FOOD SAFETY KNOWLEDGE AND PRACTICES OF PRESCHOOL EMPLOYEES WITH FOOD CONTACT IN PODGORICA, MONTENEGRO

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SUMMARY

Objectives: This is the first study in Montenegro to assess food safety knowledge, hygiene practices, and perceived barriers among childcare centre employees (N = 972) with both direct and indirect contact with food. It aimed to identify high-risk practices through structured observation and evaluate the need for targeted educational interventions in preschool institutions in Podgorica. Two hypotheses were tested: H1: there is a difference in knowledge and practices between employees with direct and indirect food contact. H2: socio-demographic characteristics influence the knowledge and practices of employees involved in food handling.

Methods: Data were collected using a structured questionnaire and an observation checklist covering food safety knowledge, self-reported and observed practices, and perceived barriers.

Results: Food safety knowledge scores were high (mean = 84.15 ± 6.22), while observed hygiene practices were substantially lower (53.09 ± 1.71%) compared to self-reported ones (78.52 ± 1.08%), revealing a marked discrepancy between knowledge and actual practices. Statistically significant differences were found between employees based on their role (direct vs. indirect contact with food), education level, prior work experience, training frequency, and presence of the Hazard Analysis and Critical Control Points (HACCP) systems ($p < 0.05$ to $p < 0.001$). Although a weak but statistically significant correlation between knowledge and practice was identified ($r = 0.16$, $p < 0.001$), it suggests that knowledge alone does not reliably predict hygiene practices. Reported barriers included time constraints, inadequate equipment, and limited workspace.

Conclusions: The findings emphasize the need for practical, job-specific training programmes and improved working conditions to effectively translate knowledge into safe hygiene practices. This evidence supports the development of context-specific policies and interventions aimed at enhancing food safety and safeguarding children's health in preschool settings. Both study hypotheses were confirmed.

Key words: food safety, preschool, knowledge and practice, childcare, food handler

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INTRODUCTION

Unsafe human practices are a frequent contributing factor to foodborne illnesses. The location where food is consumed is not always the same as where contamination occurs or where pathogens survive processing and proliferate to infectious levels (1). In childcare facilities, foodborne infections can have serious health and economic consequences, particularly for children, who are more vulnerable due to their immature immune systems and a lack of control over food intake (2, 3). Globally, children under five years of age bear approximately 40% of the foodborne disease burden, underscoring the need for strict food safety practices in these environments (4). According to EC Regulation No. 852/2004, all food business operators must comply with hygiene requirements throughout the food production and handling process (5).

In Montenegro, preschool enrolment has steadily increased over the past three decades, with a significant concentration in the capital, Podgorica (6). According to available data, around 70% of children in Podgorica attend preschool institutions, where more than 20,000 meals are prepared daily. Preschool kitchens are organized as central, mixed, or tea kitchens, depending on operational complexity, and kitchen staff are rotated annually across all three types to ensure even workload distribution and exposure to different working conditions.

Although food preparation is typically assigned to kitchen staff, food safety is a shared responsibility among all individuals who come into contact with food within the service chain, including those who serve, distribute or assist children during meals (7). Preschool teachers, who represent the final link in the food handling chain, are often not required to undergo "minimum hygiene" training or structured education aligned with the Hazard Analysis and Critical Control Points (HACCP) principles. This raises the question of why individuals who serve food directly to children, assist with feeding, and interact with food during daily routines are excluded from mandatory food safety training. While they are not directly involved in food preparation, their hygiene practices can significantly influence food safety and contribute to the development of healthy dietary habits among children.

Preschool institutions include nurseries (1–3 years) and kindergartens (3 years to school age), typically organized into age-based groups. In these settings, additional hygiene challenges arise, such as diaper changing, which increases the risk of pathogen transmission (2). Yet, practical supervision remains limited due to restricted inspection capacities and high child-to-staff ratios. Despite the absence of major foodborne outbreaks in recent years, smaller clusters of gastroenteritis linked to institutional kitchens indicate persistent risks. Furthermore, the lack of a centralized and standardized training system for all preschool staff involved in food handling, along with inconsistent HACCP implementation, points to critical oversight gaps.

These findings point to the necessity of implementing training programmes that are adapted to the specific responsibilities and working environment of preschool staff, ensuring consistent adherence to hygiene standards. Locally gathered data provide a critical foundation for effective, needs-oriented interventions.

This study aims to evaluate food safety knowledge and hygiene practices among staff in preschool institutions, identify risk-prone areas and employee categories, and determine the necessity for role-specific training interventions aligned with actual workplace conditions.

Scientific Hypothesis

H1: there is a significant difference in food safety knowledge and hygiene practices between employees coming into direct and indirect food contact in preschool institutions in Podgorica.

H2: socio-demographic characteristics significantly influence the food safety knowledge and hygiene practices of employees in preschool institutions in Podgorica.

MATERIALS AND METHODS

Samples

Our research encompassed all 972 employees coming into direct or indirect contact with food across 19 preschool institutions, in 48 educational units in various locations throughout Podgorica.

