



Research Paper

Dietetics Student Perceptions of Food Safety Communication to Vulnerable Populations: An International Study

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ABSTRACT

Registered dietitians can play an important role in delivering food safety information to vulnerable population groups. Although dietetic students are reported to perceive food safety to be important for vulnerable population groups, little is known regarding their attitudes toward their role in the delivery of food safety information. Therefore, the purpose of this study was to determine and evaluate the perceptions of dietetic students regarding their role in food safety communication to vulnerable populations from three international institutions. A total of 208 dietetics students participated in the study from Columbus, Ohio, USA ($n = 100$), Cardiff, Wales, UK ($n = 78$), and Beirut, Lebanon ($n = 30$). Predominantly, the students in this study had positive attitudes toward the importance of food safety for vulnerable groups, although more students from Lebanon were skeptical that vulnerable patients were more susceptible to foodborne infections than the general populations ($p < 0.001$). Data indicated confidence and understanding of food safety principles and a willingness to learn more about food safety for these groups, however, some students in the UK (30%) and USA (31%) were not confident that they could effectively communicate food safety to vulnerable patients. Based on the findings in this and previous studies, adjustments are recommended to the requirements for food safety knowledge among dietetic students to include food safety counseling competency.

In the context of food safety, vulnerability denotes an increased susceptibility to foodborne illnesses. For example, the risk of foodborne infections such as listeriosis is increased in certain physiological states such as during pregnancy and in advanced age (Desai et al., 2017). Other vulnerable groups at an increased risk of foodborne illness due to immunocompromised states include but are not restricted to – people with diabetes, due to autonomic neuropathy, poor glycemic control and reduced gastric acid production (Evans & Gwynne, 2020) and people living with cancer, as some cancer types impact immune system blood cell function, or as a result of the chemotherapy drugs used for the treatment of cancer (Hota et al., 2022; Rasmussen & Arvin, 1982). Additionally, people living with autoimmune conditions such as multiple sclerosis, who receive disease-modifying therapy drugs to control relapsing illness, have an increased risk of foodborne illness (Buonomo et al., 2018).

Although many vulnerable patient groups may be aware of an increased risk of communicable illnesses when immunosuppressed,

data suggest that some such groups are not aware of their increased susceptibility to foodborne illness (Evans & Redmond, 2018). Furthermore, food-related knowledge and practices among such groups may not be sufficient to ensure the safety of food (Evans & Redmond, 2018; Paden et al., 2019). Consequently, it is suggested that targeted food safety information for vulnerable groups may assist in reducing the risk of foodborne illnesses (Gillespie et al., 2009; Lund & O'Brien, 2011; Mook et al., 2011). Also, the delivery method of food safety advice and information can impact the credibility and acceptability of the information. Delivery of information from a trusted source is thought to increase the likelihood of engagement with the information and is more likely to enable consumers to implement the desirable behavior.

It is widely acknowledged that dietitians are among the most trusted and preferred sources of food safety information for consumers (Atheart et al., 2004; Hoffman et al., 2005; Redmond et al., 2005; Shepherd & Saghaian, 2008). Furthermore, vulnerable groups includ-

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ing people living with HIV (Hoffman et al., 2005), people living with cancer (Medeiros et al., 2008), people receiving chemotherapy treatment (Evans & Redmond, 2017), people who have received transplant (Chen et al., 2010), and people classed as older adults (Nan et al., 2017) are reported to prefer seeking and obtaining verbal food safety advice from healthcare professionals including dietitians. Indeed, as allied health professionals, within a broader multidisciplinary healthcare team, dietitians may have access to vulnerable groups and are therefore well placed to deliver food safety information (Gould et al., 2019). Such efforts may assist in reducing the risk of foodborne illnesses among vulnerable groups. It is suggested that the delivery of food safety information from adequately trained credible healthcare professionals such as dietitians could emphasize the importance of food safety to vulnerable groups (Gould et al., 2019). Ann Coulston, past president of the American Dietetic Association, acknowledged that dietitians are consumers' link to food safety information (Coulston, 1999). Dietitians have a responsibility to provide consumers with food safety information, particularly as they have the ability to develop actionable, and personally relevant messages to influence consumer behavior when preparing food (Coulston, 1999).

