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Original article

Cross-cultural validation of a questionnaire on food safety and food security in Italy

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Abstract. *Background and aim:* The manuscript focuses on the translation, adaptation, and validation of Food Security Survey Module (FSSM) and Food Safety Knowledge and Behaviour (FSKB) questionnaires for use in the Italian context. *Methods:* The online survey was anonymously administered by Microsoft Forms to Italian adults, October-November 2023. The retest questionnaire was done 30 days after the first round. The questionnaire's reliability was assessed using Cronbach's α. Reproducibility was measured using Cohen's kappa coefficient (κ), and the Kendall's τ correlation coefficient (τ). Feasibility was assessed trough ad hoc questions. *Results:* A total of 96 subjects participated to the round of validation. A high level of reliability was found with standardized α of 0.91 and 0.75 for FSSM and FSKB, respectively. The mean κ was 0.669, standard error (SE= 0.019) for FSKB, and τ ranged between 0.595 and 1.000, with significant correlations ($p< 0.001$). Most participants (76.0%) found the questions clear, with 63.6% completing the survey in less than 10 minutes. *Conclusions*: The translation and validation process have yielded reliable and culturally relevant instruments for assessing food safety and food security in the Italian population. These validated questionnaires can serve as valuable tools for future research and interventions in the domain of food safety/security in Italy. (www.actabiomedica.it)

Key words: food safety, food security, validation studies, questionnaires, psychometrics, cross-cultural comparison, Italy, Italian population, public health, measurement tool

Introduction

Food safety and food security are two critical dimensions in the broader context of global health and well-being. Both concepts are intricately linked to the production, process, distribution, as well as exportation and consumption of food, impacting the health of individuals and the stability of communities (1). The term food safety refers to the hygienic and sanitary aspects of food and drinking water consumption. It raises the assurance that food products are free from contaminants, pathogens, and substances that may represent a danger and may cause harm to human health. In other words, it involves a set of rules and practices aimed at ensuring that food is always consumed and treated in a healthy, hygienic, and risk-free manner, thereby safeguarding the end consumer and, consequently, human health (2). On the other hand,

the term food security is a multidimensional concept that extends beyond the mere availability of food. It denotes the socio-economic security of having a sufficient amount of food to live, along with, access, utilization, and stability (3). Food security is met when all people have physical and economic access to sufficient and safe resources of nutritious food that meet their dietary needs and food preferences. The Food and Agriculture Organization of the United Nations (FAO) estimates that every year, 600 million people worldwide fall ill due to contaminated food or water. Among them, there are 420,000 deaths, including 125,000 children under the age of 5 (4). As for food security, it is estimated that 700 million people, 70% of whom are women, live in conditions of extreme poverty (3). According to the report on foodborne diseases produced by the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC), the confirmed cases reported for major food-and-waterborne diseases are relatively high in Italy (5). The report indicates a total of 5,763 foodborne outbreaks in the year 2022, with 48,605 cases of illness, including 2,783 hospitalizations and 64 fatalities (5). In Italy, the percentage of severe food insecurity conditions remained unchanged, ranging from 1.1% to 1.2% from 2015 to 2018, before increasing in 2019 to a percentage of 1.9% (3). The issue of food insecurity is significant enough to have been included in the Sustainable Development Goals. In particular, Goal 1 "Zero Poverty" and Goal 2 "Zero Hunger" primarily address food security. In contrast, Goal 3 "Good Health and Well-being" and Goal 6 "Clean Water and Sanitation" mainly refer to the concept of food safety (6). Despite the importance of the topics of food safety and food security, currently, there are no validated tools in the Italian language specifically designed to measure the levels of food safety and food security in epidemiological studies. In light of this, the current study aimed to translate, adapt to the Italian context and validate tools able to measure food safety and food security. Actually, valid tools are fundamental for detecting the level of food safety/security, understanding associated factors, and laying the foundations for implementing actions aimed at promoting food safety and food security among the general public.

Methods

Study design and data collection

This is an observational, cross-sectional study aimed at translating and validating an Italian version of two pre-existing questionnaires developed to measure food safety and food security. Before completing the questionnaire, participants were given guidance to review the study's purpose, and instructions on how to proceed with the questionnaire were supplied. In particular, it was clarified that participation in the study implied that respondents would be contacted at a later time (after 30 days) to complete the questionnaire again. Furthermore, each participant was explained that, in addition to the questions regarding socio-demographic characteristics and the two validation questionnaires (food safety and food security), at the end of the survey, they would be required to respond to some questions regarding their satisfaction with the proposed questionnaire, identifying any encountered difficulties. In total, four different questionnaires were administered. The first was about socio-demographic characteristics, the second and the third were about food safety and food security, respectively and the fourth was the feasibility questionnaire. In detail, the Food Safety Knowledge and Behaviors questionnaire (FSKB) was previously designed, and validated, by Paden et al, and it was first adopted among cancer patients (7). The food security questionnaire used was the United States Adult Food Security Survey Module (FSSM) (8). It is used by the United States Department of Agriculture to assess food security in the United States. It is part of the larger National Health and Nutrition Examination Sur-vey (NHANES), which is conducted by the National Center for Health Statistics (NCHS). The feasibility questionnaire was used to gather information about clarity, difficulties, and time needed to take part in the study.

Participant recruitment

Eligible participants included all individuals aged 18 years and older, living in Italy. Data were collected anonymously between October and November

2023 through an online questionnaire created using Microsoft Forms. The survey was shared with both personal and non-personal contacts through social media networks. Explicit informed consent was mandatory for each participant, and those who did not provide consent were directed to the conclusion of the questionnaire. Lastly, participants were free to discontinue their participation in the study at any time. The retest questionnaire was sent to participants 30 days after the first round. We assumed that a time interval of 30 days between the two administrations was long enough to avoid recall bias and short enough to avoid changes in the studied attributes (9). Non-respondents were reminded to repeat the questionnaire another 2 times 10 days apart to help improve overall participation rates. Considering an expected Cohen's kappa of 0.75 (± 0.125), a confidence level of 90% and a drop-out rate of 5%, we calculated a minimum sample size of 76 participants (10).

