

Original Article

Prevalence of shigellosis and associated risk factors among undergraduate students of a private university in Ogun State, Nigeria

Seyi Samson Enitan^{1*}, Joan Odigie¹, Oluyemisi Ajike Adekunbi¹, Okondu Ogechukwu Emmanuel², Nwachi Idume Ogbonna³, Tsague Metago Claudette Laura⁴, Chukwudi Amaechi Ofodile⁵, Grace Eleojo Itodo⁶, Marcel Edafetanure-Ibeh¹, Abiodun Oluwasegun Adetola¹

¹Department of Medical Laboratory Science, Babcock University, Ilishan-Remo, Nigeria; ²Department of Human Kinetics and Health Education, Nnamdi Azikiwe University, Awka, Nigeria; ³Department of Education, Medical Laboratory Science Council of Nigeria, FCT-Abuja, Nigeria; ⁴Department of Public Health, Institut Universitaire et Strategique de l'Estuaire/Institut des Sciences Appliquees a la Sante, Yaounde, Cameroon; ⁵Department of Medical Laboratory Science, Nnamdi Azikiwe University, Awka, Nigeria; ⁶Department of Medical Microbiology, Federal Medical Center, Lokoja, Kogi State, Nigeria.

*Correspondence:

Seyi Samson Enitan
Department of Medical
Laboratory Science,
Babcock University,
Ilishan-Remo, Nigeria.

E-mail address:
enitans@babcock.edu.ng

Abstract

This cross-sectional, institutional-based study aimed to determine the prevalence of shigellosis and associated risk factors among Babcock University students in Ogun State, Nigeria. One hundred and twenty (120) undergraduate students, 80 females and 40 males, were asked to provide stool specimen in a sterile leak-proof single-use universal bottle with a screw-capped lid. Standard microbiological techniques were used to analyse the stool samples. A questionnaire was designed to collect demographic and clinical information from participants. The data obtained were statistically analysed using the SPSS Statistics software (version 18.0). The study showed that there was no occurrence of shigellosis among the study participants (0%), but other enteric pathogens infection were present in all participants (100%). The three most common mono-infections found among the study participants included *Staphylococcus aureus* (40%), followed by *Escherichia coli* (16.7%), and *Salmonella typhi* and *Bacillus spp.* (3.3%, each). While the most common prevalence of dual-infections included *Staphylococcus aureus* and *Escherichia coli* (33.3%), followed by *Staphylococcus aureus* and *Salmonella typhi* (3.3%). The proportion of participants who were asymptomatic (66.7%) was significantly higher than the symptomatic ones (33.3%). Identified risk factors of non-*Shigella* enteric infection included consumption of beef, vegetables, fruits, poultry/poultry products, as well as street foods, poor hand hygiene before eating, anal cleaning, and poor hand hygiene after toileting. Although shigellosis did not exist among undergraduate students of Babcock University, this study highlighted the existence of other enteric infections among the study participants. Therefore, the necessary preventive measures should be ensured and sustained.

Keywords: Prevalence; Risk-factors; Shigellosis; Undergraduate Students; Ogun State; Nigeria

Introduction

Shigellosis is a gastrointestinal tract infection caused by *Shigella*, a Gram-negative bacillus from the *Enterobacteriaceae* family. Despite the discovery of over 40 serotypes, *Shigella dysenteriae*, *Shigella flexneri*, *Shigella boydii*, and *Shigella sonnei* are the four most recognized *Shigella* species, as they are particularly contagious and can cause bloody diarrhoea (Ngoshe et al., 2017). Shigellosis is common among children under five, especially those who live in densely populated urban areas in developing countries with inadequate sanitation systems (Ngoshe et al., 2017).

