (16)	6 (20)	0.155	0.694
	Secondary and above	26 (84)	24 (80)		
Work experience (food industry)[§]	Less than 2 yr	17 (55)	13 (43)	0.807	0.369
	3 yr and above	14 (45)	17 (57)		
Designation[§]	Supervisor and/or owner	7 (23)	6 (20)	0.061	0.806
	Food operator	24 (77)	24 (80)		
Food handler training[§]	Yes	24 (77)	23 (77)	0.005	0.944
	No	7 (23)	7 (23)		
Typhoid vaccination[#]	Yes	27 (87)	28 (93)	—	0.671
	No	4 (13)	2 (7)		

[†]Age is expressed as mean ± SD; [§#]other characteristics are shown as number (%).
[†]Independent *t*-Test; [§]Chi-square test; [#] Fisher's exact test; *Significant at $P < 0.05$.

The knowledge questions for contamination prevention of RTE food were adapted from previous research *(40, 47, 50)*. The final instrument for contamination prevention consisted of 12 items. An example of a question for contamination prevention was "Using gloves while handling food reduces the risk of food contamination" (True, False, or Unsure).

Self-efficacy

A previous instrument for measuring self-efficacy *(7)* was used, slightly modified to focus on the two selected food safety behaviors. The instrument consists of a total of three items to assess the confidence and skills related to performing the selected food safety behavior. An example of a self-efficacy question related to hand washing practice was "I have the skills necessary to perform the 7-step hand-washing technique" (1 = strongly disagree, 7 = strongly agree).

Data analysis

Data analysis was performed using SPSS software (version 20, SPSS Inc., Chicago, IL). Knowledge scores were the sum of items answered correctly out of 15 points for hand washing and 12 points for contamination prevention behavior, multiplied by 100. The mean score for self-efficacy was based on a maximum of 7 points. Behavioral compliance scores for each behavior were calculated by taking the number of times the behavior was performed, divided by the number of times the behavior should have been performed, and multiplying by 100. Paired sample *t*-test and Wilcoxon signed-rank test were used for behavioral compliance and self-efficacy scores to compare the mean for pre- and posttest intervention data. For the knowledge score, analysis of covariance (ANCOVA) (using the pretest score as the covariate for the posttest score) was used to compare mean posttest score for control and treatment groups *(35)*.

RESULTS

Profile of participants

A total of 66 food handlers from 10 nationally funded schools and two different districts in Klang Valley, Malaysia, were recruited. However, five participants dropped out in the middle of the study; two due to medical reasons and three due to busy schedules. In total, 61 participants stayed in the study until completion of the data collection period. Participant profiles are shown in *Table 2*. Overall, the

TABLE 3. ANCOVA for knowledge score as a function of treatment, using pretest knowledge score as a covariate

	Pretest score	Posttest score, unadjusted	Posttest score, adjusted for pretest (std error)
Hand washing			
Treatment group (n = 31)	74.19 ± 15.66	85.16 ± 12.96	85.00 (2.10)
Control group (n = 30)	73.33 ± 10.06	71.78 ± 12.22	71.94 (2.14)
ANCOVA			F = 18.96, P = < 0.001*
Contamination prevention			
Treatment group (n = 31)	75.27 ± 23.42	89.52 ± 14.43	90.27 (2.22)
Control group (n = 30)	78.61 ± 16.62	80.56 ± 16.28	79.78 (2.26)
ANCOVA			F = 10.91, P = 0.002*

*After controlling for the pretest score using ANCOVA, there is a significant difference between control and intervention group at the 0.05 level.

Knowledge score has been converted to 100%

TABLE 4. Self-efficacy score (mean ± SD) before and after intervention

Behavior	Before	After	z	*P*-value
Hand washing				
Control group (n = 30)	6.02 ± 0.67	6.06 ± 0.64	-0.265	0.791
Treatment group (n = 31)	5.92 ± 1.13	6.52 ± 0.51	-3.009	0.003*
Contamination prevention				
Control group (n = 30)	6.09 ± 0.69	6.11 ± 0.83	-0.264	0.792
Treatment group (n = 31)	6.08 ± 0.79	6.46 ± 0.53	-2.742	0.006*

* Pre- and posttest scores were significantly different at the 0.05 level when compared through Wilcoxon signed-rank test.

