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Original Research Article

Prevalence and Associated Risk Factors of Typhoid Fever in Patients Attending Bishoftu town Health Centers, Oromia, Central Ethiopia

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ABSTRACT

Typhoid fever remains a major public health problem globally and a major cause of morbidity in the developing world. The objective of the study was to assess the prevalence and associated risk factors of typhoid fever in Bishoftu town, central Ethiopia. A health center-based cross-sectional study was conducted in three health centers in Bishoftu town, central Ethiopia from April to May 2022. Three hundred sixty-two blood samples were collected from febrile patients attending in three health centers of Bishoftu town and were tested for typhoid by Widal test. Similarly, a pretested, structured questionnaire was used to collect socio-demographic and possible risk factors. SPSS version 22 was used for statistical analysis. Univariate and multivariate logistic regression analyses were used to assess the association of various risk factors with typhoid prevalence. The overall prevalence of typhoid fever was 35.1%. Being female (AOR: 2.136, 95% CI: 1.012, 4.508, p-value = 0.047), not being able to read and write (adjusted odd ratio (AOR: 2.990, 95% CI: 1.903, 19.111, p-value = 0.007), not keeping food in hygienic conditions (AOR: 4.984, 95% CI: 1.574, 15.777, p-value = 0.006), open defecation (AOR: 3.914, 95% CI: 1.390, 10.660, p-value = 0.008), not washing hand with soap before meals (AOR: 4.400, 95% CI: 1.390, 13.291, p-value = 0.012), not washing hand with soap after defecations (AOR: 7.541, 95 CI: 2.309, 24.628, p-value = 0.001), and eating street food (AOR: 4.607, 95% CI: 0.778, 27.624, p-value = 0.001) were identified as associated risk factors to typhoid fever prevalence. The study showed typhoid fever is a significant public health problem in Bishoftu town and its surroundings. Therefore, care should be taken to keep food in hygienic conditions and to wash hands with soap before meals and after using the toilet in order to control the disease.

Keywords: Prevalence, typhoid fever, risk factors, Widal test, Bishoftu town

INTRODUCTION

Typhoid is an important bacterial enteric disease occurring in the developing world, causing a widespread and persistent problem that adversely impacts public health as well as local and national economies. Typhoid and paratyphoid fevers, collectively referred to as "enteric fevers," are caused by Salmonella enterica serovar Typhi (S. Typhi) and Salmonella enterica serovar Paratyphi (S. Paratyphi). More than 2500 serovars of S. enterica have been identified, among which the human-specific enteric pathogen is Salmonella enterica serovar Typhi (D'Aoust, 2001).

Salmonella is a gram-negative mesophilic bacterium that can grow at refrigeration temperatures (4 to 10oC), with rapid growth between 25 and 43oC, although it is usually sensitive to temperatures above 55oC. Salmonella grows actively in the pH range of 3.6 to 9.5 and optimally at nearly neutral pH values (D'Aoust, 2001).

Typhoid fever is a global public health problem that is most frequent in countries where poor sanitation makes it easier for food and water to become contaminated with human waste marked by fever, diarrhea, prostration, and intestinal inflammation. Globally, typhoid fever infections cause a considerable burden of illness and mortality. For instance, the burden of typhoid fever was 11 million cases, resulting in approximately 110,000 deaths in 2019, where the highest prevalence was observed in sub-Saharan Africa, South Asia, East Asia, and Oceania (WHO, 2023).

The diagnosis of typhoid fever can be made using various methods, including blood, bone marrow, and stool cultures, as well as serological tests and deoxyribonucleic acid (DNA) amplification. Among these, blood culture is considered the gold standard for diagnosing typhoid fever. One common serological test used for diagnosis is the Widal test, which detects antibodies against Salmonella typhi antigens in a patient's serum. However, the Widal test has several limitations, such as cross-reactivity with other infections and the influence of repeated exposure to the pathogen. These factors can hinder its ability to accurately identify infections, especially in endemic regions. A recent study on the diagnosis of typhoid fever indicated that the Widal test performs poorly compared to other rapid diagnostic tests (RDTs). The mean sensitivity, specificity, positive predictive value, and negative predictive value of the Widal test in this study were 62.94 ± 17.83, 73.31 ± 18.75, 58.85 ± 40.07, and 75.96 ± 25.93, respectively (Tegene and Eshetie, 2025). Additionally, a study conducted in Tanzania reported that stool culture had a sensitivity of 31.3%, specificity of 91.5%, positive predictive value of 29%, and negative predictive value of 91.5% (Mawazo et al., 2019).