Instruments

Data collection was conducted using a structured closed questionnaire and an observation checklist. The questionnaire consisted of 41 questions, covering areas related to the knowledge and safe hygiene practices for both employees who have direct contact with food (cooks and kitchen assistants) and those with indirect contact (medical and triage nurses, teachers, food drivers, kitchen hygienists, and others) in preschool institutions. The observation checklist contains the same questions used to assess self-reported food-handling practices.

Questionnaire Design and Observation Checklist

Based on a literature review of previously published papers (8–15), the questionnaire was designed and modified to align with the current legal acts on health and food safety in Montenegro. The questionnaire consisted of three parts: socio-demographic characteristics of the respondents (9 questions), knowledge about food safety (18 questions), and self-reported practice (20 statements).

Questions related to basic knowledge of personal hygiene, time and temperature control, cross-contamination, food storage, and equipment hygiene. Each question had three possible answers: "yes", "no", and "I don't know", to reduce the likelihood of correct guesses. Scores were assigned as follows: "yes" (1), "no" (0), and "I don't know" (0). For self-reported practices, respondents rated their food handling practices on a scale of 1–5 (1 – never, 2 – rarely, 3 – sometimes, 4 – often, 5 – always). Correct practices (often or always) scored 1, while incorrect practices (never, rarely or sometimes) scored 0.

The observation checklist for assessing safe hygiene practices consisted of 14 observed practices. Results from observation and self-report practice were analysed separately to identify potential differences between reported and observed practices. Answers to some questions included negative statements. Since higher scale scores indicate correct responses and positive statements, negative responses and statements were transformed into positive ones to calculate the total scale score. Results were converted into percentages and categorized based on the "bloom cut-off point": 80%–100% (good/positive), 50%–80% (moderate/satisfactory), and 0%–50% (poor/negative) (15).

Data Collection

The researcher and three trained assistants conducted visual observations and interviews for some food handling practices during observation of the work process, before, during, and after meal preparation. Data collection was anonymous, with each participant completing the questionnaire only once. The survey ran from 8 May 2023 to 28 June 2023, on weekdays, in preschool institutions throughout Podgorica. The only exclusion criterion was absenteeism due to illness or other work-related reasons, which was minimal. This approach ensured a comprehensive representation of participants, enhancing the validity and applicability of the collected information.

We evaluated the answered questions, and the answers are presented in the discussion section of this article. The total number of processed answers was 51,419, more than 96% of the maximum possible 53,460 (100%) responses. The questionnaire was tested with a pilot study on 15 participants hired in a preschool institution outside Podgorica. The pilot study showed that the questions were clear and acceptable. Participants of the pilot study were not included in the survey. Using Cronbach's alpha coefficient, it was calculated that the reliability of the questionnaire was 0.75.

Statistical Analysis

Statistical analysis was conducted using SPSS version 22.0 (IBM Corp., 2013). Descriptive statistics was used to summarize the data. Depending on data distribution, either parametric or non-parametric tests were applied. Pearson's correlation coefficient was used to assess associations between continuous variables. The Mann-Whitney U test and Kruskal-Wallis test were applied for group comparisons. The chi-square test was used to analyse categorical variables. McNemar's χ^2 test was applied to compare paired proportions between self-reported and observed hygiene

practices. A p-value < 0.05 was considered statistically significant, and p < 0.001 was considered highly significant.

RESULTS

Participant Characteristics

The socio-demographic characteristics of the respondents (N = 972) are presented in Table 1. The majority were women (98.3%), mostly falling within the 35–44 age group (32.2%). The average age was 39.95 ± 10.96 years, and the average work experience was 13.54 ± 10.04 years. Most participants (44.8%) had completed secondary education, while only 0.4% had completed primary school. A total of 17.4% had more than five years of work experience. Regarding food safety training, 14.3% had attended more than one training session in the past five years, 11.4% had attended once, and 74.3% had never participated in such training. Additionally, 61.8% of respondents were aware that HACCP was implemented in their institutions, but only 5.5% held a "minimum hygiene" certificate.

Table 1. *Socio-demographic profile of employees with food contact in preschool institutions in Podgorica (N = 972)*

Demographic variables	Category	n	%
Gender	Male	17	1.7
	Female	955	98.3
Institutions	Public	866	89.1
	Private	106	10.9
Age (years)	< 25	72	7.4
	25–34	235	24.2
	35–44	313	32.2
	45–55	234	24.1
	> 55	118	12.1
	Mean (SD)	39.95 (10.96)	
Professional categorization	Cook	87	9.0
	Kitchen assistant	26	2.7
	Teacher	479	49.3
	Food driver	9	0.9
	Medical and triage nurse	310	31.9
	Kitchen hygienist	10	1.0
	Other	51	5.2
Education level	Primary school	4	0.4
	Secondary school	435	44.8
	Higher vocational school	173	17.8
	University	345	35.5
	Other	15	1.5
Work experience (years)	< 1	53	5.5
	1–5	169	17.4
	5–10	199	20.5
	10–15	189	19.4
	15–20	137	14.1
	> 20	225	23.1
	Mean (SD)	13.54 (10.04)	
Participation in food safety training in the last 5 years	One time	111	11.4
	Multiple time	139	14.3
	Never	721	74.3
Has the Hazard Analysis and Critical Control Points been implemented in your establishment?	Yes	598	61.8
	No	53	5.5
	Do not know	316	32.7
Did you attend and pass the hygiene minimum course and receive a certificate?	Yes	59	6.1
	No	908	93.9