†Maximum self-efficacy score = 7

participants had a mean age of 36.26 ± 11.43 in the treatment group and 36.20 ± 11.77 in the control group. The majority of the participants in each group were female, married or previously married, Indonesian, and food operators who had at least a secondary level education. The majority of them were vaccinated against typhoid. This vaccination is mandatory for food handlers in Malaysia to prevent the spread of typhoid fever, primarily caused by *Salmonella* serotypes Typhi and Paratyphi. This life-threatening foodborne illness is common in many regions of the world, including Southeast Asia *(10)*. The majority of participants had also attended the compulsory food handler training course. The 3-h national food handlers' training course is commonly conducted in a formal classroom setting that focuses on food hygiene, and it covers various aspects of safe food handling practices such as hand washing, contamination prevention, and temperature control.

A comparison of the groups shows no significant differences ($P > 0.05$) between the participants of the control and treatment group regarding age, gender, marital status, educational level, years of work experience, designation, and whether the participants had been trained or vaccinated. In

TABLE 5. Behavioral compliance score before and after intervention

	Before	After	t/ z	P-value
Hand washing				
Control group (n = 30)	2.86 ± 9.48	6.01 ± 13.5	z = -1.423	0.155
Treatment group (n = 31)	9.09 ± 15.62	22.27 ± 19.32	z = -3.200	0.001*
Contamination prevention				
Control group (n = 30)	67.79 ± 18.97	67.39 ± 18.47	t (29) = 0.086	0.932
Treatment group (n = 31)	62.37 ± 21.66	90.58 ± 11.93	t (30) = –5.682	<0.001#

Pre- and posttest scores were significantly different at the 0.05 level when compared through Wilcoxon Signed-Rank Test* and Paired t-test#.