Extensive open defecation and improper disposal not only create an aesthetic nuisance but can also do more harm through pathogen contamination of drinking water sources, which often leads to outbreaks of waterborne diseases like typhoid. Fecal pathogens are frequently transferred to the water-borne sewage system through flush toilets and pit latrines, subsequently contaminating surface and ground water. Typhoid outbreaks do occur if control and preventive

measures are not taken in a timely manner. Typhoid fever is common among crowded and impoverished populations in communities with poor hygiene and sanitation, and it is commonly spread by eating food or drinking water contaminated with human faeces (Akoachere, 2009). Other contributing risk factors include the emergence of antibiotic-resistant strains (Dyson et al., 2019) and inappropriate, haphazard, and widespread antibiotic use, which establishes a selective pressure and is a driving force in the evolution of antibiotic drug resistance, such as MDR-salmonellae. Furthermore, problems in the identification and management of carriers and the lack of availability of cheap vaccines (WHO, 2008).

In Ethiopia, it is difficult to evaluate the burden of typhoid fever because of the limited number of studies and the lack of coordinated epidemiological surveillance systems (Tadesse, 2014). However, the prevalence of typhoid fever varies in different regions of the country. For instance, the prevalence was 1.6% in Adare General Hospital, Eastern Ethiopia (Awol et al., 2021), 5% in Shashemene referral hospital, Southern Ethiopia (Habte et al., 2018), 5.3% in Bahir Dar, Northwest Ethiopia (Amsalu et al, 2021), 10.3% in Felegeselam health centes, Pawe special district, Northwest Ethiopia (Tadess et al., 2013), 11% in Karamara hospital, Jigijiga, Eastern Ethiopia (Admassu et al., 2019), 13.2% in the Afar region, Eastern Ethiopia (Zerfu et al., 2018), 32.6% in Adiss Abeba (Andualem et al., 2014), and 33% in Ethiopia (Teferi et al., 2022). According to administrative town health bureau data, 15,000 populations were treated with typhoid fever every year in Bishoftu town health facilities (personal communication). Thus, the objective of the study was to assess the prevalence and risk factors of typhoid fever in Bishoftu town, Oromia regional state, central Ethiopia. The results of this study are significant as they provide essential evidence for local health authorities to develop and implement targeted public health interventions. These actions may include promoting safe water and sanitation practices and increasing community awareness to reduce the incidence of typhoid fever in the area.

MATERIALS AND METHODS

Study Area Description

This research was conducted in Bishoftu town, which is located in the middle of the Oromia region, in the eastern Showa Zone, 47 kilometers away from Addis Ababa, the capital city of Ethiopia (Figure 1). The Bishoftu town lies within the geographical coordinates (8° 44' 4.74'' N and 39° 0' 30.726'' E), and it sits at an elevation of 1,920 meters above sea level. According to the 2007 Central Statistical Agency report (CSA, 2007), the town has a population of 99,928; of this, 47.9% were males and 52.1% were females. The town has two government hospitals and one private hospital. Regarding health centers, the town has five governmental health centers, namely Babogaya, Chalalaki, Kata, Kurkura, and Ziquala. In addition, the town has 43 privately owned clinics. The government health centers render outpatient services for urban and rural residents.