Table 2. *Scores of knowledge, self-reported and observed practices among employees with direct and indirect contact with food from preschool institutions in Podgorica (N = 972)*

Domain	Total Mean (SD)	Direct contact Mean (SD) n = 113	Indirect contact Mean (SD) n = 859
Knowledge	84.15 (6.22)	89.54 (3.44)	83.43 (11.7)
Self-reported practices	78.52 (1.08)	93.76 (6.32)	77.96 (1.34)
Observed practices	53.09 (1.71)	67.93 (25.16)	53.67 (1.71)

Knowledge of Food Safety and Hygiene

Table 2 presents the overall mean scores for food safety knowledge and self-reported practices among all respondents (N = 972) in preschools in Podgorica, as well as subgroup results based on whether participants had direct (n = 113) or indirect (n = 859) contact with food.

All participants demonstrated a relatively high level of knowledge, with a total mean score of 84.15 ± 6.22. However,

Table 3. *Frequency of correct answers among employees with direct and indirect contact with food in preschool institutions in Podgorica (N = 972)*

Knowledge Answer: yes/no		Total n (%)	Direct contact n = 113 n (%)	Indirect contact n = 859 n (%)	p-value
1	Food poisoning is caused by a pathogenic microorganism, such as bacteria, viruses, or parasites. Yes	849 (92.0)	104 (92.0)	790 (92.0)	0.980
2	Healthy people who take risks with food can carry disease-causing agents, such as bacteria, viruses, or parasites, transmitted through food. Yes	794 (81.7)	91 (80.5)	703 (81.8)	0.735
3	Insects such as cockroaches and flies can transmit foodborne diseases caused by bacteria, viruses, or parasites. Yes	898 (92.4)	108 (95.6)	790 (92.0)	0.174
4	Food poisoning can cause serious illnesses that end in hospitalization and sometimes death. Yes	887 (91.3)	106 (93.8)	781 (90.9)	0.307
5	Those who handle food with unhygienic practices can be a source of food contamination with food poisoning agents. Yes	931 (95.8)	109 (96.5)	822 (95.7)	0.703
6	Eating raw and undercooked meat is risky for food poisoning. Yes	921 (94.8)	108 (95.6)	812 (94.5)	0.642
7	Eating raw and insufficiently washed vegetables and fruits is risky for food poisoning. Yes	906 (93.2)	112 (99.1)	794 (92.4)	0.008*
8	Eating covered remains of cooked food at room temperature for more than 6 hours has a high risk of causing food poisoning. Yes	866 (89.1)	108 (95.6)	758 (88.2)	0.019*
9	Pathogens (bacteria, viruses, parasites) transmitted through food can be seen with the naked eye. No	789 (80.5)	95 (84.1)	687 (80.0)	0.302
10	The rest of the cooked food should be thoroughly heated before consumption. Yes	611 (62.9)	90 (80.4)	521 (60.7)	< 0.001**
11	Harmful bacteria reproduce quickly at room temperature. Yes	841 (86.5)	107 (94.4)	734 (85.4)	0.007*
12	Keeping food at refrigerator temperature helps prevent food poisoning. Yes	852 (87.7)	104 (92.0)	748 (87.1)	0.132
13	Touching ready-to-eat food with bare hands can cause food contamination by food poisoning agents. Yes	804 (82.8)	98 (86.7)	706 (82.3)	0.230
14	Are food handlers suffering from food-borne diseases (*Salmonella*, *Campylobacter* spp., *Staphylococcus aureus*, hepatitis A) allowed to continue working without notifying their supervisor? No	828 (85.2)	104 (92.0)	724 (84.3)	0.029*
15	After washing, should your hands be cleaned with a multipurpose cloth or towel? No	541 (55.7)	77 (68.1)	456 (54.0)	0.002*
16	Symptoms of food poisoning can include frequent loose stools, vomiting, cramps, and abdominal pain. Yes	954 (98.1)	112 (99.1)	842 (98.0)	0.426
17	Do you wear gloves when handing out food not packaged in the manufacturer's packaging? Yes	668 (68.7)	103 (91.2)	565 (65.8)	< 0.001**
18	Do you wear work clothes or a uniform when handling and distributing unpackaged food products? Yes	742 (76.4)	83 (73.5)	659 (76.7)	0.440

Chi-square test; *p < 0.05; **p< 0.001

respondents with direct contact with food (cooks and kitchen assistants) showed significantly higher scores in both knowledge (89.54 ± 3.44) and self-reported practices (93.76 ± 6.32) compared to those with indirect contact with food, such as preschool teachers, nurses, hygiene workers, and drivers, whose mean knowledge score was 83.43 ± 11.7 and self-reported practice score was 77.96 ± 1.34 (Table 2).

Further analysis using the chi-square test revealed statistically significant differences ($p < 0.05$ to $p < 0.001$) in the responses to seven of the 18 general knowledge questions (items 7, 8, 10, 11, 14, 15, and 17), favouring those with direct food contact (Table 3). These findings underscore the importance of identifying role-specific knowledge gaps and adapting food safety training to the responsibilities and workplace conditions of each staff group.

