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Prevalence of Salmonellosis among Food Handlers and the Health Implications on the Food Consumers in Lagos State, Nigeria

Ogah JO[1], Adekunle OC[2]* and Adegoke AA[1]

[1]Department of Microbiology, Faculty of Sciences, University of Lagos, Nigeria
[2]Department of Microbiology and Parasitology, Faculty of Basic Medical Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

Abstract

Food borne diseases/illnesses (food borne infections) are global public health problem both in developed and developing countries such as Nigeria. Food handlers play an important role in the transmission of food-borne diseases. This research work is aimed to determine the prevalence of salmonellosis among food handlers and its implications on the health of food consumers in Lagos, Southwest Nigeria. Two hundred and thirty five (235) blood samples were collected into EDTA bottles from the food handlers at various locations in Victoria Island (Lagos Island) and Bariga (Lagos mainland) which were analyzed using standard methods. Questionnaires were distributed and collated among 235 respondents (food handlers) to test their knowledge on food safety. The results showed that 74 (31.5%) of the studied population had either previous or recent *Salmonella* infection as indicated by IgG and IgM anti-*Salmonella* immunoglobulin while 161 (68.5%) had neither recent nor previous infection. Ninety three (93) respondents were males while One hundred and forty two (142) were females of active working age bracket of 11-60 years old. Among 93 males screened, 26(28.0%) were infected, 67(72.0%) were not infected while 48(33.8%) females were infected out of 142 females screened for *Salmonella enterica* serovar Typhi and Paratyphi infections. Regression and T-test statistical analysis reviewed that since F cal>F tab (1.776>0.969) and t cal>t tab (6.5>5.0), it can be concluded that food handlers were not responsible for food borne infections but potential risk factors in Lagos, Southwest, Nigeria.

Keywords: Salmonellosis; Food infections; Immunoglobulin; *Salmonella enterica*; Food handlers and consumers; Widal agglutinations; Antigens; Immunoassay

Introduction

Food borne diseases/food borne illnesses (food borne infections) are global public health problem both in developed and developing countries such as Nigeria. The World Health Organization (WHO) estimated that in developed countries, up to 30% of the population suffers from food borne diseases or illnesses each year, while in developing countries up to two (2) million deaths are estimated per year [1]. Recent studies revealed that *Noroviruses, Campylobacter jejuni*, *Salmonella, Escherichia coli* O157:H7, *Listeria* and *Staphylococcus aureus* are the important food-related pathogens [2]. Hence, two types of food-borne bacterial pathogen exited: food-borne infections (e.g *Salmonellosis, Campylobacteriosis, Listeriosis, Cholera and Escherichiasis)* food intoxications such as the one caused by *Staphylococcus aureus* with a symptom occurring within 2-6 hours after ingestion of contaminated food, *Clostridium perfringens* and *Bacillus cereus* [2]. *Salmonella enterica* serovar Typhi and Paratyphi is one of the major causes of food and water borne gastroenteritis (food infection) in human, and remains an important public health problem worldwide [3]. Food handlers with poor personal hygiene and inadequate knowledge on food safety could be the source of food borne pathogens. Hence, the consequence of food contamination varies among countries and regions of the world depending on climate, geography and degree of social and economic development [4,5]. In endemic areas, identified risk factors for the disease include: eating food prepared outside the home by street vendors, drinking of contaminated water, fecal-oral and person to person due to poor personal hygiene. Typhoid fever is among the major widespread diseases affecting the population in Nigeria and has been rated eight among these infections. Nigeria like any other developing countries has been described as an endemic zone for typhoid fever [6,7].

Materials and Methods

Study design and area

A cross sectional study was conducted among food handlers working in different food service establishments on the Lagos mainland (Bariga) and Lagos Island (Victoria Island) which are made up of twenty (20) Local Government Areas; on the North and East it is bounded by Ogun State. In the West it shares boundaries with the Republic of Benin to test their knowledge on food safety and food-borne infections such as typhoid, through the distribution of designed closed questionnaire to collect data on gender, age, educational level, years of service, source of water, information about typhoid fever, source of contacting the infection and hand washing practice. Behind its southern borders lies the Atlantic Ocean. 22% of its 3,577 km^2 are lagoons and creeks [8-10].

