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Case Report

The Prevalence and Risk Factors of Typhoid Fever in Bonassama Health District, Douala Cameroon

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Abstract

Introduction: Typhoid fever is an acute, life-threatening febrile illness, with greatest impact on human population thriving in poor hygienic conditions. In Cameroon, Typhoid fever is one of the most frequently reported infections, with little known about its prevalence.

Objective: Our main objective was to ascertain the prevalence of typhoid fever in Bonassama Health District and determine the risk factors for its transmission.

Method: This was a descriptive cross- sectional study, carried out from March 2020 to November 2020. The study included 150 participants, who were recruited by convenient sampling method. The choice of inclusion of participants was made by probability of infectivity. For those who agreed to take part in the study, Stool samples were collected from them and sent for culture in the lab to isolate Salmonella, the causative agent of typhoid fever. Primary data was gotten by use of structured questionnaires, and secondary data results of stool analysis. Our data was analysed using Epi-info version 7.0 statistical software (CDC, Atlanta, GA, USA). The Acceptable P value for this study was set at ≤ 0.05, and the confidence interval was aimed at 95%.

Results: A prevalence rate of 31% of typhoid fever was gotten in this study. It is worth noting that 99.3% of participants had knowledge about typhoid fever. This study revealed that eating roadside food was significantly associated with acquiring typhoid fever as well as cooking and selling food by the road side with statistical significance of $\chi 2 = 39.482$ df = 3 P = .000 and $\chi 2 = 38.342$ df = 1 P = .000, respectively. Also, those who drank water from wells 58.7%, and those who drank water from unknown sources out of their homes (30.7%) were significantly infected showing a statistical significance of $\chi 2 = 15.895$ df = 1P = .000. Again those who do not practice regular hand hygiene 78.3% were significantly infected with statistical significance of \chi^2=38.810f df = 4 P = .000. Also, those with poor sewage disposals in their quarters 48.0% were significantly infected with typhoid fever, with a statistical significance of $\chi 2 = 16.036$ df = 1 P = .000.

Conclusion: The prevalence of typhoid fever is very high 31% in the Bonassama Health District, and it is associated to poor water supply, poor food hygiene, and poor sewage disposal. Therefore the understanding and avoidance of factors influencing the occurrence of typhoid fever in the Bonassama Health District is important in the management and prevention of the infection in the community.

Keywords: Typhoid Fever; *Salmonella*; Risk Factors; Prevalence; Healthy Carriers; Transmission; Prevention

Introduction

Typhoid fever also known as enteric fever, is an acute, life-threatening, febrile illness, caused by a gram negative bacterium called *Salmonella enterica serotype typhi S* with wide variety of presentations that range from an overwhelming multisystem illness to relatively minor cases of diarrhoea with low-grade fever [1].

Typhoid fever becomes fatal when untreated or poorly treated, and may progress to delirium obtundation, intestinal haemorrhage, bowel perforation, and even death within 1 month of onset with some survivors left with long-term or permanent neuropsychiatric complications (Crump., *et al*. 2004). The classic presentation of this infection is fever, malaise, diffuse abdominal pain, and constipation. However, about 3% - 5% of people suffer from an acute illness of typhoid fever and become carriers of the bacteria after the acute illness. These people may become long-term carriers of the bacteria even though they have no symptoms and become the source of new outbreaks of typhoid fever for many years [2].

Typhoid fever is common amongst crowded and impoverished populations in communities with poor hygiene and sanitation, and is spread commonly by eating food or drinking water contaminated with faces or less commonly by urine of an infected person [3]. Typhoid fever can also be gotten from eating poorly prepared poultry products such as eggs, and dairy products [4]. Other studies carried out on Prevalence and antimicrobial susceptibility patterns of *Salmonella* isolates in association with hygienic status from butcher shops in Gondar town, Ethiopia, revealed that animal sources of contamination such as swine and cattle are very common in poor hygienic conditions [5]. Other contributing risk factors include the emergence of antibiotic- resistant strains, problems in the identification and management of carriers and the lack of availability of cheap vaccines [6]. Besides this, the genetic make-up of the *Salmonella* strains permits their adaptation in various environments, including human, animal and non-animal hosts, and this increases the difficulty in eliminating the bacteria [7]. The most recent global estimates for typhoid fever revealed that between 11 and 21 million new cases and 128 000 to 161 000 typhoid-related deaths occur annually worldwide [1]. Unfortunately the incidence of Typhoid fever reported worldwide is actually more of an estimate as investigations of typhoid fever are usually conducted on large outbreaks, while isolated cases are often underreported [8]. Without effective treatment, typhoid fever has a case fatality of 10% - 30% [9].

Although rarely encountered in western countries today, typhoid fever is not a conquered disease as the infection remains a distressing public health concern. According to the WHO, *Salmonella* the causative agent of typhoid fever is among pathogens that caused the greatest impact on the human population and has been associated with outbreaks and sporadic cases worldwide. It remains the most frequently reported faecal- oral disease outbreaks worldwide, but mainly common in developing countries such as India, Asia and Africa where it poses public health threats due to its high endemicity, difficulty in adopting control measures, and because of its significant morbidity and mortality rates [10].