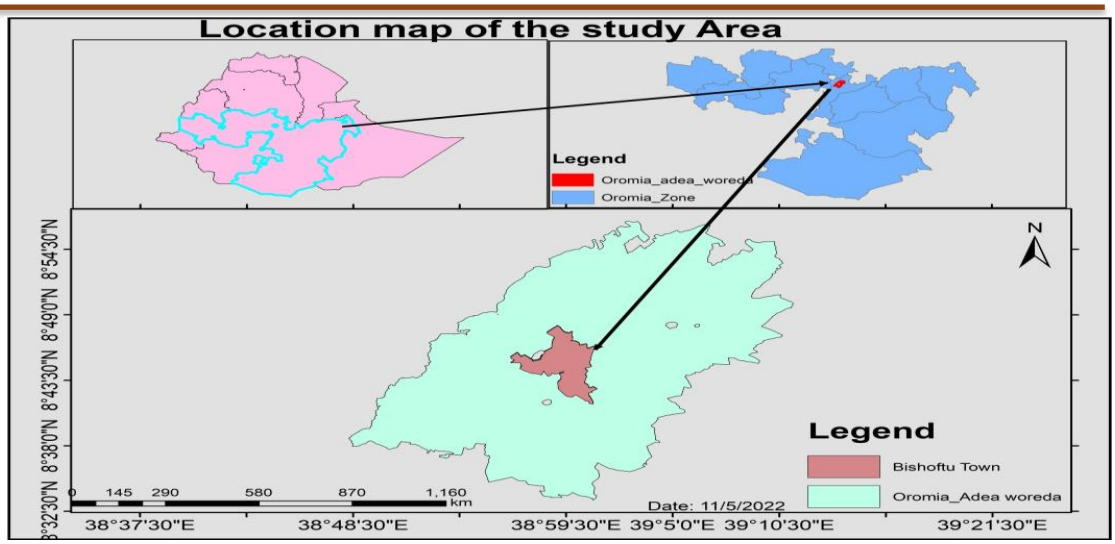

Figure 1. Map of the study area.

Study design and study period

The study was carried out mainly on patients visiting the health centers, and hence, a health center-based cross-sectional study was conducted in Bishoftu town during April and May 2022.

Source population

The population source was all febrile patients attending Babogaya, Chalalaki, and Ziquala health centers during the data collection period. Due to logistical problems, the two health centers, Kata and Kurkura, were excluded from the study.

Eligibility criteria

Inclusion and exclusion criteria

All febrile patients who consented to participate in the study and who presented to the outpatient departments of the three health centers with complaints of enteric fever, including a temperature >37.5°C, headache, constipation, diarrhea, and abdominal pain, were included in the study. In contrast, study participants who refused to take part and were receiving antibiotic treatment were excluded.

Sample size determination and sampling technique

The sample size was estimated to be 362 by using the single proportion formula at a 95% confidence interval, assuming a typhoid prevalence of 31% (Teferi et al., 2021) and 5% marginal error; by adding 10% contingency, the total sample size was 362. Participants were selected randomly using a simple random sampling method from febrile patients who attended the three health centres during April and May 2022.

Data Collection

Trained health officers and researchers gathered socio-demographic, personal, and environmental hygiene data using a questionnaire. The physicians conducted a clinical examination of the febrile patients, and those who were suspected of typhoid fever were requested to undergo a Widal test.

Serological test

One to three milliliters (ml) of venous blood were drawn under aseptic conditions from selected study participants by an experienced laboratory technologist at three health centers. The serum was separated through centrifugation. The S. Typhi O and H antigens were utilized in a Widal slide agglutination test according to the manufacturer's instructions (Bivda, United Kingdom).

In this study, a direct slide agglutination method was employed to qualitatively assess the sera's agglutination capacity. The test was conducted on a slide by adding one drop of serum alongside one drop each of the O and H antigens. After shaking the mixture back and forth for one minute, it was examined for macroscopic agglutination. If agglutination occurred within a minute, the result was categorized as reactive; if not, it was labeled as non-reactive (Cheesbrough, 2009).

Data quality control

The questionnaire, which was written in English, was translated into the regional tongues (Afan Oromo and Amharic) prior to data collection to ensure accurate results. Blood was collected and processed according to standard operating protocols. Every day, the gathered data was evaluated, and any inaccuracies were checked and corrected immediately.

Data analysis

The information recorded on the questionnaire and the results collected from the laboratory were checked for completeness and consistency, then coded and entered into the computer. The compiled data was analysed using SPSS version 22. First, descriptive statistics were computed, and the result was reported using frequency and percentage. A logistic regression analysis was used to measure the strength of the association between potential risk factors and typhoid fever. A univariate logistic regression was first done to select variables with a $P < 0.25$ significance level. Variables with a P-value < 0.25 in univariate analysis were entered into a multivariate logistic regression model to identify the determinants of typhoid fever among study participants (Bursac et al., 2008). Finally, variables with a p-value of 0.05 at a 95% confidence interval were taken as statistically significant.

Ethical consideration

The study received ethical approval from the University of Gondar, College of Natural and Computational Sciences Ethical Committee with reference letter CNCS/10/639-25-5-2020.

After they became informed about the objective of the study, written consent was obtained from each selected study participant, and any participant who was not willing to participate in the study was not forced to do so. Participants in the study were also informed that all data obtained from them would be kept confidential and that their privacy would be protected by ensuring that no names appeared in any part of the repository.

