ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2019 Oct 15; 7(19):3302-3306.
https://doi.org/10.3889/oamjms.2019.721
eISSN: 1857-9655
Public Health

Modelling of Risk Factors Associated with Foodborne Disease among School-Aged Children in Medan, Indonesia

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Citation: Lubis NDA, Amelia S, Arrasyid NK, Rozi MF. Modelling of Risk Factors Associated with Foodborne Disease among School-Aged Children in Medan, Indonesia. Open Access Maced J Med Sci. 2019 Oct 15; 7(19):3302-3306.
https://doi.org/10.3889/oamjms.2019.721

Keywords: Handler; Risk; School; Bacteria; Parasite

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Received: 19-Jun-2019; **Revised:** 23-Sep-2019; **Accepted:** 24-Sep-2019; **Online first:** 12-Oct-2019

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Foodborne disease (FBD) contributes several outbreaks worsening health quality of world population. Many risk factors associated with FBD are related to its processing, preparation, and storage as well as handling practice.

AIM: The study aimed to evaluate several proposed risk factors of foodborne disease existed among school-aged children and food-handlers in the school environment.

MATERIAL AND METHODS: The descriptive cross-sectional study enrolled 124 students consisting of 64 females and 60 males in two different public schools, 064024 and 066656, Medan, Indonesia, between April and August 2018. The bacterial and parasitological examination was carried out in Microbiology and Parasitology Department. Food-handlers were assessed their appropriateness using standardised questionnaire merit to the guidelines enacted by the Ministry of Health, Indonesia (Kepmenkes RI No.942 / Menkes / SK / VII / 2003 adapted from WHO guidelines) entitled food-handlers sanitation-hygiene requirement guidelines. Data analysis was conducted using logistic regression.

RESULTS: The study obtained that there were no food-handlers performed basic principles rules producing high-risk environment and posing a threat to children. Suspected-FBD also found in 55 or 44.4% students, and it was significantly related to several risk factors such as nail hygiene, knowledge level, nail-trimming behaviour, and hand-washing behaviour among students. Data analysis revealed modeling risk factor, Y = 23.440 + 2.003 (Nail hygiene) + 1.294 (Knowledge level) + 5.025 (Nail trimming behavior) + 7.007 (Hand-washing behavior) from logistic regression equation.

CONCLUSION: Poor hygiene and sanitation of food-handlers and children per se provide a supportive environment in producing FBDs.

Introduction

Foodborne disease or FBD frequently occur in the region which its local population neglects the hygiene and sanitation of their food preparation. It was found higher in the developing country, including Indonesia, where food-handling practice does not perform adequately [1]. World Health Organization defines FBD as infectious disease produced after the ingestion of food containing pathogenic microbial or its toxin [2]. Several microorganisms can cause FBD such as bacteria, and parasites while virus and bacterial toxin commonly produce FBD symptoms with negative test results, so the results of an individual suspected for FBDs are not uncommonly conclusive. Hence, advanced laboratory examination is inevitable to establish an accurate diagnosis, spend a much longer time [3]. There are several bacterial species including *Campylobacter sp*, *Listeria monoctyogenes*, *Salmonella enterica* or nontyphoidal, Shiga toxin-producing *Escherichia coli* O157: H7, *Yersinia enterocolitica*, or Norovirus with incidence 13.82, 0.26, 15.18, and 1.15 per 100,000 people respectively contribute to the high prevalence of FBDs worldwide [4], [5].

Several outbreaks have been underreported and neglected by the local authorities relating to its

difficult diagnosis [6]. However, it is estimated that 1 in 6 Americans has one episode of FBD with 128.000 hospitalisation and 3.000 deaths, most of its sufferer are children younger than five years old or school-aged children in the United States [7]. Meanwhile, there is little evidence of FBD surveillance in Indonesia, but the Indonesia food governmental agency noted the occurrence of FBD outbreak of 39.92% among food-related disease [8].

Although it is preventable, FBDs still becoming a neglected disease that directly impedes the world communities in achieving sustainable development goals or SDGs by 2030, second (zero hunger) and third point (good health and well-being). The point includes “end hunger and ensures access by all people, in particular, the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round” in the second point which directed to zero poor health outcome of the population caused by unsafe food handling practice. Therefore, the FBDs eradication and its prevention could benefit the country in the aspect of SDGs achievement [9]. Additionally, several short- and long-term health complications consisting of mild until life-threatening condition such as bacteremia, arthritis, kidney disease, or central nervous system infection can also reduce people’s quality of life [10].