Socio-demographic data

To assess the generalizability and applicability of our translated questionnaires, the socio-demographic characteristics of respondents were collected. In detail, the following data were recorded: gender, age, marital status, number of family members, education, type of work, physical activity, smoking habit, and use of food delivery apps or apps to contrast food waste. Age was collected on a continuous scale. Marital status was dichotomized into single (including single, separated, divorced, and widowed), and having a partner. Family size was initially assessed on a continuous scale and subsequently grouped into categories representing one, two, and three or more members. Education was a categorical variable, classified into middle education (middle school and high school), and high education (degree and postgraduate degree). Type of work was categorized into student, employed, and unemployed (including job seeker, homemaker, and retired). Physical activity was dichotomized into active ("I practice it 1-2 times a week", or "I practice it 3 or more times a week") and not active ("I do not practice it"). The investigation into smoking habits was categorized into no smoking (including "I have never smoked tobacco" and "I used to smoke but quit") and current smoking (including "I smoke occasionally" and "I smoke regularly"). The use of food delivery apps or apps to contrast food waste was dichotomized in yes or no.

Food safety questionnaire

The FSKB questionnaire contained the knowledge and behaviour sections (7). The knowledge section contained a total of 45 questions, structured as statements and categorized into five areas: general food safety, cross-contamination, food preparation, food storage, and clean-up. Participants had the option to express agreement or disagreement with each statement. Responses were coded on a binary scale, denoting correctness or incorrectness. A previous study set 80% as the minimum limit for defining knowledge of the five areas and also for the entire questionnaire (11). Based on this, participants were classified as having "Mastered Subject Area" if they achieved 80% or more correctness within specific areas (general food safety, cross-contamination, food preparation, food storage, and clean-up). Additionally, they were considered to have "Mastered Overall Score" if they attained at least 80% of correctness across the entire section. The behaviour section comprised a 23-item utilizing a five-point Likert scale (ranging from 1 = never to 5 = always). The items covered aspects such as expiration dates, damaged packaging, and the consumption of non-food items.

Food security questionnaire

The FSSM questionnaire includes 9 multiple-choice questions, specifically targeted to adults, aimed to provide information about experiences related to food access and affordability, in a period of the last 12 months (8).

Feasibility questionnaire

The feasibility survey comprised 7 multiple-choice items evaluating the clarity, feasibility, and challenges encountered by the participants (12, 13). Additionally, we investigated whether any questions were perceived

as offensive or difficult to interpret. In instances where participants found certain questions problematic, we requested them to specify those questions (for these particular questions, multiple answers were allowed). Finally, participants were prompted to indicate the amount of time taken to complete the survey, ranging from less than 10 minutes to more than half an hour.

Translation

The translation process adhered to international guidelines for culturally adapting self-report measures (14). To elaborate, four sequential phases were implemented. Initially, the questionnaire underwent direct translation by two bilingual translators, one Italian native speaker, and the second English native speaker, each of them worked independently. The translators had diverse backgrounds, with one specializing in food sciences and the other in languages and literature. In the subsequent phase, the two translations were scrutinized, and a third version was formulated through comparison and discussion with a third member of the research team. In the third phase, this consensus version underwent back translation into English. The back-translation was executed by two Italian English translators, deliberately kept unaware of the explored concepts. Finally, in the fourth phase, an expert committee reviewed the two English versions (the original and back-translated versions) to identify any potential disparities and endorse the final version of the translation.

Statistical analysis

The study included descriptive analysis of participants who responded to both administrations. For continuous non-normally distributed variables, the median and interquartile range (IQR) were reported, while categorical variables were expressed as percentages. Differences between groups were tested by Fisher's exact test and Pearson's Chi-squared test were used for categorical variables. Fisher's exact test was performed if the expected frequency in a category was lower than 5; otherwise, a Chi-square test was used if the expected frequency was higher. Wilcoxon rank sum test was used for continuous variable. Statistical significance was established at $p<0.05$. To perform validation of the questionnaire, we assessed the reliability, reproducibility, and feasibility of the questionnaires. The questionnaire's reliability was assessed using Cronbach's alpha (α), a metric that gauges the interrelatedness of the given items as a cohesive group. A greater inter-correlation among items corresponds to a higher α value. The closer α is to one, the higher is the reliability estimate of the instrument. Typically, an accepted threshold is set at > 0.70. Cronbach's α was estimated both after the first and the second round of survey administration (15). The reproducibility refers to the agreement between the two administrations (30 days apart). Based on variables type, we used the Cohen's kappa coefficient (κ), and the Kendall's τ correlation coefficient (τ). Cohen's kappa coefficient (κ) was used for the categorical variables within FSKB questionnaire, section Knowledge. κ assesses the inter-rater agreement between categorical variables, providing a robust indicator by considering the potential occurrence of the agreement by chance (16). The percentages of agreement were subsequently assessed using the Landis and Koch scoring system (17). This framework aids in a clear interpretation of the agreement estimated by κ coefficient. For a $\kappa < 0.0$, there is no agreement; $0.0 \leq \kappa \leq 0.20$ indicates low agreement; $0.21 \leq \kappa \leq 0.40$ signifies agreement; $0.41 \leq \kappa \leq 0.60$ suggests good agreement; $0.61 \leq \kappa \leq 0.80$ points to substantial agreement; and finally, $0.81 \leq \kappa \leq 1.0$ denotes excellent agreement. The Cohen's κ coefficient was calculated by each item and also for the mastery of each subject area for the FSKB, section Knowledge, and the overall score. The Kendall's correlation test was used for the ordinal variables to estimate the reproducibility of the FSSM questionnaire and the FSKB, section Behaviour. A Kendall's τ correlation coefficient (τ) of 0.7 was deemed indicative of good agreement. Feasibility was measured using the feasibility questionnaire as previously detailed. Frequencies and percentages were reported. Statistical analysis was performed using R version 4.3.1.

Ethical approval

All data were anonymous, and participation was on a voluntary basis. Collected data were entered into an anonymous password-protected computer database

and examined in an aggregate way. The study was performed following the Declaration of Helsinki and was approved by the Ethics Committee of the University of Milan, Milan, Italy (ID number: 111.23).

Results

Descriptive characteristics of the sample

A total of 103 participants filled the questionnaire in the first round, while 96 (89.32%) participants completed the retest questionnaire. However, no differences emerged comparing responders at first and second round with non-respondents at the second round (Table S1). Descriptive characteristics of responders at first round are reported in Table S1. Table 1 shows the general characteristics of the study population, stratified by sex, participating at the second round. Participants had a median age of 41 years, and 62.5% were women (n = 60), with a partner (n = 58, 60.4%), with three or more family members (n = 81, 84.4%). Moreover, they were highly educated (n = 59, 61.5% completed a tertiary education) and employed (n = 57, 59.4%). No statistically significant differences were detected between men and women apart for type of work. In fact, women were more frequently unemployed (n = 10, 16.7%) compared to men.