Dietitians can obtain food safety knowledge during dietetic training. The content of dietetic curricula needs to consider both nutrition and healthcare requirements and develop dietitians to meet the emerging health priorities of future populations (Palermo, 2015; Tweedie et al., 2021). Previous research incorporating directors of all didactic programs in dietetics approved by the American Dietetic Association reported that only 34% of dietetics programs in comparison to 70% of hospitality programs included food safety certification. It was found that the majority of dietetic programs do not require certification in food safety through programs such as the National Restaurant Association ServSafe (Scheule, 2000). However, the food safety competencies are covered through foodservice training, and the students in dietetics programs in the US often acquire food safety certification through foodservice management classes. Table 2 describes the standards, accreditation bodies and food safety requirements. The curriculum for the preregistration education and training of dietitians in the UK is less focused on foodservice application, and instead, the emphasis is put on legislation and microbiology. The dietitians in Lebanon and UK can obtain food safety Level 1-2 certificates, through the program; however, it is not known how many dietitians in clinics have or renew their certification.

Sneed and Gregoire (1998) discussed how dietitians should address consumer food safety concerns. Previous research has identified gaps in the food safety knowledge of dietitians in the US (Medeiros & Buffer, 2012; Muhammad et al., 2018). International research involving trainee dietitians has established that dietetic students from Malaysia have good levels of food safety knowledge but poor attitude and self-reported practices in relation to foodborne illness (Mohd Yusof et al., 2018) and that food safety knowledge and self-reported practices of dietetic students from Turkey were significantly greater than students not enrolled in dietetic courses (Yasemin et al., 2013). Similarly, dietetic and nutrition students in the US are reported to have significantly higher food safety knowledge and attitudinal scores than students of other disciplines (Unklesbay et al., 1998). Recent research involving dietetic students from three international institutions established that although some were knowledgeable of food safety, many lacked awareness of key concepts (Evans et al., 2021).

Although recent research has indicated that dietetic students have a good understanding of vulnerable population groups and perceive food safety to be important for these groups (Evans et al., 2021), little is known regarding the attitudes of dietetic students toward their role in the delivery of food safety information. Therefore, the purpose of this study was to determine and evaluate the perceptions of dietetic students, from three institutions in the US, UK, and Lebanon, regarding their role in food safety communication to vulnerable populations.

Material and Methods

Data collection tool. A self-administered survey used in this study was developed based on a thorough literature review of food safety behaviors and attitudes and designed as previously described (Evans et al., 2021) and using content previously validated in dietitian populations (Medeiros & Buffer, 2012). The questionnaire contained seven constructs designed to probe the attitudes of dietetic students and the key knowledge and behavior parameters that determine the students' ability to deliver food safety information to vulnerable groups. The first two constructs included the questions about demographic characteristics and food safety training. Positively and negatively worded attitudinal statements were developed in relation to key food safety concepts and attitude constructs were presented in five-point Likert scales with response categories ranging from the strongest (Academy of Nutrition and Dietetics, 2023) to the weakest (Buonomo et al., 2018) agreement, with one neutral response (British Dietetic Association, 2023). The questionnaires were piloted at Cardiff Metropolitan University by dietetics students ($n = 10$) as previously described (Evans et al., 2021). The reliability of each scale was calculated using Cronbach's Alpha with a cutoff reliability cutoff $\alpha \geq 0.75$. The scales were as follows: 1) the attitudes of dietetics students toward food safety for the vulnerable patients (8 items, α US = 0.996, α UK = 0.988, α LB = 1.0); 2) perceived role in delivery of food safety information (12 items, α US = 1.0, α UK = 0.896, α LB = 0.799); 3) perceived ability to convey food safety information (11 items, α US = 1.0, α UK = 0.881, α LB = 0.809); trusted sources of food safety information (12 items, α US = 1.0, α UK = 1.0); and learning preferences (18 items, α UK = 0.999, α LB = 1.0). The tool varied slightly in the three countries. For example, appropriate wording, spellings, and terminologies varied, and some questions were excluded resulting in different sample sizes.

Data collection approach. A cross-sectional survey-based study was conducted targeting students (18 years of age and older) enrolled in dietetic programs at three institutions in the UK, Lebanon, and US. The study included dietetic students at Cardiff Metropolitan University, Wales, UK (approved by the Health and Care Professions Council (2023)) and accredited by the British Dietetic Association (2023)), the Modern University for Business and Science, Beirut, Lebanon (institutional accreditation recently awarded by Evalag), and the Ohio State University, Columbus, Ohio, USA (accredited by the Accreditation Council for Education in Nutrition and Dietetics (ACEND) of the Academy of Nutrition and Dietetics (2023)). The three programs were chosen as a convenient sample representing the different curriculums implemented in three different, geographically, and culturally different environments. All programs are conducted in English language, and all questionnaires were developed and administered in English. The students were provided with a participant information sheet and were required to provide consent for participation. A paper-based questionnaire was made available for completion in UK and Lebanon. The questionnaire was distributed to dietetic students following a lecture and was requested to complete the questionnaire before leaving the lecture room. In the US, the recruitment material was posted through web-based learning management system and made available to the rosters of all dietetics classes. No extra credit was offered to students for participation. The participants were offered an opportunity to enter the draw for a tablet (iPad Mini, Apple Inc.). The students enrolled in dietetics program who have completed any level of food safety education were enrolled. The students accessed the survey through the link available in the recruitment post. The questionnaire was administered electronically through Qualtrics Software (Qualtrics) to complete in their own time.