Sample collection and analysis

Two hundred and thirty five (235) blood samples were collected and analyzed for qualitative detection of immunoglobulin IgG/IgM anti-*Salmonella enterica* serovar Typhi/Paratyphi in the blood of food handlers using Lateral flow chromatographic immunoassay technique and Felix-Widal agglutinations technique. All the test kits were bought from Idumota market in Lagos and kept in the refrigerator at 4°C. The

Corresponding author: Adekunle Olutoyin C, Department of Microbiology and Parasitology, Faculty of Basic Medical Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, Tel: +(234)-8067624952: E-mail: toyintoro@yahoo.co

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kits were brought to room temperature prior to use. The manufacturer's specifications were strictly adhered to; the pouch sealed kits were removed and the device was placed on the sterile working bench, the sterile disposable plastic dropper (supplied) was used to draw plasma (specimen), one drop (50 µl) of the plasma specimen was introduced into the sample well on the device avoiding air bubbles, immediately one drop (50 µl) of the sample diluent was added to the sample well, and the tests were timed for 10-15 minutes for visible colored band on the control and test region. Pink colored band on the control region (C- line) indicated that the test was conducted properly while the pink colored band (G/M line) indicated positive anti-*Salmonella typhi* or *paratyhi* in the food handler's sample [11].

Felix-widal agglutination technique: The kits were suitable for both rapid and tube agglutination tests against human sera for the detection of these agglutinins. The stained antigens were killed bacteria, stained to enhance the reading of agglutination tests. The blue stained are specific to the somatic 'O' antigens while the red stained antigens are specific to the flagella 'H' antigens. The plasma gotten from the centrifuged blood samples were used. A drop of each blood plasma was taken with the help of each sterile plastic dropper into each circle of the test slide and a drop of corresponding stained bacterial antigen suspensions were added, the content of each circle were mixed with the aid of disposable stirrer and spread over the entire area enclosed by the ring of the circle. Separate stirrer was used for each mixture. The test slides were rocked by means of mechanical rotator for one (1) minute and the degrees of agglutination were observed macroscopically immediately. Agglutination indicated positive widal while no agglutination indicated negative widal test [12-15].

Statistical analysis

Regression and T-test statistical analyses were carried out to test for significance of the prevalence of salmonellosis among food handlers. Regression value: F cal>F tab (1.776>0.969) and T-test: T cal>T tab (6.5>5.01) at 95% confidence interval of difference.

Results

Responses from two hundred and thirty-five (235) food handlers were collated and analyzed. Ninety-three, 93(39%) respondents were males while One hundred and Forty-two, 142 (61%) were females (Table 1). Most of the subjects that participated in this study 123(52.3%) were in the age bracket of 21-30 years old, followed by age 11-20 years old which constitute 55(23.4%), 31-40 years old 46(19.6%), 41-50 years old 7(3.0%) and 51-60 years old 4(1.7%). Majority of respondents (food handlers) constituting 203(86.4%) had formal education ranging from primary education to tertiary education while 32(13.6%) had no any form of formal education, but 25(10.6%) had primary education, 131(55.8%) had secondary education and 47(20.0%) had tertiary education. None of these food handlers (respondents) had food hygiene training workshop prior to their venturing into food business. One hundred and thirty-one 131(55.7%) had medical examination known as food handlers test before and/or during food business operation in their respective clinic while One hundred and four 104(44.3%) did not do medical examination (food handlers test) before and/or during food business operation. Most respondents 166(70.6%) had been in the food business for the period of 1-5 years, 24(10.2%) had been in food business for 6-10 years, 24(10.2%) for 11-15 years and 21(9.0%) had been in the food business for over 15 years. The source of water used for cooking food was analyzed, since contaminated water is one of the medium through which food consumer can contact *Salmonella* infection. The major source of water for the food handlers in Lagos State were public tap water and borehole water. Hence, 146(62.1%) agreed to have used tap water for cooking while 89(37.9%) used borehole water for cooking (Table 2). Information gathered from the food handler's to deduced the level of their knowledge or awareness about Salmonellosis (typhoid infection or fever) were assessed, and it was discovered that 160(68.1%) had prior knowledge of typhoid fever while 75(31.9%) claimed not to heard about typhoid fever or the knowledge of it before.

