Food Safety Practices and Physical Food Contamination in Indonesia's Free Nutritious Meal Program (MBG): Evidence from Kediri City

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ABSTRACT

Food safety is a critical component of public health, particularly in large-scale nutrition programs such as Indonesia's Free Nutritious Meal Program (MBG). Physical food contamination poses a significant risk to vulnerable program beneficiaries. Institutional kitchens, including Nutrition Service Units (SPPG), play a key role in ensuring food quality and safety. This study aimed to analyze the effect of personal hygiene of food handlers and kitchen sanitation practices on physical food contamination in Nutrition Service Units (SPPG) in Kediri City. This study used an observational cross-sectional design conducted in 29 SPPG in Kediri City. The total population was 580 food handlers, and 237 respondents were selected through simple random sampling. Personal hygiene and kitchen sanitation practices were measured using validated structured observation checklists and categorized into three ordered levels. Physical food contamination was assessed through direct observation. Data were analyzed using ordinal regression. The ordinal regression analysis showed a statistically significant effect of personal hygiene and kitchen sanitation on physical food contamination ($p < 0.05$), with the model explaining 82.6% of the variance (Nagelkerke $R^2 = 0.826$). Good personal hygiene was observed in 70% of food handlers and good kitchen sanitation in 68% of SPPG units; nevertheless, moderate physical contamination was found in 22% of food samples. Better hygiene and sanitation practices are strongly associated with lower contamination risk. Personal hygiene of food handlers and kitchen sanitation practices significantly influence physical food contamination in SPPG. Strengthening food safety training and improving kitchen sanitation infrastructure are recommended to minimize contamination risks in the MBG program.

I. Introduction

Food safety remains a critical public health concern worldwide, particularly in large-scale food service systems and public nutrition programs. According to the World Health Organization, an estimated 600 million people nearly 1 in 10 globally fall ill each year due to contaminated food, resulting in approximately 420,000 deaths annually, with a disproportionately high burden among children and populations in developing (WHO, 2022). A cross-sectional study by Oliveira et al. (2024) found that compliance with personal hygiene practices among food handlers remains inconsistent, emphasizing that inadequate hygiene can directly compromise food safety and increase contamination risks in food service environments. In Indonesia, the burden of foodborne illness is still high, with estimates indicating approximately 10–22 million cases of foodborne diarrheal diseases annually (Kirk M.D. et al., 2015).

Diarrheal disease, which is one of the most common manifestations of foodborne illness, continues to be a significant health problem, especially among children, and is strongly associated with poor hygiene and sanitation conditions (Azizah N. et al., 2022). These data indicate that food safety issues in Indonesia remain widespread and require serious attention. In the context of Indonesia's Free Nutritious Meal Program (MBG), Nutrition Service Units (SPPG) function as institutional kitchens responsible for preparing large quantities of food for program beneficiaries.

In Kediri City, there are 29 SPPG units involving an estimated 580 food handlers, which increases the complexity of food preparation processes and the potential risk of contamination if food safety standards are not strictly implemented. Given the large scale of food production and the vulnerability of beneficiaries, ensuring proper personal hygiene among food handlers and adequate kitchen sanitation is essential. However, empirical studies examining these factors in SPPG settings remain limited. Therefore, this study aims to analyze the effect of personal hygiene of food handlers and kitchen sanitation practices on physical food contamination in SPPG in Kediri City.

II. Methods

Study Design and Setting

This study applied an observational analytical design using a cross-sectional approach. The research was conducted in SPPG that support the implementation of MBG in Kediri City. A total of 29 SPPG were included as study sites.

Population and Sample

The population consisted of all food handlers working in SPPG in Kediri City, with a total population of 580 individuals. The sample size was determined using Slovin's formula with a 5% margin of error, resulting in 237 respondents. A simple random sampling technique was applied to select participants proportionally from each SPPG unit.

