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Prevalence of Enteric Pathogens Associated with Infections among Table Egg Consumers in Some Primary Health Establishments in the Center Region of Cameroon

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Abstract

Method: In Cameroon limited data are available regarding the prevalence of enteric bacteria associated with table egg consuming infections. As such, a situational-based study was performed in patients with complains of stomach disorders after egg consumption. Data related to sociodemographic characteristics and other factors were collected using a structured based questionnaire. Stool culture of utmost importance in stomach disorders patients and serum were collected for typhoid serological test. **Results**: A total of 207 participants took part in the survey, Results indicated nontyphoidal Salmonella infections were highest in the 3 areas of study with Mfoundi (73.44%) having the highest level of infection compared to other bacterial infection. other enteric bacteria associated to this infection were E. coli serotype 157, Aeromonas, *Citrobacter freundii*, *Enterobacter cloaca* and typhi salmonella. Meanwhile salmonelosis caused by typhic salmonella had highest prevalence in the Lekie Division (13.11%) as a result of poor hygienic practices associated with the conservation and preparation of eggs, Stool culture was observed to detect more positive cases in the diagnosis of typhoid fever than Widal test, but with no statistically significant ($p > 0.05$) difference between the stool culture and Widal test in the 3 areas of study. **Conclusion**: this study revealed that egg consumers are pruned to enteric bacterial and salmonella infections depending on how and where egg is consumed.

Keywords

Enteric Pathogens, Table Eggs, Consumption, Center Region Cameroon

1. Background

Worldwide, intestinal bacterial infection is common, the highest incidence being recorded within less developed countries, with factors such as inadequate personal cleanliness, unsanitary environments, socio-economic status, demographics and health-related practices influencing the prevalence rate of these bacterial infections. [1]. It is one of the most common infectious diseases among humans and a major cause of mortality in low-income and middle-income countries [2]. Poverty contributes equally to foodborne illnesses which have developed into a global public health issue in recent years [3]. Food-borne pathogens are a class of pathogenic microorganisms that infect people and animals through food-poor water quality or food-borne pathways [4]. Street food which is a daily meal for an estimated 2.5 billion people worldwide has been identified as one of the principal ways which these microorganisms are propagated. Consequently, foodborne illnesses resulting from pathogenic bacteria are increasingly becoming a significant health concern linked to street food and poor-quality restaurants [5].