RESULTS

Socio-demographic characteristics of the study participants

The socio-demographic characteristics of the study participants are summarized in Table 1. A total of 362 study subjects participated in this study. Of those, 212 (58.6%) were females and 150 (41.4%) were males. The largest proportion of participants, 144 (39.8%), were aged 15–29 years, while the smallest group comprised those aged 65 and above, with 8 participants (2.2%). Of the total of 362 study participants, most of them were urban dwellers (294, 81.2%). Concerning marital and educational status, 202 (55.8%) were married, and 126 (34.8%) had completed primary school. Of the total study participants, 203 (56.1%) were private workers. On the other hand, 219 (60.5%) and 133 (36.7%) study participants had a family size of 5–10 individuals and monthly income of less than 1,000 birr, respectively (Table 1).

Table 1. Socio-demographic characteristics of study participants attending three health centers at Bishoftu town, Oromia, central Ethiopia from April to May 2022 (n = 362), ETB.

Variables	Categories	Frequency	Percent (%)
Sex	Male	150	41.4
	Female	212	58.6
Age(year)	<5	10	2.8
	5-14	104	28.7
	15-29	144	39.8
	30-64	96	26.5
	>65	8	2.2
Marital status	Single	139	38.4
	Married	202	55.8
	Divorced	16	4.4
	Widowed	5	1.4
Education	Not read and write	39	10.8
	Primary school	126	34.8
	Secondary	114	31.5
	Higher education	83	22.9
Occupation	Student	83	22.9
	Government worker	36	9.9

	Farmer	40	11.0
	Merchant	30	8.3
	Private worker	203	56.1
Residence	Urban	294	81.2
	Rural	68	18.8
Family size	1-4	74	20.4
	5-10	219	60.5
	>11	69	19.1
Family monthly income (ETB)	<1000	133	36.7
	1000-3000	112	30.9
	4000-10000	97	26.8
	>11,000	20	5.5

Out of the total study participants (n = 362), the overall prevalence of typhoid fever was 35.1% (127/362). From these, the prevalence of H, O, and both H and O antigens was 21 (5.8%), 37 (10.2%), and 69 (19.1%), respectively (Table 2).

Table 2. The prevalence of typhoid and paratyphoid fever at three health centers in Bishoftu town, central Ethiopia from April to May, 2022

Antigen detected	Frequency (n = 362)	Percent
Total Negative	235	64.9
H -antigen reaction	21	5.8
O-antigen reactive	37	10.2
H and O antigen reactive	69	19.1
Total reactive antigens	127	35.1

Table 3. Typhoid fever symptomatic distribution and its prevalence (n = 362).

Characteristics	Positive N (%)	Negatives N (%)	COR(95%CI)	p.value	AOR(95%CI)	p value
Fever						
No	3 (13.0)	20(87.0)	1		1	
Yes	124(36.6)	215 (63.4)	3.845(1.120,13.200)	0.032	21.546(3.789,122.570)	0.001
Fatigue						
No	20(10.6)	168(89.4)	1		1	
Yes	107(61.5)	67(38.5)	13.145(7.700, 23.371)	0.000	25.948(11.346, 59.344)	0.000
Headache						
No	118(44.7)	146(55.3)	1		1	
Yes	9(9.2)	89(90.8)	7.992(3.862, 16.539)	0.000	9.205(3.413,24.826)	0.000
Nausea						
No	36(18.6)	158(81.4)	1		1	
Yes	91(54.2)	77(45.8)	5.187(3.234, 8.319)	0.000	4.161(1.981,8.741)	0.000
Abdominal pain						
No	30(19.9)	121(80.1)	1		1	
Yes	97(46.0)	114(54.0)	3.432(2.118, 5.562)	0.000	7.920(3.416,18.361)	0.000

Skin spot						
No	110(32.4)	230(67.6)			1	
Yes	17(77.3)	5 (22.7)	7.109(2.557, 19.768)	0.000	3.581(0.841,15.255)	0.000
Cough						
No	30(21.7)	108(78.3)	1		1	
Yes	97(43.3)	127(56.7)	2.750(1.696, 4.458)	0.000	4.218(1.890,9.410)	0.000
Sweating						
No *	+70(25.8)	201(74.2)	1		1	
Yes	57(62.6)	34(37.4)	4.814(2.907,7.971)	0.000	2.518(1.118,5.672)	0.026
Loss of appetite						
No	52(25.6)	151(74.4)	1		1	
Yes	75(47.2)	84(52.8)	2.593(1.665,4.038)	0.000	0.820(0.390,1.725)	0.820

COR: Crude odd ratio; AOR: Adjusted odd ratio; CI: confidence interval; The bold values shows variables statistically significant at $p < .05$.