Statistical analysis. The Qualtrics dataset was downloaded and managed in Microsoft Excel 2010 (Microsoft) spreadsheet. Paper-based responses were manually entered into the dataset. All responses

were anonymous. All responses with less than 85% of the information completed were removed. Microsoft Excel (Microsoft) was used for descriptive analysis, giving an illustrative summary of the data. Medians, upper and lower quartiles, and proportions for the responses were calculated. The percentages were expressed, and a sum of the response categories indicating agreement (agree/strongly agree) and disagreement (disagree/strongly disagree) for each scale and organized in tables. The differences between the student responses from the three programs were tested using chi-square test, and significant findings were presented in tables. All statistical analyses were conducted using SPSS Statistics 20 (IBM® Software Group).

Ethical approval. All methods and materials in the study were approved by The Ohio State Institutional Review Board (2018E0032). Ethical approval was obtained from Cardiff Metropolitan University School of Health Sciences Research Ethics Committee (Project reference number: 9299) and the Ethics committees at the Modern University for Business and Science (MU-20180701).

Results

Respondent demographic characteristics. The data from 208 dietetics students were included in this study. As indicated in Table 1, of those who participated, the majority were female (89%) and were aged 18–29 years (87%). One hundred of the dietetic students were from Columbus, Ohio, USA (48% of sample), 78 were from Cardiff, Wales, UK (38% of sample) and 30 were from Beirut, Lebanon (14% of sample). Most of the students reported studying full time (89%) and were in the second (35%) or third (38%) year of their dietetic studies. Participating in an internship or work placement was reported by 40% of students. For those, internship or placement ranged from 1.5 days to 8 weeks in duration and included hospital and community settings.

Food safety training in dietetic programs. The majority of the dietetics students in this study completed at least one food safety course (75%, $n = 161$), while 44 (21%) students reported not taking any food safety training. Food safety course requirements in each dietetics program were set by the Standards of Proficiency that the curriculums are accredited against. The food safety requirements are defined by the accreditation body and differ for each country. The requirements in each program were met through the completion of academic courses, food safety certificates, or both (Table 2).

Table 1
Demographic profile of dietetic student participants ($n = 208$)

Factor	Description	<i>n</i>	%
Gender	Female	185	89%
	Male	21	10%
	Not disclosed	2	1%
Age	18–29 years	181	87%
	30–44 years	23	11%
	> 45 years	4	2%
Location	Cardiff, UK	78	38%
	Columbus, Ohio, US	100	48%
	Beirut, Lebanon	30	14%
Study status	1st year	5	2%
	2nd year	72	35%
	3rd year	79	38%
	4th year	32	15%
	5th year	20	10%
Study mode	Full time	184	89%
	Part time	24	11%
Internship or placement	Yes	83	40%
	No	125	60%

Attitudes toward food safety for vulnerable patients. Overall, most of the dietetics students in this study (87.9%) agreed that the implementation of the food safety practices is more important for vulnerable patients than for healthy adults. Further, the students in all three countries were able to readily recognize the increased susceptibility to foodborne infections in vulnerable populations (80.7%). However, close to one-half (41%) of the students from Lebanon were skeptical that more vulnerable patients suffer foodborne illnesses than the general population, which was significantly more than among UK and US students ($p < 0.001$; Table 3).

There were differences in how certain high-risk practices were understood by the students in different countries. For instance, one quarter (25%) of Lebanon students thought that it was appropriate for people that have diarrhea to prepare foods for the vulnerable patients as long as they have washed their hands prior, while a smaller proportion of students from the UK, and US (3% and 13%, respectively) agreed with this statement ($p < 0.001$; Table 3). The majority of dietetics students from the UK (65%) thought that it was safe for people in high-risk groups to drink juices and smoothies made with raw fruits and vegetables, while fewer from US (30%) and Lebanon (29%), share this opinion ($p < 0.001$; Table 3).

The differences were observed for the students from the three countries in their attitudes toward the information that should be given to the vulnerable population. Fewer students from Lebanon thought the vulnerable groups should be given food safety information ($p < 0.001$), while the students in the UK were less certain that the vulnerable groups should be more concerned about the diet and nutrition than food safety ($p = 0.04$; Table 3).