Self-reported and Observed Hygienic Practices

Overall, participants reported satisfactory hygiene practices (mean = 78.52 ± 1.08). However, as shown in Table 2, those with direct food contact reported significantly higher practice scores (93.76 ± 6.32) compared to those with indirect contact (77.96 ± 1.34).

Table 4 compares self-reported and observed hygiene practices among employees with direct and indirect contact with food. Using McNemar's χ^2 test, highly significant discrepancies ($p < 0.001$) were observed for most items (questions 1–4, 6–10), while question 13 showed a significant difference ($p = 0.031$). Items 5, 11, 12, and 14 did not differ significantly. The mean observed hygiene score was 67.93 ± 25.16 for the direct-contact group and 53.67 ± 1.71 for the indirect-contact group, with some individuals in the direct-contact group scoring below 50%. These results highlight notable gaps between employees' self-reported and actual hygiene practices, which could influence the accuracy of risk assessments.

Impact of Socio-demographic Characteristics on Knowledge and Self-reported Practices

Socio-demographic factors had a statistically significant impact on both food safety knowledge and hygiene practices among respondents. Pearson correlation showed a significant positive association between knowledge and both age ($p = 0.001$) and work experience ($p < 0.001$). Mann-Whitney and Kruskal-Wallis tests indicated that participants from private childcare institutions, those who had received training, those certified in minimum hygiene standards, and those working in facilities with HACCP systems demonstrated significantly higher knowledge and better practices ($p < 0.05$ to $p < 0.001$). Additionally, participants with secondary education and prior experience in cafeterias, restaurants, or hotels achieved higher scores. No statistically significant association was found between hygiene practices and age ($p = 0.892$). Detailed statistical results, including significance levels for all group comparisons, are presented in Table 5.

Relationship between Food Safety Knowledge and Self-reported Practices

A statistically significant but weak positive correlation was found between food safety knowledge and self-reported hygiene practices among respondents who had both direct and indirect contact with food in preschool institutions in Podgorica ($N = 972$). The Pearson correlation coefficient was $r = 0.16$ ($p < 0.001$).

Table 4. *Frequency of correct self-reported and observed hygiene practices among employees with direct and indirect contact with food in preschool institutions in Podgorica (N = 972)*

Practices		Self reported	Observed	McNemar χ^2	p-value
1	Do you wash your hands with water and soap before preparing food? Yes	966 (99.3)	374 (38.8)	721.119	< 0.001**
2	Do you wash your hands with water and soap before eating your meal? Yes	967 (99.5)	546 (56.5)	364.740	< 0.001**
3	Do you wash your hands with water and soap after using the bathroom? Yes	968 (96.2)	749 (77.4)	98.660	< 0.001**
4	Do you have short, neat nails without nail polish? Yes	868 (89.3)	628 (64.6)	118.530	< 0.001**
5	Do you light a cigarette while working? No	916 (94.6)	941 (96.6)	1.285	0.257
6	Do you touch your nose while working, or sneeze into your hands? No	862 (88.7)	523 (54.0)	236.500	< 0.001**
7	Do you dry your hands after washing them appropriately (e.g., using a disposable towel or hand dryer)? Yes	909 (93.5)	751 (77.7)	51.000	< 0.001**
8	Do you put on a clean and suitable uniform before starting work? Yes	952 (98.0)	785 (80.8)	57.770	< 0.001**
9	Before starting activities, do you remove all adornments (earrings, rings, watches, and bracelets)? Yes	757 (77.7)	476 (49.1)	162.500	< 0.001**
10	Is your hair completely covered while working? Yes	746 (75.6)	517 (53.2)	102.700	< 0.001**
11	Do you work when you have diarrhoea? No	843 (86.6)	866 (89.1)	1.089	0.296
12	Do you work when you have a cold? No	650 (66.8)	679 (69.8)	1.730	0.196
13	Do you work when you have lesions on your hands? No	736 (75.6)	784 (80.7)	4.742	0.031*
14	Do you have a certified sanitary card? Yes	946 (97.3)	961 (98.9)	0.463	0.511

*p < 0.05; **p < 0.001

Table 5. *Impact of socio-demographic characteristics on knowledge and self-reported practices of employees with direct and indirect contact with food in preschool institutions in Podgorica (N = 972)*

Variable/group comparison	Test used	Statistics (r/H/U/z)	p-value
Age vs. knowledge	Pearson correlation	r = 0.81	0.001*
Work experience (years) – knowledge	Pearson correlation	r = 0.98	< 0.001**
Public vs. private employment – knowledge	Mann-Whitney U	U = 44,779; z = −0.36	0.713
Hygiene certificate – knowledge	Mann-Whitney U	U = 21,611; z = −2.51; r = 0.3	0.001*
Education level – knowledge	Kruskal-Wallis	H = 12.86	0.001*
Training attendance – knowledge	Kruskal-Wallis	H = 21.10	< 0.001**
Prior experience (job type) – knowledge	Kruskal-Wallis	H = 13.68	< 0.001**
HACCP awareness – knowledge	Kruskal-Wallis	H = 11.28	< 0.001**
Professional category – knowledge	Kruskal-Wallis	H = 28.51	< 0.001**
Age vs. practice	Pearson correlation	r = 0.00	0.892
Work experience (years) – practice	Pearson correlation	r = −0.26	0.002*
Public vs. private employment – practice	Mann-Whitney U	U = 37,107; z = −3.17; r = 0.3	< 0.001**
Hygiene certificate – practice	Mann-Whitney U	U = 21,823; z = −1.94; r = 0.2	0.005*
Education level – practice	Kruskal-Wallis	H = 45.75	< 0.001**
Training attendance – practice	Kruskal-Wallis	H = 48.35	< 0.001**
Prior experience (job type) – practice	Kruskal-Wallis	H = 30.00	< 0.001**
HACCP awareness – practice	Kruskal-Wallis	H = 20.71	< 0.001**
Professional category – practice	Kruskal-Wallis	H = 75.72	< 0.001**