General Objective

To ascertain the prevalence of typhoid fever in Bonassama Health District, and clearly identify the risk factors for transmission.

Specific Objectives

- To determine the prevalence of typhoid fever amongst inhabitants in the Bonassama Health District (BHD).
- To determine the possible risk factor associated with typhoid fever in BHD.
- To evaluate the chain of infectivity of typhoid fever amongst these inhabitants.

Methodology

Study area

Location and geography

Located on the western side of the harbour across the Wouri River in the Littoral region of Cameroon, the Bonassama health district covers the whole of Bonaberi, a metropolitan and industrial city. It is divided into eleven Health Areas.

Study design and setting

Polit and Hungler, 1999 describe research design as a blueprint, or outline, for conducting a study in such a way that maximum control will be exercised over factors that could interfere with the

validity of the research results. This study, was a cross sectional research, carried out amongst the inhabitants of Bonassama Health District.

Sampling

Sampling entails: (i) defining the population, (ii) specifying the sampling frame, (iii) selecting the sampling method, (iv) determining the sample size, and (v) specifying the replacement strategy for non-responding households.

The sample size for participants recruited in this study was calculated using the Cochran function to determine the required questionnaires by Cochran (Equation 2) assuming 95% confidence level and with ± 7% precision:

Where:
N = Population size,
t= Coefficient of confidence interval that was determined from t-student and assumed that the studied attribute is normally distributed,
s^2 = Estimated variance of responses to the questions in preliminary questionnaires,
e = Degree of accuracy or error percentage (ranges usually from 1 to 10%)
for e= 10%.

Participants were adult patients (age ≥ 15 years). From the above results, the sample size was determine to be n = 150 participants with confidence level at t = 95% with error margin e = 10%. Participants in this study were selected according to the following inclusion criteria.

Inclusion criteria

- Those patients who presented in the different health facilities in Bonassama Health District with clinical signs suspicious of typhoid fever during the period of this study.
- Street food sellers and food handlers in eating houses and restaurants who concerted to participate in the study and who were from 15 years and above, who could express themselves well.

Exclusion criteria

- All persons under the age of 15 were not recruited for the study because of immaturity in understanding and answering questionnaires.
- All those who refuse to give their consent.

Data collection

Data collection covered the period from March 2020 to November 2020. Both primary and secondary data was collected. Data collection followed a well-defined process that utilized a consortium of techniques, including:

- Primary data was gotten from structured questionnaires and
- Secondary data: This was gotten from the results of the stool culture that was done for every participant.

The questionnaire for this work was in three main parts: Part one focused on the demographic data; Part II- Knowledge of participants on typhoid fever and the prevalence; Part III- Risk factors for typhoid fever.

Materials used

Sterile Stool containers, petri dishes, Culture media (*Salmonella* Shigella agar, Selenite F broth, MacConkay agar), Urea /Indole medium, API 20e, *Salmonella* specific antisera, Incubator and sterile water.

Study procedure

After obtaining the administrative approval from the faculty of health and human science of SMU, ethical clearance from committee for scientific research for Littoral was sought. Then, the Regional delegation of health for Litoral, the DMO for BHD, the DO for Douala IV, all chiefs of different health structures in BHD were contacted, for permission to use their structures for our study. Copies of the protocol were distributed to the above mentioned personalities. Semi structured questionnaires for pre testing were used to get data for demographic and professional profiles of participants, knowledge, attitude and practices. For this population, the research procedure was explained, and then structured questionnaires administered.

For those consulting in health institutions, and presenting signs and symptoms suspicious of typhoid fever, who concerted to take part in the study, they were administered questionnaires. After questionnaires were answered by them, they were then given sterile stool cups, the procedure to collect stool sample explained to them and were ask to bring fresh stool samples immediately if possible or collect the stool in the morning and bring immediately to the hospital where it was channelled every day at 9 am to the laboratory for analysis.

For those in the community, Roadside food sellers, restaurant cooks and Roasted fish sellers, first day contact were made in the evenings when questionnaires were administered. After that stool cups were handed over to them, procedure for stool sample collection explained, against stool collection in the morning next day. For those who complained of constipation, we advise them to drink hot water in the evening and early in the morning so that they can go to stool. For them, stool collection started as early as 6:30am in the morning. We made a contact list of all the people to whom we gave stool cups every evening, and then called them up early in the morning to verify if the sample were ready. Once the answer was affirmative, we went to them to collect the sample. This exercise was done daily from 6:30am to 9am. This is because other than fresh stools that were given in the day, all stool samples were handed to the lab by 10am every day for culture, for the purpose of this study.