Perceived role in the delivery of food safety information. Future dietitians in all three countries agreed that educating dietitians to inform vulnerable patients about the importance of food safety may lead to reduction of foodborne diseases (91.9% agree/strongly agree). However, there were differences in how the students perceived their role in food safety information delivery. The students from Lebanon were less convinced that the delivery of food safety information should be a priority for dietitians ($p < 0.001$, Table 4). A greater proportion of the US students thought that the provision of food safety information should be a standard procedure for dietitians ($p = 0.007$), and fewer UK students disagreed that the dietitians do not have time to deliver food safety information ($p < 0.001$). While the majority of US (57%) and Lebanon (66%) students thought it was the responsibility of doctors and consultants (hospital-based physician or surgeons) to teach vulnerable patients about food safety, significantly fewer UK students (35%) agreed with this statement ($p < 0.05$; Table 4).

When asked about the expectations for their future profession, the dietetics students from UK and Lebanon agreed that peers and colleagues, as well as instructors, expected delivery of food safety information to clients, but more UK students reported that the delivery of food safety information is perceived as normal among practicing dietitians ($p = 0.006$). Students in the US were not asked these questions.

Perceived ability to convey food safety information. Out of the three groups, the students from Lebanon indicated the most confidence regarding the provision of food safety information to immunocompromised patient groups ($p < 0.001$). They also considered the food safety information received in programs to be adequate on most occasions ($p < 0.05$; Table 5).

Both students from the UK and Lebanon felt confident in their understanding of food safety behaviors that help reduce the risk of foodborne illness (78.3% agree/strongly agree). The majority of students from Lebanon (60%) reported that they could list WHO Five Keys to Safer Food. In contrast, 83% of UK students were not familiar with the concept ($p < 0.05$; Table 5).

The future dietitians from all three countries indicated the desire to learn more about food safety for vulnerable populations (81% agree/strongly agree) and all agreed that a continual professional develop-

Table 2
Food safety competencies within the dietetics programs in the UK, Lebanon, and US and the proportion of students that have completed food safety training through academic or certification courses

Country	Standard	Curriculum Food Safety Requirements	Food Safety Training	
			Academic course (% completed) ^c	Certificate course (% completed) ^d
UK	HCPC ^a Standards of Proficiency	<i>"Have knowledge of food safety and apply knowledge of food safety legislation and practice to manage and evaluate the service of safe food"</i>	0	100
Lebanon	ACEND ^b Standard of Proficiency	<i>"Apply safety and sanitation principles related to food, personnel and consumers"</i>	100	23.3
USA	ACEND ^b Standard of Proficiency	<i>"Apply safety and sanitation principles related to food, personnel and consumers"</i>	48	53

^a HCPC – Health and Care Professions Council (Council, 2018).
^b ACEND- Accreditation Council for Education in Nutrition and Dietetics of the Academy of Nutrition and Dietetics (Academy of Nutrition and Dietetics, 2023).
^c No academic courses that cover food safety are offered at Cardiff Metropolitan University Nutrition and Dietetics Program. (Cardiff Met Students participate in the Level 2 Food Safety and Hygiene certificated course). The Modern University for Business and Science, Beirut, Lebanon Nutrition Program offers four courses that integrate food safety information (Foodservice Management, Foodservice Practicum, Food Microbiology and Parasitology, and Food Hygiene). The Ohio State University DPD Program in Human Nutrition offers three courses (Foodservice Food Safety, Foodservice Management, and Microbiology).
^d Certificate training includes Level 1-2 certificates in UK, LB, and US and ServSafe Certificate in the US.

Table 3
Attitudes toward the importance of food safety for vulnerable patients among students enrolled in dietetics programs in United Kingdom (n = 74), Lebanon (n = 29), and United States (n = 96)