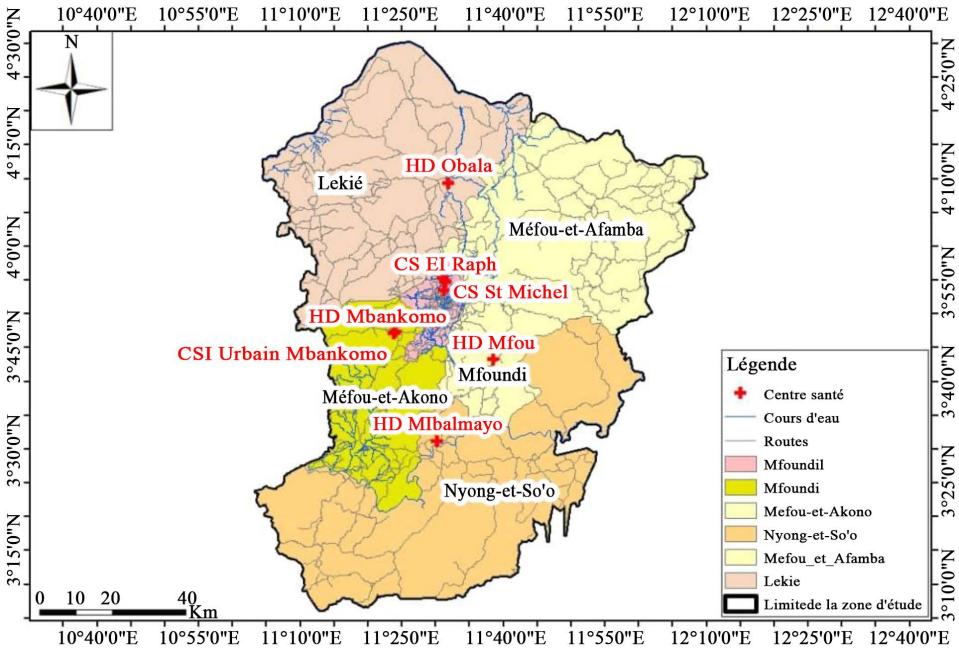
In this study egg consumption was an inclusive characteristic considered to evaluate at which level eggs consumption can transmit infection. In the United State of America, commercial eggs have been washed and graded before retail since the passage of Egg Products Inspection Act in 1976 [6] *Salmonella* infection one of the most common intestinal bacterial infection is transmitted from person to person by fecal-oral route, this has also been shown to be predominantly vehicled through contaminated water or food. [7] Approximately 3.5 billion individuals worldwide are impacted, of whom 450 million have symptoms. Microbes that cause enteric bacterial infections (EBIs), specifically Shigella (Shigellosis) and *Salmonella* (Salmonellosis), are the main causes of food-borne illnesses. Worldwide, 230,000 people died from non-typhoidal *Salmonella enterica* and 52 472 people died from *Salmonella typhi* [8]. In terms of pain and suffering, lost productivity, and medical costs, the estimated annual economic cost of enteric and *salmonella* illness ranges from $10 to 83 billion [9]. *Salmonella* infection is of public health significance worldwide, particularly with regard to developing countries, where they are a leading cause of morbidity and mortality [10]. They cause a variety of infectious diseases in both humans and animals. The most common of such disease is gastroenteritis, with bacterial multiplication in intestinal submucosa and diarrhea caused by the inflammatory response and, perhaps, also by toxins [3]. People began eating more frequently outside of their homes as a result of rising urbanization and improvements in living standards, which accelerated the unrestricted creation of food establishments. In Cameroon, poor sanitary conditions have been recorded near many water collections points where domestic animals and human collect portable water and this serves as a point of trans-

mission of many infectious diseases including typhoid fever [11]. Knowledge of the burden of enteric bacterial infection, is vital in order to determine the effects of the disease on human health. Hence, efforts to understand the trend of enteric bacterial infection in Cameroon in particular require the need for well-planned studies. Improving the quality and preservation of the functional/nutritional value of table eggs which are considered as one of mode of transmission is extremely important. In this context, it is important to determine the type of etiological agents associated with stomach disorder and febrile fever. The prevalence of acute gastroenteritis caused by enteric pathogens is not well studied or documented in many regions of Cameroon because of limited surveillance, lack of laboratory facilities to diagnose the common bacterial agents, or both. Karimo *et al.* [12] reported a prevalence of 74.28% in a district in the western region of Cameroon. Culturing the bacteria from fecal sample could be the definitive test for the diagnosis of enteric bacterial infection although inconclusive serological method like Widal test is commonly employed in many healthcare settings [13]. Therefore, the aim of this study was to determine the prevalence of enteric bacterial pathogens, especially typhoidal and non-typhoidal *Salmonella* and other pathogenic bacteria in outpatients in health structures in three divisions of the center region of Cameroon.

2. Methodology

2.1. Study Site

Figure 1 indicates the different health structures where the study was carried out in different divisions of the center region.



+ health centers.

Figure 1. Map of the study site.

This study was carried out from September 2019 to December 2023 in the center region of Cameroon Mfoundi, Mefou et Akono, and Lekie) with an estimated population of 3,525,664 habitants [14].

2.2. Study Design and Patient Population

A prospective study on febrile patients who had consumed eggs or egg products in any form were screened for typhoid fever and other enteric bacterial infections, Patients were screened by their physician for the clinical symptoms of typhoid fever which had lasted for 5 or more days including other signs of stomach disorder. Febrile patients were sent to the laboratory by their physician for Widal test and stool culture. However, patients who had received antibiotic treatment at home prior to consultations were not included in the list. By using these inclusion and exclusion criteria about 207 suspected febrile patients were then selected for the exercise.