† Maximum behavioral compliance score = 100

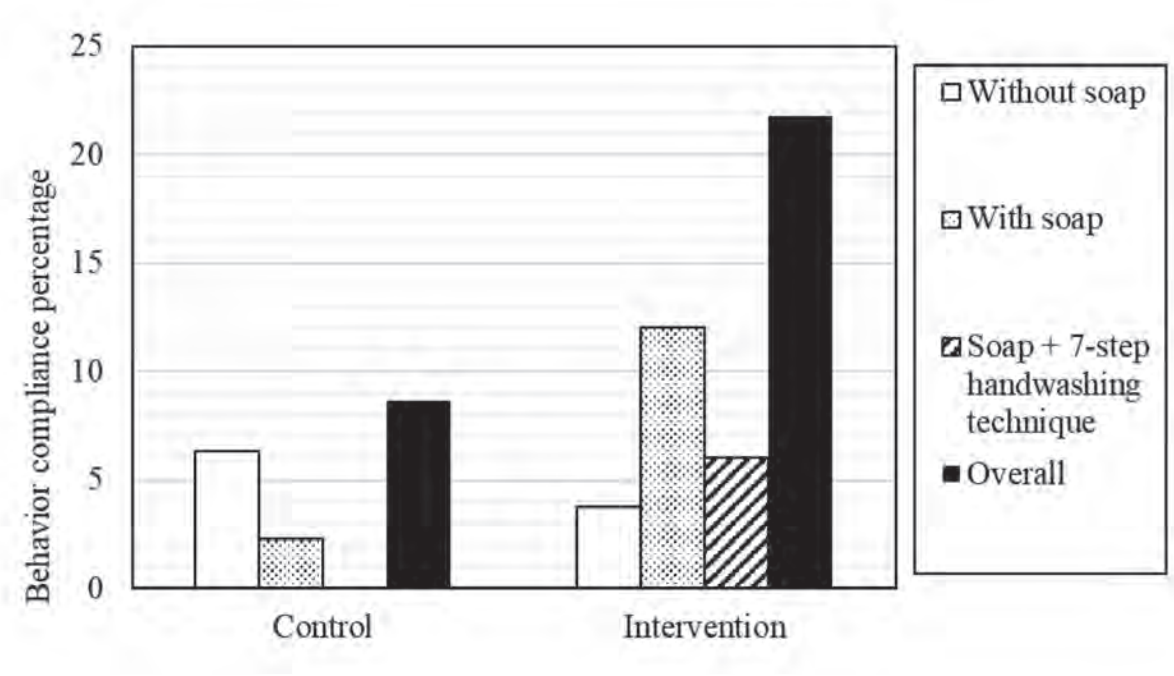

Figure 1. Post-intervention behavior compliance percentage of food handlers using different handwashing technique.

terms of nationality, slightly more Malaysians were noted to be in the intervention group (χ^2 = 5.772, P = 0.016).

Effect of intervention on food safety knowledge

Table 3 shows food safety knowledge scores before and after intervention. ANCOVA, using the pretest score of each participant as the covariate for their posttest score, was used to compare posttest knowledge scores for control and treatment groups. Analysis revealed a significant difference between the posttest knowledge scores of the control and intervention group for both hand washing (P < 0.001) and contamination prevention practices (P < 0.01). After intervention, the adjusted hand washing knowledge score of food handlers increased by 10.81 points, and the contamination prevention knowledge increased by 15.00.

Effect of intervention on self-efficacy

The self-efficacy level of participants was measured before and after intervention for both control and intervention groups *(Table 4)*. The pretest self-efficacy scores were similar for both groups. There were no significant differences in the self-efficacy scores for both practices for the control group, pre- and posttest ($P > 0.05$). After the intervention, the treatment group had a significantly higher self-efficacy score for hand washing ($P < 0.01$) and contamination prevention ($P < 0.01$). The results show that participants perceived higher confidence in performing the two selected practices at their workplace after undergoing the intervention program.

Effect of intervention on food safety behavior

The study was initially benchmarked against the 7-step hand-washing practice recommended by the Ministry of Health Malaysia (2013) *(31)*. However, preliminary studies showed that none of the respondents washed their hands using the 7-step hand-washing technique and that the use of hand soap was rare. Thus, in the measurement of behavioral compliance, researchers observed the number of occasions when the selected practice was performed, regardless of adherence to the recommended procedure.

The observed food safety behavior of food handlers, expressed as behavioral compliance score, is tabulated in *Table 5*. At baseline, participants generally exhibited higher compliance for contamination prevention compared to hand washing. Hand-washing compliance was deficient, ranging from 2.86 to 9.09, before intervention. After the intervention program, the control group showed no behavioral compliance changes for both practices, pre- and posttest ($P > 0.05$). In contrast, the treatment group showed significant improvement in hand washing ($P < 0.01$) and contamination prevention behavior ($P < 0.001$) after the 14-day intervention. For contamination prevention behavior, the score increased by 28.21 points (from 62.37 to 90.58). For hand- washing practices, the score significantly increased by 13.18 points (from 9.09 to 22.27). Even though the postintervention hand-washing behavior compliance score was only 22.27%, after the intervention there was an increase among participants in the overall frequency of soap use and the use of the 7-step hand-washing technique, as shown in *Fig. 1*.

DISCUSSION

This study shows that, at baseline, school canteen food handlers exhibited poor compliance in hand washing and moderate compliance in contamination prevention behaviors. The results echoed findings from previous studies that reported that hand-washing frequency is low in foodservice operations, with poor adherence to recommended techniques *(36, 51, 53)*.

After the intervention, which comprised on-site food safety training and a self-efficacy building program, results showed a significant increase in the knowledge, self-efficacy, and behavior of food handlers. The improvement is believed to be due to the use of multiple-component intervention strategies. Education is an important way to deliver consistent knowledge to food handlers. Instead of the usual formal classroom training, an on-site interactive training method using an iPad was selected, incorporating videos, demonstrations, and hands-on hand-washing activity. In a study to develop food safety educational materials for farm workers, Soon and Baines (2012) reported that, rather than using slides and educational booklets, practical and hands-on training sessions were preferred because these methods generate a more intense and realistic experience that garners food-handlers' interest *(52)*. Food safety knowledge acquired through training can enhance food handlers' belief that they are able to perform the desired behaviors *(25)*.