HACCP – Hazard Analysis and Critical Control Points; r – Pearson correlation coefficient; H – Kruskal-Wallis test statistic; U – Mann-Whitney U test; z – standardized test statistic (Mann-Whitney); *p < 0.05; **p < 0.001

DISCUSSION

The results of this study highlight several key aspects regarding food safety knowledge and hygiene practices among food handlers in preschool institutions. The demographic profile, predominantly female participants with a mean age of 39.95 years and substantial work experience, provides context for interpreting the recorded knowledge and practices. Training in safe food handling was found to be insufficient, with 74.3% of respondents reporting no training within the past five years. This lack of ongoing education represents a significant concern given the importance of up-to-date knowledge and practices for maintaining food safety. Only 14.3% had attended training multiple times, and 11.4% once during the past five years, indicating the need for regular educational sessions (10, 12). Awareness of HACCP implementation was relatively high, 61.8% of respondents were familiar with its application in their institution. However, only 5.5% had obtained the legally mandatory "hygiene minimum" certification introduced in June 2021 (16). This low certification rate highlights serious non-compliance with legal regulations that may jeopardize food safety (5, 10).

Knowledge scores among respondents were high (mean = 84.15 ± 6.22), with correct response rates ranging from 55.7% to 98.1%, suggesting solid theoretical understanding of key food hygiene and safety principles (Table 3). Over 90% correctly answered 7 out of 18 questions; however, 15–20% were unaware that asymptomatic carriers can transmit pathogens causing foodborne illnesses, emphasizing the need for targeted training on invisible contamination sources (1).

Significant differences ($p < 0.05$ to $p < 0.001$) were found between employees with direct and indirect contact with food. Those with direct contact demonstrated significantly greater awareness of food safety risks, particularly concerning the dangers of leaving food at room temperature, handling ready-to-eat foods without protective barriers, and the importance of excluding symptomatic workers from food handling activities (Table 3). These findings are consistent with previous studies (14, 17, 18).

Foodborne disease transmission via food handlers remains a global and persistent challenge (1, 2, 19). Knowledge deficits were observed on questions related to temperature control and cross-contamination (questions 10, 15, 17, and 18), with correct response rates ranging from 55.7% to 76.4% (Table 3). Notably, only 55.7% of respondents answered correctly regarding proper hand drying techniques after washing. Significant differences ($p < 0.001$) were also found in responses related to wearing gloves when handling unpackaged food, as well as the safe reheating of leftovers.

The majority of respondents (99.1% of those with direct contact; 92.4% of those with indirect contact) correctly recognized the risk of consuming raw, unwashed fruits and vegetables, indicating a higher level of awareness than reported in previous studies (20). Additionally, 80.5% of participants understood that pathogens are invisible to the naked eye, helping to challenge the common misconception that microbial contamination can be identified through sight, smell, or taste alone (5). Microbiological testing of surfaces in childcare institutions revealed coliform bacteria on 48.4% of food preparation surfaces and *Escherichia coli* on diaper-changing areas, indicating risks on both food-related and non-food-related surfaces (21). Similarly, 86.7% and 82.3% of

respondents with direct and indirect food contact, respectively, acknowledged that handling food with bare hands can cause microbiological contamination.

A Brazilian study found *Staphylococcus aureus* in 32.5% of ready-to-eat food samples, cutting boards, and employees' hands, confirming the health risk for children due to poor hygiene practices (22). In our study, 98% identified food poisoning symptoms – an important factor for early recognition in kindergartens. Knowledge about health conditions affecting food safety (diarrhoea, cold, vomiting, wounds) was at 85.2%, higher than reported in the study, where only 60% recognized the risk of working while ill (23). By contrast, a study in Portugal, Serbia, and Greece showed that 30.5% of participants could not associate certain health conditions with pathogen transmission, such as the incorrect belief that hypertension restricts food handling (24).

Participants self-reported satisfactory practices (72.52 ± 1.08), with over 90% correct answers on 7 out of 14 safe food handling questions (Table 4). However, observed hygiene practices were below optimal levels, with a mean score of 53.09 ± 1.71 (Table 2). Employees with direct food contact had higher but variable scores (mean = 67.93 ± 25.16), while those with indirect contact showed lower but more consistent results (mean = 53.67 ± 1.71). This indicates a knowledge-practice gap, potentially due to time pressure, limited supervision, inadequate infrastructure, and possible self-reporting bias (25, 26).

