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Comparative Study of the Widal Test against Stool Culture in the Diagnosis of Suspected Cases of Typhoid Fever in Some Low Income Communities in the Adamawa Region of Cameroon

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Abstract

Introduction: Infectious diseases constitute a major concern of public health in developing countries. Facilities and well trained staff have been shown to be one of the major obstacles in the rapid and quality diagnosis of these diseases. As such, we carried out an analysis to compare the Widal test and stool culture to identify febrile patients with Salmonella infection. **Method**: A cross sectional study was conducted to diagnose salmonella infection with out-patients who demonstrated signs of salmonella infection. Serum was harvested from blood collected from 368 (Vina = 234, Mayo Banyo 65, and Djerem = 69) patients accompanied by stool, Widal test was conducted on the spot and stool was taken to a reference laboratory for culture using standard microbiological methods, sociological set up was calculated in percentages, prevalence was calculated using excel while statistical difference was calculated using SPSS. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to compare the Widal test against stool culture. **Results:** A total of 368 (50.8% females and 49.2% males) participants took part in the survey. Salmonella prevalence (66.24%) in stool culture in the Vina division was significantly different ($p < 0.05$) from the Widal test meanwhile prevalence in Mayo Banyo (56.46%) and Djeren (53.62%) did not show any significant difference ($p > 0.05$). The sensitivity,

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specificity, PPV, and NPV of slide agglutination test against stool culture varied from different areas (Vina: 51.6%, 73.62%, 79.21% and 43.61%; Mayo Banyo: 60.53%, 77.78%, 79.31% and 58.33%; Djerem: 53.18%, 83.73% 73.91% and 67.39%) respectively. Slide agglutination test has a fair agreement with the stool culture (kappa, Vina = 0.202; Mayo Banyo = 0.37 and Djerem = 0.38). **Conclusion:** Generally, in the three areas of study, the Widal test had a fair correlation with the stool culture; This means the Widal test should not be used alone but in combination with stool culture in the detection of salmonella infections.

Keywords

Salmonella Infections, Stool Culture, Widal Test, Adamawa Region, Cameroon

1. Introduction

Public health issues associated with *Samonella enterica* in rural world remain alarming Widal test commonly used may not bring out the right diagnostic and cultural technics which is an alternative is expensive. In the 19th century, it emerged as an infectious disease and was known to affect only humans. Transmission is basically bay fecal route and water [1]. Typhoid fever (TF) continues to be a substantial public health problem in developing countries likely due to rapid population growth, increased urbanization, and limited safe water, infrastructure, and health systems [2]. *Salmonella typhi* are restricted exclusively to human hosts and are associated with systemic infection, and prolonged fever and may result in an asymptomatic carrier state. Following resolution of infection, a small number of persons, called carriers, continue to carry the bacteria. Around 2% - 5% of those who contract typhoid fever become chronic carriers, as the bacteria persists in the biliary tract after symptoms have resolved [3] Sero-epidemiological surveys have also revealed that some persons in the population have non-immunizing antibodies present in them irrespective of previous vaccination status, and will be seropositive, which is a limitation of employing sero-diagnostic rapid diagnostic tests (RDTs) in surveillance [4]. Globally in 2017, there were an estimated 14.3 million cases of typhoid and paratyphoid fever in 2017, resulting in 135,900 deaths, 15.8% of which were in Sub-Saharan Africa [5]. Serological diagnostic methods still suffer from limitations of sensitivity and specificity emphasizing the need for a quick and reliable serologic test for acute infection of typhoid fever as an alternative to the old Widal test and as a complement to blood culture [6]. Diagnostic methods for typhoid fever currently used in health facilities in Cameroon include the Widal test, which is cheaper, easy to perform and does not require complicated expertise [7]. A disturbing issue with the Widal test in rural set is that the technicians are not available and when available they are poorly trained and at times lack the concentration to appreciate the reaction of the test worst of all nothing is done to