The self-efficacy building program in this study was incorporated with Bandura's (2004) principal sources of information for self-efficacy, which are mastery of skill, verbal persuasion, and role modeling *(6)*. The combination of activities helped build food handlers' self-efficacy. When food handlers have strong self-efficacy, they believe that they have the ability to perform proper food safety steps, which may subsequently influence their intention to practice what is being taught.

According to Yu et al. (2018) *(62)*, food handlers could be hindered from transferring knowledge gained from training into actual practice because they might be overwhelmed with work and might be cognitively overloaded. It was suggested that food handlers should be allowed to practice and apply new skills learned on the job. Seaman and Eves (2006) *(46)* highlighted that the time interval right after training is crucial in setting the base for future use of the skill. Therefore, because coaching the trainee to translate learned knowledge into practice during this critical period is essential, a 10-min daily practice time was allocated for 2 weeks to give food handlers the opportunity to master the skills taught during training. Combined with verbal persuasion by a superior and role modeling by a selected peer, these factors synergistically influence the participants to believe that they can perform the behavior.

The positive findings of this study are in line with those of several past self-efficacy-based intervention studies conducted on foot self-care among elderly diabetic people *(48)*, physical activity of the elderly *(4)*, and duration of breastfeeding *(11)*, despite the different methodology and mechanism used. Nevertheless, no direct comparison could be made with food safety literature because there was a lack of intervention studies targeting self-efficacy in foodservice.

Various intervention approaches to improve food safety behavior have been reported in the literature, with variable effectiveness. Among these, education combined with motivational strategy *(15, 35)* and role modeling *(35)* showed promising results. Previous studies have attempted various strategies to produce positive changes in different food safety behaviors. Among the targeted behaviors were hand washing *(17, 35, 36, 60, 61)*, handling of work surfaces *(60, 61)*, using thermometers *(60, 61)*, hairnet usage *(35)*, jewelry usage *(35)*, and general food hygiene *(32)*. Although cross-contamination is a critical risk area for food safety, no

comparison could be made because of the lack of studies on this specific behavior.

In this study, even though both targeted food safety behaviors for the treatment group improved significantly after intervention, improvement in contamination prevention was higher than in hand-washing behavior (increase of 28.21 versus 13.18 points, respectively). For contamination prevention, the mediocre preintervention compliance score (62.37 ± 21.66) increased to 90.58 ± 11.93 postintervention. On the other hand, the postintervention hand washing compliance score increased from 9.09 to 22.27%. An increase of hand hygiene compliance from 7 to 16% *(17)* and from 29 to 50.8% *(36)* was also reported in other studies. It is believed that the improvement was less obvious for hand washing because good hand hygiene requires continuous effort and time. In a study to develop food safety educational materials and training strategies for the mushroom industry, Nieto-Montenegro et al. (2008) *(35)* highlighted that enforcing hand washing compliance was more difficult than enforcing hairnet and jewelry usage rules at the worksite. There is a higher frequency of hand washing opportunities compared to other food safety practices *(14)*; also, the fire-fighting mode of school foodservice operations makes it difficult for food handlers to consistently perform hand-washing, especially during peak hours. School canteen food handlers in Malaysia have to multitask continuously, doing food preparation, service, and cleaning. The low profit margin of Malaysian school foodservice operations *(57)* could also be a factor that influences canteen owners' willingness to invest in more manpower and resources for their school foodservice operations.

CONCLUSIONS/RECOMMENDATIONS

The intervention produced significant increases in behavioral compliance, knowledge, and self-efficacy scores for both contamination prevention and hand-washing behaviors. Findings from this study provide insight into the potential use of self-efficacy-based intervention in the Malaysian school canteen setting. Some of the techniques used in the intervention, i.e., hands-on interactive training, verbal persuasion, and allocated practice time, could be incorporated into the compulsory food handler training program.