Shigella is transmitted through the faecal-oral route: 10 to 100 bacilli are sufficient to cause illness. The only reservoir of *Shigella* is human, and it is most often spread through an infected person's stools or improperly washed fingers or hands to the mouth of a susceptible person. However, *Shigella* may also be transmitted through

Article Information
Received : 3 May 2021
Accepted : 28 Aug 2021
Published : 1 Sep 2021

infected food and water, as well as flies (Ngoshe et al., 2017). Diarrhoea (sometimes bloody), fever, stomach pain, and the urge to pass stool even though the bowels are empty are the common symptoms of *Shigella* infection that usually occur 1-2 days after contact with the pathogen. The length of incubation depends on the serotype, but typically lasts twenty-four to seventy-two (24-72) hours (Sheikh et al., 2018). Some people who are infected with *Shigella* can show no symptoms (asymptomatic), however they can still transmit the bacteria to others. The diagnosis is established when *Shigella* is isolated in a person's stool.

Shigellosis is a self-limiting disease that can last anywhere from one day to a month without medication, with an average of seven days (Lampel et al., 2018). Although some people with moderate infections usually recover without the use of antibiotics, antibiotic therapy, on the other hand, could minimize the length of diarrhoea and eradicate microbes from faeces. Patients with severe illness, sanguineous diarrhoea, dysentery, or underlying immunosuppressive disorders should be treated with antibiotics. Empiric therapy should be given while waiting for culture and susceptibility results (Ngoshe et al., 2017). Patients usually recover fully, although it can take several months for their bowel habits to return to normal. It's critical to diagnose and treat Shigellosis as soon as possible because serious complications like severe intestinal bleeding or perforations can develop within a week. About 2% of people infected with *Shigella flexneri* experience joint pains, eye inflammation, and painful urination as a result of the infection, known as post-infectious arthritis, which can last months or even years, and might lead to chronic arthritis (Taneja and Mewara, 2016).

In Nigeria, shigellosis is becoming an endemic, with a high morbidity and mortality rates. *Shigella* caused 190 million cases of gastroenteritis in 2010, according to the World Health Organization, making up for 27% of the global foodborne disease burden (Lampel et al., 2018). Due to scarcity of basic social infrastructure, overcrowding, poor personal hygiene, and immunological defects resulting from poor nutrition and background infections, the burden of *Shigella* in developing countries are higher than in developed countries (Kahsay and Muthupandian, 2016).

Ineffective waste disposal, poor food handling, and poor hygiene among university students will provide infection routes of *Shigella*. The situation is exacerbated by the fact that some students may be hosts of *Shigella* while being asymptomatic. Early detection of shigellosis along with proper treatment could reduce the risk of multi-drug resistant shigellosis among the study population. However, no study has conducted to investigate the prevalence of Shigellosis among university students. This study aims to assess the prevalence of *Shigella* infection among Babcock University undergraduate students in Ilishan-Remo, Ogun State, Nigeria.

Methods

Study Design

This is a descriptive cross-sectional study conducted between October and November, 2020 among the undergraduate students of Babcock University in Ilishan-Remo, Ogun State, Nigeria. The university has nine Faculties with a total student of around ten thousand (10,000), enrolled in a variety of academic and professional courses at both the undergraduate and postgraduate levels.

Study Population

The minimum sample size calculated with a formula by Pourhoseingholi et al., (2013), was $119 \approx 120$ students. Faeces specimens were requested from 120 consenting students. Students who had no history of antibiotics, antacids, histamine-2 receptor

antagonists (H₂ blockers), or Proton Pump inhibitors therapy in the preceding two (2) weeks were enlisted for the study.

Ethical Consideration

The Babcock University Health Research Ethics Committee (BUHREC) granted ethical approval prior to the commencement of the research study. Each participant was given an informed consent prior to data collection, where the purpose and nature of the study, as well as the sample collection process, were thoroughly explained to them. Following that, participants who agreed to be enrolled in this study were asked to fill out and sign a consent form as an evidence of their willingness to provide samples for the test while maintaining their confidentiality.