confirm if the Widal test its positive or negative which then lead to an inappropriate antimicrobial treatment of patients without the typhoid fever due to misdiagnosis. Culture of the causative organism is considered an effective diagnostic procedure in suspected typhoid fever [8] but they are expensive techniques and some bacterial culture facilities are often unavailable and also it requires laboratory equipment and technical training. Widal test alone for the detection of typhoid fever without confirmation may lead to unnecessary development of antimicrobial resistance to antibiotics which is a big problem worldwide today. The aim of this study was to compare the Widal test against stool culture in typhoid-suspected cases and to evaluate the agreement between test methods.

2. Methodology

2.1. Study Area

The study was carried out in different government health structures located in rural, semi-rural and urban set-up of Adamawa region (Vina, 9 health districts; Mayo Banyo, 4 health centers and Djerem, 4 health centers) each with an estimated population of about 1,124,000 inhabitants in 2022. The temperature of the area ranges from 20˚C - 41˚C. The inhabitants of this region are involved in diversified economic activities that range from commerce, and rearing to farming [9].

2.2. Study Design and Period of Study

A descriptive cross-sectional study was conducted from April 2019 to June 2020. The study involved obtaining blood and stool samples from visiting patients suspected of having typhoid fever. Blood samples were centrifuged to obtain serum that was subject to the Widal test. Stool samples were inoculated into Xylose Lysine. Deoxycholate Agar (XLD) (lot20420502 https://www.rapidlabs.co.uk/) and Brilliant Green Agar (lot 17040105) suitable for cultivation of *Salmonella typhi.*

2.3. Study Population

Participants of this study were out patients who were suspected of having typhoid fever. Consultation signs considered were temperatures of ≥38˚C and had bowel disturbance, headache, malaise, anorexia, etc, seeking medical attention in different health district in the study area. A total of 368 patients (distributed as follows Vina 234, Mayo Banyo 65 and Dejerem 69) of different age groups were enrolled in this study. Patients who had taken antibiotics about a week before coming to the hospital, and vaccinated individuals were all included. A questionnaire was used to establish socio-demographic information.

2.4. Questionnaire Design, Distribution and Retrieval

A total of 368 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. Ethical Approval and Consent to Participate

Institutional ethical clearance was obtained from the Ministry of health in the regional of Adamawa (ref; 077/L/MINSATE/SG/CRSPO/CB/CA of 10th April 2022). Written informed consent was equally taken, and ethical clearance was taken from the ethical committee of the hospital, coordinating the activities of each health center that was chosen.

2.6. Specimen Collection

Specimens were collected from outpatients of all age groups who presented symptoms of typhoid fever. They were asked to give verbal consent and answer brief questions about antimicrobial treatment, history of typhoid fever, vaccination and their feeding habit. Specimens for this study were blood for Widal and stool for culture. 5ml of blood was obtained from each study participant from vein puncture for Widal test. Blood samples in dry tubes were allowed to clot and serum harvested for Widal test was carried on the 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 microbiological analysis.

2.7. Laboratory Analysis

2.7.1. Widal Slide Agglutination Test Procedure

The Febrile Antigen diagnostic Widal test kit was used to perform Widal test and was carried out in accordance with the manufacturer's instructions. The reagents contained *Salmonella typhi* O and H antigens and *Salmonella paratyphi* A, B and C antigens. Positive and negative controls were included and a titter greater than or equal to 1/80 indicates salmonella infection. Before the test, the reagents and samples were brought to room temperature and the antigens properly mixed before dispensing. A drop of patient's serum to be tested was placed on to each of the required number of circles on the tile, then one drop of Widal antigen suspension was added to the reaction circles containing patient serum. Using different mixing applicator sticks provided, the tile was rocked gently back and forth and observed for agglutination macroscopically for one minute. Agglutination was a positive test result and if the positive reaction was observed with the test, it indicated the presence of clinically significant levels of the corresponding antibody in the patient's serum.