2.3. Ethical Approval and Consent of the Participants

Institutional ethical clearance was obtained from the Ministry of health at the regional delegation of health for the Renter Region, N°0007/AP/MINSANT/SG/DRSPC of 05 January 2020. Permission was also obtained from the administration of different health centers in question. Data and samples were collected after informed consent was obtained from each participant and guardian.

2.4. Questionnaire Design, Distribution and Retrieval

A total of 207 questionnaires were designed using open-ended questions to provide information about the socio-demographic factors of participants and predisposing factors to both infections. Informed consents were obtained from all participants before inclusion. Guardians gave consent for minors.

2.5. Specimen Collection

Specimens were collected from participants of all age groups who presented symptoms of typhoid fever and stomach disorder at the different study site. They were subjected to a questionnaire which gave us an idea about their sociological status. Specimens for this study were blood and stool for Widal and stool culture respectively. Blood (5 ml) of blood was collected from each study participant upon routine vine puncture for Widal test. Blood samples in plain tubes were allowed to clot and serum was collected for Widal test which was carried on spot in each health service, since there were minimum facilities to run the test.

Freshly passed fecal samples were collected in a sterile wide-mouthed container. To avoid contamination, patients were given sterile papers to pass stool on it before picking a portion and putting in the sterile wide-mouthed container. Each sample container was labelled with the patient's code number, date and time. Stool samples were aseptically transported to the Microbiology laboratory of the Institute of Agricultural Research for Development IRAD Wakwa for mi-

crobiological analysis.

2.6. Widal Test

Blood, serum was collected and transferred to agglutination slide. Then, Widal test reagents (containing *Salmonella typhi* and *paratyphi* antigen) were added and observed for agglutination.

2.7. Stool Collection and Inoculation

Using a sterile tube, each patient collected a quantity and presented it in the laboratory. Hard stool was emulsified using physiological saline solution. All the stool samples were liquated and peptone water was added onto it and incubated for 24 hours at 37˚C. The activated stool was inoculated onto Brilliant green ager and incubated at 42˚C for 24 hours while the same samples were equally inoculated in XLD and incubated for 48 hours at 37˚C.

2.8. Biochemical Identification

Salmonella and other enteric bacteria were presumptively identified using Kligler Iron Agar, (Difco™), Oxidase, Citrate, and confirmed by using Analytical profile index test (API).

2.9. Data Analysis and Management Pathogens in Collected Samples

We crosschecked and coded Data on laboratory results before entering into computer software. Data were cleaned and analyzed using Statistical Package for Social Sciences (SPSS) version 23.0 (SPSS software. 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. p-value of < 0.05 was considered statistically significant.

3. Results

Table 1 indicates the socio-demographic setup of the population of the study area. In this table, different individuals from different backgrounds and different age groups were assessed on their frequency and number of eggs consumed. Most participants were in three age group of 0 - 20 and 21 - 40. Above 40 years the number of participants reduced. Table 1 equally indicates that 57% of the study population consumed fried eggs, 35.75% consumed boiled eggs, 5.31% consumed raw eggs, 45.89% consumed eggs at home while 58.94% consumed on the streets and 83.57% of the population consumed more than one eggs per day.

Table 1. Sociodemographic and environmental characteristics of study participants.

	0 - 20 years		*21 - 40 years*		*41 - 60 years*		*>60 years*		*Total*
Characters	**Female** N = 46 (22.22%)	**Male** N = 50 (24.15%)	**Female** N = 37 (17.87%)	**Males** N = 30 (14.49%)	**Female** N = 20 (09.66%)	**Male** N = 16 (7.73%)	**Female** N = 6 (2.89%)	**Male** N = 2 (0.96%)	**207**