Data Collection

In addition to the collection of stool specimens, participants' demographic and clinical information was collected using pre-made questionnaires. Participants' demographic characteristics, such as age, study level, marital status, ethnicity, and hall of residence, were included in the first section of the questionnaire. Clinical details pertaining to shigellosis history (fever, abdominal pain, constipation, nausea, vomiting, loss of appetite, bloody diarrhoea, etc.), risk factors (if any), personal hygiene, and healthcare-seeking behaviours were included in the second section of the questionnaire.

Sample Collection

Each participant was asked to provide a stool sample. They were given a sterile, leak-proof single-use universal bottle with a screw-capped lid, as well as the instructions on how to extract their stool specimen aseptically by themselves (Ngoshe et al., 2017). The stool specimen of each participant was later assigned a Personal Identification Number (PIN) and was taken to the laboratory unit, Department of Medical Laboratory Science, Babcock University to be processed within 2 hours of collection or stored in the refrigerator at 4°C for up to 3 days when a delay was anticipated.

Detection of Shigella Organisms Using Stool Culture

One gram of the stool sample (formed/semi-formed) was collected and emulsified in a sterile universal bottle with 5ml of Selenite-F broth and Nutrient broth. The sample was inoculated into the Xylose-Lysine Deoxycholate Agar (XLD), Salmonella-Shigella Agar (SSA), MacConkey Agar (MCA), Deoxycholate Citrate Agar (DCA), and Blood Agar (BA) media and incubated for 18-24 hours at 37°C. Suspected colonies were sub-cultured on Triple Sugar Iron (TSI) Agar. Bacterial growth was subjected to Gram staining, motility, and biochemical tests for verification of the organism after another 18-24 hour incubation period, as described by Cheesbrough (2006) and Francis et al (2008). The streak plate technique, as described by Ochei and Kolhatkar (2007), was used to obtain pure cultures of isolate within a mixed bacterial population. Bacterial isolates were identified using standard methods as described by Cheesbrough (2006), Francis et al. (2008), and Mokhtari et al. (2015).

Data Analysis

The SPSS Statistics software package (version 18.0) was used to conduct the statistical analyses. One-way analysis of variance (ANOVA) and the Tukey-Kramer Multiple Comparisons Test were utilised to see if there were any substantial variations in the prevalence of shigellosis among the students based on their demographic characteristics, in which p-value of less than 0.05 was considered significant. Comparisons of categorical data were analysed using the Chi-square test, while Fisher's exact test was used for small values that are less than five. A $p \leq 0.05$ was considered statistically significant.

Results

The prevalence of shigellosis and associated risk factors were investigated among Babcock University undergraduate students in Ogun State, Nigeria. The study enlisted 120 participant (80 females and 40 males). Majority of participants (63.3%) were within the age range of 21-25yrs, and most of the them (90%) were single. On the basis of their study level, half of them (50%) were 500 level students. The 100 level and 200 level students were not recruited for the study as they studied from home due to the COVID-19 pandemic. Vast majority of the participants (76.7%) were Christians, and from Ibos ethnicity (46.6%) (Table 1).

Interestingly, there was no record of shigellosis among the study participants. None of them (0%) was tested positive for shigella; instead, they all (100%) were tested positive for other enteric pathogens (Figure 1). Female participants had higher rate of enteric pathogens infection incidence (66.7%) than male participants. On the basis of their age range, the highest prevalence was found among students aged 21-25yrs (63.3%). Higher incidence was found among participants who were single (90%), and the 500 level students (50%). Higher incidence of enteric pathogens infection was also found among participants who practiced Christianity (76.7%), and among the Ibos ethnicity (46.6%). Majority of participants (76/120) had mono-infection. The percentage of participants with mono-infection (63.3%) was significantly higher than those with dual-infection (36.7%) with $p=0.0001$ (Table 2). Sixty-eight (41.5%) of the isolated bacteria were Gram-negative, while ninety-six (58.5%) were Gram-positive bacteria (Figure3).