In other to get representative samples from the whole Health District, one health unit was selected from each health area, were patients presenting with signs and symptoms in clinical settings were recruited for the purpose of the study. Also, in each Health Area, at least three fish roasters, roadside food sellers and restaurant cooks were equally recruited. The Study was carried out from March 2020 to November 2020.

Procedure of laboratory analysis

Stool samples collected from participants every morning in closed caps stool containers and brought to the laboratory by health care workers. In the lab, the stool sample was immediately inoculated in selenite F broth first and then sub-cultured the next day on SS and XLD agar respectively, for growth of colonies.

XLD and SS agar are weight out and prepared and poured out aseptically on sterile culture plates. Method of reconstitution is by boiling. And then allowed to cool to 50* temperature before pouring. Both media solidify at room temperature and stored in the refrigerator for use. The inoculated plates are then placed and left in the incubator for twelve hours under the temperature of 37*c.

Selenite 7 broth is able to facilitate the multiplication of *Salmonella typhi,* and *Salmonella paratyphi* and at the same time help supress the other coliform from the stool. Sub-culturing is done on prepared plates of SS Agar, XLD Agar and Mackonkey Agar respectively, and incubated again for 12 - 24 hours.

Culture plates are examined in the morning to determine growth of *Salmonella typhi*, *Salmonella paratyphi* and other coliforms. *Shigella* and *E. coli* are commonly seen.

- *Shigella* generally shows with 2 mm colonies and colourless in appearance
- *E. coli* are smooth raised colonies in lactose fermenters appearing red in colour
- *Salmonella* are colourless colonies raised with centered dark spots.

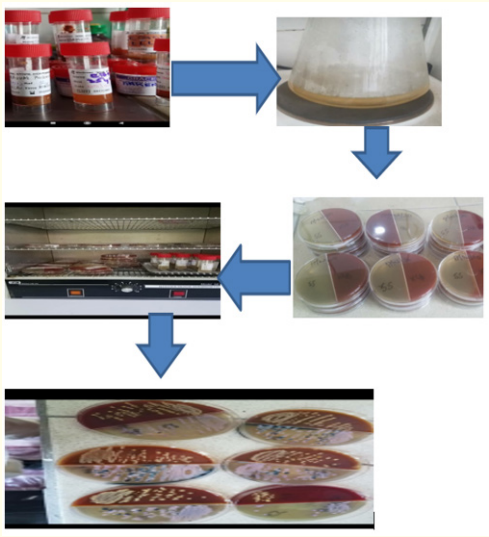

Figure 1: Procedure of stool culture from collection, inoculation, refrigeration, incubation, and identification of *salmonella*.

Data analysis

We crosschecked and coded Data on laboratory results before entering into computer software. Data were cleaned and analysed using Statistical Package for Social Sciences (SPSS) version 23.0 [SPSS software Chicago Inc., USA]. Summarization of data was done using frequency distribution and two-way tables; the association between other independent and dependent variables was determined using Chi-square or kappa Test. The value of kappa, < 0.09; 0.1-0.19; 0.2-0.49; and > 0.5 were considered poor, moderate, strong and almost perfect agreement respectively. A p-value of less than 0.05 was considered statistically significant.

Assumptions

In conducting this study, it was assumed that in other to best manage typhoid fever, it is important to have a picture of the prevalence, and its risk factors.

It was assumed that the study population is representative of the population affected by typhoid fever in the health district.

It was also assumed that the results obtain during the study are accurate.

It was assumed that understanding the population's perspective of typhoid fever was necessary in developing communication tools for preventing.

Problems and limitations

The first challenge was recruiting a sufficient number of participants. Thus access to the participants and obtaining permission for the research was a major challenge. Secondly the researcher was restricted by time and cost, which determined the choice of more efficient method, such as the questionnaire, instead of the more time consuming focus groups or participant observation. In terms of the methodology chosen, there are several limitations which need to be mentioned. The first one is the fact that because of the small sample, the data collected and the findings made cannot be extrapolated on a broader scale. In other words, the generalizability of the results is questionable. However, because a mixed approach was adopted, the results could be of importance to other health districts in Cameroon.

Results

In this chapter, the results of our findings are presented. The results are presented as a function of the objectives. We start with objective 1 (section 4.1) and end with objective 3 (section 4.4).

Socio-demographic characteristics of the participants in this study

Of the 150 participants who took part in the study, 95 (63.3%) where females, while 55 (36.7%) male. Most of them 48 (32.0%) were within the age range 15 - 28, while the least number of participants were those 50 years and above 20 (13.3%). All of them could read and write and of varying professional backgrounds (Table 1a and b) below.

Variables	Characteristics	Frequency	Percentage (%)
Sex	Female	95	63.3
	Male	55	36.7
Age range	15 - 29	48	32
	30 - 39	45	30
	40 - 49	37	24.7
	50+	20	13.3
Education	Primary School	40	26.7
	Secondary School	74	49.3
	High School	22	14.7
	University	14	9.3

Table 1a: Socio demographic data of participants.