These discrepancies mirror findings from previous research (23, 25, 26), which emphasize that the frequency of handwashing does not necessarily reflect its effectiveness. For example, one study (25) reported that despite satisfactory self-reported practices, most food handlers failed to adhere to the recommended handwashing frequency in actual working conditions. Similarly, another study (23) found that more than one-third of respondents believed the duration of handwashing should vary depending on the preceding activity. Additionally, *Salmonella* spp. was detected on the hands of 48% of food handlers in a different study (26), despite their moderate general knowledge (mean score 61.7 ± 8.1) and particularly high scores in personal hygiene (mean score 97.7 ± 11.4).

Collectively, these findings indicate that self-reported hygiene practices tend to overestimate actual compliance, and that training without follow-up is insufficient for ensuring proper hygiene, as theoretical knowledge must be actively integrated into daily routines (27). Proper handwashing with clean, running water and soap for at least 20 seconds remains one of the most effective measures to reduce the risk of foodborne and other infectious diseases (3).

In our study, over 96% of participants reported proper handwashing before eating and after toilet use, yet observed compliance was considerably lower, at 56.5% and 77.4%, respectively (Table 4, $p < 0.001$). Similarly, previous studies reported that teachers often failed to wash their hands correctly due to workload and suboptimal working conditions (7).

Work surfaces, including tables used for plays and meals, were not consistently cleaned according to established protocols, increasing the risk of cross-contamination. Even when written procedures were available, implementation was often inconsistent. These observations underscore the need for clear, written cleaning protocols and their strict enforcement in preschool settings, particularly before meals, when contamination risks are highest (14). Cleaning before meals is particularly critical, while post-meal cleaning, though still necessary, carries relatively less immediate risk. Clearly defined staff responsibilities at both stages are essential for maintaining hygienic standards.

Regarding clothing and personal hygiene, 98% of respondents reported wearing clean uniforms, yet only 80.8% were observed doing so (Table 4, $p < 0.001$). Similarly, 89.3% reported having short, neat, unpolished nails, 77.7% claimed to remove jewellery, and 75.6% reported using hair coverings, whereas observed compliance was lower at 64.6%, 49.1% and 53.2%, respectively (all $p < 0.001$). Poor personal hygiene and contaminated surfaces remain significant contributors to foodborne illness risks (9, 28) suggesting that enhanced staff organization and targeted training could reduce these risks.

Respiratory hygiene was also inconsistent. While 88.7% of participants reported avoiding nose-touching or sneezing into hands during food preparation, only 54% adhered to this practice during observation (Table 4, $p < 0.001$), posing a particular risk for contamination with pathogens such as *S. aureus* and highlighting the importance of routine monitoring (29). Hand drying practices were reported by 93.5% as appropriate, yet observed compliance was 77.7% (Table 4, $p < 0.001$). The lack of hand-drying machines and incomplete access to sinks suggests that infrastructure may contribute more to hygiene gaps than individual negligence (11).

For working while having a cold, 66.8% reported refraining from work, while 69.8% were observed adhering to this practice, without a statistically significant difference (Table 4). Workplace pressures may discourage staff from taking sick leave, increasing the risk of respiratory illness transmission in preschool settings.

High compliance was observed in avoiding smoking, working during diarrhoea, and maintaining valid health certificates, with rates exceeding 94% (Table 4). A statistically significant discrepancy was noted for working with hand lesions ($p = 0.031$, question 13), likely reflecting staff continuing to work despite injuries due to the unavailability of replacements. This practice increases the risk of pathogen transmission, emphasizing the need for both staff support and strict hygiene monitoring.

Routine screening remains crucial, as asymptomatic carriers may harbour pathogens, with previous studies identifying high prevalence of intestinal parasites (45%) and *Salmonella* spp. (3.5%) among food handlers (19).

Socio-demographic factors significantly influenced food handlers' knowledge and self-reported hygiene practices (Table 5). Respondents employed in private childcare institutions reported significantly better hygiene practices compared to those in public institutions ($p < 0.001$). A positive correlation was found between knowledge and age ($p = 0.001$), as well as between knowledge and work experience ($p < 0.001$), indicating that older and more experienced employees tend to possess higher food safety knowledge, which aligns with previous studies (11, 14, 27). Although the correlation between hygiene practices and age was not statistically significant ($p = 0.892$), a negative trend was observed, possibly suggesting that younger workers may adhere more consistently to hygiene protocols, potentially due to recent training or increased risk awareness. These results support the continued use of visual and educational material such as posters and flyers to reinforce food safety practices (20) and highlight the need to establish standardized criteria for categorizing food handlers by work experience to improve data comparability (10).

Participation in training had a statistically significant impact on both knowledge and practices ($p < 0.001$). Respondents who had undergone training, particularly those with multiple sessions, demonstrated significantly higher scores, consistent with previous findings (10, 12). Education level also influenced outcomes: notably, respondents with secondary education achieved the highest knowledge and practice scores ($p = 0.001$), likely reflecting the typical educational profile of frontline food handlers. Conversely, those with higher education levels scored lower, possibly due to differing job roles or less direct involvement in food handling.

Prior professional experience in cafeterias, restaurants, and hotels was significantly associated with better knowledge and practices ($p < 0.001$), consistent with findings from other studies (11), though not universally confirmed (10). Additionally, respondents who had completed a certified "minimum hygiene" course scored significantly higher in both knowledge ($p = 0.001$) and practices ($p = 0.005$) compared to those without such certification. Similarly, working in environments with implemented HACCP systems was linked to significantly better results ($p < 0.001$), reinforcing the importance of structured food safety protocols.