Majority of the respondents does not know how someone can contact *Salmonella* infection (typhoid fever) while 81(34.5%) were aware on how typhoid infection can be contacted. These people had no idea that *Salmonella* infection can be gotten from contaminated water ("bad water"), food, chicken and eggs. Food hygiene practice through

Characteristics	Frequency (%)
Sex	
Male	93 (39.0)
Female	142(61.0)
Age group (years)	
11-20	55 (23.4)
21-30	123 (52.3)
31-40	46 (19.6)
41-50	7 (3.0)
51-60	4 (1.7)
Educational background	
Illiterate	32 (13.6)
Primary	25 (10.6)
Secondary	131 (55.8)
Tertiary	47 (20.0)
Years in business	
1-5	166 (70.6)
6-10	24 (10.2)
11-15	24 (10.2)
>15	21 (9.0)
Medical examination	
Yes	131 (55.7)
No	104 (44.3)
Total	**235 (100)**

Regression and T-test statistical analysis: 95% Confidence interval of difference at F cal >F tab (1.776>0.969) and t cal > t tab (6.5>5.0).

Table 1: Socio-demography of food handlers studied in Lagos.

Characteristics	Frequency(%)
Source of water	
Public tap water	146 (62.1)
Borehole	89 (37.9)
Information about salmonellosis	
Yes	160 (68.1)
No	75 (31.9)
Source of contacting Salmonella infection	
Yes	81 (34.5)
No	154 (65.5)
Contaminated H2O, food, egg and chicken meat	
Yes	93 (39.6)
No	142 (60.4)
Hand washing with soap and water after toilet	
Yes	221 (94.0)
No	4 (6.0)
Total	**235 (100)**

Regression and T-test statistical analysis: 95% Confidence interval of difference at F cal>F tab (1.776>0.969) and t cal>t tab (6.5>5.0).

Table 2: Knowledge and hygienic practices among food handlers in relation to *Salmonella* infection studied in Lagos.

Characteristics	Frequency (%)	IgG/IgM
	Males	
Infected	26 (28.0)	13/13
Non-infected	67 (72.0)	80/80
	Females	
Infected	48 (33.8)	29/19
Non-infected	94 (66.2)	113/123
	Both	
Infected	74 (31.5)	42/32
Non-infected	161 (68.5)	
Total	235 (100)	235

Regression and T-test statistical analysis: 95% Confidence interval of difference at F cal>F tab (1.776>0.969) and t cal>t tab (6.5>5.0).

Table 3: *Salmonella enterica* serovar Typhi and Paratyphi infection among Food handlers studied in Lagos.

hand washing with soap and water after using toilet were observed through the administration of questionnaires and respondents showed that 221(94.0%) washed their hands with soap and water while 14(6.0%) only washed hands with ordinary water.

The lateral flow chromatographic immunoassay for the detection and differentiation of immunoglobulin (IgG and IgM) anti-*Salmonella typhi* and *paratyphi* in human serum, plasma or whole blood was used to aid in the diagnosis of infection with *S. typhi* and *paratyphi*. Thus it aided the determination of current or previous/latent *Salmonella* infection. The results showed that 74(31.5%) of the 235 studied population (both males and females) were infected with *Salmonella enterica* serovar Typhi and Paratyphi (Table 3) which indicated the percentage of infection in both males and females in the entire 235 studied population). This implied that out of Ninety-three (93) males screened for *Salmonella typhi* and *paratyphi* infection, 26(28.0%) males were infected with *Salmonella enterica* serovar Typhi and Paratyphi while 67(72.0%) males were not infected with *Salmonella enterica* serovar Typhi and Paratyphi. One hundred and Forty-two (142) females in the other hand were screened for *Salmonella enterica* serovar Typhi and Paratyphi infection, 48(33.8%) females were infected with *Salmonella* while 94(66.2%) females were not infected with *Salmonella spp*. However, among the positive *Salmonella* infection, some of them 42(56.8%) had previous/latent infection or exposure to *Salmonella enterica* serovar Typhi and Paratyhi as indicated by immunoglobulin G (IgG) while others 32(43.2%) had recent or acute infection as indicated by immunoglobulin M (IgM).