Statements regarding food safety associated with vulnerable patients	Median *	Proportion that agreed and strongly agreed with the statement (Response 1 or 2)			Proportion that disagreed and strongly disagreed with the statement (Response 4 or 5)			Significant differences
		UK	LEB	USA	UK	LEB	USA	
It is more important to implement food safety practices when patients are immunosuppressed	1.00	85%	86%	91%	11%	3%	4%	$p = 0.287$
Vulnerable patient groups are at no more risk of foodborne illness than the general population	5.00	18%	10%	14%	81%	76%	82%	$p = 0.88$
It is ok for people who have diarrhea to prepare food for vulnerable patients as long as they wash their hands first	5.00	3%	25%	13%	92%	43%	81%	$X^2(4, n = 196) = 33.140, p < 0.001$, Cramer's $V = 0.291$
It is safe for people in high-risk groups to eat soft cheese made from unpasteurized milk, like Brie or Camembert	4.00	6%	10%	4%	86%	72%	78%	$p = 0.281$
It is safe for people in high-risk groups to drink juices and smoothies made with raw fruits and vegetables	3.00	65%	29%	30%	17%	43%	39%	$X^2(4, n = 195) = 24.677, p < 0.001$, Cramer's $V = 0.252$
Vulnerable patients do not need to be given any food safety information	5.00	1%	7%	2%	97%	79%	98%	$X^2(4, n = 198) = 20.925, p < 0.001$, Cramer's $V = 0.230$
Vulnerable patients should be more concerned about diet and nutrition than food safety	4.00	7%	10%	11%	69%	86%	79%	$X^2(4, n = 198) = 10.014, p = 0.040$, Cramer's $V = 0.159$
I'm skeptical that more vulnerable patients suffer from foodborne illness than the general population	4.00	11%	41%	26%	65%	24%	60%	$X^2(4, n = 198) = 21.479, p < 0.001$, Cramer's $V = 0.233$

* 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree.

ment course would ensure that dietitians are knowledgeable of food safety (88.4%; Table 5).
Trusted sources of food safety information. Overall, the dietetics students in this study identified public health agencies in their countries (local public health departments in the US; Ministry of Public Health in Lebanon; PHE/HPA in the UK), as well as academic courses to be the most trusted sources of food safety information. This was followed by the private healthcare services, disease-specific charities, university extension, and public agricultural agencies (US Department of Agriculture, US FDA, Lebanon Ministry of Agriculture, and Defra in the UK). However, students from the US and UK in this study had more trust in their public health agencies than their counterparts in Lebanon

($p = 0.007$). The perception of the government agencies as trusted sources of food safety information among US students was lower than that of students from the UK and Lebanon toward agricultural agencies ($p < 0.001$; Table 6). Non-government organizations were the least trusted sources of food safety information by the students in all three countries (Median = 5, Table 6).
Preferences for future food safety training. When asked about preferences for future food safety training, the dietetics students from UK and Lebanon in this study identified hands-on practical sessions in domestic kitchens and catering environments, and food safety case study tutorials as the most preferred future training forms (Median = 4, Table 7). Lectures, seminars, and group projects were moderately

Table 4

Attitudes toward the perceived role in the delivery of food safety information among students enrolled in dietetics programs in United Kingdom ($n = 74$), Lebanon ($n = 29$) and United States ($n = 95$)

Statement regarding the perceived role in the delivery of food safety information	Median*	Proportion that agreed and strongly agreed with the statement (Response 1 or 2)			Proportion that disagreed and strongly disagreed with the statement (Response 4 or 5)			Significant differences
		UK	LEB	USA	UK	LEB	USA	
The role of the dietitian is to provide nutritional advice, not food safety information	5	16%	14%	7%	65%	76%	85%	$X^2(4, n = 198) = 9.879, p = 0.043$, Cramer's V = 0.158
The delivery of food safety information is not a priority for dietitians	5	24%	10%	6%	55%	72%	85%	$X^2(4, n = 198) = 19.659, p < 0.001$, Cramer's V = 0.223
The provision of food safety information should be a standard procedure for dietitians	1	70%	72%	92%	8%	10%	3%	$X^2(4, n = 198) = 14.259, p = 0.007$, Cramer's V = 0.190
Dietitians should only give food safety information if a patient asks	5	14%	14%	5%	68%	66%	91%	$X^2(4, n = 198) = 16.565, p = 0.002$, Cramer's V = 0.203
Dietitians do not have the time to provide food safety information	5	26%	14%	2%	35%	79%	83%	$X^2(4, n = 198) = 49.000, p < 0.001$, Cramer's V = 0.352
It is the responsibility of doctors and consultants to teach vulnerable patients about food safety	3	18%	66%	57%	35%	24%	28%	$X^2(4, n = 197) = 39.753, p < 0.001$, Cramer's V = 0.318
Educating dietitians to inform vulnerable patient groups of the importance of food safety may reduce the risk of foodborne illness	1	93%	79%	95%	1%	3%	2%	$p > 0.05$
Peers and colleagues think that I should deliver food safety messages to clients as a practicing dietitian	1	55%	100%	N/A	14%	0%	N/A	$p = 0.476$
My instructors expect me to deliver food safety messages to clients as a practicing dietitian	1	51%	80%	N/A	21%	20%	N/A	$p = 0.060$
Delivery of food safety information is perceived as normal among practicing dietitians	3	28%	100%	N/A	28%	0%	N/A	$X^2(2, n = 48) = 10.178, p = 0.006$, Cramer's V = 0.460
I intend to deliver food safety messages as a future practicing dietitian or nutrition professional	1	56%	100%	N/A	7%	0%	N/A	$p = 0.061$
I see providing food safety information to patients as something which could compromise the provision of dietetic care	3	16%	60%	N/A	49%	20%	N/A	$p = 0.163$

* 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree.