Continued

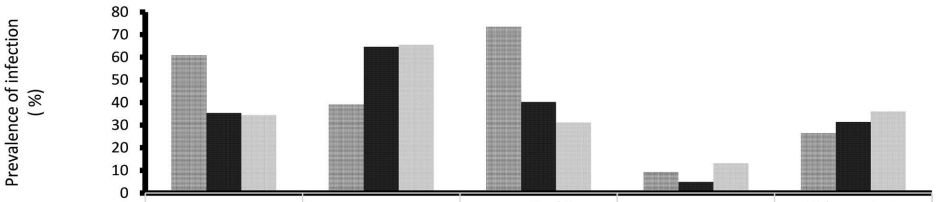
Civil status									
Married	0 (0%)	1 (3.33%)	9 (30%)	5 (16.67%)	7 (23.33%	7 (23.33%)	0 (0%)	1 (3.33%)	30 (14.5%)
Bachelor	46 (32.86%)	48 (34.28%)	20 (14.28%)	22 (15.71%)	3 (2.14%)	1 (0.71%)	0 (0%)	0 (0%)	140 (67.6%)
Divorce	0 (0%)	0 (0%)	6 (27.27%)	3 (13.64%)	6 (27.27%)	5 (22.73%)	1 (4.54%)	1 (4.54%)	22 (15.7%)
Widow	0 (0%)	0 (0%)	1 (6.67%)	1 (6.67%)	5 (33.33%)	3 (20%)	5 (33.33%)	0 (0.0%)	15 (7.2%)
Education									
Uneducation	10 (43.48%)	12 (52.17%)	1 (4.34%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	23 (11.11%)
Educated	36 (20.0%)	38 (20.54%)	36 (19.45%)	30 (16.22%)	20 (10.81%)	16 (8.65%)	06 (3.24%)	02 (1.08%)	185 (89.37%)
Occupation									
Civil servant	**0** (0%)	**0** (0%)	**9** (28.13%)	**8** (25%)	**7** (21.87%)	**8** (25%)	**0** (0%)	0 (0%)	**32** (15.5%)
Trader	**1** (2%)	**0** (0%)	**15** (30%)	**13** (26%)	**11** (22%)	**6** (12%)	**2** (4%)	**2** (4%)	**50** (24.1%)
Farmer	**1** (6.25%)	**0** (0%)	**3** (18.75%)	**6** (37.50%)	**1** (6.25%)	**2** (12.5%)	**3** (18.75%)	**0** (0%)	**16** (7.7%)
Housewife	**0** (0%)	**0** (0%)	**3** (50%)	**0** (0%)	**2** (33.33%)	**0** (0%)	**1** (16.67%)	**0** (0%)	**06** (2.9%)
Settlement									
Rurale areas	**35** (24.48%)	**34** (23.78%)	25 (17.48%)	**19** (13.29%)	**15** (10.49%)	**9** (6.29%)	**5** (3.49%)	**1** (0.69%)	**143** (69.08%)
Urban area	**11** (17.19%)	**16** (25.0%)	**12** (18.75%)	**11** (17.19%)	**5** (7.81%)	**7** (10.94%)	**1** (1.56%)	**1** (1.56%)	**64** (30.92%)
Nature of egg consummed									
Fried egg	**28** (23.73%)	**28** (23.73%)	**21** (17.79%)	**22** (18.64%)	**05** (4.24%)	**11** (9.32%)	**1** (0.85%)	**2** (1.69%)	**118** (57%)
Raw egg	**0** (0%)	**01** (9.09%)	**03** (27.27%)	**0** (0%)	**01** (9.09%)	**02** (18.18%)	**03** (27.27%)	**01** (9.09%)	**11** (5.1%)
Boild egg	**15** (20.27%)	**16** (21.62%)	**15** (20.27%)	**11** (14.86%)	**10** (13.51%)	**03** (4.05%)	**03** (4.05%)	**01** (1.35%)	**74** (35.75%)
Products containing egg	**12** (22.64%)	**08** (15.09%)	**13** (24.53%)	**06** (11.32%)	**08** (15.09%)	**06** (11.32%)	**0** (0%)	**0** (0%)	**53** (25.60%)
Place of consumption									
At home	**22** (23.15%)	**20** (21.05%)	**14** (14.73%)	**12** (12.63%)	**11** (11.58%)	**08** (8.42%)	**07** (7.37%)	**01** (1.05%)	**95** (45.89%)
Out of home	**25** (20.49%)	**30** (24.59%)	**23** (18.85%)	**21** (17.21%)	**11** (9.02%)	**11** (9.02%)	**0** (0%)	**01** (0.82%)	**122** (58.94%)
Egg consumption frequence									
01 - 03 times	**34** (19.65%)	**43** (24.85%)	**29** (16.76%)	**25** (14.45%)	**18** (10.4%)	**15** (8.67%)	**07** (4.05%)	**02** (1.16%)	**173** (83.57%)
>03 times	**01** (50%)	**00**	**00**	**00**	**00**	**01** (50%)	**00**	**00**	**02** (0.96%)