Indonesia, through the Ministry of Health, has legalised several basic principal rules No.942 / Menkes / SK/VII / 2003 entitled guidelines for food-handlers sanitation-hygiene requirement similarly adapted from WHO guidelines [11]. Nevertheless, the continuance of the food-handlers to the guidelines remains questionable. Therefore, prompt strategy to improve several factors lead to the incidence of FBDs is compulsory. It could help the authority to strategise the prevention approach [12], [13]. The study aimed to provide the analysis of FBD risk factors in the school environment by assessing food-handlers, student behaviour, and their knowledge levels related to food hygiene and sanitation.

Material and Methods

The cross-sectional study enrolled 124 students consisting of 64 females and 60 males in two different public primary schools in Medan, Indonesia (identifier 064024 and 066656) between April and August 2018. Direct observation was performed in the school environment involving students and food handlers. The study also obtained written informed consent from all participant included in the study without any coercion. Sample collection was conducted by the total sampling technique of the fifth and sixth grade in the school marked their eligibility to answer several questions. A brief explanation was also carried out before the observation. Finally, of 147 students, only 124 give their guardian approval of the study.

Proposed risk factors

There were several proposed-risk factors of foodborne disease in school-aged children evaluated during the study. The risk factor evaluated during the observation consisting of nail hygiene, nutritional status, knowledge level, nail trimming, and hand-washing behaviour. Knowledge level of students was measured using a standardised questionnaire in the previous study. It contains 15 closed questions in Indonesia language, such as the adequacy of nutritious food, food as a source of energy, carbohydrate, protein, cholesterol, starch, calcium, and healthy diet or its consumption handled in school environment particularly by food-handlers [14]. The interpretation has created three categories of levels based on the correct answer given by respondents in percentage (76-100%, high; 56-75%, moderate; and < 56%, low). Anthropology measurement (weight and height) was noted in addition to the children behaviour towards hygiene and sanitation. Food-handler behaviour was assessed using food-handlers sanitation-hygiene requirements guidelines of Ministry of Health, Republic of Indonesia (Identifier: Kepmenkes RI No.942 / Menkes / SK / VII / 2003) [11]. The rules consist of requirements in hand-washing practice, hand and cloth hygiene, several protections used while food-handling practice (apron or head-cover), equipment hygiene, behaviour, water availability, and any related illnesses of the food-handlers (cough and sneezing) (Appendix 1).

Parasitological and bacterial examination

Direct-swab of hands and their equipment was carried out to determine any pathogenic bacterial species contaminates food-handlers followed by the inoculation onto two types of agar, blood and McConkey (Oxoid, Basingstoke, United Kingdom). Any positive culture underwent further identification using gram staining, and biochemical reaction analysis for Enteric pathogen. Faecal samples of the students were examined for its positivity of any parasitic (Kato-Katz method, lugol, trichrome, and modified-acid fast staining) and bacterial manifestations (faecal culture).

Foodborne illnesses

A descriptive questionnaire consisting of closed questions such as respondent, guardian/parent's identity, the frequency of food consumption handled by food-handlers as well as FBDs symptomatology was used to determine any presence of FBDs. The assumption was created after

the evaluation revealed that there were no food-handlers abided to the guidelines of hygiene-sanitation guidelines of the Ministry of Health, Republic of Indonesia. Therefore, exposure to the high-risk environment for FBDs was evident. Consequently, an individual with gastrointestinal tract symptoms (nausea, vomiting, abdominal pain, and diarrhoea) and pathogen manifestation (parasitic and bacterial positive examination) was diagnosed with foodborne illness or food poisoning, therefore, so-called 'suspected foodborne disease' also used as the dependent variable [14].

Statistical analysis and study approval

The study used the Statistical Package for Social Sciences 21 (SPSS Inc.version 21). Each variable which had p-value < 0.25 from bivariate analysis would include in the multivariate using logistic regression for proposed risk factors. The variation inflation factor (VIF) measurement for no more than 10 aimed to avoid multicollinearity or inter-variable relationships in modelling logistic regression analysis. The study was also approved and registered by the local ethical committee for medical research, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia (identifier: 265 / TGL / KEPK FK USU-RSUPHAM / 2018)

Results

Baseline characteristics

Food-handlers behavioural evaluation was conducted using hygiene-sanitation guidelines of Ministry of Health, Republic of Indonesia. Based on the guidelines, there were no food-handlers performed their handling practice per the rules causing the exclusion of the variable from the analysis. A total sampling of food-handlers in the school environment proved that 22 of food-handlers had taken part in FBD transmission. Equipment and hands of the food-handlers have positive culture results for *Escherichia coli, Klebsiella pneumonia,* and *Staphylococcus aureus* (skin commensal). The results of culture examination support the evidence of a high-risk environment for school-aged children.