Table 5

Attitudes toward the perceived ability to communicate food safety information among students enrolled in dietetics programs in United Kingdom ($n = 74$), Lebanon ($n = 29$) and United States ($n = 95$)

Statements regarding ability to communicate food safety	Median*	Proportion that agreed and strongly agreed with the statement (Response 1 or 2)			Proportion that disagreed and strongly disagreed with the statement (Response 4 or 5)			Significant differences
		UK	LEB	USA	UK	LEB	USA	
I would be confident to give an immune-compromised patient food safety information	3.00	30%	72%	44%	57%	14%	30%	$X^2(4, n = 198) = 26.315, p < 0.001$, Cramer's V = 0.258
The food safety education I received is not clinically applicable	5.00	31%	14%	8%	43%	59%	61%	$X^2(4, n = 196) = 15.298, p = 0.004$, Cramer's V = 0.197
I would like to learn more about food safety for vulnerable patient groups	1.00	91%	76%	77%	3%	3%	10%	$p = 0.080$
A Continual Professional Development course would ensure that dietitians are knowledgeable of food safety	1.00	95%	79%	86%	0%	3%	6%	$p = 0.062$
I consider the food safety training I received during my dietetics degree to be adequate	3.00	35%	72%	52%	31%	14%	11%	$X^2(4, n = 198) = 20.137, p < 0.001$, Cramer's V = 0.226
I would find it difficult to identify individuals or groups at a high risk for food	5.00	23%	0%	N/A	54%	40%	N/A	$p = 0.169$
I am confident I could identify factors which may put individuals at risk foodborne	1.00	74%	100%	N/A	14%	0%	N/A	$p = 0.436$
I am confident I could list the World Health Organizations Five Keys to safer food	5.00	9%	60%	N/A	84%	40%	N/A	$X^2(2, n = 48) = 9.325, p = 0.009$, Cramer's V = 0.441
I need to have in-depth knowledge of microbiological principles to understand food safety information	4.00	23%	100%	N/A	56%	0%	N/A	$X^2(2, n = 48) = 12.279, p = 0.002$, Cramer's V = 0.506
I worry that I do not know the correct food safety information to provide patients identified at risk with the correct information	3.00	44%	0%	N/A	44%	60%	N/A	$p = 0.085$
I am confident I understand food safety behaviors which help reduce the risk of foodborne illness	1.00	76%	100%	N/A	14%	0%	N/A	$p = 0.544$

* 1 = Strongly agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree.

Table 6

Perceived trustworthiness of food safety information sources among students enrolled in dietetics programs in United Kingdom ($n = 77$), Lebanon ($n = 28$) and United States ($n = 95$)

How trustworthy do you consider the food safety information to be when provided by the following sources	Median*	Proportion that perceived the source to be trustworthy (Response 1, 2, 3)			Proportion that perceived the source to be untrustworthy (Response 8, 9, 10)			Significant differences
		UK	LEB	USA	UK	LEB	USA	
Nationwide campaign	3.00	79	46	41	1	14	3	$X^2(4, n = 200) = 34.724, p < 0.001$, Cramer's V = 0.295 $p = 0.113$
Academic/university courses	2.00	81	57	75	3	11	3	
University extension	3.00	81	57	56	3	11	1	$X^2(4, n = 200) = 20.440, p < 0.001$, Cramer's V = 0.226
US Department of Agriculture, Food and Drug Administration (US) Ministry of Agriculture (LEB) Department for Environment, Food & Rural Affairs (UK)	3.00	82	54	55	2	7	26	$X^2(4, n = 167) = 21.194, p < 0.001$, Cramer's V = 0.252
Department of Health Services (US) Ministry of Public Health (UK) Public Health England/Health Protection Agency (UK)	2.00	96	69	81	2	10	1	$X^2(4, n = 168) = 14.246, p = 0.007$, Cramer's V = 0.206
Disease-specific research organization/charity	3.00	71	61	73	0	4	2	$p = 0.630$
Private healthcare services	3.00	77	69	67	2	7	3	$p = 0.665$
Non-governmental organization	5.00	26	21	35	7	21	8	$p > 0.169$
Public Healthcare services	2.00	95	62	N/A	0	7	N/A	$X^2(4, n = 72) = 13.197, p < 0.001$, Cramer's V = 0.428

* 10-point Likert-type scale: 1 = Extremely trustworthy, 10 = Extremely untrustworthy).