Variables and Definitions

The independent variables in this study were personal hygiene of food handlers and kitchen sanitation practices. Personal hygiene refers to the cleanliness and hygienic behavior of food handlers during food preparation, including handwashing, use of personal protective equipment, and overall body cleanliness. This variable was measured using a structured observation checklist consisting of 20 items adapted from the Food Safety Guidelines published by the Indonesian Ministry of Health (Kepmenkes No. 1098/Menkes/SK/VII/2003). The checklist covered five domains: (1) personal cleanliness (e.g., clean hands and nails, no open wounds), (2) use of personal protective equipment (e.g., gloves, apron, hair cover, mask), (3) handwashing behavior (e.g., frequency and technique of handwashing before and after food handling), (4) health status (e.g., absence of communicable illness during food preparation), and (5) behavioral practices (e.g., refraining from eating, drinking, or smoking while handling food). Each item was scored as compliant (1) or non-compliant (0). The total score was then categorized into three ordered levels: (1) good (score ≥75% of maximum), (2) enough (score 56–74%), and (3) less (score ≤55%). Kitchen sanitation refers to the condition and maintenance of the kitchen environment, including cleanliness of utensils, food storage, waste management, and environmental hygiene. This variable was also measured using a structured observation checklist consisting of 25 items adapted from the same Ministry of Health guidelines. The checklist covered five domains: (1) kitchen facility condition (e.g., adequate ventilation, clean floors and walls), (2) food storage (e.g., appropriate temperature, covered containers, separation of raw and cooked food), (3) equipment cleanliness (e.g., washing and sanitizing of utensils and food contact surfaces), (4) waste management (e.g., availability and use of covered waste bins, frequency of waste disposal), and (5) pest control (e.g., absence of insects and rodents, use of preventive measures). Scores were categorized into three ordered levels: (1) good (score ≥75%), (2) enough (score 56–74%), and (3) less (score ≤55%). The dependent variable was physical food contamination, defined as the presence of foreign objects such as hair, dust, or other visible contaminants in food. Physical food contamination was assessed through direct observation by trained inspectors using a structured checklist of 15 items, and categorized into three ordered levels: (1) no contamination, (2) moderate contamination (1–2 types of contaminant observed), and (3) high contamination (≥3 types of

contaminant observed).

Data Collection

Data were collected through direct observation using structured observation checklists for personal hygiene (20 items), kitchen sanitation (25 items), and physical food contamination (15 items). Observations were conducted by four trained inspectors who had completed a standardized training session on checklist application and scoring prior to data collection, ensuring inter-rater reliability. All three instruments were tested for content validity by three public health experts with experience in food safety, and for reliability using Cohen's Kappa coefficient ($\kappa \geq 0.80$), confirming substantial to near-perfect inter-rater agreement. Observations at each SPPG were conducted during active food preparation hours to capture real-time practices.

Data Analysis

Data were analyzed using both descriptive and inferential statistics. Descriptive analysis was used to present the distribution of variables in terms of frequency and percentage. Inferential analysis was performed using ordinal regression to examine the effect of personal hygiene of food handlers and kitchen sanitation on physical food contamination. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

This study was conducted in accordance with ethical principles for research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of STRADA Indonesia University with approval number 0723413/EC/KEPK/I/04/2026. Prior to data collection, all participants were informed about the purpose and procedures of the study, and written informed consent was obtained from each respondent.

Participation in this study was voluntary, and respondents had the right to withdraw at any time without any consequences. Confidentiality and anonymity of participants were strictly maintained by ensuring that no personal identifiers were recorded or disclosed. All data collected were used solely for research purposes.

III. Results

Table 1. Characteristics of respondents

No	Characteristics	ΣN	Σ%
1	**Age (year)**		
	18-25	95	40
	26-33	81	34
	>33	61	26
2	**Gender**		
	Man	119	50
	Female	118	50
3	**Education**		
	Elementary / middle school	114	48
	High school	85	36
	Diploma/ Bachelor	38	16
4	**length of working (year)**		
	0-1	28	12
	1-2	62	26
	>2	147	62

No	Characteristics	ΣN	Σ%
5	**Personal hygiene**		
	Good	166	70
	Enough	71	30
	Less	0	0
6	**Kitchen Sanitation**		
	Good	161	68
	Enough	52	22
	Less	24	10
7	**Physical contamination of food**		
	High contamination	0	0
	Moderate contamination	52	22
	No contamination	185	78
	Total	**237**	**100**

Table 2. Analysis Data

Variable	*p value*	R Square value
Y = Physical Food Contamination X1 = Personal Hygiene of Food Handler X2 = Implementation of Kitchen Sanitation	**0,000**	**0,826**
There is the effect of variable Y on variables X1 and X2 by 82.6%.		

The results of the ordinal regression analysis are presented in the Pseudo R-square table, which indicates the proportion of variance in the dependent variable explained by the independent variables. This analysis was conducted to assess the extent to which personal hygiene and kitchen sanitation practices influence physical food contamination.

The model demonstrated strong explanatory power, as reflected by the Pseudo R-square values. The McFadden coefficient was 0.733, while the Cox and Snell coefficient was 0.788, and the Nagelkerke coefficient reached 0.826 (82.6%). Among these, the Nagelkerke value is commonly used to interpret the goodness of fit in ordinal regression models.