Prevalence of typhoid fever and associated risk factors

Multivariate logistic regression analysis showed that being female, unable to read and write, not keeping food in hygienic conditions, open defecation, not washing hands before meals and after defecation, and eating street food increased the risk of typhoid fever infections. Females were 2.1 times (AOR: 2.136; 95% CI: 1.012, 4.508; P value = 0.047) more infected by typhoid fever than males (Table 4). Study participants who could not read and write were almost three times (AOR: 2.990; 95% CI: 0.903, 9.902; P value = 0.073) more infected than study participants who completed higher education. The risk of typhoid fever was almost five times (AOR: 4.984; 95% CI: 1.574, 15.777; P value = 0.006) higher among study participants who kept their food in hygienic conditions. Study participants that defecated in open fields were almost four times more infected by typhoid fever compared to study participants that used flushed latrines (AOR: 3.914; 95CI: 1.437, 10.660, P = 0.008). The risk of typhoid fever was 4.4 times greater in those study participants who had not washed their hands before meals with soap (AOR: 4.400; 95% CI: 1.390, 13.921, P = 0.012) than their counterparts. Similarly, those study participants that lacked habits of hand washing after toileting were 7.5 times more infected than those study participants that washed their hands frequently before meals with soap (AOR: 7.541; 95% CI, 2.309, 24.628, P: 0.001). The risk of typhoid fever was 3.1 times higher in study participants who ate street food regularly than in study participants who did not eat street food (AOR: 3.160, 95% CI: 1.569, 6.364, P = 0.001).

Table 4. Univariate and multivariate analyses of typhoid fever and different risk factors (n = 362).

Characteristics	Positive N (%)	Negatives N (%)	COR(95%CI)	P value	AOR(95%CI)	P value
Sex						
Male	44(29.3)	106 (70.6)	1		1	

Female	83 (39.2)	129 (60.8)	1.633(1.043,2.517	0.032	2.136(1.012,4.508)	0.047
Age (year)						
	4(40)	6(60)	1.111(0.164,7.506)	0.914	NA	
5-14	39(37.5)	65(62.5)	1.000(0.226,4.417)	1.000	NA	
15-29	53(36.8)	91(63.2)	0.971(0.223,4.225)	0.968	NA	
30-60	28(29.2)	68 (70.8)	0.686(0.151,3.065)	0.622	NA	
>60	3(37.5)	5(63.5)	1			
Marital Status						
Single	50(36.0)	89(64.0)	2.247(0.244,20.666)	0.474	NA	
Married	73(36.1)	129(63.9)	2.264(0.248,20.635)	0.469	NA	
Divorced	3(18.8)	13(81.2)	0.923(0.074,11.535)	0.950	NA	
Widowed	1(20.0)	4(80.0)	1			
Educational Status						
Not read and write	19(48.7)	20(51.3)	3.431(1.516,7.762)	0.003	2.990 (1.903,19.111)	0.007
Primary school	51(40.5)	75(59.5)	2.456(1.306,4.618)	0.005	1.545(0.615,3.881)	0.355
Secondary school	39(34.2)	75(65.8)	1.878(0.980, 3.596)	0.057	1.691(0.675,4.236)	0.263
Higher education	18 (21.7)	65(78.3)	1		1	
Occupation						
Student	36(43.4)	47(56.0)	1.480(0.866,2.529)	0.152	NA	
Government worker	12(33.3)	24(66.7)	0.966(0.451,2.668)	0.929	NA	
Farmer	14(35.0)	26(65.0)	1.040(0.506,2.141)	0.133	NA	
Merchant	6(20.0)	24 (80.0)	0.483(0.187,1.247)	0.133	NA	
Private worker	59(34.1)	114 (65.9)	1			
Residence						
Urban	102(34.7)	192(65.3)	0.914(0.528,1.581)	0.747	NA	
Rural	25(36.9)	43(63.2)	1			
Number of family size						
1-5	22(29.7)	52(70.3)	0.688(0.345,1.370)	0.287	NA	
6-10	78(35.6)	141(64.4)	0.849(0.486,1.484)	0.566	NA	
>11	27(39.1)	42(60.9)	1			
Family monthly income						
<1000 birr	58(43.6)	75(56.4)	4.282(1.225,15.672)	0.023	0.320(0.051,2.016)	0.225
1000-4000 birr	44(39.3)	68(60.7)	3.667(1.015,13.249)	0.047	0.342(0.052,2.245)	0.264
4000-10000 birr	22(22.7)	75(77.3)	1.662 (0.446,6.199)	0.449	0.216(0.035,1.349)	0.101
>10000	3(15.0)	17(85.0)	1		1	
Keeping food in refrigerator or hygienic conditions						
No	24(52.2)	22(47.8)	7.273(3.145,16.818)	0.000	4.984(1.574,15.777)	0.006
Sometimes	91(40.0)	133(59.4)	4.561(2.351,8.850)	0.000	2.211(0.912,3.362)	0.077
Regularly	12(13.0)	80(87.1)	1		1	
Source of drinking water						