Reliability

Supplementary Table 2 shows the Cronbach's α, the item-test correlation, item-rest correlation and average inter-item correlation for the second round. The results show a high level of inter-correlations among items, actually, during the first round, the standardized Cronbach's α were 0.92, 0.71 and 0.76, respectively for FSSM, FSKB (section Knowledge) and FSKB (section Behaviour). In the second phase they were 0.91, 0.73 and 0.75, respectively. Results are shown in Table 2.

Reproducibility

Cohen's kappa coefficient test was calculated for each item of the FFKB questionnaire, section Knowledge. Mean κ was 0.669, standard error (SE = 0.019), and it ranged between 0.133 and 0.844 (Table S3). Percentages of correctness of knowledge for each item, for both rounds are reported in Figure S1. Moreover, the κ was calculated to evaluate the concordance between the subject mastery and the overall mastery score in the first and second round. The κ ranged between 0.556 (Clean Up area) and 0.932 (Food Preparation area), while κ was 0.755 for the overall score (Table S4). Kendall's τ ranged between 0.643 and 1.000 in the FSSM questionnaire, and all the correlations were significant ($p < 0.001$). The mean Kendall's τ was 0.853. Regarding the τ coefficient in the FSKB questionnaire, section Behaviour, it ranged between 0.595 and 1.000 and the correlations were significant ($p < 0.001$). The mean Kendall's τ was 0.709. Results item-by-item are shown in Table S5 a-b.

Feasibility

Most participants (76.0%) found the questions clear, while only one (1.0%) reported that the questions were "not clear at all". Moreover, 61.5% of participants had no difficulty answering. Considering those who declared difficulties, one participant suggested adding "Don't know" option in the Food Safety questionnaire, section Knowledge. Furthermore, 91 participants (94.8%) declared that they did not find questions they would not have answered. Most of the participants (63.6%) did not find the questionnaire time-consuming. The majority (n = 94) completed the survey in less than 20 minutes during both rounds, with 43 (44.8%) of them declared they completed the questionnaire in less than 10 minutes in both. Results are shown in Figure 1.

Discussion

Interpretation of the results

The study comprehensively assessed the validity of the Italian version of two instruments, the FSSM and FSKB questionnaires, intended for use in the general population. The reliability assessment, conducted through Cronbach's α test, demonstrated high internal

Table 1. Descriptive characteristics of the sample (second round), stratified by sex.

Characteristic	Overall n = 96	Women n = 60	Men n = 36	p-value
Age	41.00 (23.00, 55.25)	43.00 (25.00, 57.25)	28.00 (21.75, 53.00)	0.144[1]
Marital Status				0.106[3]
Having a partner	58 (60.4%)	40 (66.7%)	18 (50.0%)	
Single	38 (39.6%)	20 (33.3%)	18 (50.0%)	
Family Size				0.089[2]
One	2 (2.1%)	2 (3.3%)	0 (0.0%)	
Two	13 (13.5%)	11 (18.3%)	2 (5.6%)	
Three or more	81 (84.4%)	47 (78.3%)	34 (94.4%)	
Education				0.074[3]
Middle education	37 (38.5%)	19 (31.7%)	18 (50.0%)	
Tertiary education	59 (61.5%)	41 (68.3%)	18 (50.0%)	
Type of Work				0.004[2]
Student	29 (30.2%)	13 (21.7%)	16 (44.4%)	
Employed	57 (59.4%)	37 (61.7%)	20 (55.6%)	
Unemployed	10 (10.4%)	10 (16.7%)	0 (0.0%)	
Physical activity				0.092[3]
Active	48 (50.0%)	26 (43.3%)	22 (61.1%)	
Not active	48 (50.0%)	34 (56.7%)	14 (38.9%)	
Smoking Status				0.060[3]
Current smoker	22 (22.9%)	10 (16.7%)	12 (33.3%)	
Not smoker	74 (77.1%)	50 (83.3%)	24 (66.7%)	
Use of Food Delivery Apps	37 (38.5%)	22 (36.7%)	15 (41.7%)	0.626[3]
Use of Apps to contrast Food Waste	21 (21.9%)	13 (21.7%)	8 (22.2%)	0.949[3]

[1] Wilcoxon rank sum test, [2] Fisher's Exact Test, [3] Pearson's Chi-squared test

Table 2. Standardized Cronbach's α of each questionnaire, by round.

Questionnaire	First round	Second round
FSSM	0.92	0.91
FSKB (Knowledge)	0.71	0.73
FSKB (Behavior)	0.76	0.75

Abbreviations: FSKB: Food Safety Knowledge and behaviour questionnaire, FSSM: Food security survey module.

consistency, with values ranging between 0.71 and 0.96. In terms of reproducibility, the calculation of Cohen's κ coefficient indicated moderate to substantial agreement. Additionally, the values obtained for Kendall's τ coefficients suggest a strong reliability and reproducibility of the instruments used to assess food security, food safety knowledge, and food safety behavior. The study also investigated the questionnaire's reception among participants. Almost all questions were perceived as clear, free from difficulty in answering, and with a completion time that, in the majority of cases, was less than 10 minutes. In detail, most items in the FSKB questionnaire, section knowledge, exhibited good, substantial or excellent agreement, with the exception of the statement "Sponges will not be contaminated with bacteria since they are used to wash utensils with soap and water" which showed poor agreement with a Cohen's κ of 0.130. However, considering the