Table 1. Socio-demographic characteristics of the study participants

Characteristic	Category	Frequency(N)	Percentage (%)
Gender	Male	40	33.3
	Female	80	66.7
	Total	120	100
Age Range	16-20yrs	36	30
	21-25yrs	76	63.3
	26-30yrs	8	6.7
	Total	120	100
Marital Status	Single	108	90
	Married	12	10
	Total	120	100
Study Level	100 level	0	0
	200 level	0	0
	300 level	8	6.7
	400 level	28	23.3
	500 level	60	50
	600 level	24	20
	Total	120	100
Religion	Christianity	92	76.7
	Islam	24	20
	Others	4	3.3
	Total	120	100
Tribe	Yoruba	44	36.7
	Ibo	56	46.6
	Hausa	8	6.7
	Others	12	10
	Total	120	100

The most common bacteria found in study participants with mono-infection were *Staphylococcus aureus* (40%), followed by *Escherichia coli* (16.7%). Meanwhile, the most common bacteria that caused dual-infections among the participants were *Staphylococcus aureus* and *Escherichia coli* (33.3%), followed by *Staphylococcus aureus* and *Salmonella typhi* (3.3%) (Table 3).

Vast majority of the participants (66.7%) said that they had no signs or symptoms. Most common signs and symptoms cited by symptomatic patients were headache (23.3%), abdominal pain (13.3%), loss of appetite (10.0%), and vomiting, and diarrhoea (6.7% each).

Identified risk factors associated with non-Shigella enteric infection among the study participant included awareness of shigellosis, history of shigellosis, consumption of beef, fish, vegetables, fruits, poultry/poultry products, as well as street foods, poor hand hygiene before eating, high toilet-student ratio, anal cleaning, and poor hand hygiene after toileting (Table 6).

Table 2. The prevalence of enteric infection in relation to the socio-demographic characteristics of the study participants.

Characteristic	Category	No of stool samples examined N (%)	No positive for enteric infection N (%)	No negative for enteric infection N (%)
Gender	Male	40 (33.3)	40 (33.3)	0 (0)
	Female	80 (66.7)	80 (66.7)	0 (0)
	Total	120 (100)	120 (100)	0 (0)
Age range	16-20yrs	36 (30)	36 (30)	0 (0)
	21-25yrs	76 (63.3)	76 (63.3)	0 (0)
	26-30yrs	8 (6.7)	8 (6.7)	0 (0)
	Total	120 (100)	120 (100)	0 (0)
Marital status	Single	108 (90)	108 (90)	0 (0)
	Married	12 (10)	12 (10)	0 (0)
	Total	120 (100)	120 (100)	0 (0)
Study level	100 level	0 (0)	0 (0)	0 (0)
	200 level	0 (0)	0 (0)	0 (0)
	300 level	8 (6.7)	8 (6.7)	0 (0)
	400 level	28 (23.3)	28 (23.3)	0 (0)
	500 level	60 (50)	60 (50)	0 (0)
	600 level	24 (20)	24 (20)	0 (0)
	Total	120 (100)	120 (100)	0 (0)
Religion	Christianity	92 (76.7)	92 (76.7)	0 (0)
	Islam	24 (20)	24 (20)	0 (0)
	Others	4 (3.3)	4 (3.3)	0 (0)
	Total	120 (100)	120 (100)	0 (0)
Tribe	Yoruba	44 (36.7)	44 (36.7)	0 (0)
	Ibo	56 (46.6)	56 (46.6)	0 (0)
	Hausa	8 (6.7)	8 (6.7)	0 (0)
	Others	12 (10)	12 (10)	0 (0)
	Total	120 (100)	120 (100)	0 (0%)

*Due to the zero occurrences in the last column, no statistical values are applicable.