N= number of persons per age group.

Figure 2 portrays the frequency of enteric and other serotypes of *Salmonella* isolated.

Mfoundi division had the highest infections with non typhi *Salmonella* and *E. coli* 157. The Mefou Akono division had the highest prevalence with *Enterobacter cloacae* and *Aeromonas hydrphylia.* In Lekie division, about 65.57 % of the popu-

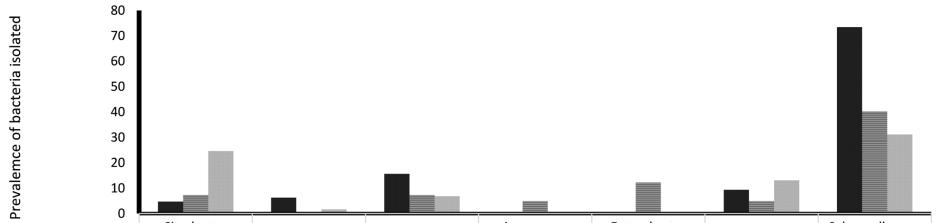
lation had no infection while 31.11% of the population was infected with non *typhi Salmonella* and about 36.06% with other enteric bacteria.



	Infection	No infection	non-Typhic Salmonella	Typhic Salmonella	Other enteric bacteria
Mfoundi	60.94	39.06	73.44	9.3	26.56
Mefou et Akono	35.36	64.63	40.24	4.88	31.4
Lekie	34.43	65.5	31.15	13.11	36.06

Figure 2. Variation of number of non-infected and infected persons within the study area.

Figure 3 shows the frequency of enteric bacteria and other serotypes of *Salmonella* isolated. Mfoundi division had the lowest frequency of C. *citrobacter freundii* compared to 73.43 prevalence of non *typi Salmonella.* Mfoundi division also had the highest frequency of *E. coli* 157. The Mefou Akono division had the highest prevalence with *Enterobacter cloacae* and *Aeromonas hydrophila,* 40.24% with non typhi *Salmonella*. The Lekie division had the highest frequency of *Citrobacter freundii* and the lowest concentration with non typhi *Salmonella and E. coli* 157.



	Citrobacter freundi	Proteus mirabilis	E.coli 157	Aeromonas hydrophila	Enterobacter cloacae	Typhic Salmonella	Salmonella non typhi
Mfoundi	4.69	6.25	15.65	0	0	9.37	73.44
Mefou et Akono	7.3	0	7.32	4.88	12.19	4.88	40.24
Lekie	24.59	1.64	6.84	0	0	13.11	31.15

Figure 3. Diversity, prevalence and distribution of enteric bacteria among study participants**.**

Figure 4 demonstrates how different sites of the study area were generally infected. It shows that infection was highest in Mfoundi and Mefou Akono and minimal in the Lekie Division.

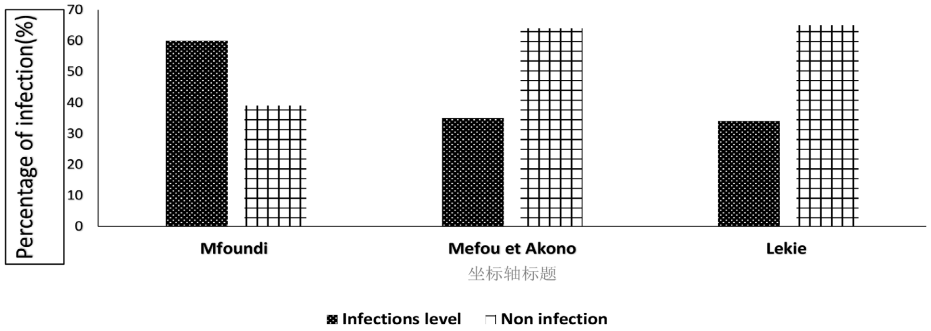


Figure 4. Variation level of infection in different areas of the study areas.