Pipe water	93(33.3)	186(66.7)	4.500(1.022,19.806)	0.047	2.658(0.370.19.111)	0.331
Well water	32(50.8)	31(49.2)	9.290(1.987,43.427)	0.003	4.680(0.610,35.891)	0.138
Packed water	2(10.0)	18(90.0)	1		1	
Treating drinking water						
No	72(57.1)	54(42.9)	6.667(0.403,31.682)	0.017	3.638(0.555,23.843)	0.178
Sometimes	53(23.7)	171(76.3)	1.550(0.329,7.297)	0.579	1.005(0.152,6.628)	0.996
Regularly	2(16.7)	10(83.3)	1		1	
Type of toilet used						
Open defecation	30 (50.8)	29 (49.2)	4.737(2.324,9.653)	0.000	3.914(1.437,10.660)	0.008
Pit latrine	78(39.6)	119 (60.4)	3,001(1.693,5.321)	0.000	1.920(0.864,4.268)	0.110
Flushed latrine	19 (17.9)	87 (82.1)	1		1	
Hand washing with soap before meal						
No	67(67.7)	32(32.3)	17.913(7.979,40.217)	0.000	4.400(1.390,13.921)	0.012
Sometimes	51(28.8)	126(71.2)	3.463(1.614,7.429)	0.001	1.606(0.503,4.580)	0.376
Regularly	9(10.5)	77(89.5)	1		1	
Hand washing with soap after defecations						
No	73(70.9)	30(29.1)	35.283(13.920,89.434)	0.000	7.541(2.309,24.628)	0.001
Sometimes	48(28.9)	118(71.1)	5.898(2.416,14.403)	0.000	2.827(0.902,8.400)	0.061
Regularly	6(6.5)	87(93.5)	1		1	
Eating street food						
No	64(24.8)	194(75.4)	1		1	
Sometimes	55(59.1)	38(40.9)	4.387(2.659,7.239)	0.000	3.160(1.569,6.364)	0.092
Regularly	8(72.7)	3(27.3)	8.083(2.083,31.389)	0.003	4.606(0.778,27.624)	0.001
Knows means of transmissions of typhoid fever						
No	101(42.3)	138(57.7)	2.730(1.651,4.516)	0.000	0.978(0.473,2.020)	0.952
Yes	26(21.1)	97(78.9)	1		1	
Keeping personal hygiene						
No	12(41.4)	17(58.6)	3.706(1.287,10.667)	0.015	1.147(0.279,4.722)	0.849
Sometimes	107(37.8)	176(62.2)	3.192(1.444,7.056)	0.04	1.168(0.402,3.398)	0.775
Regularly	8(16.0)	42(84.0)	1		1	

COR: Crude odd ratio; AOR: Adjusted odd ratio; CI: confidence interval NA; not applicable

DISCUSSION

The main objective of this study was to determine the seroprevalence of typhoid fever and the associated risk factors in Bishoftu City. These findings offer valuable insights into the current burden of the disease and emphasize the need for enhanced preventive and control measures. The overall seroprevalence of typhoid fever in this study was 35.1%, which is similar to the pooled prevalence of 33% reported from Widal test examinations in Ethiopia (Teferi et al., 2022). However, this prevalence is higher than the 10.3% found in the Pawe District (Tadesse and Tadesse, 2013), 19% at the Ayinba Health Center in north-west Ethiopia (Birhanie et al., 2014), 3.2% in the Afar region (Zerfu et al., 2018), 1.6% in Hawassa (Awol et al., 2021), 5% in Shashemene Referral Hospital (Habte et al., 2018), and 2% in Jakarta, Indonesia (Vollaard et al., 2004). In contrast, the prevalence of typhoid fever in this study was significantly lower than the rates reported in similar health facility-based research in Ambo (56.2%, Deksissa et al., 2019), Mekele (68.5%, Wasihun et al., 2015), and Nigeria (69.6%, Abioye et al., 2017). This difference may result from variations in Widal test kits, pronounced ecological differences, seasonal variations, variations in cultural practices, and variations in laboratory facilities; poor sanitary conditions in cities like Bishoftu; contamination of drinking water in the town; and the discharge of inadequately treated sewage into the water and environment of the town (Sur et al., 2007; Sutiono et al., 2010; Traoré et al., 2015; . Eba et al., 2019). Additionally, it can be difficult to establish a cut-off level of baseline antibody in a particular area or community because the antibody titer levels seen in a healthy population can change over time and between different localities (Cheesbrough, 2009).