Table 3. Distribution of enteric pathogens isolated from the study participants

Isolates	Frequency (N)	Percentage
<i>Shigella spp</i>	0	0.0
<i>Escherichia coli</i>	20	16.7
<i>Staphylococcus aureus</i>	48	40.0
<i>Salmonella typhi</i>	4	3.3
<i>Bacillus spp.</i>	4	3.3
<i>Staphylococcus aureus & Escherichia coli</i>	40	33.3
<i>Staphylococcus aureus & Salmonella typhi</i>	4	3.3
Total	120	100.0

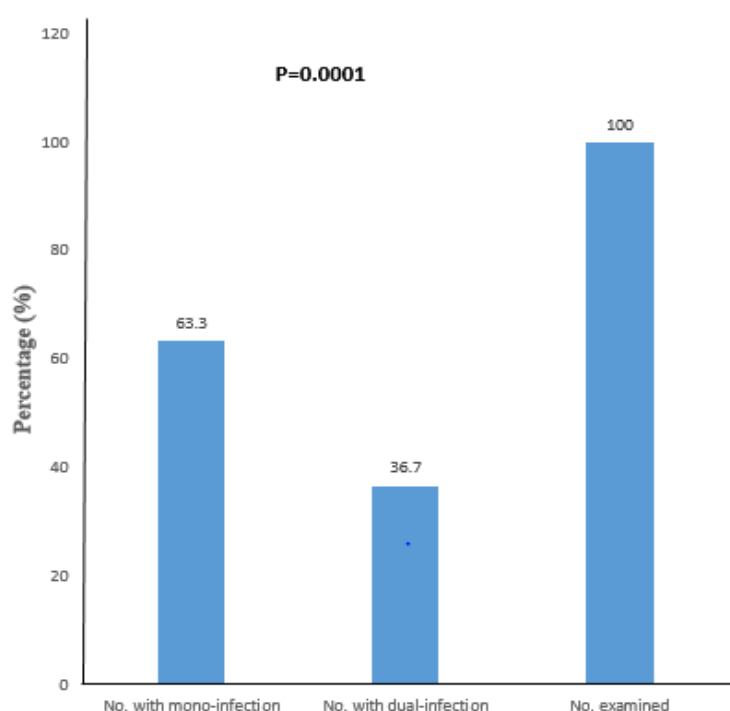


Figure 1: A bar chart showing the nature of enteric infections among the study participants.

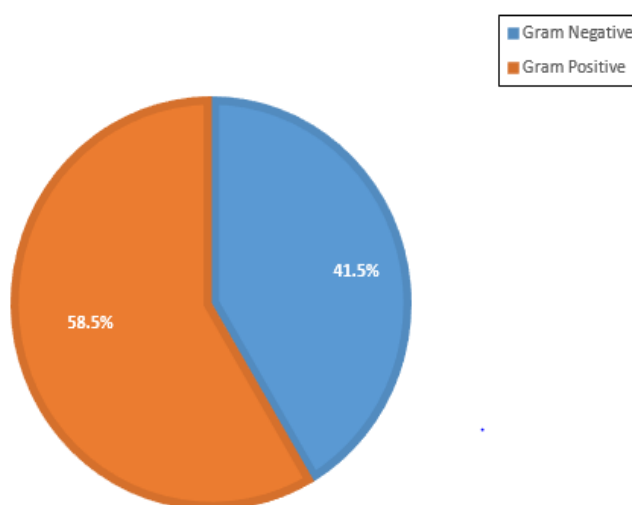


Figure 2. A pie-chart showing the Gram reaction of enteric bacterial isolated from the study participants.