2.7.2. Stool Culture

Fecal samples were emulsified using physiological saline. 1 ml of the suspension was added to the prepared buffered peptone water and Rappaport Vassilliadis

Broth for activation and incubated 18 - 24 hours at 37˚C. From Buffered peptone water the samples were then inoculated in prepared XLD agar and incubated for +37˚C ± 1˚C.

While same sample activated in Rappaport Vassilliadis Broth was inoculated in prepared Brilliant Green agar and incubated at 41˚C ± 1˚C, and 72 hours ± 3 hours. Sterility of the prepared culture media was checked by incubating 5% representative of the batch culture at 37˚C and 41˚C respectively overnight and observing for bacterial growth before inoculation and incubation of the representative samples, Hydrogen sulfide production under alkaline conditions causes colonies to develop black centers, which is the preliminary identification of *Salmonella typhi*—Red Colonies, Black Centers). Then *S. typhi* was identified as black colonies on the culture medium and biochemical (Analytical Profile index test) tests were used to confirm the isolated bacteria.

2.7.3. Quality Control

Standard operational procedures were followed during the processing of each sample. All the instruments used for sample processing were checked every morning for proper functioning.

Data Analysis and Management

Data of laboratory results were crosschecked and coded before entering into computer software. The Data were cleaned and analyzed using excel and Statistical Package for Social Sciences (SPSS) version 23.0 or Stat Graphics Centurion Version 16 .2 .04.

3. Results

Socio-Demographic Factors of the Participants

Table 1 indicates the socio demographic factors considered in this exercise A total of 178 (48.36%) males and 190 (51.63%) females from Adamawa region, ranging from less than 20 to over 60 years partake in this exercise as indicated (Table 1). Majority of the participants were between 20 and 40 years of age. Participant from urban area accounted for 55.7% of those that partake in the exercise and bachelors accounted for 65.2%. Most students who participated in the exercise were all from secondary establishments and they accounted for 37.5% of the total participants. Religious factor was equally taken into consideration and their percentage counts ranged from 69.8% Traders equally took part in exercise and their percentage of participation ranged from 16%.

Figure 1 indicates the frequencies age and sex of participants in the 3 divisions of the study area. Males constituted the e highest participants at the age group of 0 to 20 years in all the 3 divisions. While in the age group of 21 to 40, females dominated in al the 3 divisions. In age group 41 to 60 years most of the participants were equally females.

Table 2 explains the Widal test and stool culture conducted based on age group in the study area. In age group 0 to 2 years, 35.38% of the samples in health centers in Mayo Banyo were positive for Widal test and stool while

32.31% of the samples within this age group in the division were negative to Widal test and stool culture. 34.19% of samples obtained in health centers in Vina division were positive for Widal test and culture while 24.77% of the samples were negative to Widal test and stool culture. Health centers in Djerem division had the minimum (24.79%) number of samples that were positive in stool culture and Widal test and the highest percentage (44.98%) of samples that were negative in stool culture and Widal test.

Table 1. Socio-demographic factors of the participants *with Percentage Frequency* in Adamawa region.

