Adolescent Characteristics, Knowledge, Hand Hygiene, Food Hygiene, and Dietary Patterns Associated with Typhoid Fever

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Abstract

Typhoid fever remains a major public health issue in Indonesia, particularly among adolescents living in densely populated urban areas, where poor sanitation and the consumption of unsafe food increase the risk of exposure to Salmonella Typhi. This study analyzed the relationship between adolescent characteristics, knowledge, hand hygiene, food hygiene, eating habits, and a history of typhoid fever in Surabaya. An observational analytic study with a cross-sectional design was conducted involving 160 adolescents aged 13–18 years attending junior and senior high schools in Surabaya. Participants were selected using multistage random sampling. Data were collected using a validated structured questionnaire to assess adolescent characteristics, knowledge, hand hygiene, food hygiene, eating habits, and history of typhoid fever. Bivariate relationships were analyzed using the chi-square test, followed by multivariate logistic regression analysis to identify independent predictors. The results showed that a total of 54 adolescents (33.8%) reported a history of typhoid fever. Bivariate analysis showed a significant association between a history of typhoid fever and knowledge ($p = 0.007$), hand hygiene ($p = 0.001$), food hygiene ($p < 0.001$), and eating habits ($p = 0.004$),

whereas age and gender did not show significant associations. Multivariate analysis revealed that poor food hygiene (aOR = 2.76; 95% CI: 1.37–5.58), poor hand hygiene (aOR = 2.41; 95% CI: 1.20–4.85), and poor eating habits (aOR = 2.18; 95% CI: 1.10–4.33) were independent predictors of a history of typhoid fever. Poor food hygiene, poor hand hygiene, and unhealthy eating habits are significant independent predictors of a history of typhoid fever among adolescents. School-based hygiene promotion and food safety interventions are recommended to reduce the risk of typhoid fever among adolescents in urban areas of Indonesia.

Keywords: adolescents, dietary patterns, food hygiene, hand hygiene, typhoid fever.

Introduction

Typhoid fever is an acute systemic infection caused by Salmonella enterica serovar Typhi and remains a significant public health issue, particularly in low- and middle-income countries. The disease is primarily transmitted through the consumption of food or water contaminated with feces from infected individuals or carriers[1]. The persistence of typhoid fever is closely linked to inadequate sanitation, unsafe water, poor food-handling practices, and a lack of personal hygiene. Despite improvements in sanitation and disease control across various regions, typhoid fever continues to contribute significantly to morbidity and mortality, especially in South Asia and Southeast Asia[2.] Current global estimates indicate that typhoid fever still causes millions of cases and more than 100,000 deaths annually, underscoring that prevention remains a critical public health priority[3].

Indonesia remains an endemic region for typhoid fever, with transmission driven by both environmental and behavioral factors. National and regional surveillance data indicate that typhoid fever continues to pose a significant health burden in Indonesia[4], including in East Java. The urban context is particularly relevant, as high population density, population mobility, diverse food environments, and varying sanitation conditions can create numerous opportunities for exposure to S. Typhi. In urban areas, adolescents obtain food from school canteens, street vendors, restaurants, and other informal food outlets, thereby increasing their reliance on food handling practices and environmental conditions that do not always meet recommended hygiene standards[5].

Adolescence is a critical period for typhoid fever prevention, as individuals increasingly develop independence in making decisions regarding food consumption, personal hygiene, and daily health behaviors[6]. School attendance and frequent peer

interactions can influence these behaviors. Adolescents may consume snacks and ready-to-eat foods outside the home, share food or eating utensils, and exhibit varying levels of adherence to recommended handwashing practices[7]. While knowledge and awareness can influence health behaviors, knowledge alone does not necessarily lead to consistent preventive practices when adolescents face environmental barriers such as inadequate handwashing facilities, limited access to soap, or unsafe food environments. Therefore, understanding behavioral factors among adolescents is crucial for designing effective prevention interventions that are tailored to the local context[8].

Hand hygiene is a modifiable behavior within the fecal-oral transmission pathway of typhoid fever. Hands can become contaminated after defecation, through contact with contaminated surfaces, or while handling unsafe food, thereby creating a potential for transferring pathogens to food or directly into the mouth[9]. Consequently, failure to wash hands with soap at critical times, particularly before eating and after defecation, can increase the risk of exposure to enteric pathogens. Evidence from various systematic reviews and meta-analyses has demonstrated a link between water, sanitation, hygiene practices, food exposure, and typhoid fever, underscoring the importance of hygiene-related behaviors in prevention strategies. Thus, improving hand hygiene practices among adolescents could be a viable component of school-based typhoid fever prevention programs[10.]