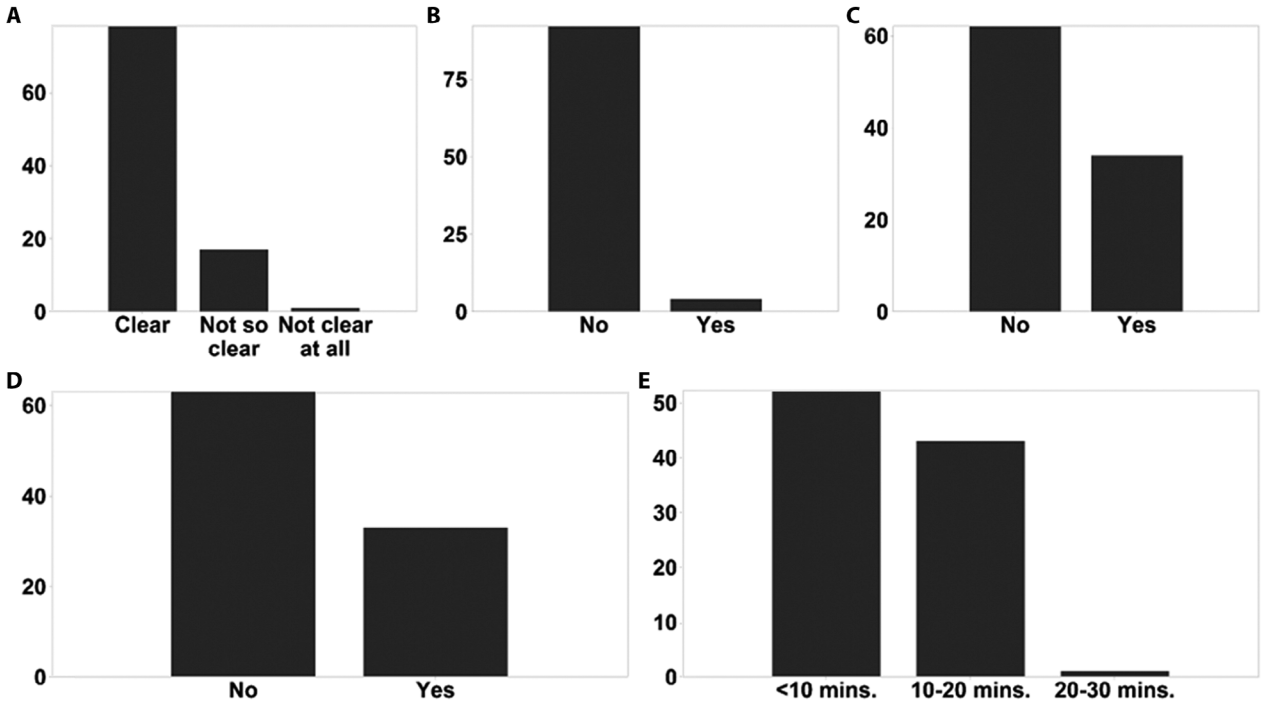

Figure 1. Feasibility analysis. A: Regarding the content, how did you consider the questions? B: Did you have difficulties answering some questions? C: Did you find any questions you would not have answered? D: Did you find the questionnaire particularly time consuming? E: How long did it take you to answer the questionnaire? The y-axis represents the number of respondents. The x-axis represents the options for answers.

answers provided in the feasibility part, most participants declared that they would have liked having a "don't know" option so that they try to guess the correct answer. This could explain the poor agreement of the item. However, the categorization in "Mastered Subject Area" and "Mastered Overall Score" demonstrated good (General Food Safety and Clean Up), substantial (Food Handling, Food Storage and Overall Score) and excellent (Food Preparation) agreement, highlighting the reliability of the area and overall questionnaire. Considering the FSSM and the FSKB, section Behavior, Kendall's τ revealed a strong association between the two phases. Indeed, all τ coefficients were near or higher than 0.7, indicating a "substantial correlation". Previous study calculated comparable Cronbach's α for FSSM (α = 0.931) (18) and FSKB, section Knowledge (α = 0.75) (11), so that our translation achieved the goal of reproducibility. To summarize, although the proposed questionnaires consisted of a relatively high number of items, they proved to be valid, even in their Italian version. The multi-faceted nature of the utilized questionnaires, capable of covering various dimensions related to food safety and security, enhances their utility in capturing a comprehensive understanding of knowledge and behaviors of the Italian population. However, despite the relatively high number of items that collectively set up the survey, it proved to be easy to complete and not overly burdensome. The majority of the sample reported having completed the survey in less than 10 minutes, and almost all stated that they had finished it in less than 20 minutes.

Implication for policies and practices

The validation of Italian versions of questionnaires on food safety and food security carries significant implications for policies and practices in various domains. Indeed, having these validated tools allows for measuring the level of knowledge within the general population concerning the topic of food safety, analyzing incorrect behaviors related to food handling, and consequently being able to implement actions aimed at improving knowledge and inducing necessary behavioral changes for better handling,

preservation, and management of food at the household level. Recent data highlighted that even though 12-20% of documented foodborne outbreaks can be traced back to home settings, it is equally true that domestic outbreaks are less likely to be officially reported to surveillance systems, and therefore are largely underestimated (6). As a consequence, understanding and ensuring food safety, even on a household level, is crucial to prevent foodborne illnesses and safeguard public health. Actually, food safety regulations alone are not sufficient to counteract such illnesses, particularly at the domestic level (19). On the contrary, understanding how they are perceived by the general public, identifying lesser-known aspects, and understanding major challenges in proper food management are essential to effectively ensure the population's health and enhance the country's economic stability (20). Indeed, outbreaks of foodborne illnesses can lead to economic losses due to healthcare costs, loss of productivity, and damage to the reputation of the food industry (21). Moreover, these insights can guide the development of targeted policies aimed at ensuring access to a sufficient and nutritious supply of food (22, 23). Addressing malnutrition, promoting optimal growth and development, and preventing diet-related health issues, including obesity, is fundamental (24). Indeed, even if it seems counterintuitive, food insecurity —characterized by insufficient access to nutritionally rich foods— contributes to increased consumption of low-nutrient, calorie-dense foods, thereby increasing obesity (25). This becomes especially critical in the context of global challenges such as the pandemic of COVID-19, climate change, population growth, conflicts, and general resource scarcity, which significantly impact food production and distribution (26-28). Indeed, population-based data on food security can inform public health initiatives aimed at promoting healthy eating habits and reducing food insecurity. As well as they might contribute to understanding the factors associated with food insecurity that can in turn guide policymakers in allocating resources strategically (29). Lastly, quantifying the entity of food insecurity in Italy might raise awareness about food security issues, with the final aim of advocating for policymakers to prioritize food security initiatives.

Future perspective for research

In considering the future perspectives of our study validating the Italian version of the FSSM and FSKB questionnaires, several exciting avenues for exploration and impact emerge. In light of the obtained results and considering the significant implications of having suitable tools for assessing food safety and food security, we can affirm that the translated and adapted questionnaires in the Italian context demonstrate a good level of validation, enabling their use in future research studies that can be extended to a larger number of participants. Indeed, having validated questionnaires allows to conduct cross-sectional studies aimed at assessing the status of food safety and food security in the Italian population. Simultaneously, conducting longitudinal studies using the validated questionnaire will allow to track changes in perceptions and behaviors related to food safety and security over time evaluating potential effectiveness of interventions or policies aimed at improving knowledge and practices of food safety, in addition to addressing food insecurity. Furthermore, these tools could be employed in studies measuring the effectiveness of educational interventions whose purpose may be to enhance knowledge and empower the general population, making individuals more sensitive and aware of food safety and food security issues. Moreover, having cultural and language-validated tools is important to make more accurate assessments among countries, opening opportunities for global collaborations and cross-cultural comparisons. Additionally, having cultural adaptation of a previous adopted questionnaire is fundamental in order to improve comparability among studies and among countries. Finally, having questionnaires translated into Italian is useful because future studies could explore the validity of these questionnaires in other subpopulations. This includes, for example, professionals in the food industry or healthcare professionals specifically involved in food hygiene and safety. This is particularly relevant to those engaged in communication and outreach activities with the public.