	0 - 20 years		21 - 40 years		41 - 60 years		>60 years		total
Parameter	Female n = 77 (20.1%)	Male n = 97 (26.4%)	Female n = 89 (24.2%)	Male n = 62 (16.8%)	Female n = 18 (4.9%)	Male n = 13 (3.5%)	Female n = 6 (1.6%)	Male n = 6 (1.6)	368
Treatment									
Traditional	0%	4 (4.1%)	4 (4.5%)	4 (6.4%)	2 (11.1%)	0%	2 (33.3%)	1 (16.7%)	17 (4.6%)
Antibiotics	2 (2.6%)	4 (4.1%)	5 (5.6%)	6 (9.7%)	2 (11.1%)	1 (7.7%)	1 (16.7%)	1 (16.7%)	22 (6%)
Civil status									
Married	8 (10.4%)	59 (5.1%)	24 (27%)	17 (27.4%)	6 (33.3%)	6 (46.1%)	0%	1 (16.7%)	121 (32.9%)
Bachelor	68 (88.3%)	92 (94.8%)	41 (46.1%)	35 (56.5%)	1 (5.6%)	2 (15.4%)	0%	1 (16.7%)	240 (65.2%)
Divorced	0%	0%	16 (18%)	6 (9.7%)	4 (22.2%)	3 (23.1%)	0%	0%	29 (7.9%)
Widow	0%	0%	8 (9%)	4 (6.4%)	7 (36.9%)	2 (15.4%)	6 (100)	4 (66.7%)	31 (8.4%)
Education									
Non	18 (23.4%)	36 (37.1%)	2 (2.2%)	1 (1.6%)	0%	0%	3 (50%)	1 (16.7%)	61 (16.6%)
Primary	28 (36.4%)	34 (35.1%)	9 (10.1%)	7 (11.3%)	2 (11.1%)	2 (15.4%)	2 (33.3%)	4 (66.7%)	88 (23.9%)
Secondary	26 (33.8%)	22 (22.7%)	43 (48.1%)	28 (45.2%)	10 (55.6%)	7 (53.8%)	1 (16.7%)	1 (16.7%)	138 (37.5%)
University	5 (6.5%)	5 (5.1%)	35 (39.3%)	26 (41.9%)	6 (33.3%)	49 (30.7%)	0%	0%	126 (34.2%)
Occupation									
Civil servant	0%	0%	29 (32.6%)	20 (32.3%)	6 (33.3%)	5 (38.5%)	0%	0%	60 (16.3%)
Trader	0%	2 (2.1%)	24 (27%)	21 (33.9%)	7 (38.9%)	5 (38.5%)	1 (16.7)	1 (16.7%)	61 (16.6%)
Farmer	0	2 (2.1%)	11 (12.4)	6 (9.7%)	2 (11.1%)	2 (15.4%)	1 (16.7%)	5 (83.3%)	29 ((7.9)
House wife	8 (10.4%)	0%	11 (12.4%)	1 (1.6%)	3 (16.7%)	0%	4 (66.7%)	0%	27 (7.3%)
Settlement									
Rural settings	30 (39%)	46 (47.2%)	43 (48.3%)	29 (46.8%)	7 (38.9%)	4 (30.8%)	2 (33.3%)	2 (33.3%)	163 (42.3%)
Urbane setting	47 (61%)	51 (52.6%)	46 (51.7%)	33 (53.2%)	11 (61.1%)	9 (69.2%)	4 (66.7%)	4 (66.7%)	205 (55.7%)
Religions									
Islam	27 (35%)	33 (34%)	21 (23.6%)	16 (25.8%)	3 (16.7%)	5 (38.5%)	3 (50%)	3 (50%)	111 (30.2%)
Christianity	50 (64.9%)	64 (66%)	68 (76.4%)	46 (74.1%)	15 (83.3%)	8 (61.5%)	3 (50%)	3 (50%)	257 (69.8%)

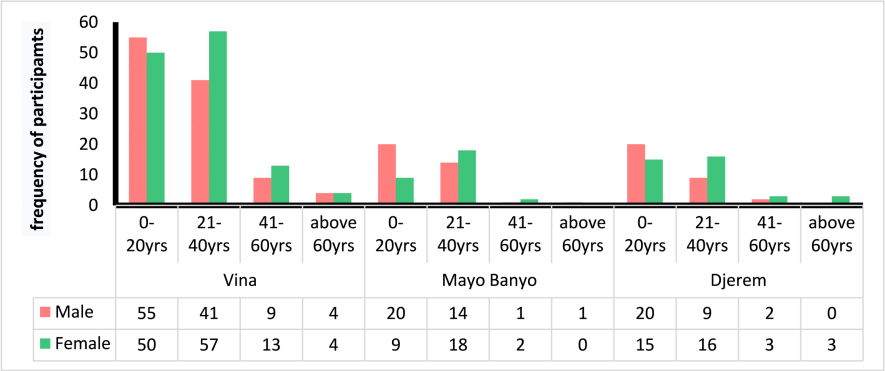

Figure 1. Frequency of participants with respect to sex and age group in study area.