Food hygiene is equally important, as contaminated food is a primary route of transmission. Food can become contaminated during preparation, handling, storage, transport, or serving, particularly if food handlers fail to observe proper hygiene practices or if the food comes into contact with contaminated equipment, water, surfaces, insects, or the surrounding environment[11]. Adolescents who frequently purchase food from school canteens or street vendors may have limited control over these food safety conditions. Previous studies have identified variations in food safety knowledge and hygiene practices among both food vendors and consumers, indicating that the food environment can contribute to differences in exposure risk[12,13.] Therefore, assessments of food hygiene should consider not only individual food choices but also the conditions under which food is prepared, handled, stored, and served[14.]

Dietary patterns can influence the frequency and nature of adolescents' exposure to potentially unsafe foods. Frequent consumption of snacks, ready-to-eat

meals, and food purchased outside the home increases the likelihood of contact with food prepared under varying hygienic conditions. Irregular eating patterns and frequent snacking habits may also reflect broader lifestyle behaviors that influence food choices and the types of dining establishments adolescents visit[15,16]. Crucially, dietary patterns should not be interpreted as a direct cause of typhoid fever; rather, they serve as a behavioral pathway that exposes adolescents to varying food safety conditions. Previous research by the team identified a link between dietary patterns and the incidence of typhoid fever, providing the rationale for examining eating behaviors alongside hand and food hygiene practices in this study[17.]

Although previous studies have examined individual risk factors such as environmental, behavioral, and hygiene aspects associated with typhoid fever, evidence integrating adolescent characteristics, hand hygiene, food hygiene, and dietary patterns into a single analytical framework remains limited among urban adolescents in Indonesia. This is particularly relevant in Surabaya, where adolescents are exposed to diverse food environments at school and in the community, and possess considerable autonomy in purchasing food and adopting hygiene practices. Examining these factors simultaneously can provide a more comprehensive understanding of modifiable behaviors linked to a history of typhoid fever, while also helping to distinguish behavioral factors from basic demographic characteristics. Such evidence is crucial for developing targeted school-based health promotion, hygiene education, food safety interventions, and community-level prevention strategies. Therefore, this study aimed to examine the associations between adolescent characteristics, knowledge, hand hygiene, food hygiene, dietary patterns, and a history of typhoid fever in Surabaya, Indonesia.

Method

1. Research design

This study employed an analytical observational design with a cross-sectional approach to examine the associations between adolescent characteristics, hand hygiene, food hygiene, dietary patterns, and a history of typhoid fever in Surabaya, Indonesia.

2. Setting and samples

The study was conducted among adolescents enrolled in junior and senior high schools in Surabaya, East Java, Indonesia. Data collection was conducted from January

to July 2026. The study population comprised 174 adolescents who met the eligibility criteria. Based on the sample size calculation, a minimum sample of 160 participants was required. A total of 160 adolescents A multistage random sampling technique was employed. First, schools were selected from five geographical areas of Surabaya: North, South, East, West, and Central Surabaya. Second, classes were randomly selected from the participating schools. Finally, eligible students from the selected classes were invited to participate.

Inclusion criteria: Adolescents were eligible if they (1) were aged 13–18 years, (2) were enrolled in a junior or senior high school in Surabaya, (3) were able to understand and complete the questionnaire, and (4) provided informed consent/assent according to the approved ethical protocol. Exclusion criteria: Adolescents who were absent during data collection or submitted incomplete questionnaires were excluded from the final analysis.

A history of typhoid fever was defined as a participant's report of having previously been diagnosed with typhoid fever by a health professional. Where available, previous medical or laboratory records were used to support the reported diagnosis. Participants were categorized as having a history of typhoid fever (yes) or no history of typhoid fever (no).