Strengths and limitations

The current study possesses both strengths and limitations. On the positive side, the study benefits

from a rigorous validation process, involving translation, cultural adaptation, and robust statistical analyses. The inclusion of diverse participants from different demographic backgrounds enhances the questionnaire's applicability across a broad spectrum of the Italian population. Additionally, the study contributes to the growing body of knowledge on food safety and security by providing a validated instrument for future research endeavors. Another significant strength of the current work is the adherence to a meticulous translation and validation process, defined by a rigorous methodology, well-established in the literature (30). Cohen's κ was used to assess the agreement between two raters, specifically evaluating the agreement between individual sentences and the mastery of knowledge areas. This assessment considered the possibility of chance guessing between the two rounds, enhancing the questionnaire reproducibility. A good match in knowledge categories, factoring in chance agreement, contributes to questionnaire's overall reproducibility. For assessing the correspondence between the FSSM and FSKB questionnaires, section Behaviour, we used Kendall's τ correlation test. This choice was motivated by the presence of more than two categories, and the test itself is more robust than other correlation tests (31, 32). The high level of correlation observed between the two rounds highlights the reproducibility and consistency of the two questionnaires. Another strength of our study is the use of a feasibility questionnaire is a valuable tool employed during the validation phase. Obtaining feedback on the clarity of the questionnaire ensures that participants can easily comprehend and respond to the items. Moreover, receiving feedback provides insights into potential challenges and allows questionnaire developers to gain ideas about real-world considerations and participant perspectives. Lastly, to the best of our knowledge, this is the first study validating an Italian version of the food safety and food security questionnaires. This is an important element that opens doors for subsequent researchers. However, certain limitations warrant consideration. The generalizability of findings may be constrained by the study's specific sample demographics, and efforts to include a more representative population could enhance external validity. Indeed, participation was voluntary, and therefore a potential selection bias might have occurred. Additionally, cultural nuances in interpreting survey questions may persist despite translation efforts, emphasizing the importance of ongoing cultural validation. Moreover, a social desirability bias may be present. There's a chance that certain respondents were inclined to convey socially acceptable opinion rather than their personal views. Despite these limitations, the study lays a solid foundation for advancing research on food safety and security in the Italian context.

Conclusions

In conclusion, this study represents a significant contribution to the field of food safety and food security research in Italy. The successful translation and validation of the questionnaires demonstrate their reliability and applicability within the Italian cultural context. The rigorous four-phase translation process, adhering to international guidelines, ensures the linguistic adaptation of the instruments. Moreover, the robust statistical analyses performed guaranteed the validity of the questionnaires, that can be used by policymakers, public health practitioners, and researchers to establishment of baseline data, measure food safety and food security over time, and the efficacy of interventions. Lastly, the high internal consistency, as indicated by Cronbach's α coefficient, reinforces the reliability of the questionnaire for future research endeavors. Moreover, the feasibility assessment indicated a favorable response from participants. Having validated Italian tools is a crucial step in advancing our understanding of food safety and security issues in the Italian context, providing a solid foundation for future research and initiatives aimed at enhancing the well-being of the population.

Ethic Approval: Study approved by the Ethics Committee of the University of Milan, Milan, Italy (ID number: 111.23).

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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ANNEX

Table S1. Comparison between responders and non-responders in the first and second round of validation. Fischer test was used for categorical variables, Wilcokson rank sum test was used for continuous variable (age). Statistical significance was established at $p<0.05$.

Characteristic	Overall n = 103	Non-responders n = 7	Responders n = 96	p-value
Sex				1.000
Female	65 (63.1%)	5 (71.4%)	60 (62.5%)	
Male	38 (36.9%)	2 (28.6%)	36 (37.5%)	
Age [mean (range)]	43.0 (23.50, 55.50)	54.00 (38.00, 56.50)	41.00 (23.00, 55.25)	0.271
Marital Status				1.000
Having a partner	62 (60.2%)	4 (57.1%)	58 (60.4%)	
Single	41 (39.8%)	3 (42.9%)	38 (39.6%)	
Family Size				0.236
One	3 (2.9%)	1 (14.3%)	2 (2.1%)	
Two	14 (13.6%)	1 (14.3%)	13 (13.5%)	
Three or more	86 (83.5%)	5 (71.4%)	81 (84.4%)	
Education				0.707
Secondary education	39 (37.9%)	2 (28.6%)	37 (38.5%)	
Tertiary education	64 (62.1%)	5 (71.4%)	59 (61.5%)	
Type of Work				0.610
Student	30 (29.1%)	1 (14.3%)	29 (30.2%)	
Employed	62 (60.2%)	5 (71.4%)	57 (59.4%)	
Unemployed	11 (10.7%)	1 (14.3%)	10 (10.4%)	
Physical activity				0.438
Active	50 (48.5%)	2 (28.6%)	48 (50.0%)	
Not active	53 (51.5%)	5 (71.4%)	48 (50.0%)	
Smoking Status				1.000
Current smoker	23 (22.3%)	1 (14.3%)	22 (22.9%)	
Not smoker	80 (77.7%)	6 (85.7%)	74 (77.1%)	
Use of Food Delivery Apps	41 (39.8%)	4 (57.1%)	37 (38.5%)	0.432
Use of Apps to contrast Food Waste	22 (21.4%)	1 (14.3%)	21 (21.9%)	1.000