Table 2 indicates the prevalence of Widal test and stool culture in the diagnosis typhoidal Salmonella.

Table 2. Prevalence of salmonella infection in each area of study.

Method	Mfoundi				Mefou et Akono				Lékié			
	No of sample	% positive	% negative	P value	No of samples	% positive	% negative	P value	No of sample	% positive	% negative	P value
Widal test	n = 64	32 (50%)	32 (50%)	**0.2**	n = 82	36 (43.90%)	46 (56.10%)	**0.4**	(n = 61)	20 (32.79%)	46 (56.10%)	**0.7**
Stool culture	n = 64	39 (60.74%)	25 (39.06%)		n = 82	29 (35.37%)	53 (64.63%)		(n = 61)	21 (34.43%)	40 (65.57%)	

Table 3 indicates the results of stool culture, Widal test and p value variations in the with the age groups. A total of 88 males and 109 females were involved in this study.

Table 3. Age groups Widal test and stool culture analysis.

	Mfoundi n = (64)					**Mefou et Akono n = (82)**					**Lékié (n = 61)**				
Parameter	Widal test		Stool culture			Parameter	Widal test		Stool culture			Parameter	Widal test		Stool culture		
Age (years)	+	-	+	-	P value	Age (years)	+	-	+	-	P value	Age (years)	+	-	+	-	P value
0 - 20 (n = 27)	11	16	15	12	0.28*	0 - 20 (n = 46)	17	29	15	31	0.66*	0 - 20 (n = 21)	08	13	10	11	0.5*
21 - 40 (n = 23)	12	11	13	10	0.77*	21 - 40 (n = 22)	14	08	09	13	0.13*	21 - 40 (n = 23)	07	16	07	16	1*
41 - 60 (n = 12)	08	04	10	02	0.36*	41 - 60 (n = 10)	03	07	03	07	1*	41 - 60 (n = 15)	04	11	04	11	1*
Above 60 (n = 02)	01	01	01	01	1*	Above 60 (n = 04)	02	02	02	02	1*	Above 60 (n = 02)	01	01	00	02	0.4*
Sex						Sex						Sex					
Male (n = 35)	16	19	19	16	0.09*	Male (n = 23)	13	20	11	22	0.61*	Male (n = 30)	09	21	12	18	0.4*
Female (n = 29)	16	13	20	09	0.28*	Female (n = 49)	23	26	18	31	0.31*	Female (n = 31)	11	20	09	22	0.5*

Key: *Result not significant ($p < 0.05$).

Table 4 highlights positive, false positive, true negative and false negative which help in the calculation of sensitivity, specificity, positive predictive and negative predictive values of Widal test compared to stool culture. Negative predictive values were 80,43%and 75.62% in Mefou et Akono and Lekie respectively. But lowest (50.00%) in the Mfoundi division.

Table 4. Table indicating the sensitivity, specificity, positive predictive value and negative predictive values in the area.

	Positive		*False positive*		*False negative*		*True negative*		*Sensitivity*	*Specificity*	*PPV*	*NPV*
	C +	*W+*	*W+*	*C-*	*W-*	*C+*	*C-*	*W-*				
Mfoundi	23		09		16		16		58.97%	64.00%	71.88%	50.00%
Méfou Akono	20		16		09		37		68.97 %	69.81 %	55.56%	80.43%
LEKIE	11		09		10		31		52.38 %	77.50%	55.00%	75.61%

Table 5 indicates Widal test stool culture results and Kappa values of the 3 study areas. Kappa values were 0.23, 0.37 and 0.30 in Mfoundi, Mefou Akono and Lekie respectively.