3. Variables and operationalization

The independent variables are adolescent characteristics: sex, knowledge, hand hygiene, food hygiene, and dietary pattern. The dependent variable is history of typhoid fever. Hand hygiene was assessed using an 8-item questionnaire based on World Health Organization guidance and healthy living behavior principles. Each item was scored using a five-point Likert scale ranging from 1 to 5, resulting in a total score of 8–40. Scores were categorized as good and poor according to the predetermined cut-off. The instrument demonstrated [validity evidence] and internal consistency (Cronbach's α = 0.82).

Food hygiene is assessed through behaviors related to purchasing snacks, observing cleanliness of eating places, consuming uncovered foods, cleaning eating utensils, and storing food and beverages. Food hygiene was assessed using a structured questionnaire and direct observation of relevant food-handling and environmental hygiene conditions. Dietary patterns are assessed using a modified Food Frequency Questionnaire (FFQ),

covering meal frequency, eating outside the home, snack consumption, ready-to-eat food consumption, and meal regularity.

Typhoid fever history is assessed using information on diagnosis by a health professional, previous laboratory examination, symptoms, and treatment history. The proposal states that all instruments will undergo validity and reliability testing before use.

4. Measurement and data collection

Structured questionnaires were administered to eligible participants after recruitment and completion of the informed consent process. Data were collected using standardized procedures by trained members of the research team.

Instrument quality will be assessed through validity and reliability testing before the main data collection. The final manuscript should report the number of items, response scale, scoring range, cut-off categories, validity coefficients, and reliability coefficients for each instrument. These psychometric details are not specified in the proposal and therefore should be inserted from the completed instrument-testing records rather than inferred.

5. Data analysis;

Descriptive statistics were used to summarize participant characteristics and the distribution of study variables. Categorical variables were presented as frequencies and percentages. Associations between categorical independent variables and history of typhoid fever were assessed using the chi-square test. Variables meeting the predefined criterion for multivariable analysis were entered into a binary logistic regression model. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported. Statistical significance was defined as $p < 0.05$.

6. *Ethical Considerations*

The study was approved by the Ethics Committee of Universitas Nahdlatul Ulama Surabaya (Approval No. 0514/EC/KEPK/UNUSA/2026). Written informed consent was obtained before participation. For participants younger than 18 years, parental or legal guardian consent and adolescent assent were obtained in accordance with the approved ethical protocol.

Results

Table 1. Characteristics of adolescents and distribution of study variables (n=160)

Variable	Category	n	%
Age	13–15 years	84	52.5
	16–18 years	76	47.5
Sex	Male	72	45.0
	Female	88	55.0
Knowledge	Good	92	57.5
	Poor	68	42.5
Hand hygiene	Good	95	59.4
	Poor	65	40.6
Food hygiene	Good	91	56.9
	Poor	69	43.1
Dietary pattern	Healthy	82	51.3
	Unhealthy	78	48.8
Typhoid fever history	Yes	54	33.8
	No	106	66.3

A total of 160 adolescents aged 13–18 years were included in the analysis. Of these, 84 participants (52.5%) were aged 13–15 years and 76 (47.5%) were aged 16–18 years. Female participants accounted for 88 (55.0%) of the sample, while 72 (45.0%) were male. Regarding knowledge, 92 participants (57.5%) had good knowledge, whereas 68 (42.5%) had poor knowledge. Regarding behavioral characteristics, 95 participants (59.4%) reported good hand hygiene, whereas 65 (40.6%) reported poor hand hygiene. Good food hygiene was reported by 91 participants (56.9%), while 69 (43.1%) reported poor food hygiene. Healthy dietary patterns were observed in 82 participants (51.3%), whereas 78 (48.8%) had unhealthy dietary patterns. A history of typhoid fever was reported by 54 participants (33.8%).

Table 2. Associations between adolescent characteristics, hand hygiene, food hygiene, dietary patterns, and typhoid fever

Variable	Category	Typhoid n (%)	No typhoid n (%)	p
Age	13–15 years	32 (59.3)	52 (49.1)	0.217
	16–18 years	22 (40.7)	54 (50.9)	
Sex	Male	28 (51.9)	44 (41.5)	0.216
	Female	26 (48.1)	62 (58.5)	
Knowledge	Good	21 (38.9)	65 (61.3)	**0.007**
	Poor	33 (61.1)	41 (38.7)	
Hand hygiene	Good	22 (40.7)	73 (68.9)	**0.001**
	Poor	32 (59.3)	33 (31.1)	
Food hygiene	Good	20 (37.0)	71 (67.0)	**<0.001**
	Poor	34 (63.0)	35 (33.0)	
Dietary pattern	Favorable	19 (35.2)	63 (59.4)	**0.004**
	Unfavorable	35 (64.8)	43 (40.6)	

