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An Epidemiological Study on an Outbreak of Gastroenteritis Linked to Dinner Served at a Senior High School in Accra

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***Abstract*—**Background: An outbreak of gastroenteritis occurred in December 2019 after students of a Senior High School in Accra were served with kenkey and fish during their dinner. An investigation was conducted to characterize the affected people, the source of contamination, the etiologic food and agent. Methods: An epidemiological study was conducted with cases selected from the student population who were ill. Controls were selected from among students who also ate from the school canteen during dinner but were not ill. Food history of each case and control was taken to assess their exposure status. Epi Info 7 was used to analyze the data obtained from the outbreak. Attack rates and odds ratios were calculated to determine the risk of foodborne infection for each of the foods consumed by the population. The source of contamination of the foods was ascertained by conducting an environmental risk assessment at the school. Results: Data were obtained from 126 students, out of which 57 (45.2%) were cases and 69 (54.8%) were controls. The cases presented with symptoms such as diarrhea (85.96%), abdominal cramps (66.67%), vomiting (50.88%), headache (21.05%), fever (17.86%) and nausea (3.51%). The peak incubation period was 18 hours with a minimum and maximum incubation periods of 6 and 50 hours respectively. From the incubation period, duration of illness and the symptoms, non-typhoidal salmonellosis was suspected. Multivariate analysis indicated that the illness was associated with the consumption of the fried fish served, however this was statistically insignificant (AOR 3.1.00, P = 0.159). No stool, blood or food samples were available for organism isolation and confirmation of suspected etiologic agent. The environmental risk assessment indicated poor hand washing practices on the part of both the food handlers and students. Conclusion: The outbreak could probably be due to the consumption of the fried fish that might have been contaminated with *Salmonella* sp. as a result of poor hand washing practices in the school.

***Keywords*—**Case control study, food poisoning, handwashing, *Salmonella,* school.

I. Introduction

EATING foods contaminated with pathogens can result in foodborne diseases. Over the years, a greater number of morbidity and mortality worldwide has been attributed to foodborne diseases (FBDs) [1]-[3]. More than 250 FBDs have been identified worldwide [4] and the prevalence varies from one locality to the other. Prevalence of waterborne/foodborne diseases among OPD cases at the Ridge hospital in Greater Accra Region of Ghana was 2.56% in 2013 and the age group 15–24 years had the highest number of cases [5].

A review on food safety and hygiene study in Ghana by Ababio et al. cited a report of the Ministry of Food and Agriculture and the World Bank in 2007. According to this report, one in every 40 Ghanaian suffer serious food borne illness per year of which 420,000 cases are reported with an annual death rate of 65,000 costing the government US $ 69,000,000.00 annually [6]. The review also revealed that 77% of traceable FBDs results from improper handling in food service establishments [6].

Symptoms of FBD usually occur between 2 to 72 hours after the consumption of contaminated food. The severity of FBDs is dependent on factors such as the causative organism, age of patients and the immunity of the affect person. Foods served during conferences, social events, restaurants as well as street vending and ones from school canteens have been implicated as the etiologic food in most FBD outbreaks [4], [6]-[11].

The burden of cooking under unhygienic conditions is enormous, affecting the confidence of consumers/public and consequently posing a threat on the socioeconomic development of the nation by straining health care systems, and harming national economies, tourism and trade. These outbreaks mainly occurred due to poor handling and storage practices by food handlers.

A. The Outbreak

The Food and Drugs Authority (FDA), during its daily scanning of media houses for rumors of foodborne outbreaks, observed a news item on a suspected FBD outbreak at a Senior High School in Accra on 3th December 2019. The news item indicated that over 100 students were experiencing various symptoms of food poisoning after consuming kenkey served at the school canteen. The Public Education and Foodborne Disease Surveillance Unit of Food Drugs Authority, in collaboration with the District Health Directorate for Korle Klottey Municipality, investigated the outbreak, with the aim of characterizing the affected people, determining the etiologic food, the source of contamination and the etiologic agent.