Even though the number of participants that use soap and follow the 7-step hand-washing technique increased after intervention, there is room for improvement in the hand-washing behavioral compliance score. In addition to the intervention program, specific barriers that hinder food handlers from performing hand washing need to be addressed. Time barriers, highlighted in many studies, are not something that can be set aside. This barrier can be reduced by providing adequate manpower and resources to generate a conducive environment for food handlers to perform food safety practices.

The study is not without limitations. Direct observation in school foodservice operations is an expensive, labor-intensive, and time-consuming method. Excessive time was required for data collection and recruitment, not forgetting the problem caused by the high turnover rate of food handlers. The study took approximately 2 years, and the contracts of most of the school canteen contractors who participated in the study expired the same year. Thus, a longer intervention period and postintervention follow-up could not be carried out, and the long-term effectiveness of the intervention remains uncertain. Future research should conduct data collection on a time schedule that is compatible with the duration of school canteen contracts to allow evaluation of whether the positive changes in behavior will be retained over a longer period.

In addition, the improvement is believed to be the result of the use of multiple-component intervention strategies, comprising on-site food safety training and a self-efficacy building program. Because the effect of the intervention was measured as a whole, the specific impact of implementing the self-efficacy program alone could not be established. It is recommended that future study include a third (food safety training only) and fourth treatment group (self-efficacy building program only) to determine the specific effect of each treatment.

All the schools that participated in the study are nationally funded schools that are run by small-scale family businesses. Due to the low number of food handlers per school (from four to nine), many supervisors and owners are the main chefs on the premises and are equally involved in food preparation, service, and cleaning. Due to the nature of operations in Malaysian school foodservice, the participants comprised both supervisor-owners and operators. Future studies could investigate the effect of intervention on different groups, i.e., operators and supervisors.

Lastly, use of video-recording technology is recommended to overcome some of the limitations of the direct-observation method, such as the possibility of the Hawthorne effect. Despite the limitations noted, this study is a pioneering work that provides essential information on the use of self-efficacy-based educational intervention in school foodservice.

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APPENDIX A. SUPPLEMENTARY MATERIAL

Appendix – shows the Food safety observation form related to this article.

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APPENDIX
SUPPLEMENTARY MATERIAL 1

FOOD SAFETY OBSERVATION FORM

School: _____ Date: _____

Observer:

Site:	Total no. of food handlers observable in school:_____ Production: _____ Service: _____ Cleaning:_____	Start time:_____ End time: _____

Initial of Food Handler Observed	Gender	Designation	Job function
	□ Male □ Female	□ Owner □ Employee	□ Production □ Service □ Cleaning

A. PREVENTING CONTAMINATION OF READY-TO-EAT (RTE) FOOD

Observation activity	No. of times should do	No. of times did it	Description
RTE food is **covered** during service			
Food handlers not engaging into any behavior that could result in contamination of food: ● **No bare hand contact** with RTE food ● **Proper coughing/ sneezing** technique used			
Food shall not be brought into direct contact with any material that may contaminate the food. ● Separate **raw food** from RTE food ● Avoiding **stacking** any uncovered RTE food in such a manner that it comes into contact with food in other plate, dish or container. ● Separate **chemical/ detergent** from RTE food ● Separate **pest** from RTE food			

SUPPLEMENTARY MATERIAL 2

B: HAND WASHING OBSERVATION FORM										
Items	No. of times should wash hands	No. of times did wash hands	Hand washing techniques used							
			Water only	1.Wash hands with enough soap	2. Rub hands palm to palm	3. Rub each finger, interlace fingers	4. Rub nails/ fingertips on palm	5. Rub the back of both hands.	6. Rinse hands with water	7. Dry thoroughly with towel
After touching bare skin *(other than clean hands/ arms)*										
After touching clothing										
After coughing, sneezing										
After using handkerchief/ tissue										
After eating, drinking										
Before food preparation										
Before handling different types of food products *(meat, vege)*										
After touching potentially hazardous food										
When switching between raw and cooked food										
Before wearing gloves										
After cleaning equipment, utensils										
After handling soiled equipment, utensils										
After cleaning										
When changing tasks										
After handling money										
Others										