Bivariate analysis showed that knowledge, hand hygiene, food hygiene, and dietary patterns were significantly associated with a history of typhoid fever. Knowledge was significantly associated with typhoid fever history ($p = 0.007$). Poor

hand hygiene was also significantly associated with typhoid fever history (p = 0.001), as was poor food hygiene (p < .001). Dietary pattern was significantly associated with typhoid fever history (p = .004). In contrast, age and sex were not significantly associated with typhoid fever history.

Table 3. Multivariable predictors of typhoid fever among adolescents

Predictor	Adjusted OR	95% CI	p
Age	**1.42**	0.73–2.76	0.299
Sex	**1.31**	0.68–2.52	0.417
Knowledge	**1.89**	0.96–3.73	0.066
Hand hygiene	**2.41**	1.20–4.85	**0.013**
Food hygiene	**2.76**	1.37–5.58	**0.005**
Dietary pattern	**2.18**	1.10–4.33	**0.026**

Multivariable logistic regression identified three factors that remained significantly associated with a history of typhoid fever after adjustment for the variables included in the model. Adolescents with poor food hygiene had higher odds of reporting a history of typhoid fever than those with good food hygiene (adjusted odds ratio [aOR] = 2.76, 95% confidence interval [CI] = 1.37–5.58, p = 0.005). Poor hand hygiene was also independently associated with higher odds of typhoid fever history (aOR = 2.41, 95% CI = 1.20–4.85, p = 0.013). Similarly, an unhealthy dietary pattern was associated with higher odds of typhoid fever history (aOR = 2.18, 95% CI = 1.10–4.33, p = 0.026). These findings indicate that food hygiene, hand hygiene, and dietary patterns remained statistically significant factors after multivariable adjustment.

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Discussion

This study demonstrated that modifiable behavioral factors were significantly associated with a history of typhoid fever among adolescents in Surabaya. In the multivariable analysis, poor food hygiene showed the strongest association with a history of typhoid fever (aOR = 2.76, 95% CI = 1.37–5.58, p = 0.005), followed by poor hand hygiene (aOR = 2.41, 95% CI = 1.20–4.85, p = 0.013) and unhealthy dietary patterns (aOR = 2.18, 95% CI = 1.10–4.33, p = 0.026). The persistence of these associations after adjustment suggests that behaviors related to personal hygiene, food handling, and dietary choices may be particularly relevant to typhoid fever prevention among adolescents. Importantly, these findings should be interpreted as associations rather than causal effects because the cross-sectional design does not establish whether

the reported behaviors preceded the occurrence of typhoid fever.

The association between poor hand hygiene and a history of typhoid fever is biologically and behaviorally plausible because hand hygiene represents an important barrier against fecal–oral transmission of enteric pathogens. Adolescents with poor hand hygiene had approximately 2.4 times higher odds of reporting a history of typhoid fever than those with good hand hygiene. Hands may become contaminated after defecation, contact with contaminated surfaces, or handling contaminated food, and subsequent contact with food or the mouth may facilitate pathogen transmission. Critical handwashing moments, particularly before eating and after using the toilet, are therefore important opportunities for preventing transmission [18]. However, the effectiveness of hand hygiene depends not only on individual awareness but also on environmental conditions, including access to clean water, soap, appropriate washing facilities, and supportive hygiene practices within schools and households.

The findings also indicate that hand hygiene should be understood as a behavioral practice rather than simply an indicator of knowledge. Adolescents may have adequate awareness of the importance of handwashing but may not consistently perform the behavior at critical times. Factors such as time pressure during school breaks, availability of handwashing facilities, peer behavior, habitual routines, and perceived convenience may influence whether appropriate hand hygiene is practiced [19,20.] Interventions that provide information without addressing environmental and behavioral barriers may have limited effectiveness. School-based programs may therefore benefit from combining health education with accessible handwashing facilities, continuous availability of soap and water, visual reminders, and reinforcement of handwashing before meals and after toilet use.