Table 5. Results of Widal test, stool culture and kappa values.

	Mfoundi				*Méfou and Akono*				*Lekie*			
Widal test	Culture		Total	Kappa	Culture		Total	Kappa	Culture		Total	Kappa
	+	-			+	-			+	-		
Positive	23	09	32	0.23	20	16	36	0.37	11	09	20	0.30
Negative	16	16	32		09	37	46		10	31	41	
Total	39	25	64		29	53	82		21	40	61	

4. Discussion

This study involved people from all age groups and all walks of life, the screening inclusive characteristic used was the consumption of eggs in any form and anywhere by respondents who presented themselves in the health centers and had signs of typhoid fever and stomach disorder. As such the screening collected samples from 207 in three divisions in different local health structures in urban and rural areas. In this study of relationships between prevalence of gastroenteritis and sociodemographic characteristics in relation to egg consumption shows that all areas of studies were infected with non typhic *Salmonella* and other forms of enteric bacteria. Mfoundi division was seen to content the highest (73.44%) level, followed by Mefou and Akono (40.24%) and Lekie (31.14%) as seen on Figure 2 and Figure 3. This variation in the level of infection with non typhic salmonella could be due to the fact Mfoundi is an urban area and the level of egg consumption could be higher than in the other two sites which are mostly rural areas. It was reported that economic status of the household is tied to access to animal source food [15]. Therefore, Per capita household income has a positive influence on egg consumption. As the household income increases, egg consumption increases, **thereby** obliterating the household level of income, and upper asymptote for egg consumption and thus lead to more infection by non tyhpic *Salmonella*. This confirmed by Sumit Ballal and others [16] who reported a prevalence rate 43% of enteric bacteria infection in India from stool sample. The Lekie division was found to have low level of infection among the egg consumers. *Salmonella paratyphi* and *typhi* are bacteria which are mostly found only in human. Hence egg consumers who were positive with *Salmonella* infection in the study area must have taken it from road side with shops, which are very common in many municipalities in many regions of Cameroon. In a study of enteric bacterial infection among food handlers in Southern Tibeso, Gemechu *et al.*, [17] reported a 9,3% among food handlers. Other enteric bacteria had a prevalence of 36.06% in Lekie and 31.70% in Mefou et Akono which are mostly made up of area settings, meanwhile in the Mfoudi division which is and

urban had a lower prevalence (26.56%) showing that the level of awareness of contamination is lower in urban areas than in rural settings. This is in conformity with Tyagi *et al.* [18], who reported that the kitchen environment in rural areas constitutes a source of contamination compared to kitchen in urban areas. In this study, we discovered that the highest percent of the *Salmonella* obtained in the respondents were a group of different non typhoidal *Salmonella* that constituted 73.44% in the Mfoundi and 40.244% in the Mefou and Akono divisions while Lekie had 31.14% of the non-typhoidal *salmonella*. this is in accordance with Kirk and colleagues [19] who pointed out that diarrheal and invasive infections caused by non-typhoidal *Salmonella enterica* is considered as the largest burden of a disease among enteric diseases. Enteric bacteria were also isolated which could either be associated to egg consumption or to other feeding habits by the respondents This is similar to other research results published by Geti *et al.* [20] who reported a 13% prevalence rate of enteric bacteria among food handlers in Ethiopia. Generally, the Mfoundi division which at the time of the survey was urban had the highest level of infection. This could be due to over population and unsanitary nature of the environment eating spots along the road side which serve as restaurants. Moreover, household economies are more advanced in urban area compared to local areas which have less demand for egg consumption as a source of contamination. The Mefou Akono division and Lekie had less infected respondents, in conformity with Babale *et al.* [21], who reported that Egg consumption is primarily concentrated in urban areas because households are better informed unlike in the rural areas.