Occupation	Office worker	6	4
	Builder	9	6
	Business	19	12.7
	Road-side fish roaster	25	16.7
	House wife	9	6
	Nurse	5	3.3
	Restaurant cook	32	21.3
	Road -side food seller	29	19.3
	Student	11	7.3
	Teacher	5	3.3
	Total	150	100

Table 1b: Socio demographic data of participants.

Knowledge of respondents on typhoid

- In the course of this study, we asked the question; have you ever heard about typhoid fever before?
- From the answers, it was evident that a majority 149 (99.3%) of the respondents knew about typhoid fever while only one (0.7%) did not.
- We also ask the question: Has anybody in your house had typhoid fever before? Most of them 102 (68%) reported that their household members often suffer from the disease.
- Respondents were further asked if they knew possible mechanisms through which typhoid fever could be contracted. The key question was, "Do you know how someone can get infected by typhoid fever?" Of the 150 respondents, 17 (47.0%) said one can contract typhoid fever by not cooking food well, 36 (24.0%) said by drinking water from the well, 3 (2%) when you don't eat well, 14 (9.7) said when you keep food overnight, 15 (10%) said people get typhoid if they are dirty, and 11 (703%) said we can have typhoid if we eat unwashed fruits (Figure 2).

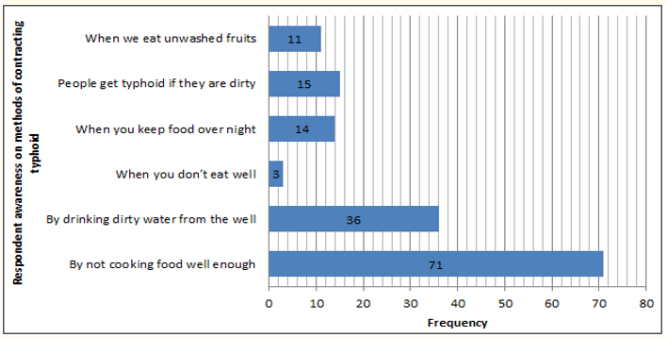

Figure 2: Respondents knowledge on pattern of infection of typhoid.

The prevalence of typhoid fever

Occurrence of typhoid fever in BHD, the last two years

In the Bonassama Health District, there are no previous data on the prevalence of typhoid fever. In other to have a clue of what has been in the past, we asked the question: Have you been diagnosed positive for typhoid fever in the last two years? The results in figure 3 below, show that 117 (78%) of the study population said they had suffered from typhoid fever episode within the last two years, while (22%) had not.

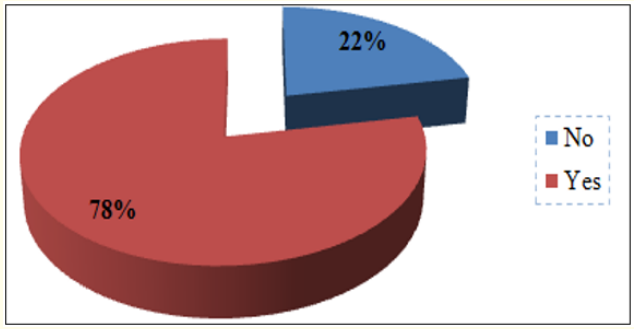

Figure 3: The claim of typhoid fever suffering in the last two years in BHD.

The above results are based on recall data and not on presentation of medical record or medical laboratory results.

However, in other to confirm or discard this claim and to verify the prevalence of typhoid fever in the District it was necessary to test the participants by Stool culture and to find out what are the risk factors influencing the occurrence of typhoid fever?

Occurrence of typhoid fever during this study

In this study, 150 participants were tested for typhoid fever by stool culture. Of these, 46 (31%) were tested positive, while 104 (69%) were tested negative (Figure 4).

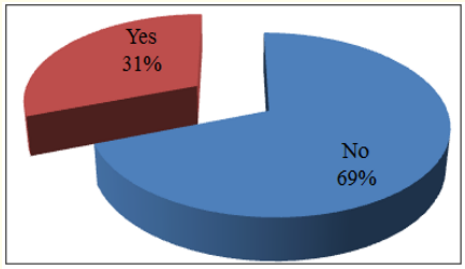

Figure 4: Prevalence of typhoid fever in this study in the BHD.

To bring out a clear picture of the findings, we compared the claimed of typhoid results in the for the last two years, to the typhoid results from this study. The results showed that 78% of participants claimed that they had been diagnosed positive with typhoid fever in the last two years, as compared to 31% in this study (Table 2).

ID	Question	No (%)	Yes (%)
1	Have you ever been diagnosed positive for typhoid fever in the last two years?	33 (22%)	117 (78%)
2	Number of respondents positive for typhoid by stool culture in this study	104 (69.0%)	46 (31.0%)

Table 2: Frequency distribution of respondents by past and present typhoid positivity.