Table 2. Prevalence of Widal test and stool culture with percentage scores within age groups in Adamawa region.

	C+ W+			C– W+			C+ W–			C– W–		
	Vina n = 80	Banyo n = 28	Dejerem n = 17	Vina n = 21	Banyo n = 6	Dejerm n = 6	Vina n = 75	Banyo n = 15	Djerem n = 15	Vina n = 58	Banyo n = 21	Djerem n = 31
0 - 20 yrs	40 (37.38%)	12 (40%)	8 (22.2%)	9 (8.4%)	2 (6.7%)	5 (13.9%)	33 (30.3%)	7 (23.3%)	9 (25%)	25 (23.3%)	9 (30%)	14 (38.9%)
21 - 40 yrs	32 (32.9%)	8 (25.8%)	6 (24%)	9 (9.2%)	4 (12.9%)	1 (4%)	32 (32.9%)	7 (226.%)	4 (16%)	24 (24.7%)	12 (37.1%)	14 (56%)
41 – 60 yrs	07 (31.8%)	2 (66.6%)	2 (40%)	03 (13.6%)	0 (0%)	0 (0%)	6 (27.3%)	1 (33.3%)	2 (40%)	6 (27.3.6%)	0 (0%)	1 (20%)
60+ yrs	01 (12.5%)	1 (100%)	1 (33.3%)	0 (0.0%)	0 (0%)	0 (0%)	4 (50%)	0 (0%)	0 (0%)	3 (37.5.5%)	0 (0%)	2 (66.7%)
Total % per character	34.19%	35.38%	24.644%	8.97%	9.23%	08.7%	32.05%	23.08%	21.7%	24.79%	32.31%	44.98%

Table 3 indicates values of Kappa test calculated to find out the correlation between the Widal test and the stool culture, In this test Kappa values varied from 0.2 in the Vina division indicating a fair correlation and to 0.4 in the Mayo Banyo and Djerem division indicating a much better agreement.

Table 4 indicates that In the Vina division among the 101 positive for Widal test, 80 were positive for stool culture and 75 more positive stool cultures were negative to Widal test (Table 3) the overall sensitivity, specificity, positive predictive and negative predictive values were of Widal test were 51.61%, 73.42%, 79.21%, and 43.61% respectively meanwhile in the Mayo Banyo division, among the 29 participants that were positive for Widal test 23 were positive for stool culture and 15 that were positive for stool culture were negative to Widal test. With sensitivity of 60.53%, specificity of 77.78%, with positive predictive and negative predictive values of 79.31% and 58.33% respectively., Widal and stool culture results in the Djerem indicated that among the 23 patients who were positive for Widal test, 17 were positive for stool culture and 15 more who were positive in stool culture were negative with the Widal test analysis with a sensitivity of 53.18%, specificity of 83.73% and with positive and negative predictive values of 73.91% and 67.39% as indicated on Table 4.

The sensitivity, specificity, positive and negative predictive values of Widal test against stool culture for the 3 different areas are presented in Table 5. This

means that since stool culture was considered the ideal to which Widal would be compared to, its sensitivity and specificity when cultured for *S. typhi* using Xylose Lysine Deoxycholate agar (XLD) and *Brilliant green agar* were 100% each. Sensitivity is the probability that a truly infected individual will test positive, while specificity is the probability that a truly uninfected individual will test negative.

Table 3. Comparison of slide agglutination test and stool culture in the study area.