Discussion

Over 61% of the respondents in this study were females, which is an indication that food business is predominantly a job for women; this was supported by the report of Abdul-Salam and Kaferstein [16] reviewed by Musa and Akande, [17]. The involvement of men in this food business is also relatively significant which constitute 39% of the studied population. In this study, majority of these food handlers were young adult of active working age within the age group of 21-30 123(52.4%), 11-20 55(23.4%), 31-40 46(19.6%) while only 7(3.0%) and 4(1.7%) of matured adult age group 41-50 and 51-60 respectively were observed, the low level of participation in food business among these age group may be that since at this age there is no vigor or strength to be able to cope with the stress involved in food business.

Majority of respondents (food handlers) constituting 203(86.4%) had formal education ranging from primary education to tertiary education while 32(13.6%) had no any form of formal education; however 25(10.6%) had primary education, 131(55.8%) had secondary education and 47(20.0%) had tertiary education. None of these food handlers (respondents) had food hygiene training workshop prior to their venturing into food business. Since majority 203(86.4%) had one form of education, hence most of them would have observed food safety and personal hygiene practice thereby reducing food borne infection that can originate from food handlers. However, those that attended primary school (10.6%) and illiterate ones (13.6%) had little or no knowledge of food safety and personal hygiene; they would lack appreciation for safe food handling practice. The consequence is that they could be perceived as a potential risk to food safety due to their low educational background and hence, may have a little or no understanding of the risk of microbial or chemical contamination of food or how to avoid them. Food handlers therefore, need to be educated or trained on basic principles of food safety. Their training should include essential information on safe food handling, source of microbial or chemical contamination, personal hygiene, time, temperature control and the need to undergo frequent medical checkup [18] reported by Musa and Akande [17].

One hundred and thirty-one 131(55.7%) had undergone medical examination known as food handler's test before and/or during food business operation in their respective clinic. This supported the claim that most employers such as operators of fast foods and hotels in developed and developing countries still emphasizes medical examination and food handlers test before working in food service establishment [19], while One hundred and four 104(44.3%) did not do medical examination (food handler's test) before and/or during food business operation. These are mostly food vendors called "mama put". The implication of this is that there is tendency to fall sick and shed bacteria and other microbes into the food thereby contaminating the food and become a risk factor to food consumers. Unfortunately, most of these food handlers do not go for periodic medical examination since they were asymptomatic. This negates the importance of the initial medical examination [17]. The health implication of this action to the food consumers is when the foods which contained salmonellae are ingested, the bacteria reaches the small intestine from which they enter the lymphatic and then the bloodstream. They are carried by the blood to many organs, including the intestine. The organisms multiply in intestinal lymphoid tissue and are excreted in stools. After incubation period of 10 – 14 days, the followings symptoms could be observed: constipation, nausea, diarrhea, vomiting, fever, malaise, and headache, at later stage of infection bradycardia and malygia, toxemia, enlargement of spleen, apathy or mental confusion and septicemia could results. It can also lead to intestinal perforation (ulcer), intestinal hemorrhage and renal failure may occur and subsequently death in untreated cases [20,21]. The attitude of food handlers not going for periodic food handling test and medical examination is a great risk to food safety because acute illness or convalescent stage are well known to be periods which food contamination occurred [6,12]. Reports have shown that out-breaks of food borne illnesses were traced to food handlers where food contamination usually occurred during or immediately after an acute illness [6,10] as reported by Musa and Akande [17] About 70.6% of the studied populations are new in this food business between 1-5 years; the high level of food vending in our country, Nigeria could be attributed to unemployment, in order to earn a living they decided to join the food business without prior training as well as experience on the job. This research work supported the earlier report by Abdul-Salam and Kaferstein [16] "that food vending is rapidly increasing in size and scope in developing countries". 10.2% of food handlers have been in the food business between 6-10 and 11-15