Baseline characteristics of students enrolled in the study were depicted in Table 1. Parasitological identification found that several species consisting of soil-transmitted helminth and intestinal protozoa infected school-aged children in the environment, *Blastocystis hominis* and *Giardia lamblia* is the most prevalent infection. Besides, there was one student who positive for *Hymenolepsis nana* infection. In total, there were 24 or 19.35% of students proved its parasitic manifestation in the study. There were 55 or 44.4% of the students stated as suspected-food borne disease related to positivity of foodborne disease symptomatology and pathogen existence.

Table 1: Baseline characteristics of the students included in the study

Characteristics	Total N (%) or Mean (SD)
Gender	
Male	60 (48.39)
Female	64 (51.61)
Weight (kg)	34.9 ± 9.30
Height (cm)	140.6 ± 8.65
Nutritional status (Weight/Height)	
Obese	21 (16.93)
Normal	70 (56.45)
Wasted	27 (21.77)
Severely wasted	6 (4.83)
Knowledge level	
High	100 (80.64)
Moderate	23 (18.54)
Low	1 (0.80)
Parasitological species	
Ascaris lumbricoides	1 (4.35)
Hookworm	1 (4.35)
Trichuris trichiura	2 (8.69)
Blastocystis hominis	13 (56.52)
Giardia lamblia	6 (26.10)
Total	23 (100)

Proposed risk factors associated with suspected foodborne disease

Based on logistic regression analysis, it was found the value of 0.954 as determination coefficient (R squared). It was referred that five independent variables could explain the variable variation of risk factors related to foodborne disease among students. Then, as a result of F test was shown in p-value = 0.001, it indicated that alpha as much as 5% had been fulfilled and defined as a suitable regression model with the provided data. The formula is based on table two which shown the final analysis of logistic regression in the study, Y = 23.440 + 2.003 (Nail hygiene) + 1.294 (Knowledge level) + 5.025 (Nail trimming behavior) + 7.007 (Hand-washing behavior). The prediction of having foodborne diseases could be performed by looking into the resulted formula.

Table 2: Multiple logistic regression analysis of various risk factors associated with foodborne disease

Variables	OR	p-value	Collinearity Statistic (VIF)	95% CI
Constant	23.440	0.395		
Nail hygiene	2.003	0.038	1.203	1.085-3.398
Knowledge level	1.294	0.001	5.027	0.621-2.877
Nail trimming behavior	5.025	0.027	1.278	3.291-6.290
Hand-washing behavior	7.007	0.048	1.592	3.896-9.025

Discussion

The study has resulted in a proposed risk factor equation for FBDs among school-aged children in the two different school environments. The analysis was based on the assumption of gastrointestinal tract symptoms and pathogen manifestations of bacterial and parasitic species. Therefore, the terms 'suspected-food borne disease' was used for the study. FBDs have been neglected because of its lack

of features and self-limiting properties unless it emerges as an outbreak. There have been a few guidelines precisely defining foodborne diseases, so the negative results of several tests do not automatically exclude the patients from FBD diagnosis. The surveillance system in developed countries has provided for excellent tools shaping a prevention method for FBDs among their population. In the United State, the official has recorded the outbreak surveillance since 1973 [15], [16], [17]. In Canada, there were approximately 2.4 million people diagnosed with FBD with unknown causative agents, partly because of the diverse range of the agent, mainly toxin or food-substance producing negativity [18].

The arrangement of an outbreak surveillance system, as well as risk factors analysis, provides an accurate approach to prevent and eradicate FBDs among the susceptible population [19]. Nevertheless, the intricate diagnosis of FBDs has challenged the researcher to proposed new rules in predicting the risk factors. The risk factor analytical study usually uses the contamination of food product as dependent variables. A study involved dining hall assessment in Shah Alam, Malaysia has determined the presence of FBD risk factor, it was found that safe food source and personal hygiene were in an acceptable level while storage temperature and cross-contamination still below in standard level [20]. While a study reviewed foodborne outbreaks during 2000-2010 found that contamination factors (food safety practices) including direct-hand contact by infected food-handlers still played a pivotal role, causing school season outbreaks [13]. Our study did not divide the proposed risk factors into three parts of food processing; hence, it emphasised on the transmission among the children who perform the appropriate method of self-hygiene and sanitation.