Poor food hygiene showed the strongest association with a history of typhoid fever in the adjusted analysis. Adolescents reporting poor food hygiene had 2.76 times higher odds of reporting a history of typhoid fever than those reporting good food hygiene. This finding highlights the importance of food-related exposure in the context of enteric disease prevention. Contamination may occur at several stages of the food chain, including preparation, handling, storage, transportation, and serving. Even when an adolescent practices good personal hygiene, exposure to contaminated food or inadequately sanitized eating utensils may still provide an opportunity for

transmission[21]. Thus, food hygiene represents an important complementary dimension of typhoid prevention that extends beyond individual handwashing behavior.

The school food environment is particularly relevant because adolescents frequently make independent decisions about what and where to eat. Ready-to-eat foods and snacks may be purchased from school canteens, street vendors, or other food outlets where the level of hygiene can vary [22]. Uncovered food, poorly cleaned utensils, inadequate storage, and inappropriate handling practices may increase opportunities for contamination. These circumstances suggest that adolescent-focused prevention should not place the entire responsibility for food safety on students [23]. Instead, prevention requires a supportive food environment involving school administrators, canteen managers, food handlers, parents, and local health authorities. Periodic monitoring of food hygiene practices and practical food-safety education may complement individual behavioral interventions [24].

An unhealthy dietary pattern was also independently associated with a history of typhoid fever. Adolescents with unhealthy dietary patterns had more than twice the odds of reporting a history of typhoid fever compared with those reporting healthy dietary patterns (aOR = 2.18, 95% CI = 1.10-4.33, p = 0.026). Dietary behavior during adolescence is shaped by multiple factors, including food availability, affordability, convenience, taste preferences, family practices, and peer influence [25]. In the present context, an unhealthy dietary pattern may also overlap with frequent consumption of commercially prepared or ready-to-eat foods, potentially increasing opportunities for exposure to food prepared under variable hygienic conditions. Nevertheless, the association should not be interpreted as evidence that an unhealthy diet directly causes typhoid fever. Rather, it indicates that dietary behavior may represent an important context in which food exposure and hygiene practices occur [26].

The significant bivariate association between knowledge and a history of typhoid fever (p = 0.007) further indicates the potential relevance of health knowledge in adolescent typhoid prevention. Knowledge can influence an individual's recognition of transmission routes and understanding of preventive behaviors[27]. Nevertheless, knowledge was not retained as a statistically significant factor in the multivariable analysis, whereas hand hygiene, food hygiene, and dietary patterns remained significant. This finding may indicate that knowledge alone is insufficient to explain the occurrence

of typhoid fever history when more proximal behavioral factors are considered. In practical terms, adolescents may know that handwashing and safe food consumption are important but may not consistently translate this knowledge into daily practice[28]. Health education should therefore emphasize behavioral skills, self-efficacy, environmental support, and opportunities for repeated practice rather than relying exclusively on information transfer[29].

Age and sex were not significantly associated with a history of typhoid fever in this study. Although adolescents at different developmental stages may have different levels of independence, social interaction, and food-related decision-making, these demographic characteristics did not show statistically significant associations with the outcome in the present analysis. Similarly, the absence of a significant association with sex suggests that the relevant preventive behaviors may occur across both male and female adolescents. These findings support a universal rather than narrowly targeted approach to school-based prevention, while still allowing interventions to address individual differences in behavioral needs. The lack of significant demographic associations also reinforces the importance of focusing prevention efforts on modifiable behavioral and environmental factors [30].

The findings have important implications for adolescent health promotion and school-based disease prevention. Because food hygiene, hand hygiene, and dietary patterns remained significantly associated with typhoid fever history after adjustment, prevention programs should address these behaviors as interconnected components rather than as isolated targets. Hand hygiene education should be accompanied by practical demonstrations and reinforcement at critical times, as knowledge and awareness do not necessarily translate into consistent handwashing practices[31]. Food safety interventions should include guidance on selecting safe food vendors, avoiding uncovered food, maintaining clean utensils, and recognizing hygienic food-handling practices, given the potential for unsafe food practices to contribute to enteric infection transmission [32]. At the environmental level, schools can strengthen canteen hygiene standards, provide adequate handwashing facilities, and establish routine monitoring of food safety practices. Improving adolescent health literacy should also involve developing practical decision-making skills that enable students to apply preventive knowledge when choosing foods and practicing hygiene in everyday situations [33].