II. Method

A. Study Population and Design

The Public Education and Foodborne Disease Surveillance Unit of Food Drugs Authority, with assistance from the Ghana Field Epidemiology and Laboratory Training Programme

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(GFELTP) of the School of Public Health-Legon, collected incidence data on the food poisoning using the Foodborne Illness Reporting forms (FDA/FSMD/FM-FBD/2012/01) and these were used to develop a case definition (Any student suffering from symptoms of foodborne illness e.g. vomiting, diarrhea and/or abdominal cramps after eating dinner at the school's canteen on 2nd December, 2019). An active case search was conducted using the case definition. Controls were selected from among students who also ate from the school canteen during dinner but did not experience any symptoms of FBD. Food history of each case and control was taken to assess their exposure status. The data obtained were analyzed using Microsoft Excel 2016 and Epi Info 7. Attack rates and odds ratios were calculated and these were used to determine the risks of foodborne infection from the foods eaten. Bivariate and multivariate logistic regression was conducted to determine association between the various demographic characteristics and exposure factors. To determine the source of food contamination, an environmental risk assessment was conducted at the school's canteen and kitchen.

B. Data Processing and Analysis

Data were coded and refined using Microsoft Excel 2016 software. After checking for consistency and completeness of data, these records were then exported into Epi Info 7 and analyzed statistically. Baseline characteristics of the population were explored using simple descriptive method such as frequency distribution. The incubation period for the etiologic agent was determined by constructing an Epi Curve using the time of onset of symptoms in hours. To determine the risks of foodborne infection from the foods eaten, attack rates and crude odds ratios were calculated for each food item. Food showing association with the outcome was stratified to determine their adjusted odds ratios. P-value of 0.05 was set as significant level for all the analysis

C. Laboratory Analysis

Water for drinking at the school and for food preparation were sampled and analyzed for Total Viable Count, Total Coliforms, *E. coli*, *Pseudomonas aeruginosa* and *Clostridium perfringens*.

The laboratory analysis was conducted according to ISO standards. For Total Viable Count, ISO 6222:1999 was used. ISO 9308-1:2014 was used for analysing Total Coliforms and *E. coli*. ISO 16266:2006 and ISO 14189:2013 was used for analysing *Pseudomonas aeruginosa* and *Clostridium perfringens* respectively.

D. Sample Preparation-Total Viable Count

1 ml of each sample was taken with 9 ml of Maximum Recovery Diluent (MRD) to prepare serial dilution up to 10^{-4}. Each dilution was plated into four sterile petri dishes, making a total of 16 plates for each sample. About 15 ml of molten YEA agar cooled at 45 °C was then added, swirled and allowed to set. Plates were incubated at 37 °C and 22 °C respectively. Thus, two plates of each dilution were incubated at 37 °C and 22 °C. A total of 16 plates were incubated and examined for growth.

E. Sample Preparation-Total Coliform, E. coli, Pseudomonas aeruginosa, Clostridium perfringens

Samples were cleaned thoroughly with 70% alcohol mixed well and aseptically opened. 100 ml of the each sample was measured and filtered in the membranic filtration apparatus for *E. coli* and coliforms. 1 ml of the sample was taken with 9 ml of MRD to prepare serial dilution up to 10^{-4}. Each dilution was plated into four sterile petri dishes, making a total of 16plates for each sample per test parameter. About 15 ml of molten YEA agar cooled at 45 °C was added, swirled and allowed to set.

III. Results

A. Characteristics of Cases and Controls

Data were obtained from 126 students (Table I). Out of this population, 62 representing 49.2% were females and 64 representing 50.8% were males. The mean age of the population was 16 years (SD: 1.4, Range: 13-20). The population was mainly students from Senior High School (SHS) 1 and 3 classes who were in the school's hostel.

A total 57 students (45.2%) were classified as cases and 69 were classified as controls (54.8%). The cases presented with symptoms such as diarrhea (86.0%), abdominal cramps (66.7%), vomiting (50.88%), headache (21.1%), fever (17.9%) and nausea (3.5%). The earliest on-set of symptoms was reported around 1:00am of 3rd December, 2019 (7 hours after exposure) and the latest was around 8:00pm of 4th December, 2019 (50 hours after exposure).