In order to get a better understanding in the disparity between these findings, we then went further to ask the question; 'By what kind of test was your typhoid fever diagnosed'? The answers revealed that 124 (83%) of participants claimed they had been tested by blood test Widal, 9 (6%) claimed that they had never been tested while 17 (11%) claimed that they were tested by stool culture (Figure 5).

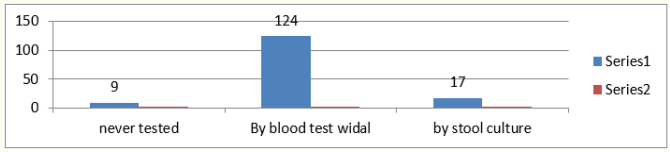

Figure 5: Claim of typhoid test method in the past by participants.

Then, we went further to compare the typhoid positive result claim to the results of investigations in this study. The results revealed that 36.8% of those who claimed that they had been tested positive in the past, are also positive now.

We went further to investigate the prevalence of typhoid fever in relation to some selected variables (Table 4), and the results obtained showed that those of the age range 15 - 29 years (32.3%), where more affected. And that those with secondary education (49.3%) were more affected as well as more female (63.3%) (Table 4).

			Have you ever been diagnosed positive before?		Total	Chi square test
			No	Yes		
Typhoid positive now	No	Count	30	74	104	
		% within have you ever been diagnosed positive before	90.0%	63.20%	69.30%	x^2 (N = 150) = 7, 226, df = 1, P = .001)
	Yes	Count	3	43	46	
		% within have you ever been diagnosed positive before	9.10%	36.80%	30.70%	x^2 (N = 150) = 9, 263, df = 1, P = .002
Total		Count	33	117	150	

Table 3: Relationship between past and present typhoid results.

Assessment of exposure mechanisms (Risk factors)

We investigate the prevalence of typhoid fever in relation to some risk factors (Table 5).

Typhoid occurrence and drinking water

The results obtained in this study showed that those who were mostly affected (38%) drank water from the well, as well as those who drank water from unknown sources out of their homes 38.3% were largely affected. (χ^2 = .7.928, df = 1 p = .005).

Sociodemographic characteristics	Independent variable	Diagnosed positive now by stool culture		Total (N = 150)	Chi square statistic
		No	Yes		
Age range	15 - 29	28 (19.0%)	20 (13.3%)	48 (32.3%)	
	30 - 39	34 (23.0%)	11 (7.3%)	45 (30.3%)	df = 3
	40 - 49	27 (18.0%)	10 (6.6%)	37 (24.6%)	P = .253
	50+	15 (10%)	5 (3.3%)	20 (13.3%)	
Education	High school	17 (77.3%)	5 (22.7%)	22 (14.7%)	
	Primary	24 (60%)	16 (40%)	40 (26.7%)	df = 3
	Secondary	52 (11.3%)	22 (14.6%)	74 (49.3%)	P = .410
	University	11 (7.3%)	3 (2.0%)	14 (9.3%)	
Sex	Male	42 (28.0%)	13 (8.6%)	55 (36.6%)	df = 1
	Female	62 (41.3%)	33 (22.0%)	95 (63.3%)	P = .155

Table 4: Frequencies of typhoid fever with respect to some independent variables.

Typhoid occurrence and food eating places

We discovered that 104 (69.3%) of the respondents ate food regularly out of their homes. And amongst them, 45 (43%) were tested positive for typhoid fever in this study. According to the places where they ate food, 48 (32%) ate cooked food by the road side amongst them, 26 (54.2%) were tested positive followed by those who ate roasted fish by the road side 43 (28.7%) amongst whom 19 (44.2%) were also tested positive (χ^2 = 39.482 df = 3 p = .000)

Typhoid fever occurrence and hand hygiene

Again we investigated on the relationship between typhoid positive results and hand washing. The results showed that none (0.0%) of those who always wash their hands regularly after toilet use and before serving food were tested positive (χ^2 = .6.683, df = 1 p = .010).

Typhoid occurrence and roadside food sellers

We also noticed that those who cook and sell food by road site 54 (36%); roadside roasted fish sellers, and cooked food, constituted the majority of those who were tested positive 32 (70%) = 8.066 df = 1 p = .014).

Typhoid occurrence and waste disposal

The results of this study also showed that, most of the participants did not have good waste disposal system in their quarter, (χ^2 = .6.683 df = 1 p = .010).

Now we went further to investigate how the street food sellers and restaurant cooks wash their vegetables before cooking in the question; 'As a food seller, how do you wash your vegetable before cooking'? (Figure 6).

The results showed that 42 (28%) of participants said they wash their vegetables 2 times in a basin, 25 (16.6%) said the wash once and rinse while 19 (12.6%) said they half boil and then wash. While 39 (26%) said they don't sell food and the rest of participants gave no answer (17%).