In Japan, Michino and Otsuki conducted a study among school-aged children, it was proved that 29 incidents of contaminated food items similarly occurred as the findings of nine infected food-handlers. The study analyzed outbreaks in Japan commonly started from mass food-handling practice involving food-handlers in elementary school or nursery school [21]. Moreover, the cross-contamination of some food products was evident in Indonesia. Widjaja et al., determined that fecal contamination of drinking water (65%), dishwater (91%), and ice cubes (100%) were highly prevalent in its population. They identified no hand-washing practice, direct hand contact with foods, use of unsterilized ice cubes, gender preference of male with poor handling, and low educational background as the prominent characteristic of food-handlers enrolled in the study [22]. Food-handlers involve in a particular stage of disease transmission, and it is emphasized from literature, improper sources of food and its handling is the most common risk factors present during the outbreak [23]. Based on the World Health Organization (WHO), food handler is any person who directly involved in a food business who handles food including its packaging, food equipment, or the substance contact surfaces. The shedding of the pathogen mostly occurred during handling practice resulting in surpassing the infective dose to create symptomatology disease. The different line of toxin triggering symptoms of FBDs take place during the proliferation of any pathogen in the food product, it produces symptoms impromptu from a certain period of minutes or hours after ingestion [24]. There are some studies showed that several factors in promoting FBDs among general population besides infected food-handlers including improper storage and cooking process, poor experience staff, poor hygiene condition, cross-contamination, and raw ingredient contamination are analysed in all outbreak form [25], [26].

Based on the study, several proposed risk-factors significantly related to suspected foodborne disease among the school-aged children in the study location. Furthermore, an approach has created fundamental parts in diagnosing FBD. Albeit, it also remains uncertain problems for several decades, causing the surveillance are scarcely conducted in the developing region. Whereas food-handling practice still did not perform adequately, and higher prevalence of FBD occurs in the country without any formal notification. Therefore, establishing and initiating prompt prevention methods is mandatory to tackle FBD among the population. The study also did not escape the limitation since there are no clear guidelines to determine FBD as diagnosis, so the assumption was created to provide further analysis.

References

1. On SL, Rahayu WP. Estimates for the burden and costs of foodborne diarrhoeal illness in Indonesia. 2017; 3(1):3-16.

2. World Health Organization. Foodborne disease outbreaks: guidelines for investigation and control. World Health Organization; 2008.

3. Centers for Disease Control and Prevention, "Incidence and Trends of Infection with Pathogens Transmitted Commonly Through Food: Foodborne Diseases Active Surveillance Network, 10 U.S. Sites, 1996-2012. Morb Mortal Wkly Rep. 2013; 62(15):283-7.

4. Kalyoussef S, Feja KN. Foodborne illnesses. Adv Pediatr. 2014; 61(1):287-312. https://doi.org/10.1016/j.yapd.2014.04.003 PMid:25037134

5. Vasickova P, Dvorska L, Lorencova A, Pavlik I. Viruses as a cause of foodborne diseases: a review of the literature. Veterinární medicína. 2005; 50(3):89-104. https://doi.org/10.17221/5601-VETMED

6. Switaj TL, Winter KJ, Christensen SR. Diagnosis and Management of Foodborne Illness. Am Fam Physician. 2015; 92(5).

7. Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson M-A, Roy SL, et al. Foodborne illness acquired in the United States-major pathogens. Emerging infectious diseases. 2011; 17(1):7.

https://doi.org/10.3201/eid1701.P11101 PMid:21192848 PMCid:PMC3375761

8. Badan Pengawas Obat dan Makanan (National Agency of Drug and Food Control). Laporan tahunan. In: Department H, editor. Samarinda2011.

9. World Health Organization. Health and sustainable development: Key health trends. Geneva: World Health Organization; 2002.

10. Batz MB, Henke E, Kowalcyk B. Long-term consequences of foodborne infections. Infectious Disease Clinics. 2013; 27(3):599-616. https://doi.org/10.1016/j.idc.2013.05.003 PMid:24011832

11. Departemen Kesehatan Republik Indonesia (Department of Health, Republic of Indonesia). Keputusan menteri kesehatan Republik Indonesia nomor 942/MENKES/SK/VII/2003 (Guidelines for food hygiene sanitation requirements), 2003. Available from: http://dinkes.surabaya.go.id/portal/files/kepmenkes/Kepmenkes%20942-MENKES-SK-VII-2003-Makanan%20Jajanan.pdf

12. Lukacsovics A, Hatcher M, Papadopoulos A. Risk Factors and Surveillance Systems for Foodborne Illness Outbreaks in Canada. National Collaborating Centre for Environmental Health; 2014.