years while only 9.0% were in the business for over 15 years now. This further proved that most people went into the food business recently as a result of unemployment.

Assessment of source of water used for cooking was evaluated and discovered that two main source of water were available for use in Lagos State. 146(62.1%) used public tap water and 89(37.9%) used borehole water for cooking. It was observed also in all the food service establishments that the only drinkable water is sachet water known as "pure water" and bottle water which were produced in a more hygienic and safe way and whereas the water were said to be treated before used by the public. Hence the rate of water contamination or pollution is minimal; as a result the food consumers are at low risk of contracting water borne illnesses such as typhoid which can be observed in this study as few 74 (31.5%) people were infected with *Salmonella.* According to Nickerson and Sinskey [22-24] as reported by Smith et al., [7] *Salmonella spp* do not multiply significantly in the natural environment, but survive for weeks in water and for several years in soil if the temperature, humidity and pH are favourable. Therefore, it can be deduced that the carriers of *S. typhi and paratyhi* probably did not acquire the infection from drinking water and cooked food since the water used for cooking is been heated to 100°C for a long time thereby killing the bacteria and other microbes likely to be in the water, and the food consumers equally drink sachet water known as "pure water" and bottle water which were produced in a more hygienic and safe way and approved by the National Agency for Food, Drug Administration and Control (NAFDAC).

Majority of the food handlers 154(65.5%) have little or no knowledge of the source of contacting *Salmonella* infection, therefore can become a potential carriers thereby infecting their customers through fecal contaminated hands, water and food such as chicken meat and eggs. 81(34.5%) of the population had a knowledge of source of contacting *Salmonella* infection, this is due to the level of education attained and personal development. Hence, more awareness and education should be carried out among food handlers periodically in order to ensure food safety thereby preventing food borne illnesses.

Assessment of hand washing practices revealed that almost all the food handlers (94%) agreed to have washed their hands always with soap and water after using lavatories while very few (6%) only washed hands after using lavatories with only water without soap, this is in line with the report by Andargic et al., [25] in Gondar town. However, only few had practice of washing their hands always in- between when cooking, touching dirty materials and body parts. These reflected food handler's lack of awareness about food contamination with poor hygiene practices. Health education intervention on food safety during processing, preparation and storage of food in food service establishments should therefore be introduced [5].

In this study, 235 blood samples collected from food handlers within the studied area in Lagos among which 93 (39%) were males and 142(61%) were females. It was observed that 74 (31.5%) of the overall studied population had either previous or recent *Salmonella* infection as indicated by IgG and IgM anti-*Salmonella* respectively [11,20] while 161(68.5%) do not have. The low incidence of typhoid infection among the studied population could be attributed to the consciousness of people about infectious diseases and the need to maintain food safety, personal hygiene and availability of portable water in urban areas such as Lagos. However in this research work, it was discovered that more females 48(33.8%) had *Salmonella* infection out of 142 females screened than males 26(28.0%) out of 93 males screened. Though some reports showed that sera from females were more Widal positive than sera from males [26] which is similar to the report by WHO [27] that the prevalence of typhoid fever is higher in females than in males. This may be as a result of the fact that more females are involved in food business than males and as well had more contact with sources of causative organism such as fresh fruits, contaminated vegetables, chicken meat and eggs, and shellfish from contaminated water [28] reported by Abu et al.,[26].