Discussion

Our study population was made up of mostly female (95%). The average age of participants was 30 years and most of them had attained at least secondary school education. This is impressive and indicates that most inhabitants of the BHD have minimum required educational level which can enable them to assimilate any kind of health education made available for them. Also, they were able to understand the questionnaire for this study clearly and gave answers accordingly.

The study results revealed that majority 99% of respondents knew about typhoid fever and also reported that members of their households have suffered from the infection. This agrees with a study carried out in Ethiopia by Kumsa in 2019 [11] in which he

Sociodemographic characteristics	Independent variable	Diagnosed positive now by stool culture		Total (N = 150)	Chi square statistic
		No	Yes		
Source of drinking water	River	2 (33%)	4 (67%)	6 (4%)	df = 3
	Well	66 (75%)	22 (38%)	88 (58.7%)	P = .129
	Spring	2 (66.7%)	1 (3.3%)	3 (2%)	
	Pipe borne	34 (64.2%)	19 (35.8%)	53 (35.3%)	
Drink water from unknown source?	No	33 (97.1%)	71 (61.2%)	104 (69.3%)	df = 1
	Yes	1 (2.9%)	45 (38.3%)	46 (30.7%)	P = .000
Eat out of home ?	No	45 (25.1%)	1 (5.6%)	46 (30.7%)	df = 1
	Yes	59 (56.7%)	45 (43%)	104 (69.3%)	P = .014
Eating places other than home	Cooked by road side	22 (4.8%)	26 (54.2%)	48 (32%)	df = 3
	Restaurant	43 (97.7%)	1 (2.3%)	44 (29.3%)	P = .000
	Home	15 (100%)	0 (0%)	15 (10%)	
	Roasted fish by road side	24 (55.8%)	19 (44.2%)	43 (28.7%)	
Wash hands regularly after toilet use and before seving food?	Yes always	70 (46.6%)	0 (0.0%)	70 (46.6%)	f df = 4
	No	3 (4.8%)	2 (1.3%)	5 (6.1%)	P = .000
	NA	7 (4.6%)	5 (3.3%)	12 (7.9%)	
	Sometimes	27 (22.6%)	36 (78.3%)	63 (42.2%)	
	Yes always	70 (46.6%)	0 (0%)	70 (46.6%)	
Do you cook and sell food by road side?	No	82 (54.6%)	14 (9.3%)	96 (63.9%)	df = 1
	Yes	32 (21.3%)	22 (14.6%)	54 (36.1%)	P = .000
Do you have good waste disposal in your quarter?	No	40 (26.6%)	34 (22.6%)	72 (48.0%)	df = 1
	Yes	64 (61.5%)	12 (26.1%)	78 (50.7%)	P = .000

Table 5: Frequency of typhoid fever occurrences with respect to some risk factors.

Figure 6: Food sellers practice of food hygiene.

reported that 76.9% of the respondents had knowledge about typhoid fever. However, it was noticed that, despite the participant's awareness on typhoid fever, most of them 59% did not know how an individual can be infected with typhoid fever. This suggests that, necessary healthcare doctrine on the prevention of the disease is needed in the Health District.

Socio-demographic data and typhoid fever infection

From the study results, we noticed that women were more infected with typhoid fever than men (Table 4). However, this relationship is not significant (, df = 1, P = .713). This is an indication that both males and females are at equal risk and therefore vulnerable. We infer from the results that sex is not a predisposing factor toward suffering from typhoid. The result also indicates that

control of typhoid should be aimed at both the females and males for effective typhoid control. This is similar to the study results obtained by Khan in 1999 in Durban South Africa, and another study in Ali Pur, Islamabad in 2017 by same author [12], where he said that more women are prone to having typhoid fever. This is however contrary to a study carried out in Kenya by Kibiru in 2016 [13] in which he said male and female where equally affected by typhoid fever.

Typhoid fever occurrence and the level of education

The study results reveal that the susceptibility of suffering from typhoid fever was more to those with low level of education than those who had attained a higher level of education (Table 4). The results suggest that education plays a key role in the prevalence of typhoid in the district. We also infer from the study that the higher the level of education the more the typhoid occurrence decreased. This is line with another study carried out by Namrata Prasad in 2017 in Figi India where he reported that [14]; typhoid fever is more common amongst the less educated indigents of Figi. This is also in line with another study carried out by Kibiru in 2016 in Maina- Ethiopia [13], where he reported that typhoid fever was more common in the slumps.

Typhoid occurrence and age

In this study, we discovered that age was not significant in getting infected with typhoid fever though we noticed that those of aged 15-29 years suffered more from typhoid than other age groups while the age range (Table 4). This is in line with another study carried out by Kibiru in 2016 in Ethiopia where he reported that typhoid fever was more common in the age group of 20-30 years, and also another study by Soegianto 2005 [15] in Jakarta-Indonesia where he reported that children of much younger age including young adults where more prone to typhoid fever infection.