47 of the cases (83.9%) needed medical attention and ten were self-limiting (16.1%). Out of the cases that sought medical attention, 37, representing 78.7% were hospitalized. Relatively equal number of males (50.9%) was affected as were females (49.1%). The mean age of the affected population was 16 years (SD: 1.5, Range: 13-20) with the age distribution as shown in Table I. The shape of the epicurve suggests a point source outbreak with minimum and maximum incubation period of 6 hours and 50 hours respectively. The peak incubation period was 18 hours (Fig. 1).

TABLE I
DISTRIBUTION OF CASES AND CONTROLS BY THEIR DEMOGRAPHIC CHARACTERISTICS

Demographic Characteristics	Cases(ill)		Controls (Not ill)		Total	
	No.	(%)	No.	(%)	No.	(%)
Sex						
Male	29	45.3	35	54.7	64	50.8
Female	28	45.2	34	54.8	62	49.2
Age						
13 - 15	17	29.8	16	23.2	33	26.2
16 - 18	35	61.4	47	68.1	82	65.1
>18	5	8.8	6	8.7	11	8.7
Class						
SHS 1	43	75.4	23	34.3	66	53.2
SHS 2	9	15.8	20	29.9	29	23.4
SHS 3	5	8.8	24	35.8	29	23.4
TOTAL	57	45.2	69	54.8	126	100

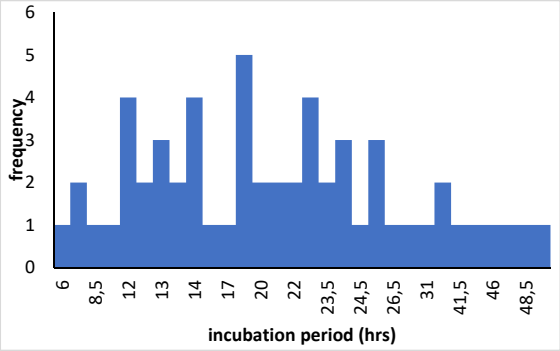

Fig. 1 Epi curve of An Outbreak of Gastroenteritis Linked to Dinner Served at a SHS in Accra-December 2019

B. Source of Food Borne Illness

The attack rates for all the foods were fairly the same (Table II), ranging from 48% to 52%. The highest attack rate was associated with the ground pepper, which recorded 52.3%. The bivariate analysis (Table III) indicated association between population ill and the consumption of all the food items served (Kenkey, fried fish and ground pepper). All these associations were statistically significant. The multivariate analysis indicated association between the population ill and the consumption of the fish, however this association was also statistically insignificant (AOR 3.1, P = 0.159).

TABLE II
DISTRIBUTION OF POPULATION AMONG THE VARIOUS FOODS CONSUMED

Food consumed	No. ill	No. not ill	Total population		Attack rate (%)
			n	%	
Kenkey	54	57	111	88.1	48.7
Ground Pepper	45	41	86	68.3	52.3
Fried Fish	53	51	104	82.5	51.0

TABLE III
BIVARIATE AND MULTIVARIATE ANALYSIS OF POPULATION WITH THE VARIOUS FOODS CONSUMED

Food consumed	Crude Odds Ratio	p-value	Adjusted Odds Ratio	p-value
Kenkey	3.8	0.036	1.5	0.62
Ground Pepper	2.6	0.019	1.3	0.60
Fried Fish	4.8	0.005	3.1	0.15

C. Laboratory Investigation: Causative Agent

Most patients who reported at various health facilities had clinical samples taken for laboratory analysis. However, the analyses were not to confirm the presence of foodborne pathogens. The clinical samples from all the cases tested negative for Rapid Diagnostic Test (RDT) for Vibrio Cholerae. The cases had started antibiotic treatment at the time of investigations. Hence clinical samples could not be obtained for further analysis.

Limited food samples were available at the time of investigation. Samples of suspected foods (kenkey, fish and ground pepper) were not available for laboratory assessment. However, laboratory analysis conducted on samples of water used in cooking operation and drinking showed compliance with the GS 175-1:2013 for Total Viable Count/370 C/48hrs/ YEA, Total Viable Count/220 C/72hrs/YEA, Total Coliform Count/370 C/24hrs/CCA, *E. coli* count/370 C/24hrs/CCA, *Pseudomonas aeruginosa*//370 C/24hrs/CA and *Clostridium perfringens*/440 C/24hrs/CA.