The multivariate analysis showed that the risk of typhoid fever is very high in study participants who present with fever, fatigue, headache, nausea, abdominal pain, skin spots, coughing, and sweating. Similar to the present study, patients having a fever for greater than or equal to 5 days had abdominal pain and a skin rash that had a significant association with culture-confirmed typhoid fever in a study conducted in Shashemene, southern Ethiopia (Habte et al., 2018). However, a statistically significant association was not observed in clinical presentations such as fatigue and cough in Shashemene, South Ethiopia (Habte et al., 2018) and headache, joint pain, and back pain in eastern Ethiopia (Zerfu et al., 2018). The variation might be that the widal test used in our study might cross-react with other febrile illnesses that exaggerate the associations compared to culture-confirmed typhoid fever conducted in Shashemene (Habte et al., 2018). The current findings are also in line with the World Health Organization (WHO) guideline that the stepped ladder fever pattern or insidious onset fever, skin rash, anorexia, mild cough, and constipation were the most prevalent symptoms of untreated typhoid fever in the first week of infection (NICD, 2022).

The risk of typhoid fever was 2.1 times (AOR =2.136, 95% CI: 1.012, 4.508; P = 0.047) higher in females than males. Similar to the present study, the risk was higher in females in Ambo, Central Ethiopia (Deksissa et al., 2019), in the Afar region of eastern Ethiopia (Zerfu et al., 2018), in Arba

Minich, Southern Ethiopia (Lemi, 2019), in Ejere District, West shewa zone of Oromia (Bekele et al., 2013), and in the Gahanna-Volta region of Ghana (Fusheini et al., 2020). The reason for the highest prevalence of infection in females might be that females acquire infection during food preparation, child care, and other household activities. Differences in culture and sample size may contribute to the variations observed. However, other previous studies in Sokoto, Nigeria, showed that the frequency of typhoid fever was higher among males than females (Alhassan et al., 2012). A study by Eba and Bekele (2019) in the Lalo Assabi District, West Wollega, Ethiopia, indicated that both males and females were at relatively equal risk of infection, making them equally susceptible to the disease.

People who cannot read or write are at higher risk (AOR =2.990, 95% CI: 0.903, 4.508; P = 0.007) of acquiring a typhoid infection. Similar to the present study, a lower level of education is associated with an increased prevalence of typhoid fever in studies conducted in Ambo, Ethiopia (Deksissa et al., 2019), and Indonesia (Sutiono et al., 2010). This may be due to the lack of awareness that makes study participants more susceptible to contracting diseases from things like contaminated hands, water, dirt, and food. However, unlike our findings, Birhanie et al.(2014) reported the absence of a significant association between typhoid fever and the educational background of the study participants.

The risk of getting infected with typhoid fever was almost five times higher (AOR: 4.984; 95% CI: 1.574, 15.772; P value = 0.006) in study participants who did not keep their food in hygienic conditions. This finding is in agreement with studies conducted in Dawuro Zone, South-Western Ethiopia (Abera et al, 2021), where the risk of typhoid fever decreased in study participants who stored food in hygienic conditions. However, a statistically significant difference was not observed in study participants who stored food in the refrigerator in a study conducted in Karachi, Pakistan (Batool et al., 2021).

Study participants who defecated in open fields were four times (AOR: 4.006, 95% CI: 1.489, 10.784, P value = 0.006) more infected by typhoid fever than those who used flushed latrines. Similar results were found in studies conducted in Kolkata, India (Sur et al., 2007). However, statistically significant associations were not observed between latrine usage and typhoid fever prevalence in a study conducted in Bahir Dar, north-west Ethiopia (Gasem et al., 2001). The possible explanation might be that open defecations may contaminate water used for drinking and cooking purposes. Human faeces and urine are important links in the life histories of Salmonellae, which cause typhoid fever.