The prevalence of typhoid fever in bonassama health district

Out of the 150 stool samples collected and cultured from the 150 participants who took part in this study, 46 were positive for *Salmonella* typhi making the overall prevalence of typhoid fever in this study population to be up to 31.0% (Figure 4).

On recall data from participants, who claimed that they had been diagnosed of typhoid fever, we had an overwhelming seventy eight percent (78%) of typhoid occurrence in the last two years as shown by the results in figure 6. This implied that locally, typhoid fever could be having a very high prevalence in the district. After carrying out the diagnosis of typhoid fever by stool culture on the same group of participants who reported an overwhelming 78% of typhoid prevalence in the district, the results obtained showed 31% prevalence of typhoid fever as shown on figure 4. These results still show a very high prevalence of typhoid fever in the Bonassama Health District.

We went further to compare the number of respondent who claimed that they had been diagnosed positive with typhoid fever in the past, to the typhoid results from this study. The results showed that 36.8% of participants, who have been diagnosed positive with typhoid fever in in this study, also claimed that they had been diagnosed positive in the past (Table 5). The results shows a statistical significant relationship between past and present results (, df = 1, P = .002). This suggests that being positive of typhoid now may depend on whether someone had it in the past or not. Nonetheless, the drop in the prevalence from 78 to 31% could be linked to the fact that these people had been placed on treatment with appropriate anti biotics and so many of them have been cured. This is line with a study carried out by Korean in 1987 in which he reported that effective treatment of typhoid fever in Antimicrobial therapy led to a 78% recovery rate. However, we could also link the persistent high prevalence as notice in this study to Multidrug resistance. Given that most of the people diagnosed in the past might have taken one or more antibiotics probably randomly and with or inappropriate dosing, thereby creating resistance. It is therefore possible that the re-occurrence of typhoid fever in most of them is due to Antimicrobial resistance (AMR). This is supported by other studies Chui., *et al.* in 2002, where they said emergence of MDR *Salmonella* strains poses a great challenge in terms of effective treatment of the infections of typhoid fever. Also Njunda 2012 [16] on Antibiotic susceptibility profile for *Salmonella enterica* in the Buea Health District reported that AMR is a major cause of persistent *Salmonella* infection in humans.

One can also be tempted to say that, the high prevalence in the past, could be link to poor diagnostic methods. Most of the people who claimed that they had been diagnosed positive for typhoid fe-

ver in the past, had been diagnosed by the Widal test (Figure 5). Many researchers and scientist including CDC [17] and WHO had earlier criticized the use of Widal test to diagnose typhoid fever saying that is not an effective test for typhoid fever since it gives many false positive and even false negative results. This is supported by a study carried out by Mawazo., *et al.* in 2018 [18] on Performance of Widal test and stool culture in the diagnosis of typhoid fever among suspected patients in Dar es Salaam, in which he concluded that Widal test is not reliable for diagnosis of typhoid fever since false positive and negative results are common: and that, the consequences of false positive results include misuse of antibiotics, which increase antibiotic resistance, and persistent high prevalence of the infection as well as increased cost of treatment due to increased hospital stay for inpatients and missing of fatal diagnosis of febrile illnesses.

Risk factors for typhoid fever in the bonassama health district

Sources of drinking water

The results obtained in this study showed that those who were mostly affected (38%) drank water from the well, as well as those who drank water from unknown sources out of their homes 38.3% were largely affected. We infer from the study that drinking water from well and unknown sources was a risk factor for contracting typhoid fever. ($\chi2$ = .7.928, df = 1 p =.005). Given that there could be possible drainage of toilet refuge, sewage from homes and floods entering into these wells to contaminate them those who drink from these sources are bound to get infected with *Salmonella*. This is supported by several studies carried out in the past. Akoacherie in 2009 [3] carried out a study on the Phenotypic characterization of *Salmonella enterica typhi* isolates from food-animals and Abattoir Drains in Buea, and reported that typhoid fever is common amongst crowded and impoverished populations in communities with poor hygiene and sanitation, and is spread commonly by eating food or drinking water contaminated with faces or less commonly by urine of an infected person**.** Hosoglu in 2006 [19] also reported that in contrast to outbreaks of typhoid fever where contaminated drinking water was reported to be a source, drinking water in the home is not an independent risk factor but that consumption of water outside the home was associated with typhoid fever. Centers for Disease Control and Prevention (CDC) in august 2018 also published an article which said that; infection with typhoid fever is common with people drinking water and beverages contaminated with human waste untreated tap water ingested directly, used to make ice or roadside drinks, or swallowed during teeth brushing or showering.