However, as noted by previous authors, the effectiveness of HACCP depends on consistent adherence to basic hygiene principles, particularly hand hygiene (5, 18). Regular training every 6 to 12 months, supported by periodic evaluations, remains essential for sustaining hygiene standards (8, 10). Knowledge and practices also differed significantly by professional category ($p < 0.001$), with cooks and kitchen assistants demonstrating superior food safety knowledge and practices, likely due to their direct involvement in food preparation tasks (11, 14).

The results underline the value of position-sensitive training approaches, particularly for personnel with indirect food contact, while also highlighting how workplace dynamics, such as visual reminders, structured oversight, and organizational responsibility, contribute to effective HACCP adherence.

A statistically significant but weak positive correlation was observed between food safety knowledge and hygiene practices ($r = 0.16$, $p < 0.001$), suggesting that knowledge alone has limited predictive value for actual practices. This aligns with previous studies reporting inconsistencies between knowledge and practice (8, 11, 18). The small effect size may result from the large sample size, where minor effects achieve statistical significance but lack practical relevance. Therefore, interpreting p-values without considering effect sizes and confidence intervals can be misleading. Future research should address both statistical and practical significance to better assess these relationships. Given the weak association, supervisors play a crucial role in modelling proper hygiene, providing resources, and supporting the translation of knowledge into practice (28).

Although this study revealed significant discrepancies between knowledge and practice, further statistical analysis, such as multivariate logistic regression, could yield deeper insights into the predictors of unsafe practices. Future research should model observed practices as the outcome variable, considering factors such as knowledge level, training history, staff-to-child ratio, institutional type (public vs. private), and facility infrastructure (e.g., availability of handwashing stations and soap). This approach would help identify structural or systemic barriers beyond individual knowledge.

The potential influence of researcher presence (Hawthorne effect) and the inherent limitations of self-reported data, such as the tendency to over-report desirable behaviours, should be acknowledged when interpreting these findings.

CONCLUSION

This study revealed a high level of food safety knowledge among preschool employees (mean = 84.15 ± 6.22), while self-reported hygiene practices were moderately satisfactory (78.52 ± 1.08), and observed practices were significantly lower (53.09 ± 1.71). These findings indicate a considerable discrepancy between knowledge and actual practices, particularly under real working conditions. Significant differences were identified between staff with direct versus indirect food contact, as well as between reported and observed practices, underscoring that knowledge alone is insufficient to ensure compliance with hygiene standards.

The results highlight the importance of addressing practical obstacles, such as time constraints, insufficient equipment, and inadequate food preparation space. It is essential to raise awareness among all employees involved in food handling and to clearly define responsibilities within the workflow. Training efforts should correspond to the practical demands and real-world settings of each role, rather than applying a uniform model across all positions.

In conclusion, the findings of this study emphasize the necessity for continuous, practice-oriented training that enables staff to recognize and respond effectively to hygiene-related risks. These results provide a strong foundation for revising existing training programmes and developing new, targeted approaches that more effectively bridge the gap between knowledge and practice, ultimately enhancing food safety and protecting children's health in preschool institutions.

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Conflicts of Interest

None declared

Adherence to Ethical Standards

All subjects gave informed consent for inclusion before participating in the study. Ethical approval for the study was obtained from the Institute for Public Health of Montenegro (No. 01-3790, 28 April 2023) and the Ministry of Education (No. 01-011/23-3394/2, 3 May 2023).

REFERENCES

1. Yiannas F. Food safety culture. New York: Springer; 2009.
2. Brady MT. Infectious disease in pediatric out-of-home child care. Am J Infect Control. 2005;33(5):276-85.
3. Fan S. Food safety practices in childcare centers in Kansas [master's thesis]. Manhattan (KS): Kansas State University; 2013.
4. World Health Organization. WHO's first-ever global estimates of foodborne diseases find children under 5 account for almost one-third of deaths [Internet]. Geneva: WHO; 2015 [cited 2024 May 31]. Available from: https://www.who.int/news/item/03-12-2015-who-s-first-ever-