A Nagelkerke value of 0.826 indicates that 82.6% of the variation in physical food contamination can be explained by the independent variables, namely food handlers' personal hygiene and kitchen sanitation practices. The remaining 17.4% of the variation is influenced by other factors not included in the model, such as food storage conditions, environmental factors, or food processing techniques. These findings suggest that personal hygiene and kitchen sanitation are strong determinants of physical food contamination in institutional food service setting.

Table 3. Cross-tabulation of Personal Hygiene of Food Handlers and Physical Food Contamination

Personal Hygiene	No Contamination n (%)	Moderate Contamination n (%)	High Contamination n (%)	Total n (%)
Good	148 (89.2)	18 (10.8)	0 (0.0)	166 (100)
Enough	37 (52.1)	34 (47.9)	0 (0.0)	71 (100)
Less	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	**185 (78.1)**	**52 (21.9)**	**0 (0.0)**	**237 (100)**

p value = 0.000 (Ordinal Regression)

Table 4. Cross-tabulation of Kitchen Sanitation and Physical Food Contamination

Kitchen Sanitation	No Contamination n (%)	Moderate Contamination n (%)	High Contamination n (%)	Total n (%)
Good	161 (100)	0 (0.0)	0 (0.0)	161 (100)
Enough	24 (46.2)	28 (53.8)	0 (0.0)	52 (100)
Less	0 (0.0)	24 (100)	0 (0.0)	24 (100)
Total	**185 (78.1)**	**52 (21.9)**	**0 (0.0)**	**237 (100)**

p value = 0.000 (Ordinal Regression)

IV. Discussion

The Characteristics of Food Handlers

The demographic profile of food handlers in this study reflects a relatively young, gender-balanced, and experienced workforce. These characteristics have important implications for food safety management within the MBG program. From a public health perspective, a young workforce presents both opportunities and challenges. While younger workers generally exhibit higher physical capacity and adaptability to procedural changes, the literature consistently shows that age is positively associated with hygiene compliance when accompanied by adequate training and supervision (Kunadu et al., 2021). Targeted induction training for newer and younger staff is therefore essential to bridge the gap between knowledge and practice.

The near-equal gender distribution (50% male, 50% female) is noteworthy given that several studies have reported gender-based differences in hygiene behavior, with female food handlers tending to demonstrate higher compliance with handwashing and sanitation protocols (Al-Kandari et al., 2022). This finding suggests that gender-sensitive training strategies may help improve overall compliance rates across mixed-gender settings. The educational profile of the workforce, with nearly half holding only elementary or middle school qualifications, underscores the need for practical, non-text-heavy training materials and visual standard operating procedures that do not rely on high literacy levels. As Tessema et al. (2022) emphasized, formal education level is a significant predictor of food safety knowledge and self-reported practice; however, targeted skill-based training can compensate for gaps in formal education. Finally, while the majority of respondents (62%) had more than two years of work experience, Getahun et al. (2023) caution that prolonged exposure to routine tasks may breed complacency, underscoring the value of periodic refresher training and unannounced hygiene audits to sustain behavioral standards over time.

In terms of gender distribution, the respondents were equally divided between male and female (50% each), suggesting that food handling activities in SPPG are not gender-specific. Previous studies indicate that gender differences in food safety practices are generally minimal, although some evidence suggests that female food handlers tend to demonstrate slightly better hygiene practices due to higher risk awareness and attentiveness to cleanliness. A recent study by Al-Kandari et al. (2022) found that female food handlers showed significantly better compliance with hand hygiene and sanitation practices compared to males.

Educational background is another important characteristic, with nearly half of the respondents (48%) having only elementary or middle school education, and only 16% having diploma-level education. This indicates that a substantial proportion of food handlers may have limited formal knowledge related to food safety and hygiene principles. According to health behavior theory, education level is strongly associated with knowledge acquisition, risk perception, and the ability to understand and implement hygiene standards. Recent studies support this relationship; for example, a study by Tessema et al. (2022) found that food handlers with higher educational attainment were significantly more likely to demonstrate

good food safety practices.

Working experience also plays a crucial role in shaping food safety behavior. In this study, the majority of respondents (62%) had more than two years of working experience, indicating a relatively experienced workforce. Longer work experience is generally associated with improved skills and familiarity with food handling procedures. A recent study by Getahun et al. (2023) highlighted that although experienced food handlers tend to perform better in routine tasks, they may develop complacency over time, leading to inconsistent hygiene practices.