Contaminated food

The results in table shows that eating commercially prepared food was a risk factor to typhoid infection. We discovered that 104 (69.3%) of the respondents ate food regularly out of their homes. And amongst them, 45 (43%) were tested positive for typhoid fever in this study. According to the places where they ate food, 48 (32%) ate commercialized cooked food by the road side amongst them, 26 (54.2%) were tested positive. This was followed by those who ate roasted fish by the road side 43 (28.7%) amongst whom 19 (44.2%) were also tested positive. A statistical relationship was found between eating out and being infected with typhoid fever. ($\chi2$ = 39.482 df = 3 p = .000). Our results is supported by the study report by Kibiru 2016 on the risk factors for typhoid fever in Kenya where he said that eating commercially prepared food was a risk factor. Mohamad Hassan also reported in 2001 that the poor hygiene of commercialized food was a risk factor for typhoid fever in Indonesia. This is very evident in this study looking at the results in figure 6, how participant that cook and sell food, wash their vegetables. It was evident that only 42 (28%) of participant wash the vegetables minimally well, hence do not completely wash off bacterium in the vegetable they prepare. This is also supported by WHO publication on transmission of typhoid fever September 2019 that stated 'the typhoid bacillus is transmitted by consumption of contaminated food or water. Again Mohammad Ayas in 2018 [20] reported that Carrier rate of typhoidal *S. enterica* serovars in food handlers working in different food streets of Karachi is very high, and that these food handlers might be contributing to the high endemicity of typhoid fever in Karachi, Pakistan.

Poor waste disposal

The results of this study also showed that, poor waste disposal was a risk factor for typhoid fever, and that the is a significant relationship between having poor waste disposal in the quarter and being positive for typhoid fever ($\chi2$ = .6.683 df = 1 p = .010) (Table). We notice that up to 72 (48.0%) of the participants did not have good waste disporsal in their quarter, and from these, up to 34

(22.6%) were tested positive for typhoid fever in this study. This is in line with a study report by Kumsa, 2019 on the risk factors for typhoid fever in Lalo Asaba in which he said that Dirty environment is a reservoir of *Salmonella* that in turn infect the people torching them. This is also supported by Kibiru, 2016 on the risk factors of typhoid fever in Miana where he reported that those who dispose well of their waste are less likely to get contaminated with *Salmonella*.

Chain of infectivity

The results of this study showed a statically significant relationship between hand washing and being tested positive for typhoid fever ($\chi 2 = .6.683$, df = 1 p = .010) (Table 5). It was seen that those who do not and those who wash their hands only sometimes before serving food were more infected. We noticed that from the 46 participants that were tested typhoid positive, up to 36 said they wash their hands only some times. From this number we realize that up to 22 of them where those who cook and sell food by the road side. Since typhoid fever is mainly contracted by fecal- oral route. We infer from this study that those who cook and sell food and do not wash their hands always after toilet use, and even those who do not constitute a risk factor, and a chain of infectivity for typhoid fever, as they can transmit the infection to those who come and eat their food. This brings to light the case of Mary Malon, popularly known as Typhoid Mary, describe and published by Sober, who was the first to describe a healthy carrier of typhoid fever in the United States. Sober reported that the cook Mary had served in 8 families, seven of them had experienced cases of typhoid. Twenty-two people presented signs of infection and some died. Mary Malon never manifested signs and symptoms over so many years, and was transmitting the infection to so many people. Anal of Gastroenterology. 2013. This is also supported by the report of the center for disease control (CDC) 2016, which said one can get infected with typhoid fever if you eat food or drink a beverage that has been touched by a person who is shedding the bacterial in their stool and has not washed their hands thoroughly after going to the bathroom.

Conclusion

Despite more information on the outbreaks of typhoid fever now than ever before, and a range of proven options for prevention, gaps remain in the understanding of typhoid fever prevalence and the best way to implement prevention strategies in low-resource settings. This study found out that 117 (78%) of participants had suffered an episode of typhoid fever in the last two years, and presently, 46 (31%) are still having the infection. We also found out that poor water supply, contaminated food, poor hand and environmental hygiene were the main risk factors for typhoid fever in the district. In conclusion, the study found out that there is a high prevalence of typhoid fever in the BHD (31%). It became evident during this study that the decisions to implement appropriate public health measures and preventive strategies for typhoid fever infections in Cameroon depend, in part, on the availability of locally improved laboratory diagnostics methods and relevant data on the prevalence of the infection. Moreover, accurately estimating the prevalence of typhoid fever is challenging because data are not available. However, there is a great need to carry out investments in water and sanitation, food safety measures, public awareness, improved diagnostics, treatment strategies, and immunization programs.

Recommendations

- Stake holders in Health should outline a unanimous and effective method for the diagnosis of typhoid fever in all health structures.
- Effective communication methods using radio and televising channels should be designed for the general public on the routes of transmission, and risk factors associated with typhoid fever infection as a means to reduce the infectivity rate.
- Intensified training should be done and illustrative tools be made available for health professional who are best partners in disease prevention.

Suggestions for Further Studies

- Based on the findings of this study, we will strongly recommend that similar studies should be carried out in other health districts for comparative purposes.
- Also, based on the findings of this study, we recommend that studies should be carried out to investigate the relationship between roadside food and infection with typhoid fever.
- Studies on patients' perspective on the chain of infectivity of typhoid fever should be carried out.

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