	Vina				Mayo Banyo				Djerem			
Widal test, Slide agglutination	Stool culture			Kappa value	Stool culture			Kappa value	Stool culture			Kappa value
	Positive	Negative	Total		Positive	Negative	Total		Positive	Negative	Total	
Positive	80	21	101		23	06	29		17	06	23	
Negative	75	58	133		15	21	36		15	31	46	
Total	155	79	234	0.20	38	27	65	0.37	32	37	69	0.38

Table 4. Comparison of Widal test with stool culture on typhoid suspected cases.

Method	Vina				Mayo Banyo				Djerem			
Method Vina	No of samples	No of positive	No of negative	p values	No of samples	No of positive	No of negative	p values	No of samples	No of positive	No of negative	p values
Widal test	234	101 (43.16%)	133 (56.84%)	0.00001	65	29 (44.62%)	36 (55.38%)	0.09*	69	22 (31.88%)	47 (68.12%)	0.04800*
Stool culture	234	155 (66.24%)	79 (33.76%)		65	38 (58.46%)	27 (41.54%)		69	32 (46.38%)	37 (53.62%)	

Table 5. Prevalence of typhoid fever according to diagnostic methods.

Health facility	Sensitivity	specificity	Positive predictive value	Negative predictive value
Vina	51.61	73.42	79.21	43.61
Mayo-Banyo	60.53	77.78	79.31	58.33
Djerem	53.18	83.73	73.91	67.39

4. Discussion

With advancing technology and research, the world continues to quest for better ways of fighting infectious disease and ***antimicrobial resistance***, correct, rapid and accurate diagnosis methods are needed to achieve this goal. In many parts of the tropics like Cameroon in particular, febrile presenting diseases such as typhoid fever are among the diseases which are commonly diagnosed [10]. Therefore, a study was carried out to evaluate the diagnostic accuracy of the commonly performed Widal test and stool culture in some local health centers in the

Adamawa region of Cameroon.

The actual prevalence of typhoid fever was found to vary from one area to another in the different health districts. With Widal test the prevalence in Vina division was 43.16% while stool culture gave a prevalence of 66.24% statistically there was a significance difference ($p < 0.05$) between the Widal test and stool culture in this health establishment on the contrary to other works published by Abdulhai [11] in Kano Nigeria. Meanwhile, in other health districts, the prevalence of Widal test and stool culture were equally high but statistically, there was no significance difference (Mayo Banyo Widal test = 44.62%), stool culture = 58.46%), Djerem Widal test = 31.88%, stool culture = 46.38%). The prevalence of Widal test and stool culture were higher than those obtained by Wam [8] who reported a prevalence of 39.3% in patients using the stool culture method and 57.1% using the Widal test method in Akum health district. High prevalence values obtained in this exercise could be due to the quality of the reagents used and continuous training in laboratory techniques offered to health workers to improve the quality of work in the quest for better ways to diagnose infectious diseases in Cameroon and Adamawa region in particular.

Another contributing factor to the high prevalence of bacteria in the stool culture could be due to overcrowding with poor access to clean water and sanitation as reported by Tangwa *et al.* [12]. Faecal matter may gain access to the water through runoff water or through sewage from sewers and pit latrines. This could have been a major contributing factor to the high prevalence considering that a number of patients come from rural and riverine areas where facilities for sewage disposal are not controlled The consequences of false positive results include miss-use of antibiotics, likely danger of increasing the antibiotic resistance, increased cost of treatment due increased hospital stay for inpatients and missing of fatal disease of febrile illnesses.

This study revealed that *Salmonella* infection cuts across all age groups. The age groups most susceptible in the three study areas range between 0 to 20 and 20 to 40 years old. These results differ from the study carried out by Ramyil [13] colleagues which showed that those between 24 - 29 years were more susceptible to typhoid fever' The age range of 1 to 40 years is considered tender and active age. In this light, both children and adults can get typhoid fever through ingestion of contaminated food and water. People living in overcrowded areas with poor hygienic conditions and lack of access to safe drinking water are prone to infection by typhoid fever. In this study age was not significantly associated with *Salmonella* infection, on the contrary, a study by Lunguya [14] reported that older age and longer duration of fever were indication of typhoid fever.