It was also discovered that out of 74(31.5%) positive *Salmonella,* 42(17.9%) had previous exposure or infection while 32(13.6%) had recent or acute infection. This report corroborated with the report of Akinyemi et al., [29] who carried out such study on 235 patient's blood samples with symptoms of typhoid in different hospitals in Lagos, he isolated *Salmonella spp* from 42 samples. In this study, most of the food handlers were not aware that they had typhoid till there were screened since they was no clinical signs and symptoms which further support claims by [5,30-32] that food handlers harbour *S. typhi* asymptomatically. The explanation to this may be the ability of the body defense mechanism to fight the invaded bacteria and other pathogenic micro-organisms [2,20]. Secretory IgA antibodies may prevent attachment of *Salmonella* to intestinal epithelium [21], as is known to be the only immunoglobulin (Ig) secretions that prevent bacteria and viruses to attach to mucous membranes [20]. However, when the IgA failed to prevent the attachment of the bacterium on the mucous membrane of the intestine, the first line of defense IgM is produced and released into the blood within one week of infection and lasted for about six weeks and later IgG which is secondary body defense is produced and released in the blood which persist longer and were detected in the blood using lateral flow chromatographic immunoassay and Widal agglutination techniques [11,20].

In order to determine the sensitivity and specificity of the technique used for this research, Felix-widal agglutination test was employed. It was discovered that all the positive samples were also positive with widal rapid slide agglutination test with a titre values ranging from 1:80 to 1:160 significant titre. Though there were few cases of positive widal agglutination test (about 10%) that proved negative with IgG/IgM rapid lateral flow chromatographic immunoassay. This agreed with the relative sensitivity, specificity and overall agreement of the test kits supplied as reported by CTK Biotech to be 91.2%, 99.0% and 97.9% respectively for IgM, while that of IgG was 92.9%, 99.0% and 98.5% respectively [11]. Although, the availability of rapid technique does not preclude the use of bacteriological culture media which remains the gold standard for definitive diagnosis of typhoid fever, lack of immediate availability during the acute febrile illness and long period of incubation usually between 48-72 hours for stool culture and 3-5 days for blood culture may limit its use. In an acute febrile illness in an endemic typhoid region where the clinical picture is ambiguous, a rapid, accurate, specific and sensitive test should be used to differentiate typhoidal from non-typhoidal febrile illnesses [26].

According to Cheesbrough [20], about 75-90% of patients with typhoid infection can be detected during the first ten days and in about 30% of patients during the third week of infection in the blood. In chronic salmonellosis, it has been reported that *S. typhi* can be more rapidly and successfully isolated from bone marrow than from blood, especially if the patient has been treated with antibiotics. The rapid lateral chromatographic immunoassay which can detect and distinguished between recent and previous (latent) infection and the ability to pick the antibodies produced within the shortest period of infection makes it reliable and sensitive. Though, that does not exclude its limitation as no technique is 100% sensitive. A negative agglutination by Widal

technique and rapid lateral flow chromatographic immunoassay may not exclude typhoid infection because of several reasons such as the carrier state, inadequate inoculum of bacterial antigen in the host to induce antibodies production, previous antibiotic treatment and variation in the preparation of commercial antigens. Salmonellosis is common in developing countries such as Nigeria especially in rural areas due to lack of portable water, inadequate sewage disposal, flooding [26], and lack of personal hygiene.

Conclusion

The prevalence of Salmonellosis commonly known as typhoid fever among food handlers and the general public in developing country such as Nigeria, and the increasing menace of multi-drug resistance (MDR) by *Salmonella spp* is indeed a public health problem. The resultant effect on the health of food consumers would affect productivity, social and other aspect of life. Therefore, there is an urgent need to curtail the spread of this disease and other food borne illnesses. This study showed high incidence of *Salmonella* infection among food handlers studied (31.5%). Regression and t-test statistical analysis showed no significant relationship between an outbreak of *Salmonella* food-borne infection and food handlers in Lagos, South-West, Nigeria. However, health education intervention on food safety and hygiene should be strengthened to ensure food safety during food preparation and storage in food service establishment.

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