Table S2. Cronbach's α, item-total correlation and item-rest correlation

Questionnaire	Question	Item-total correlations	Item-rest correlation	Alpha
Food Safety Knowledge	All harmful bacteria are destroyed by thorough and complete cooking.	0.185	0.126	0.735
	Moldy hard cheddar cheese is safe to eat if you scratch the mold off the surface of the cheese.	0.274	0.194	0.733
	Organically grown produce is less likely to cause foodborne illness than conventionally grown produce.	0.227	0.140	0.736
	Pesticide residues are the most serious food safety problem.	0.237	0.146	0.736
	Young children are more vulnerable to foodborne illnesses than teenagers or adolescents.	0.125	0.043	0.740
	Unsafe foods can be identified by the way they look and smell.	0.173	0.085	0.739
	Food allergies are a serious food safety problem.	0.102	0.020	0.741
	Food home illness outbreaks are associated with eating all types of food.	0.190	0.104	0.738
	Bacteria and viruses found in food can make you sick.	0.198	0.147	0.735
	Disease-causing bacteria can be found on food.	0.181	0.137	0.735
	It can take only a small number of harmful bacteria to make a person sick.	0.157	0.072	0.739
	One of the most common causes of foodborne illness is failure to properly cool food.	0.285	0.196	0.733
	Deli meats or cold cuts sliced at the deli counter are safe to eat for seven days after purchase.	0.161	0.073	0.739
	It is safe to leave hot, thoroughly cooked food on the counter to completely cool to room temperature before putting it in the refrigerator.	0.449	0.375	0.724
	Meat that has been handled and/or prepared properly can be kept in the freezer for 6 months and still be safe to eat.	0.145	0.061	0.739
	The temperature of a home refrigerator should be at 40o F or below.	0.205	0.138	0.735
	Disease-causing bacteria can survive and/or grow at refrigerator temperatures.	0.304	0.229	0.731
	It is safe to leave meat on the counter to thaw.	0.531	0.460	0.718
	If a green bean casserole is left on the kitchen counter overnight, it is safe to eat if it is properly reheated.	0.547	0.476	0.717
	To be safe to eat, the temperature of stuffing cooked inside a turkey should be at least 145° F.	0.300	0.211	0.732
	Chicken breasts should be cooked until the temperature in the middle is 180° F. (Note recent change to 165° F)	0.500	0.426	0.720
	Cooked rice held at room temperature for more than 4 hours is safe to eat.	0.484	0.409	0.721
	I can always tell that my hamburger is completely cooked by its color.	0.350	0.264	0.729

Table S2 (*Continued*)

Questionnaire	Question	Item-total correlations	Item-rest correlation	Alpha
	It is safe to use unpasteurized eggs in recipes that will not be cooked.	0.213	0.143	0.735
	Cooked meat held at room temperature for more than 2 hours is safe to eat.	0.414	0.332	0.726
	Using a food thermometer is the best way of knowing that food is thoroughly cooked.	0.496	0.427	0.721
	It is safe to eat raw cookie dough or cake batter that contains raw eggs.	0.257	0.193	0.733
	After cutting up raw meat or chicken, you should wipe off cutting board with wet dishcloth or sponge before using the board to cut produce.	0.168	0.094	0.737
	It is safe to store fresh produce below raw meat and poultry in the fridge.	0.456	0.377	0.723
	It is important to wash hands after "cracking" an egg.	0.339	0.270	0.729
	When grocery shopping, raw meat, fish and/or poultry should be packed separately from ready-to-eat foods from the deli or produce area.	0.312	0.244	0.731
	In the kitchen, food can become contaminated with harmful bacteria during handling and storage.	0.374	0.323	0.729
	The sauce that was used to marinate raw chicken can be refrigerated and used again safely.	0.301	0.241	0.731
	Since a food thermometer has a metal stem, it does not need to be sanitized after using it.	0.265	0.206	0.732
	It is safe to place cooked meat on the same unwashed plate you used for the uncooked meat.	0.354	0.304	0.730
	Countertops may be sanitized by washing with soap and water.	0.259	0.173	0.734
	Hand sanitizers are the best way to wash your hands.	0.291	0.202	0.733
	You should wash the outside of a cantaloupe before cutting it.	0.311	0.224	0.731
	You should wash your hands with warm, soapy water for at least 15 seconds before starting to prepare food.	0.169	0.106	0.736
	It is safe to eat a snack while you are preparing food.	0.287	0.198	0.733
	If you use a dishcloth to wipe up liquid from raw meat or chicken, it is safe to use the cloth for washing dishes if you rinse the cloth in hot water.	0.260	0.188	0.733
	Sponges will not be contaminated with bacteria since they are used to wash utensils with soap and water.	0.133	0.088	0.736
	It is safe to use the same spoon to taste and then stir the food without washing the spoon.	0.254	0.194	0.733
	It is safe to use a cloth towel to clean up spills on kitchen surfaces and then use it to dry off washed fresh fruits or vegetables.	0.140	0.122	0.736
	After handling raw meat, fish and/or poultry, wiping hands on a paper towel is sufficient to clean hands.	0.075	0.048	0.737

Questionnaire	Question	Item-total correlations	Item-rest correlation	Alpha
Food Safety Behaviour	I cook with other people	0.426	0.338	0.761
	I borrow food from other people	0.305	0.233	0.767
	I get food from workplace	0.360	0.281	0.764
	I acquire discarded food	0.198	0.133	0.771
	I acquire food from private individuals	0.484	0.401	0.757
	I seek roadkill	0.080	0.064	0.772
	I hunt or fish	0.202	0.149	0.770
	I purchase food from private individuals	0.133	0.078	0.772
	I purchase expired foods	0.329	0.244	0.766
	I purchase nearly expired foods	0.340	0.263	0.765
	I purchase foods in dented or damaged packages	0.399	0.326	0.762
	I remove slime from lunch meat	0.617	0.508	0.747
	I remove mold from cheese	0.707	0.617	0.736
	I remove mold from grains	0.721	0.605	0.736
	I remove insects from grains	0.686	0.561	0.741
	I remove spoiled parts of fruits/vegetables	0.631	0.532	0.745
	I store perishables inadequately	0.392	0.255	0.769
	I eat spoiled food	0.269	0.195	0.768
	I eat expired food	0.365	0.276	0.765
	I eat non-food items	0.274	0.198	0.768
	I eat other people's leftovers	0.235	0.140	0.772
	I eat roadkill	0.137	0.122	0.771
	I eat pet food	0.137	0.122	0.771
Food Security	Which of these statements best describes the food eaten in your household in the last 12 months	0.762	0.633	0.877
	(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more	0.919	0.875	0.841
	The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more	0.700	0.579	0.877
	(I/we) couldn't afford to eat balanced meals	0.892	0.826	0.848
	In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food	0.732	0.668	0.870
	In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food	0.732	0.668	0.870
	In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food	0.711	0.657	0.874
	In the last 12 months, did you lose weight because there wasn't enough money for food	0.747	0.714	0.878

Table S3. Test-retest reliability of the Food Safety questionnaire, section Knowledge: Cohen's kappa coefficient test (κ), percentage of agreement and Landis and Koch score, item-by-item