Table 4. Signs and symptoms of gastroenteritis in association with positivity of enteric bacteria

Current signs/symptoms	No. of participants examined N (%)	No. positive for other enteric bacteria N (%)
High fever	0 (0)	0 (0)
Loss of appetite	12 (10)	12 (10)
Headache	28 (23.3)	28 (23.3)
Vomiting	8 (6.7)	8 (6.7)
Abdominal Pain	16 (13.3)	16 (13.3)
Diarrhoea	8 (6.7)	8 (6.7)
None	80(66.7)	80(66.7)

Table 5. Risk factors associated with non-Shigella enteric infection among the study participants

Characteristics	Responses	No. of participants examined N (%)	No. Positive for other enteric infection N (%)	No. Negative for other enteric infection N (%)
Awareness of Shigellosis	Yes	64 (53.3)	64 (53.3)	0
	No	56 (46.7)	56 (46.7)	0
History of Shigellosis	Yes	112 (93.3)	112(93.3)	0
	No	8 (6.7)	8 (6.7)	0
Consumption of beef	Yes	112(93.3)	112(93.3)	0
	No	8 (6.7)	8 (6.7)	0
Consumption of fish	Yes	116(96.7)	116(96.7)	0
	No	4 (3.3)	4 (3.3)	0
Consumption of Vegetables and Fruits	Yes	120 (100)	120 (100)	0
	No	0 (0)	0 (0)	0
Consumption of Poultry/Poultry Products	Yes	116(96.7)	116(96.7)	0
	No	4 (3.3)	4 (3.3)	0
Consumption of Street Vended Food	Yes	100(83.3)	100(83.3)	0
	No	20 (16.7)	20 (16.7)	0
Hand hygiene before eating	Wash always	68 (56.7)	68 (56.7)	0
	Wash often	44 (36.7)	44 (36.7)	0
	Wash less often	8 (6.7)	8 (6.7)	0
	Never	0 (0)	0 (0)	0
Toilet-Student ratio	1:2	44 (36.7)	44 (36.7)	0
	1:4	48 (40)	48 (40)	0
	1:6	28 (23.3)	28 (23.3)	0
Anal Cleaning	Use tissue paper	68 (56.7)	68 (56.7)	0
	Wash with water	52 (43.3)	52 (43.3)	0
	Do nothing	0 (0)	0 (0)	0
Hand hygiene after toileting	Wash Always	100(83.3)	100(83.3)	0
	Wash Often	20 (16.7)	20 (16.7)	0
	Wash less often	0 (0)	0 (0)	0
	Never	0 (0)	0 (0)	0

* Due to the zero occurrences on the last column, no statistical values are applicable.