Table 7

Preferences for future food safety training among students enrolled in dietetics programs in United Kingdom ($n = 44$) and Lebanon ($n = 5$)

Statements regarding ability to communicate food safety	Median*	Least preferred (Response 1 or 2)			Most preferred (Response 4 or 5)			Significant differences
		UK	LEB	USA	UK	LEB	USA	
Hands-on practical sessions in a domestic type kitchen	4	14	20	n/a	72	60	n/a	$p = 0.467$
Hands-on practical sessions in a catering environment	4	21	40	n/a	66	40	n/a	$p = 0.158$
Self-learning, i.e. provided with access to relevant documents and guidelines	2	60	60	n/a	34	0	n/a	$X^2(2, n = 49) = 6.550, p = 0.038$, Cramer's V = 0.366
Lectures on food microbiology and foodborne pathogens	3	39	40	n/a	39	60	n/a	$p = 0.362$
Lectures on food safety risks and how to reduce risks through food safety practices	3	25	60	n/a	48	40	n/a	$p = 0.485$
Seminars/tutorials considering the most suitable methods for communicating food safety information	3	18	40	n/a	48	40	n/a	$p = 0.274$
Group project to identify barriers to food safety behaviors	3	41	40	n/a	21	40	n/a	$p = 0.347$
Individual project to identify barriers to food safety behaviors	2	57	60	n/a	17	0	n/a	$p = 0.834$
Group project to produce a food safety information resource for a patient group	3	43	40	n/a	32	60	n/a	$p = 0.674$
Individual project to produce a food safety information resource for a patient group	2	50	60	n/a	27	40	n/a	$p = 0.806$
Tutorials exploring dietetic case studies where food safety information plays an important role in treatment.	4	18	20	n/a	71	60	n/a	$p = 0.915$
Hands-on in a microbiology laboratory environment	3	41	20	n/a	39	80	n/a	$X^2(2, n = 49) = 9.975, p = 0.041$, Cramer's V = 0.451

* 5 point Likert-type scale of preference: 1 = Least preferred, 5 = most preferred.

scored (Median = 3), while the least preferred forms of training were individual projects and self-learning (Median = 2). Hands-on microbiology labs were better preferred in Lebanon than UK ($p = 0.041$). The UK students had more positive attitudes toward self-learning when provided with the resources, such as relevant documents and guidelines ($p = 0.038$; Table 7).

Discussion

For the first time, this study gives an international perspective of student dietitians' attitudes and perceptions toward delivering food

safety information to vulnerable patients. This study expands upon the findings from our previous report in which we presented and contrasted knowledge, practices, and risk understanding among the same group of students (Evans et al., 2021). Given the critical role that attitudes play in predicting the food safety related behavioral intentions (Lin & Roberts, 2020), the findings of this study contribute to a better understanding of dietitians and other healthcare professionals relating to the communication of food safety messages to patients. This report fulfills the current gap and provides knowledge base for the development of effective approaches to help dietitians better serve vulnerable groups and reduce their risks of foodborne infections.

It was encouraging to find that future dietitians in this study predominantly indicated positive attitudes about the importance of food safety to vulnerable groups. This is in accordance with the expectation and the previous reports where food safety competencies were ranked as very important or essential for future dietitians (Scheule, 2000). Dietetics students in this study indicated confidence in understanding the food safety principles relevant to high-risk patients and were willing to learn more about food safety for these groups. This is in disparity with the previously found lack of understanding of some general food safety principles that may pose serious challenges to readiness of dietetics students to provide appropriate food safety advice to high-risk patients, highlighting the urgency to address food safety education gaps in dietetic curricula.

This study compared the perceived ability of dietetics students in three countries (UK, Lebanon, and US) to communicate food safety to vulnerable groups, as well as the trusted sources of food safety information. Except for the students from Lebanon, the majority of future dietitians were not confident that they could effectively communicate food safety to populations at risk. This is most likely due to the fact that the current focus of food safety education for dietetics students is predominantly through foodservice management. It is essential that dietitians obtain sufficient food safety knowledge at degree level and acquire the ability to provide food safety advice and information to vulnerable patient groups. The future dietitians in this study, regardless of the program, wanted to learn more about food safety for vulnerable populations and expressed positive attitudes toward continual professional training in food safety. Although McCabe-Sellers and Beattie (2004) suggest that dietetics professionals can update knowledge and practice through online resources to stay knowledgeable and prepared to meet the food safety needs of clients, we show that self-learning was not highly preferred by the dietetic students. Instead, the students reportedly appreciated hands-on practical sessions in domestic kitchens and catering environments. This is important to have in mind when designing future materials and opportunities for food safety education of dietitians and dietetics students.