The probable etiologic agent associated with the etiologic food and having an average incubation period close to 6 – 50 hrs is salmonella (6-72 hours) [12]. Nontyphoidal *Salmonellosis* was the suspected disease condition.

D. Findings from Environmental Risk Assessments at Implicated Catering Facility

For kenkey preparation, Corn dough was purchased from the market on Saturday at about 1:30 pm and stored in the kitchen. The preparation of the 'Aflata' was done on Sunday when the sack of dough was opened. The kenkey was put on fire by mid-day on Monday and packed into each tables food flask 15 minutes to dinner. The cooking processes did not reveal any time-temperature abuse or possible contamination of the kenkey with *Salmonella* as the boiling temperature will have eliminated any *Salmonella* sp. present.

The fish that was served with the kenkey was bought on Monday at about 2:00 pm from a cold store and arrived at the school's kitchen by 3:00 pm. The fish was cut and washed in three different bowls filled with water, the last of which was salt water. The water was allowed to drain in a basket for about an hour covered with a white lace cloth. The frying of the fish started at about 4:00pm after which it was dished into individual bowl for serving at the canteen during dinner at 6:00pm. The cooking processes revealed time-temperature abuse prior to frying the fish; however, frying temperature will have eliminated any salmonella sp. present.

The ingredients used in the preparation of the 'Ground pepper' were pepper, tomato and onion. These were purchased from the market on Monday 2nd December and washed three times prior to blending each ingredient separately. A saucepan with vegetable oil is kept on fire and the blended ingredients were poured into it to simmer for about an hour and half. The pepper sauce was then dished out into bowls for serving. This cooking process did not reveal any time-temperature abuse or possible contamination of the pepper with *Salmonella* as the frying temperature will have eliminated any *Salmonella* sp. present.

After dishing out the food at the kitchen, each table's food is carried from the kitchen to the canteen by one person from that table. Students wash their hands in common bowls containing soapy water and rinse in a different bowl. The environmental assessment revealed that prior to the outbreak; the student population did not have soap and running water available to them for washing their hands. Hence, most of the students washed their hands without soap whiles others washed in the communal bowls with the soapy water.

The source of water for cooking operation was from the Ghana Water Company and the water is fetched prior to its usage.

IV. DISCUSSION

The epi curve indicates that the outbreak was a point source

outbreak and consistence with outbreaks that are caused by *Salmonella* sp. [13], [14]. Hence cholera could be ruled out and this was confirmed by the negative results from the RDT for cholera. The outbreak may be from food served and consumed at one particular time only. Thus, during the dinner served on 2nd December 2019. *Salmonella* sp. (6-72 hrs), *Bacillus cereus* (8-16 hrs) and *Clostridium perfringens* (6-24 hrs) were initially suspected, however, *Bacillus cereus* and *Clostridium perfringens* were ruled out. *C. perfringens* type of food poisoning is due to the production of the enterotoxin CPE, which is generated in the small bowel during sporulation of the ingested vegetative cells (at least 10^7). Symptoms include abdominal pain, nausea, and diarrhea which occur 6–24 hours after intake of contaminated food [15]. *C perfringens* is a spore forming bacteria that is relatively tolerant to cold temperature and the spores are heat resistant [16]. It is associated with cooked meat, poultry, gravy, sauces, meat containing soups, refried beans and the risk factors include storing cooked foods at room temperature; storing cooked foods in large containers in refrigerators; holding foods at warm (bacterial-incubating) temperatures; preparing foods several hours before serving; inadequate reheating of leftovers [17]. The risk factors were inconsistent with what was observed during the environmental assessment. The food was not cooked and stored at room temperature for some time before serving. This practice would have allowed the spores of *C. perfringens* to germinate and cause the foodborne illness.