global-estimates-of-foodborne-diseases-find-children-under-5-account-for-almost-one-third-of-deaths.
5. Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. Off J Eur Communities. 2004 Apr 30;47(L 139):1-54.
6. Statistical Office of Montenegro, Monstat. [Preschool education - data] [Internet]. Podgorica: Monstat; 2024 [cited 2024 May 31]. Available from: https://www.monstat.org/cg/page.php?id=1676&pageid=76. Montenegrin.
7. Mohamed NA, Mohd Razi NA, Faroque H, Che Amir Farid AA-R, Mohd Rani MD, Isahak I. Hand hygiene awareness among childcare providers. Asian J Med Biomed. 2020;4(2):17-21.
8. da Vitória AG, de Souza Couto Oliveira J, de Almeida Pereira LC, de Faria CP, de São José JFB. Food safety knowledge, attitudes and practices of food handlers: a cross-sectional study in school kitchens in Espírito Santo, Brazil. BMC Public Health. 2021 Feb 12;21(1):349. doi: 10.1186/s12889-021-10282-1.
9. Putri MS, Susanna D. Food safety knowledge, attitudes, and practices of food handlers at kitchen premises in the Port 'X' area, North Jakarta, Indonesia 2018. Ital J Food Saf. 2021 Nov 22;10(4):9215. doi: 10.4081/ijfs.2021.9215.
10. Ncube F, Kanda A, Chijokwe M, Mabaya G, Nyamugure T. Food safety knowledge, attitudes and practices of restaurant food handlers in a lower-middle-income country. Food Sci Nutr. 2020 Feb 13;8(3):1677-87.
11. Hamed A, Mohammed N. Food safety knowledge, attitudes and self-reported practices among food handlers in Sohag Governorate, Egypt. East Mediterr Health J. 2020 Apr 16;26(4):374-81.
12. Dora-Liyana AL, Mahyudin NA, Ismail-Fitry MR, Ahmad-Zaki A, Rasiyuddin H. Food safety and hygiene knowledge, attitude, and practices among food handlers at boarding schools in the northern region of Malaysia. Int J Acad Res Bus Soc Sci. 2018;8(17):238-66.
13. Ulusoy BH, Çolakoğlu N. What do they know about food safety? A questionnaire survey on food safety knowledge of kitchen employees in Istanbul. Food Health. 2018;4(4):283-92.
14. Sharif L, Obaidat MM, Al-Dalalah M-R. Food hygiene knowledge, attitudes and practices of the food handlers in the military hospitals. Food Nutr Sci. 2013;4(3):245-51.
15. Hamzah NA, Hadi NH, Samad NIA, Anua SM, Abdul Rahman H. Knowledge, attitude, and practice on food poisoning among pre-school food handlers in Kelantan, Malaysia. Int J Acad Res Bus Soc Sci. 2022;12(7):1855-69.
16. Government of Montenegro. [Law on the protection of the population from infectious] [Internet]. Official Gazette of Montenegro. 2018;012/18, 064/20, 059/21 [cited 2024 May 31]. Available from: https://www.gov.me/dokumenta/74e5080c-cbd5-45f9-aaba-6ae3ee665405. Montenegrin.
17. Martins RB, Hogg T, Otero JG. Food handlers' knowledge of food hygiene: the case of a catering company in Portugal. Food Control. 2012;23(1):184-90.
18. Tan SL, Bakar FA, Abdul Karim MS, Lee HY, Mahyudin NA. Hand hygiene knowledge, attitudes, and practices among food handlers at primary schools in Hulu Langat district, Selangor (Malaysia). Food Control. 2013;34(2):428-35.
19. Aklilu A, Kahase D, Dessalegn M, Tarekegn N, Gebremichael S, Zenebe S, et al. Prevalence of intestinal parasites, salmonella and shigella among apparently health food handlers of Addis Ababa University student's cafeteria, Addis Ababa, Ethiopia. BMC Res Notes. 2015 Jan 24;8:17. doi: 10.1186/s13104-014-0967-x.
20. Parry-Hanson Kunadu A, Ofosu DB, Aboagye E, Tano-Debrah K. Food safety knowledge, attitudes and self-reported practices of food handlers in institutional food service in Accra, Ghana. Food Control. 2016;69:324-30.
21. Cosby CM, Costello CA, Morris WC, Haughton B, Devereaux MJ, Harte F, et al. Microbiological analysis of food contact surfaces in child care centers. Appl Environ Microbiol. 2008 Nov;74(22):6918-22.
22. de Souza Costa Sobrinho P. [Bacteriological quality and food safety in a nutrition program]. Nutr Hosp. 2014;29(1):80-7. Spanish.
23. Osaili TM, Abu Jamous DO, Obeidat BA, Bawadi HA, Tayyem RF, Subih HS. Food safety knowledge among food workers in restaurants in Jordan. Food Control. 2013;31(1):145-50.
24. Smigic N, Djekic I, Martins ML, Rocha A, Sidiropoulou N, Kalogianni EP. The level of food safety knowledge in food establishments in three European countries. Food Control. 2016;63:187-94.
25. Rebouças LT, Santiago LB, Martins LS, Rios Menezes AC, Araújo MP, Almeida RC. Food safety knowledge and practices of food handlers, head chefs, and managers in hotels' restaurants in Salvador, Brazil. Food Control. 2017;73(Part B):372-81.
26. Lee H, Abdul Halim H, Thong K, Chai L. Assessment of food safety knowledge, attitude, self-reported practices, and microbiological hand hygiene of food handlers. Int J Environ Res Public Health. 2017;14(1):55. doi: 10.3390/ijerph14010055.
27. Tuncer T, Akoğlu A. Food safety knowledge of food handlers working in hotel kitchens in Turkey. Food Health. 2020;6(2):77-89.
28. Abdullah Sani N, Siow ON. Knowledge, attitudes, and practices of food handlers on food safety in food service operations at the Universiti Kebangsaan, Malaysia. Food Control. 2014;37:210-7.
29. Beyene G, Mamo G, Kassa T, Tasew G, Mereta ST. Nasal and hand carriage rate of Staphylococcus aureus among food handlers working in Jimma Town, Southwest Ethiopia. Ethiop J Health Sci. 2019 Sep;29(5):605-12.

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