According to WHO reports. [22], developing countries, mostly Widal test as serological test to diagnose typhoid fever caused by the typhic types of. *Salmonella.* In this, study the prevalence Widal test ranged from 50%, 43.90% and 32.79% in the Mfoudi, Mefou Akono and Lekie division respectively (**Table 2**). The infection touched all the age groups as seen on **Table 3**. Statistically, there was no significant difference between the Widal test and stool culture in all age groups in all the study areas, in agreement with Verma *et al.* [23] during a comparative evaluation of various tests for diagnosis of concurrent malaria and typhoid fever in a tertiary care hospital of Northern India. In the present study, the prevalence of stool culture was higher than that of Widal test and was ranged from 60.94%, 35.37% and 34.43% in the Mfoundi, Mefou Akono and Lekie division respectively. The age group more susceptible was those between 0 - 40 years old, although the results were not significant compared to those of other age groups (However, the result is not significant $p < 0.05$). This is in agreement with the studies conducted ($p > 0.05$) reported on the prevalence of Widal and stool culture in Santa Health district in Cameroon [24].

The result of the present study demonstrated average sensitivity and specificity of Widal test in all the study area with a minimum sensitivity of 52.38% in the Lekie division and a highest specificity of 77.50% still in the Lekie division. This finding was in contradiction with the finding of Ameya *et al.* [25] who re-

ported a sensitivity of Widal test (84.2%) and confirms the results of Wam *et al.* [24] who recorded low sensitivity (40.0%) and specificity(32.4) of Widal test when compared to stool culture. The positive predictive value (PPV) and negative predictive value (NPV) of Widal test ranged from 55.00% (PPV) in the Lekie division to 80.43% (NPV) in Mefou Akono division. This means that most of the proportion of patients with positive test results were correctly diagnosed meanwhile, the NPV value of Widal test was 80.43 %.in the Mefou Akono indicating that a negative Widal test result has a good predictive value for the absence of the disease. This was in conformity with results recorded by Oppong *et al.* who reported on Enteric pathogens associated with gastroenteritis among children sub-Saharan Africa [26] Meanwhile highest prevalence of typhi infection was found in the Lekie division may be as a result of poor sanitary condition and weakened immune response which may offer a window of pathogenicity for abs well as bacteria. Salmonellosis waterborne diseases is linked to poor hygiene (Cordoso *et al.* [27]).

The assessment of agreement between two different diagnostic methods can also indicate how the test methods are close to each other. Statistically, there was a fair agreement (kappa = 0.23, 0.36 and 0.29 in the Mfoundi, Mefou Akono and Lekie division respectively) between Widal slide agglutination and stool culture.

But the current findings agrees with a study conducted in by Gemechu *et al.*, [17], which indicated moderate agreement (kappa = 0.325), indicating that the result of Widal test in diagnosis of typhoid fever moderately agrees with stool culture.

5. Conclusion

This study showed high prevalence of enteric bacterial pathogens among egg consumers in all our study sites Mfoundi division which is an urban area was highly infected with non typhidal S*almonella* followed by Mefou et Akono and Lekie which are mostly rural area. Different enteric bacteria were isolated in varying prevalences included *Citrobacter freundii*, *Proteus mirabilis, E. coli* 157, *Aeromonas hydrophila,* typhoidal Salmonella, *Enterobacter clocae* and other non-typhoidal *Salmonella*. In the quest to identify respondents who were typhoid positive, Widal agglutination test and stool culture gave kappa values of 0.23, 0.36 and 0.29 in the Mfoundi, Mefou Akono and Lekie division respectively, indicating that Widal test had a moderately faire agreement with stool culture in the detection of typhoidal *Salmonella.* Generally, to avoid infection from eggs we should limit the consumption of raw eggs and promote the consumption physically acceptable boiled eggs.

Competing Interest

The authors declare that they have no competing interest.

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Limitations

Our limitations were mostly based on logistics, the attitude some of participants who requested for payment before they could give us fecal samples, and lastly the unholy behavior of some laboratory staffs in some health institutions.

Author Contributions

Author Contributions: **Conceptualization**: Ngueguim Lucie, **Methodology**: Ngueguim Lucie, Tangwa Viban and Ngu Ngwa Victor **Resources**: Ngueguim Lucie and Tangwa Bernard Viban.

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