Bacillus cereus, which is a spore forming bacteria, usually causes two form of food poisoning, diarrheal type and vomiting (emetic) type. The emetic type is caused by the toxins produced by the pathogen and has an onset time of 0.5 to 6 hours after consumption of contaminated food. Symptoms include nausea and vomiting [16]. Considering the shorter incubation period, the emetic type of *Bacillus cereus* was ruled out. The incubation period for the case was between six to 50 hours with the peak been at 18 hours. The diarrheal type mimics the symptoms of *C. perfringens* and this type is caused by the vegetative form of *Bacillus cereus.* This was also ruled out because it was inconsistent with the risk factors identified during the environmental assessment. The cooking temperatures of the food (Kenkey, Fried fish and ground pepper) would have eliminated most of vegetative form of *Bacillus cereus.*

Salmonella can cause two types of illness, depending on the serotype: nontyphoidal salmonellosis and typhoid fever [12]. The symptoms of the nontyphoidal salmonellosis are nausea, vomiting, abdominal cramps, diarrhea, fever and headache, which was consistent with the symptoms presented by most of the cases. The effective dose for *Salmonella* sp. causing non-typhoidal salmonellosis is as low as one cell and this is dependent on factors such as the age of the person, the immunity of host and strain differences among members of the genus [18], [19]. Route of entry is oral through the ingestion of contaminated food, fecal particles or contaminated water. Thus, it is spread through the fecal-oral route and through contact with contaminated water. *Salmonella* infection accounts for a large number of gastroenteritis worldwide [20]-[22]. Over 95% of illness of *Salmonella* infection are foodborne related, and nontyphoidal salmonellosis alone accounts for about 30% of mortality ensuing from foodborne illnesses in the United States [23]

Cross contamination occurs when *Salmonella* is spread from a contaminated source such as contaminated food or an infected food handler, to other foods being prepared or in storage as well as objects in the environment. For instance, potentially contaminated raw meats or poultry or eggs may contaminate other foods if not kept separate from each other during cooking or storage, or when utensils, work surfaces, equipment, and hands are not adequately cleaned by the food handler after they have come into contact with these products. The contamination can spread to other foods that come into contact with the contaminated kitchen surfaces and utensils. The cross contamination can occur at any point during the food preparation and serving.

The environmental assessment revealed that food handlers and student observe poor hand washing practices. This could be due to the lack of access to soap and running water for hand washing by the students and food handlers. Post process cross contamination may have occurred to the fried fish by the food handlers or the students due to the poor hand washing practices in the School. The fish was served using the bare hands and this could have facilitated the spread of the pathogen. The washing of hands in a communal bowl of water may have exposed the hands of the students to *Salmonella* sp. prior to the consumption of their food. It could also be that the fish was contaminated by a food handler during serving due to poor hand washing.

Studies in Ghana have shown that most food handlers have knowledge in hygienic practice but rarely use this knowledge in their daily activities [24]-[26]. Poor hand washing practices have been identified as a risk factor for most FBDs or gastroenteritis outbreaks [27]-[29]. One study in Ghana reported that 77% of traceable FBDs occurred as a result from improper handling of food by food handler in food service establishments including school canteens [30].

V. Conclusion

Confirmations of etiological agent for most foodborne/ waterborne disease outbreaks are often challenging since most of them are of mixed etiology and absence of food or clinical samples due to delays in investigations [31]-[35]. This outbreak could however be due to the consumption of the fried fish that was probably contaminated with *Salmonella* sp. as a result of poor hand washing practices in the school.

VI. Public Health Interventions

The school authorities have provided Veronica Buckets as a temporarily measure to enable the students and food handlers wash their hands under running waters. These buckets and other hand washing facilities have been equipped with soap for effective hand washing.

The FDA has also educated the entire student population together with some teaching staff on effective hand washing

and WHO's five keys to safer foods.

Acknowledgment

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Ethics and Consent to Participate

The investigation was conducted under the auspices of FDA. The Authority has the legal mandate to ensure public health and safety as well as ensure that all foodborne disease outbreaks are investigated. For this reason and the fact that this was an acute occurrence, which would have outrun its course by the completion of the ethical approval process, no ethical approval was sought.

Disclaimer

The authors declare that they have no competing interest as far as this work is concerned. All views expressed in this work are views of the authors and does not represent the views or position of any institution.

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