The risk of acquiring typhoid fever was 4.2 (AOR = 4.217, 95% CI: 1.337, 13.303, P value = 0.014) times higher in study participants that did not wash their hands with soap before meals compared to those that washed their hands regularly. This is in agreement with studies conducted in Bahir Dar, northwestern Ethiopia (Batool et al., 2021), and Indonesia (Gasem et al., 2001),

where typhoid fever infections were reduced in study participants who washed their hands with soap before meals. Similarly, the risk of infections with typhoid fever was 7.3 (AOR = 7.355, 95% CI: 2.227, 23.753, P value = 0.001) higher in study participants who did not wash their hands with soap after defecation compared to those who washed their hands regularly with soap. This is in line with studies conducted in Hawassa, southern Ethiopia (Awol et al., 2021), in Dawuro Zone, south-western Ethiopia (Abera et al., 2021), in West Wollega, Ethiopia (Eba et al., 2019), and in Indonesia (Alba et al., 2016). The possible explanation could be that typhoid fevers are spread through the oral-faecal cycle, in which hands play a significant part, and people who routinely wash their hands have a lower risk of contracting them (NICD, 2022). The habit of frequently washing hands is crucial, especially in areas with poor environmental hygiene.

A statistically significant higher risk of typhoid fever (AOR: 4.006, 95% CI: 1.489, 10.784, P value = 0.006) was observed in study participants that consumed street foods regularly, unlike a study conducted in Bahir Dar, northwest Ethiopia (Gasem et al., 2001), and Pakistan (Batool et al., 2022). However, statistically significant higher risks of typhoid fever infections were observed in study participants who consumed street food in studies conducted in Indonesia (Vollaard et al., 2004; Gasem et al., 2001). The difference might be due to differences in study area, street food type, and extent of cooking. The higher risk of typhoid fever in those who consumed street food might be because street vendors have only limited facilities for cooled storage of foods and for washing hands, foods, and dishes. In addition, the low hygienic standards could therefore contribute to the transmission of enteric fever (Lemi et al., 2019).

Although univariate analysis showed a statistically significant higher risk of typhoid fever in those study participants who treated their drinking water, a statistically insignificantly higher risk of typhoid fever was observed in those study participants' who treated their drinking water in multivariate analysis. However, treatment of household water reduced the risk of infection in a study conducted in India (Giri et al., 2021). Similarly, a statistically insignificant higher risk of typhoid fever was observed in study participants that used well water, unlike a study reported from Bahir Dar, where a statistically significant higher risk of typhoid fever infections was observed in study participants that used well water in multivariate analysis (Gasem et al., 2001). The variations might be due to different types of water treatment and study designs used. The lack of statistically significant relationships in multivariate analysis might also be attributed to the establishment of partial immunity brought on by recurrent low-dose exposure to Salmonella typhi through contaminated water supplies. Health education, provision of essential drugs, immunization, treatment of common diseases and injuries, adequate supply of safe water and basic sanitation, communicable disease control, and food supply and proper nutrition are some of the strategies to be considered for the wellbeing of humans (Bekele et al., 2023; Aschalew et al., 2019).

Limitations

Overestimation of the prevalence of typhoid fever in the study area due to the application of the Widal agglutination test is one of the limitations of the study. The Widal test is not as accurate as tests that involve culturing of the bacteria. The Widal test might lead to a cross-reaction of antibodies produced against S. Typhi O and H antigens with other Enterobacteriaceae, coupled with false-positive results in patients with malaria and other infections. Furthermore, since the study was health center-based, it might not reflect the prevalence of enteric fever in the community. In addition, unmeasured confounders like malnutrition and immune status should be taken into account. Future studies are encouraged to directly address these gaps for more accurate estimation and generalization of results.

CONCLUSION AND RECOMMENDATION

Typhoid fever has been an important public health issue in Bishoftu town and its environs. Sex, educational status, keeping food in hygienic conditions, type of toilet used, hand washing with soap before meals and after defecations, and eating street food are associated risk factors for typhoid fever. Therefore, it is imperative to undertake health education, keep food in hygienic conditions, wash hands with soap before meals and after using the latrine, and avoid eating street food to control and prevent typhoid fever. As far as possible, human excreta should be deposited in flush lavatories and then piped to sewage works, where it is treated and made harmless. The pit latrine should not be near streams or wells to avoid seepage and eventual contamination of the water. All latrines must have a lid to prevent the entry of flies that can spread infection. Further epidemiological studies in community settings rather than health center-based studies in order to provide reliable information at a population-wide level in order to curtail the burden of typhoid fever.

Data Availability

In response to a convincing request, data are available from the corresponding author.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

GM: Identified the research problem, collected and analyzed the data, and participated in the draft and final write-up of the manuscript.

DB: Collected and analyzed the data, and participated in the draft and final write-up of the manuscript.

EA: Collected and analyzed the data, and participated in the draft and final write-up of the manuscript.

ST: Identified the research problem, processing and data analysis, and wrote the manuscript.

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