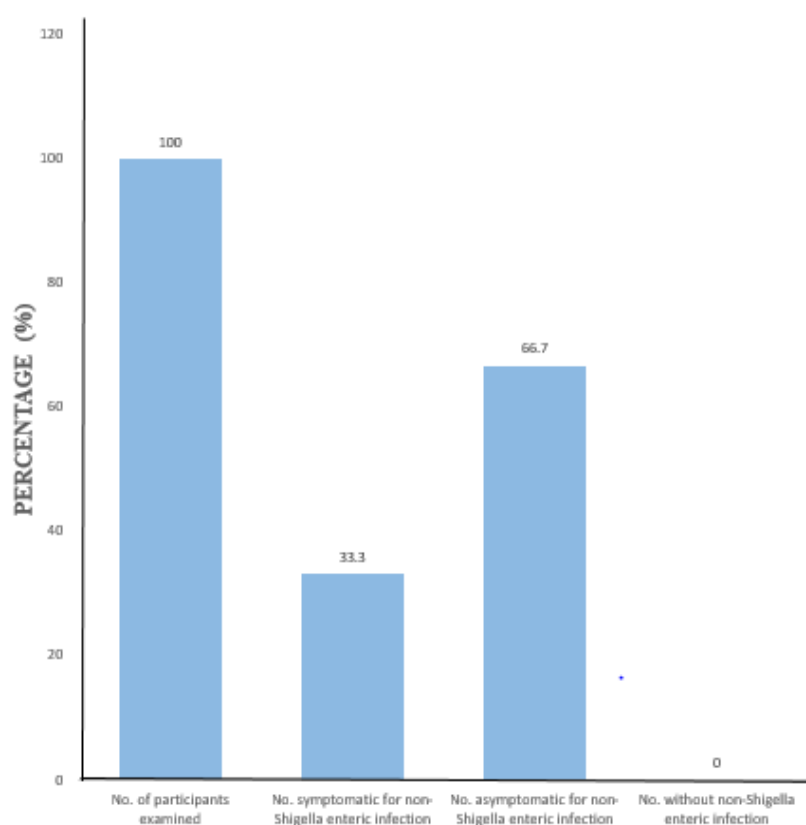


Figure 3. A bar chart showing the distribution of symptomatic and asymptomatic non-Shigella enteric infection among the study participants.

Discussion

Shigella spp. are important etiological agents of diarrhoea worldwide, including in areas where health, jobs, and education have improved. The presence of more than 40 *Shigella* serotypes and subtypes; each with its own epidemiological, immunological, pathological, and virulence characteristics; makes development of effective prevention strategies difficult as demonstrated by the lack of a commercially available multivalent vaccines (Lima et al., 2014). The bacteria's low infectious dosage, direct person-to-person transmission, contaminated food-water transmission, and low susceptibility to stomach acids are contributing factors to the widespread of shigellosis. The role of vectors, such as houseflies, in *Shigella spp.* transmission, has also been evaluated and added to the list of causes for its spread (Lima et al., 2014). To our knowledge, no study has investigated the prevalence of Shigellosis among undergraduate students. This study aimed to investigate the prevalence of shigellosis among Babcock University undergraduate students in Ilishan-Remo, Ogun State, Nigeria.

This study showed that there was zero prevalence (0%) of shigellosis among undergraduate students of Babcock University. The zero prevalence (0%) recorded for Shigellosis in this study was inconsistent with the 13.5% reported by Iwalokun et al. (2001), in a study carried out in Lagos State, Nigeria. It also disagrees with a similar study by Hussen et al. (2019), which reported 6.6% prevalence of shigellosis in Ethiopia.

Meanwhile; all of the study participants (100%) were tested positive for other enteric infections besides shigellosis. The prevalence rate of non-Shigella enteric infections in this study was higher than the 86.5% prevalence recorded by Iwalokun et al. (2001) in

a study conducted in Lagos State, Nigeria. The outcome of the study is also different from a study by Getie et al. (2019), who reported a 13.2% prevalence of enteric bacteria among food handlers in Gondar, Northwest Ethiopia. The reasons for this disparity may be due to differences in geographical location, socio-economic status, level of awareness of the bacteria, personal hygiene, and environmental sanitation of the study participants.

In regards to gender, the prevalence of non-Shigella enteric pathogens was 33.3% and 66.7% for males and females, respectively. This contradicts the findings of Iwalokun et al. (2001), who found a 50% prevalence rate of non-Shigella enteric pathogens including *Escherichia coli* in males and females. When it comes to age, the highest prevalence of non-Shigella enteric infections was recorded among participants aged 21-25yrs (63.3%). Since Babcock University undergraduate students were the only population studied, it is difficult to say if the infection is more prevalent in young adults than in children or the elderly. A previous study by Iwalokun et al. (2001) on people who sought treatments at some selected hospitals/clinics in Lagos showed other enteric pathogens like *Escherichia coli* was most common among the people within the 20-29 age group (16.4%) than in other age groups. Higher prevalence rates, especially in that age group, maybe due to their proclivity for poor hygienic practices, while people in the higher age group may be more conscious of and educated about the importance of good hygienic practices, and may even assist those in the lower age group in doing so.