Personal Hygiene of Food Handlers at SPPG in Kediri City

The cross-tabulation results (Table 3) reveal a clear dose-response pattern: all food handlers rated as having good personal hygiene worked in SPPG units with no physical contamination or only moderate contamination, while moderate hygiene was associated with a substantially higher proportion of moderate contamination cases (47.9%). This gradient reinforces the theoretical premise of the Health Belief Model, which posits that hygiene behavior is driven by perceived susceptibility, perceived severity, self-efficacy, and cues to action (Rosenstock, 1974). In institutional food service settings like SPPG, where large quantities of food are prepared under time pressure, the gap between knowledge and actual practice is a well-documented phenomenon. Oliveira et al. (2024) identified inadequate handwashing technique—rather than frequency alone—as a primary driver of contamination risk, suggesting that checklist-based monitoring must assess the quality, not just the occurrence, of hygienic behaviors. Furthermore, consistent with the findings of Getahun et al. (2023), supervisory support and feedback mechanisms appear critical in converting acceptable intentions into sustained, compliant behavior. The implication for SPPG management is that periodic observation-based assessments, rather than one-time training sessions, are likely to yield more durable improvements in personal hygiene compliance.

Implementation of Kitchen Sanitation in SPPG Kediri City

The cross-tabulation of kitchen sanitation against physical food contamination (Table 4) demonstrates a particularly striking relationship: all SPPG units classified as having good kitchen sanitation recorded no physical food contamination, while units with moderate sanitation showed moderate contamination in more than half of cases (53.8%), and units with poor sanitation showed moderate contamination in all cases (100%). This near-perfect stratification suggests that kitchen sanitation may exert an even more decisive influence on physical contamination outcomes than individual hygiene behavior, possibly because environmental factors—such as inadequate pest control, uncovered food storage, or poorly maintained equipment—create structural contamination risks that cannot be entirely mitigated by individual handler behavior alone. This aligns with the Hazard Analysis and Critical Control Points (HACCP) framework, which emphasizes that risk control must operate at the system level, not solely at the individual level (Motarjemi & Lelieveld, 2019). The FAO (2022) similarly highlights that environmental contamination vectors, including inadequate ventilation, water supply, and waste management infrastructure, are frequently underestimated in institutional settings. The finding that 32% of SPPG units in Kediri operated under suboptimal sanitation conditions points to a systemic infrastructure gap that warrants urgent policy attention. Investment in physical kitchen upgrades—particularly in waste disposal systems, pest-proofing, and food storage infrastructure—should be prioritized alongside behavioral interventions to achieve meaningful reductions in contamination rates across the MBG program.

Physical Food Contamination at SPPG in Kediri City

The ordinal regression model explained 82.6% of the variance in physical food contamination (Nagelkerke $R^2 = 0.826$), indicating that personal hygiene and kitchen sanitation together account for the overwhelming majority of contamination risk in SPPG settings. This high explanatory power has important implications for program design: it confirms that food safety interventions targeting these two domains are likely to be highly effective if implemented rigorously and consistently. The remaining 17.4% of unexplained variance may reflect factors such as food supply chain quality, raw material contamination at the point of procurement, temperature management during food transport, or unmeasured environmental variables. Future research should explore these additional determinants to develop a more comprehensive contamination prevention framework for large-scale institutional feeding

programs. The significance of this study extends beyond Kediri City. As Indonesia continues to scale the MBG program nationally, the empirical evidence produced here provides a strong justification for embedding standardized food safety training and kitchen sanitation audit protocols into the program's national operational guidelines. Abebe et al. (2023) similarly concluded that food contamination in institutional settings is highly amenable to intervention when systematic monitoring, infrastructure investment, and behavioral training are implemented in concert. The present study adds to this evidence base by demonstrating that both human and environmental factors must be addressed simultaneously—and in that order of priority given the near-perfect stratification observed in the kitchen sanitation cross-tabulation—to achieve durable food safety outcomes in SPPG settings.

V. Conclusion

This study confirms the proposed hypothesis that personal hygiene of food handlers and kitchen sanitation practices significantly influence physical food contamination in SPPG Kediri City. The findings demonstrate that both variables are strong predictors, with the ordinal regression model explaining 82.6% of the variation in physical food contamination. This indicates that improvements in hygiene behavior and environmental sanitation can substantially reduce contamination risks in institutional food service settings.

Despite the majority of respondents demonstrating good personal hygiene (70%) and acceptable kitchen sanitation (68%), the presence of moderate hygiene practices and suboptimal sanitation conditions highlights inconsistencies in implementation. These gaps contribute to the persistence of physical food contamination (22%), suggesting that compliance with food safety standards is not yet optimal. Therefore, the study provides empirical evidence that both human behavior and environmental factors must be addressed simultaneously to ensure effective food safety management.

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