13. Venuto M, Garcia K, Halbrook B. Analyses of the Contributing Factors Associated With Foodborne Outbreaks in School Settings (2000-2010). J Env Health. 2015; 77(7).

14. Suharsimi A. Prosedur penelitian suatu pendekatan praktik. Jakarta: Rineka Cipta. 2006.

15. Bean NH, Griffin PM. Foodborne disease outbreaks in the United States, 1973-1987: pathogens, vehicles, and trends. J Food Protect. 1990; 53(9):804-17. https://doi.org/10.4315/0362-028X-53.9.804 PMid:31018312

16. Centers for Disease Control and Prevention (CDC). Surveillance for foodborne disease outbreaks--United States, 2009-2010. MMWR. Morbidity and mortality weekly report. 2013; 62(3):41.

17. American NA, American Medical Association. Diagnosis and management of foodborne illnesses: a primer for physicians and other health care professionals. MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports. 2004; 53(RR-4):1.

18. Adak GK, Meakins SM, Yip H, Lopman BA, O'Brien SJ. Disease risks from foods, England and Wales, 1996-2000. Emerg Infect Dis. 2005; 11(3):365. https://doi.org/10.3201/eid1103.040191 PMid:15757549 PMCid:PMC3298246

19. Thomas MK, Murray R, Flockhart L, Pintar K, Pollari F, Fazil A, et al. Estimates of the burden of foodborne illness in Canada for 30 specified pathogens and unspecified agents, circa 2006. Foodborne pathog Dis. 2013; 10(7):639-48. https://doi.org/10.1089/fpd.2012.1389 PMid:23659355 PMCid:PMC3696931

20. Musa M, Jusoff K, Khalid K, Patah MO, Anuar J, Zahari H. Food Borne Illness Risk Factors Assessment in UiTM Shah Alam, Malaysia. World Appl Sci J. 2010; 8(7):864-70.

21. Michino H, Otsuki K. Risk factors in causing outbreaks of foodborne illness originating in schoollunch facilities in Japan. Journal of Veterinary Medical Science. 2000; 62(5):557-60. https://doi.org/10.1292/jvms.62.557 PMid:10852411

22. Vollaard AM, Ali S, van Asten H, Ismid IS, Widjaja S, Visser L, et al. Risk factors for transmission of foodborne illness in restaurants and street vendors in Jakarta, Indonesia. Epidemiol Infect. 2004; 132(5):863-72. https://doi.org/10.1017/S0950268804002742 PMid:15473149 PMCid:PMC2870173

23. Greig JD, Todd EC, Bartleson CA, Michaels BS. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 1. Description of the problem, methods, and agents involved. J Food Prot. 2007; 70(7):1752-61. https://doi.org/10.4315/0362-028X-70.7.1752 PMid:17685355

24. World Health Organization. Five keys to safer food manual. 2006.

25. Sockett PN, Rodgers FG. Enteric and foodborne disease in children: a review of the influence of food-and environment-related risk factors. Paediatr Child Health. 2001; 6(4):203-9. https://doi.org/10.1093/pch/6.4.203 PMid:20084237 PMCid:PMC2804543

26. World Health Organization. Strengthening surveillance of and response to foodborne disease: a practical manual. Geneva: World Health Organization, 2017:96. Available from: https://apps.who.int/iris/bitstream/handle/10665/259476/9789241513265-eng.pdf?sequence=1&isAllowed=y

Appendix 1

The Decision of The Ministry of Health of Republic of Indonesia (Identifier: 942/MENKES/SK/VII/2003) on the requirement of hygiene and sanitation against food handlers

Chapter II

Food Handler

Article 2

Food handlers during handling practice must meet the minimum requirement, such as (8 points):

a. Do not suffer from infectious disease, shown by the symptoms: cough, sneeze, diarrhea, and any other gastrointestinal tract symptoms
b. No skin wound without its coverage (for open wound/ carbuncle or other types of wounds)
c. To ensure hand, hair, nail and cloth hygiene
d. Using the protection (apron and headcover)
e. Hand-wash behavior before handling
f. To provide adequate equipment including utensil for food picking tools or hand mat
g. Not to smoke and directly scratch the body (ear, nose, mouth, or other parts of the human body)
h. Not to sneeze and cough in front of food products without closing mouth and nose