Regarding the risk factors associated with the occurrences of non-Shigella enteric infections, the history of enteric infection is an important risk factor. It is well documented that once an individual has been previously exposed to diarrhoea causing-agents, the chances of recurrence exist especially in endemic regions. Toilet-Student ratio is also another important risk factor. Majority of the study participants who tested positive for any of other enteric pathogens stay in Halls of residence with a toilet-student ratio of 1:4 and 1:6, which we considered inadequate. The state of some of the hostel's toilet facilities at the time of our visit raised significant health concerns, as some students have a habit of not flushing the toilet after usage. These enteric pathogens are more prevalent in areas with inadequate environmental and among people with poor personal hygiene (Painter et al., 2015; Escobedo et al., 2018).

With regards to the consumption of street foods, 100 participants (83.3%) who tested positive for non-Shigella enteric pathogens indicated that they consumed street foods. This could be due to poor hygiene of the food vendors. Regarding the symptoms of non-Shigella enteric infections among the study participants; 13.33% males and 20% females were symptomatic. In regards to age, 16.67% were symptomatic within the 16-20yrs age group, 80% were symptomatic within the 21-25yrs age group, and 3.33% were symptomatic within the 26-30yrs age group. Symptomatic infection has been reported in both immunocompromised and immune-deficient patients of all ages, but once the primary infection has been established, the immune system of the host plays an important role in determining the duration and severity of the disease (White et al., 2015). Symptomatic infection was characterized in this study with the presence of bacteria along with one or more signs and symptoms of gastroenteritis in the participants.

Asymptomatic infection, on the other hand, was characterized as the identification of bacteria in the absence of any signs or symptoms of gastroenteritis in the participants. Although individuals exhibit no signs or symptoms of the disease, they might harbour and shed these bacteria indiscriminately, unaware that they are an important reservoir of infection. Aside of effective anti-bacterial treatment, convalescent and chronic carriers of these bacteria must be detected and adequately handled to break the cycle of infection within the university community.

Regarding the indications for gastroenteritis among the study participants, most of them who tested positive for non-Shigella enteric bacteria (66.7%) indicated no symptoms, 23.3% indicated headache, 13.3% indicated abdominal pain, 10% indicated the loss of appetite, and 6.7% indicated vomiting and diarrhoea. This showed that the manifestation of gastroenteritis may vary from one person to another, depending on their physiologic and immunologic responses to the infecting agent. Thus, knowledge on the natural habitats, modes of transmission, and clinical significances of these non-Shigella bacteria will help in the understanding of their epidemiological roles.

Conclusion

Although shigellosis was not found among undergraduate students of Babcock University, this study found the existence of other enteric infections among the participants and identified risk factors closely related to the occurrence of these infections, which included a history of the enteric infection, consumption of street foods, and toilet-student ratio. Public health awareness programs should be carried out and sustained within the University community, while environmental and sanitary measures such as hand hygiene, toilet hygiene and proper waste disposal should be enforced in the university to manage the non-Shigella infection. An improvement in the toilet-student ratio in the student halls of residence is a must. Moreover, there is need for regular screening and monitoring of portable water sold within and around the University community, while ensuring that procedures employed in water treatment meet global best practices to ensure public health safety of drinking water. Food handlers and vendors should practice good kitchen and personal hygiene and they should also be regularly screened for the presence of these enteric pathogens. Last, individuals infected by these enteric pathogens should be properly treated. More in-depth studies are needed to fully understand the molecular mechanisms behind virulence and pathogenicity of these bacteria.

Authors' contributions

Conceptualization: SSE and JO; Data Curation: SSE, JO and OA; Formal Analysis: OOE and NIO; Funding Acquisition: SSE and JO; Investigation: SSE and JO; Methodology: SSE, JO and OJA; Project Administration: SSE; Resources: SSE, JO and OAA; Software: OOE and AOA; Supervision: SSE and OAA; Validation: OOE and GEI; Writing – Original Draft Preparation: SSE, JO and ME; Writing – Review & Editing: SSE, CAO and GE.

Consent for publication

The patient guardian given written consent to the inclusion of material about patient.

Conflict of interest

There is no conflict of interest was reported by the authors.

Funding

This study received no external funding.

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