It is also clear that the format of training must be adjusted to the cultural needs of the students in different countries. This study outlines a lower affinity to self-learning among the students in Lebanon. The influence of culture on students' learning preferences has long been recognized (Kovach et al., 2009; Rice, 2019; Vita, 2001). Although there is currently little research comparing the effectiveness of material delivery methods on the learning ability of dietetics students, food safety education has to be delivered within the cultural context both to future dietitians and high-risk patients (Kovach et al., 2009).

This study presented some limitations related to the implementation of similar study designs in different countries. While the dietetics programs were similar in the food safety requirements, the number of enrolled students and year of study when the food safety training was implemented was varied. We had to employ a different approach to student recruitment in each country, which may have led to the enrollment of participants with varied food safety completed courses. Because of the limited number of programs ($n = 3$ institutions) and students ($n = 208$) in our study, the generalization of the findings should be done cautiously. While the sample size may seem limited when compared to consumer surveys, it is essential to acknowledge the inherent small cohorts of dietetic students enrolled in programs at the three institutions. The data encompassed multiple year groups, contributing to a comprehensive representation despite the initial impression of a modest sample size. We believe that this study indicates the need for the research to be duplicated in multiple institutions in each country to obtain a larger population of dietetic students.

The findings related to the students' perceptions of their own ability to convey food safety information to the patients may vary in different countries due to different professional organizations. This is also true for the inferences about the expectations of the role of

dietitians in different countries. This is of particular importance because of the evolving role of dietitians. Currently, the emerging trends in precision nutrition will require new approaches to nutrition and dietetics in which food safety education for vulnerable patients must be integrated. It will be important that food safety education of dietetic students remains aligned, if not ahead, of these advancements. Food for vulnerable patients has to be safe and nutritious in order to maximize food-related health and well-being and therefore, food safety is included in international curricula for the training of dietitians (Evans et al., 2021). Because their education had no population focus, it was not surprising that the future dietitians in this study showed a low understanding of certain high-risk practices as it relates to increased susceptibility to foodborne diseases. Similarly, in our previous study, the students reported low understanding of several general food safety concepts (Evans et al., 2021). Registered dietitians have been shown to possess moderate food safety knowledge previously (Medeiros & Buffer, 2012) and insufficient understanding of specific human pathogens (Buffer et al., 2013; Evans et al., 2021). This may lead to insufficient readiness of dietetics students to provide food safety advice to high-risk patients and broader community as they enter the workforce. Therefore, in order to appropriately prepare dietitians to better serve their clients, we suggest that future training of dietetic students should not only incorporate basic microbiology and immunology but also patient-focused food safety behavior change principles and case studies. Additionally, it is important to evaluate how current dietetic programs interpret food safety requirements in their curriculums, and to establish and integrate if there is space in current curriculum population-focused food safety requirements, such as food safety counseling and communicating individual patients' susceptibility to foodborne illness.

Adequate food safety messaging received at relevant timepoint can critically impact high-risk patients. For example, it has been shown that food safety information should be provided to cancer patients early in their treatment to make them aware of their susceptibility to foodborne infections that can change the course of their treatment (Paden et al., 2019). The patient education often takes place in clinical settings where dietitians are expected (Cody & Stretch, 2014) and uniquely positioned to convey food-related messages (Gould et al., 2019). Because of this, the ability of dietitians to communicate food safety to vulnerable patients is of utmost importance. Based on the findings in this and previous studies, adjustments to the food safety competency requirements, such as the inclusion of food safety counseling for vulnerable populations, are recommended. Additional recommendations proposed include continuing education modules specifically designed to target the dietitians' knowledge specific to vulnerable population needs.

Conclusion

To maximize health and wellbeing, food must be both safe and nutritious – particularly for vulnerable patients, consequently, it is of utmost importance that dietitians are sufficiently trained to effectively communicate food safety messages with vulnerable patients. Although food safety is incorporated into existing dietetic curricula, the curricula lack population-focused food safety education, food safety-specific behavior change principles, and food safety communication training. This may contribute to dietetic students lacking confidence in their ability to effectively communicate food safety information to vulnerable patient groups, despite indicating confidence in understanding basic food safety principles. We believe that adjustments are required to dietetic curricula to enable dietitians to identify vulnerable patients and provide bespoke food safety counseling relevant to individual patients' susceptibility to foodborne illness to facilitate food safety behavior change.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The authors welcome correspondence from other researchers who wish to replicate this work with different populations of dietetic students.

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