Question	Kappa (90% CI)	Concordance (%)	Landis and Koch score
It can take only a small number of harmful bacteria to make a person sick.	0.806 (0.798 - 0.815)	88 (91.67%)	Substantial
Unsafe foods can be identified by the way they look and smell.	0.727 (0.718 - 0.736)	84 (87.50%)	Substantial
Young children are more vulnerable to foodborne illnesses than teenagers or adolescents.	0.700 (0.690 - 0.710)	84 (87.50%)	Substantial
Bacteria and viruses found in food can make you sick.	0.806 (0.793 - 0.820)	93 (96.88%)	Substantial
Food home illness outbreaks are associated with eating all types of food.	0.714 (0.705 - 0.724)	84 (87.50%)	Substantial
Organically grown produce is less likely to cause foodborne illness than conventionally grown produce.	0.772 (0.764 - 0.781)	86 (89.58%)	Substantial
Pesticide residues are the most serious food safety problem.	0.792 (0.784 - 0.799)	86 (89.58%)	Substantial
Moldy hard cheddar cheese is safe to eat if you scratch the mold off the surface of the cheese.	0.699 (0.688 - 0.710)	85 (88.54%)	Substantial
All harmful bacteria are destroyed by thorough and complete cooking.	0.619 (0.604 - 0.635)	88 (91.67%)	Substantial
Food allergies are a serious food safety problem.	0.838 (0.830 - 0.846)	90 (93.75%)	Excellent
Disease-causing bacteria can be found on food.	0.652 (0.629 - 0.675)	93 (96.88%)	Substantial
Disease-causing bacteria can survive and/or grow at refrigerator temperatures.	0.646 (0.634 - 0.658)	84 (87.50%)	Substantial
It is safe to leave meat on the counter to thaw.	0.628 (0.618 - 0.638)	79 (82.29%)	Substantial
Meat that has been handled and/or prepared properly can be kept in the freezer for 6 months and still be safe to eat.	0.597 (0.585 - 0.608)	80 (83.33%)	Good
The temperature of a home refrigerator should be at 40o F or below.	0.472 (0.456 - 0.488)	83 (86.46%)	Good
If a green bean casserole is left on the kitchen counter overnight, it is safe to eat if it is properly reheated.	0.687 (0.678 - 0.696)	81 (84.38%)	Substantial
One of the most common causes of foodborne illness is failure to properly cool food.	0.619 (0.609 - 0.629)	78 (81.25%)	Substantial
Deli meats or cold cuts sliced at the deli counter are safe to eat for seven days after purchase.	0.538 (0.526 - 0.550)	77 (80.21%)	Good
It is safe to leave hot, thoroughly cooked food on the counter to completely cool to room temperature before putting it in the refrigerator.	0.721 (0.711 - 0.730)	85 (88.54%)	Substantial
I can always tell that my hamburger is completely cooked by its color.	0.708 (0.699 - 0.717)	82 (85.42%)	Substantial
Chicken breasts should be cooked until the temperature in the middle is 180° F. (Note recent change to 165° F)	0.659 (0.650 - 0.669)	81 (84.38%)	Substantial
Cooked rice held at room temperature for more than 4 hours is safe to eat.	0.844 (0.837 - 0.851)	89 (92.71%)	Excellent
Using a food thermometer is the best way of knowing that food is thoroughly cooked.	0.726 (0.716 - 0.735)	85 (88.54%)	Substantial
Cooked meat held at room temperature for more than 2 hours is safe to eat.	0.750 (0.742 - 0.758)	84 (87.50%)	Substantial

Question	Kappa (90% CI)	Concordance (%)	Landis and Koch score
To be safe to eat, the temperature of stuffing cooked inside a turkey should be at least 145° F.	0.667 (0.657 - 0.676)	80 (83.33%)	Substantial
It is safe to eat raw cookie dough or cake batter that contains raw eggs.	0.495 (0.479 - 0.512)	85 (88.54%)	Good
It is safe to use unpasteurized eggs in recipes that will not be cooked.	0.717 (0.705 - 0.730)	89 (92.71%)	Substantial
After cutting up raw meat or chicken, you should wipe off cutting board with wet dishcloth or sponge before using the board to cut produce.	0.839 (0.830 - 0.848)	91 (94.79%)	Excellent
In the kitchen, food can become contaminated with harmful bacteria during handling and storage.	0.678 (0.661 - 0.695)	91 (94.79%)	Substantial
It is safe to place cooked meat on the same unwashed plate you used for the uncooked meat.	0.840 (0.829 - 0.851)	93 (96.88%)	Excellent
The sauce that was used to marinate raw chicken can be refrigerated and used again safely.	0.685 (0.672 - 0.698)	88 (91.67%)	Substantial
Since a food thermometer has a metal stem, it does not need to be sanitized after using it.	0.515 (0.497 - 0.534)	88 (91.67%)	Good
When grocery shopping, raw meat, fish and/or poultry should be packed separately from ready-to-eat foods from the deli or produce area.	0.744 (0.733 - 0.756)	89 (92.71%)	Substantial
It is important to wash hands after “cracking” an egg.	0.659 (0.648 - 0.671)	85 (88.54%)	Substantial
It is safe to store fresh produce below raw meat and poultry in the fridge.	0.688 (0.678 - 0.697)	81 (84.38%)	Substantial
After handling raw meat, fish and/or poultry, wiping hands on a paper towel is sufficient to clean hands.	0.795 (0.770 - 0.820)	95 (98.96%)	Substantial
Countertops may be sanitized by washing with soap and water.	0.615 (0.605 - 0.626)	79 (82.29%)	Substantial
You should wash the outside of a cantaloupe before cutting it.	0.662 (0.652 - 0.672)	80 (83.33%)	Substantial
Sponges will not be contaminated with bacteria since they are used to wash utensils with soap and water.	0.133 (0.112 - 0.153)	87 (90.62%)	Low
Hand sanitizers are the best way to wash your hands.	0.615 (0.605 - 0.625)	78 (81.25%)	Substantial
You should wash your hands with warm, soapy water for at least 15 seconds before starting to prepare food.	0.448 (0.430 - 0.466)	86 (89.58%)	Good
If you use a dishcloth to wipe up liquid from raw meat or chicken, it is safe to use the cloth for washing dishes if you rinse the cloth in hot water.	0.572 (0.559 - 0.586)	84 (87.50%)	Good
It is safe to eat a snack while you are preparing food.	0.685 (0.675 - 0.694)	81 (84.38%)	Substantial
It is safe to use the same spoon to taste and then stir the food without washing the spoon.	0.678 (0.664 - 0.692)	89 (92.71%)	Substantial
It is safe to use a cloth towel to clean up spills on kitchen surfaces and then use it to dry off washed fresh fruits or vegetables.	0.662 (0.622 - 0.702)	95 (98.96%)	Substantial