The sensitivity and specificity of Widal test indicate the probability of a true typhoid patient to be positive by Widal test. The sensitivity, specificity, PPV and NPV of Widal test in this study were not the same in all the study areas, these values are seen in **Table 5**. Sensitivity was 51.61% in the Vina division, 60.53% in the Mayo Banyo division and 53.18% in the Djerem division at 95%CL respec-

tively. Similar results were observed in a study conducted in Vietnam (64%) [15].

The Widal slide agglutination true-negative results against stool culture were 73.42% in Vina division, 77.75% in the Mayo Banyo division and 83.73% at the Djerem division at 95% CI. This has a major impact on provision of effective patient management and reduces trust of patients in health services. As it designates the ability of an individual who does not have a disease to be tested negative. Other studies conducted in Nigeria on adults in hospitals showed that Widal test had low specificity [16].

This variation in negative predictive values may be due to geographical variations. The Widal agglutination varies with geographical location based on the indemnity of enteric fever, prevalence of no typhoid salmonella infection, and other infections which cross-react with salmonella antigen [17]. Low sensitivity may be associated equally with the sample collection time stool is not sensitive in early infection [18].

The positive predictive values in this study varied from 79.21% in the health districts in Vina to 79.31% in the health districts of the Mayo Banyo and finally to 73.91% in the health district of Djerem division. The positive predictive value is the ratio of participants truly diagnosed as positive to those who show positive test results. This characteristic can predict how likely it is for a participant to be truly positive in case of positive test results. It is the most important measure of a clinical diagnostic method since it represents the proportion of patients with positive test results that are correctly diagnosed [19] The negative predictive values in the area of study were all average and ranged from 43.31% in the Vina division to 58.33% in the Mayo Banyo division and finally to 67.39% in the Djerem division. This indicates that a negative Widal test result has an average predictive value for the absence of the disease. Though the PPV and NPV are low it does not concord with results recorded by Wam [18] with PPV of 28.13% and NPV of 6.44% at the Akum health district in Cameroon.

The assessment of agreement between two different diagnostic methods can also indicate how the test methods are close to each other. Statistically, the kappa values varied from 0.201 in the Vina division to 0.37 in the Mayo Banyo division and finally to 0.37 in the Djerem division. Theses kappa values demonstrated a fair agreement between Widal test and the stool culture methods These results concord with those obtained by Gemechu in Ethiopia [18]. Most people prefer Widal test to stool culture under the presumption that at early infection stool culture is positive in only 30 to 40% of the patients and that stool culture may bring about false positive results as a result of contaminations.

Limitations

Our limitations were mostly based on logistics, the attitude of some participants who requested compensation before they could give out their fecal samples, and lastly the unholy behavior of some laboratory staff in some health institutions was very discouraging

5. Conclusion

In this study, the prevalence of salmonella in stool culture results was relatively higher than the prevalence in the Widal test. Hence, the Widal test as the only laboratory test for the diagnosis of typhoid fever will produce a wrong diagnosis. The Widal test had a fair agreement with the stool culture. This means the Widal test should not be used alone but in combination with stool culture. Since the study area was vast other studies should be carried out to determine which of the serotypes are found in each zone

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Authors' Contributions

Conceptualization: Ngueguim Lucie; Methodology: Ngueguim Lucie, Tangwa Viban and Ngu Ngwa Victor; Resources: Ngueguim Lucie and Ngueguem Romain; Writing original draft: Ngueguim Lucie and Tangwa Viban; Validation; and supervision: Mamadou Abdoulmoumini and Ngu Ngwa Victor.

Conflicts of Interest

The authors report no conflicts of interest in this work.

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