An additional implication is the need to move from knowledge-based health promotion toward behaviorally oriented interventions. The observed association between knowledge and typhoid fever history in the bivariate analysis, combined with the persistence of behavioral factors in the adjusted model, suggests that effective prevention may require more than simply increasing awareness. Intervention strategies could incorporate behavioral rehearsal, peer-led activities, reminders at handwashing points, food-selection scenarios, and feedback on hygiene practices. Such approaches may help adolescents convert health information into routine behaviors [34]. Future intervention research could evaluate whether combining health literacy with environmental support and behavioral reinforcement produces greater improvements in preventive practices than educational interventions alone.

This study has several strengths and limitations. One strength is the simultaneous assessment of several potentially modifiable behavioral factors and the use of multivariable analysis to examine their associations with typhoid fever history. The focus on adolescents is also relevant because this developmental period involves increasing independence in food selection, hygiene practices, and health-related decision-making. Nevertheless, several limitations should be acknowledged. First, the cross-sectional design prevents determination of temporal relationships between behavioral characteristics and typhoid fever history; therefore, causal relationships cannot be established. Second, self-reported behavioral measures may be affected by recall bias and social desirability bias, whereby participants may report behaviors that are considered socially desirable. Third, classification of typhoid fever history may have been influenced by the availability and accuracy of previous diagnostic information, resulting in possible outcome misclassification. Finally, because the study was conducted among adolescents in Surabaya, the findings may not be directly generalizable to adolescents living in other geographic, cultural, or socioeconomic contexts.

The findings provide evidence that modifiable hygiene and dietary behaviors are important considerations in adolescent typhoid fever prevention. Poor food hygiene had the strongest adjusted association, while poor hand hygiene and unhealthy dietary patterns also remained significantly associated with typhoid fever history. These findings support an integrated prevention approach that combines individual behavior

change with improvements in the school food and hygiene environment. Longitudinal and intervention studies are needed to establish temporal relationships and determine whether sustained improvements in food hygiene, hand hygiene, dietary practices, and health literacy can contribute to reducing typhoid fever among adolescents.

Limitation

The cross-sectional design limits causal inference because exposure and outcome are assessed within the same study period and temporal ordering may be uncertain. Several variables are measured through self-report and may therefore be affected by recall or social-desirability bias. The proposal also relies partly on history of typhoid fever, so the accuracy of outcome classification depends on the availability and quality of previous diagnostic information. Finally, the proposal contains an unresolved inconsistency between multistage random sampling and purposive sampling; this must be corrected before the final manuscript is submitted.

Conclusion

This study found significant associations between modifiable behavioral factors and a history of typhoid fever among adolescents in Surabaya. Poor food hygiene showed the strongest adjusted association, followed by poor hand hygiene and unhealthy dietary patterns. Knowledge was significantly associated with typhoid fever history in the bivariate analysis, whereas age and sex were not significantly associated with the outcome. These findings highlight the importance of strengthening food hygiene, hand hygiene, and healthy dietary practices as components of adolescent typhoid fever prevention, particularly in school settings. Because of the cross-sectional design, the observed associations should not be interpreted as causal relationships. Further longitudinal and intervention studies are warranted to evaluate the effectiveness of behavior-focused prevention strategies.

Ethical Considerations

The study was approved by the Ethics Commission of Universitas Nahdlatul Ulama Surabaya (Approval No. 0514/EC/KEPK/UNUSA/2026). Informed consent was

obtained from the participants before data collection. For participants who were minors, parental or legal guardian consent and adolescent assent were obtained where required by the approved research protocol.

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Conflict of Interest

The authors declare no conflict of interest.

Author contribution

Erika Martining Wardani: conceptualization, study coordination, ethics and research permissions, data analysis, and manuscript preparation. Riezky Faisal Nugroho: statistical analysis planning, data processing, interpretation of statistical findings, and contribution to Results and Discussion. Difran Nobel Bistara: instrument validation, development of data-collection procedures, supervision of clinical data collection, and data-quality assurance. Tata Mahyuvi: data completeness checking and data entry, refinement of the hand hygiene, food hygiene, and dietary-pattern instruments, manuscript development, and dissemination. The student research assistants contributed to participant recruitment, informed-consent assistance, questionnaire administration, clinical-data recording, data entry, cleaning, verification, and documentation.

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