Table S4. Test-retest reliability of the Food Safety questionnaire, section Knowledge: Cohen's kappa coefficient test (κ), percentage of agreement and Landis and Koch score, for the five areas

Subject Mastery Area	**Kappa (90% CI)**	**Concordance (n, %)**	**Landis and Koch score**
Clean Up	0.578 (0.566 - 0.590)	70 (83.33%)	Good
Food Handling	0.669 (0.659 - 0.678)	81 (84.38%)	Substantial
Food Preparation	0.932 (0.926 - 0.938)	94 (97.92%)	Excellent
Food Storage	0.679 (0.665 - 0.693)	89 (92.71%)	Substantial
General Food Safety	0.556 (0.540 - 0.573)	87 (90.62%)	Good
Overall Mastery Score	0.755 (0.740 - 0.770)	92 (95.83%)	Substantial

Table S5. Test-retest reliability of the a) Food Security questionnaire, and b) Food Safety questionnaire, section Behaviour: Kendall's τ and p-values

a)

Question	**Tau**	**p-value**
Which of these statements best describes the food eaten in your household in the last 12 months	0.643	< 0.001
(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more	0.826	< 0.001
The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more	0.754	< 0.001
(I/we) couldn't afford to eat balanced meals	0.783	< 0.001
In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food	1.000	< 0.001
How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months	1.000	< 0.001
In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food	1.000	< 0.001
In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food	1.000	< 0.001
In the last 12 months, did you lose weight because there wasn't enough money for food	1.000	< 0.001
In the last 12 months, did (you/you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food*	n. a.	n. a.
If yes, how often did this happen—almost every month, some months but not every month, or in only 1 or 2 months**	n. a.	n. a.

*no variability in terms of participants' response; ** All participants answered negatively to the previous screening question; therefore, none of the subjects were redirected to this question.

b)

Question	**Tau**	**p-value**
I acquire food from private individuals	0.723	< 0.001
I purchase foods in dented or damaged packages	0.688	< 0.001
I purchase nearly expired foods	0.639	< 0.001
I purchase food from private individuals	0.655	< 0.001
I purchase expired foods	0.695	< 0.001
I acquire discarded food	0.752	< 0.001
I hunt or fish	0.794	< 0.001
I seek roadkill	0.703	< 0.001

Question	Tau	p-value
I store perishables inadequately	0.607	< 0.001
I cook with other people	0.767	< 0.001
I eat spoiled food	0.631	< 0.001
I eat pet food	1.000	< 0.001
I eat expired food	0.657	< 0.001
I eat other people's leftovers	0.669	< 0.001
I eat roadkill	0.622	< 0.001
I eat non-food items	0.660	< 0.001
I get food from workplace	0.758	< 0.001
I borrow food from other people	0.741	< 0.001
I remove insects from grains	0.738	< 0.001
I remove mold from grains	0.772	< 0.001
I remove mold from cheese	0.687	< 0.001
I remove slime from lunch meat	0.750	< 0.001
I remove spoiled parts of fruits/vegetables	0.595	< 0.001

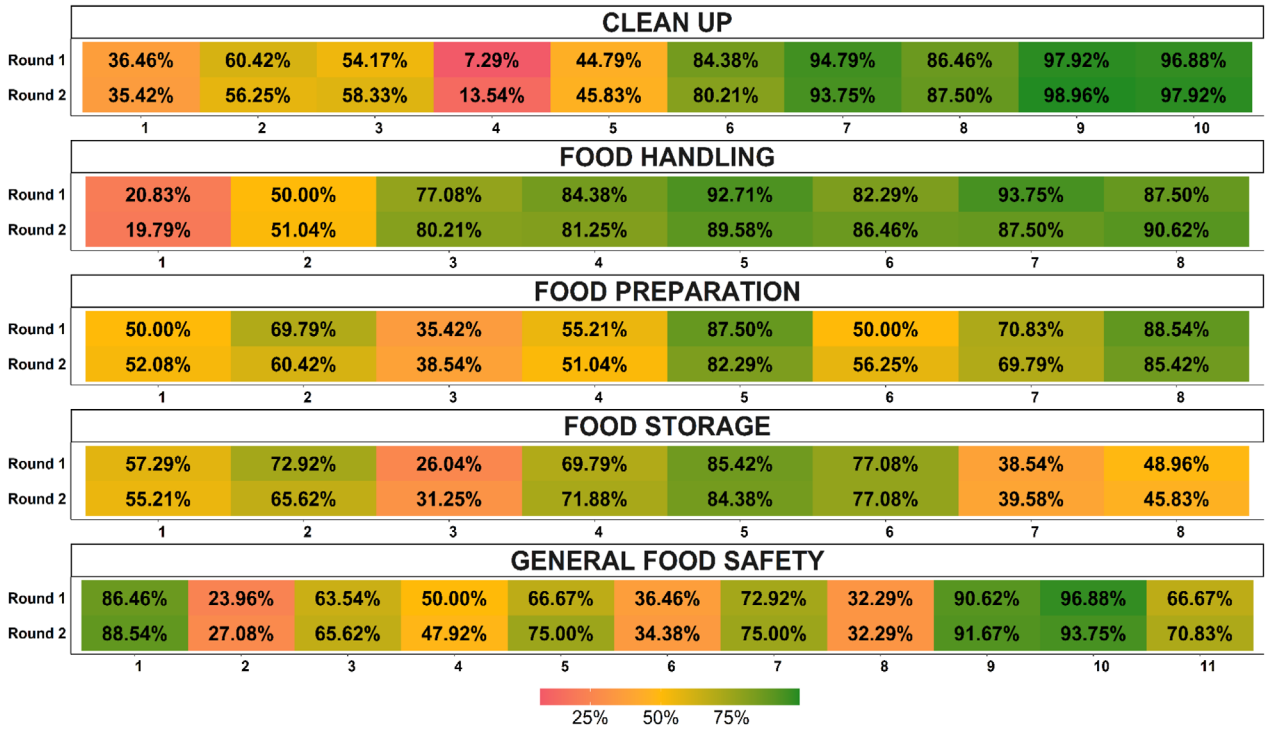

Figure S1. Percentages of correctness for each item, for both rounds, regarding the Food Safety questionnaire, section knowledge