HAWASSA UNIVERSITY COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES FACULTY OF BIOLOGICAL SCIENCE DEPARTMENT OF BIOLOGY

PREVALENCE OF TYPHOID FEVER AND RELATED RISK FACTORS IN GUMER DISTRICT, GURAGE ZONE, CENTRAL REGIONAL STATE, ETHIOPIA

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PREVALENCE OF TYPHOID FEVER AND RELATED RISK FACTORS IN GUMER DISTRICT, GURAGE ZONE, CENTRAL REGIONAL STATE, ETHIOPIA

BY:

ADVISOR MELESE BIRMEKA (PhD)

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ADVISOR'S APPROVALSHEET

We here by certify that we have read and evaluated this MSc Thesis Proposal entitled **"PREVALENCE OF TYPHOID FEVER AND ITS RISK FACTORS IN GUMER DISTRICT, GURAGE ZONE, CENTRAL REGIONAL STATE, ETHIOPIA "** prepared under our guidance by **LAKE AYNU GPBIOL K 015/10**).) under our supervision, therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department

Melese Birmeka (PhD) Signature _____Date_____
Major Advisor

Internal examiner_____ Signature _____ Date_____

External examiner_____ Signature _____ Date_____

STATEMENT OF DECLARATION

I, **LAKE AYNU GPBIOL K 015/10**) , the undersigned, declare that this thesis entitled "**PREVALENCE OF TYPHOID FEVER AND ITS RISK FACTORS IN GUMER DISTRICT, GURAGE ZONE, CENTRA REGIONAL STATE, ETHIOPIA**" submitted in partial fulfillment for the award of Degree of Masters of Biology , is my own work conducted under the supervision of my advisor Melese Birmeka (PhD). I have adequately cited and referenced all the original sources. I further declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

Declared By:

Name	ID Number	Signature	Date
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ABBREVIATIONS AND ACRONYMS

ANOVA = Analysis of variance

AOR = Adjusted Odds Ratio

CI = Confidence Interval

COR = Crude Odds Ratio

CSA = Central Statistical Agency

df = Degree of freedom

EF = Enteric fever

FMOH = Federal Ministry of Health

GDHCs = Gumer District health centers

GPAQ = Global Physical Activity Questionnaire

KAP = knowledge, awareness and practice

MD = Managing director

OR = Odds ratio

P = Probability

PTF = Paratyphoid fever

S. typhi = *Salmonella typhi*

SIM = Sulfide Indole Motility Test

SPSS = Statistical package for social science

TF = Typhoid Fever

ABSTRACT

Typhoid fever (TF) continues to be a major public health problem in many developing countries. . *In Ethiopia, like any other sub-Saharan African country, the condition is worsened due to shortage of safe potable water and toilet access, low health education and overall high illiteracy level. The objective of this study was to assess the prevalence of TF and its asosated risk factors in Gumer District, Gurage zone, Central Ethiopia regional state, Ethiopia. In this health facility-based cross-sectional study design, all patients attending Gumer District selected Health Center A structured questionnaire was administered to capture socio-demographic and other -related variables in association to the risk of TF. Blood samples collected, sera separated and tested by the slide agglutination (Widal) method were used. The required statistical analysis was done using SPSS software Pearson's correlation.* Univariate and multivariate logistic regression models were used to test the association between socio-demographic variables and seropositivity for salmonella antigens used with p-value ≤0.05 considered statistically significant. Out of 384 patients diagnosed 278 (72.4%) were TF seropositive the highest proportion (52 .6 %) of cases occurring among the *age 16-31 years (adjusted odds ratio (AOR) 2.259, 95% confidence interval (CI) 1.227-4.161, p=0.009), males 172(80.4%) TF positive with (AOR 0.861, 95% CI 0.131-1.72, p=0.000), lack of toilet 144 (37.5%) from this 202(52.6%) TF positive with (AOR 1.672, 95% CI 1.610-1.7100, p=0.000), and illiteracy 90(81.8%) TF positive with (AOR 2.756 95% CI 1.416-4.322, p= 0.004 uncooked vegetables 168(76.7%) with (AOR) 2.103 95% CI 1.213-3.171 p=0.029) were* independent significant predictors of TF seropositivity. TF is a serious public health burden in the locality calling for scale-up of intervention strategies including provision of safe water supply, toilet coverage and health education. Residents should be sensitized on control of fly densities from their latrines, washing hands with soap and clean safe water after visiting the latrine and before preparing or eating food. They should also be sensitized on washing and/ or pealing fresh fruits before eating and how to treat water at home before drinking using cheap, simple and effective methods like filtration, boiling and using water treatment agents like aqua safe and water guard

Key words: prevalence, Risk factors, S. typhi, slide agglutination test, widal test

1. INTRODUCTION

1.1 BACKGROUND OF STUDY

Typhoid fever also called enteric fever is a systemic bacterial disease, the most endemic disease in most countries mostly caused by *S.typhi* and the second causative agent is *Salmonella enterica serovars Paratyphi (S. Paratyphi*) and the man is the only reservoir for this bacteria (Aljanaby and Medhat, 2017 ; Teferi *et al*., 2021). Still millions of people were infected with typhoid fever each year, and it is still a major public health issue in low-income nations such as east and west Asian and Africa countries (Galgallo *et al.,* 2018). The global impact of TF is tremendous that an estimated 15-36 million clinical cases and 266,000-700,000 deaths occur annually (WHO, 2019). Sub-Saharan Africa is carrying the highest TF burden with an incidence of 10-100 per 100,000 cases per year (Tadesse, 2014). A study conducted in Singida Region of Tanzania showed that the annual burden of TF increased from 771 cases per 100,000 persons in 2003 to 1,402 per 100,000 in 2004 (Allen and Honest 2010). A study in a rural village of Agogo, Ghana also showed an incidence of over 200 cases per 100,000 persons per year (Marks *et al., 2010*).

Globally in 2020, *Salmonella enterica serovars typhi* caused 15.3 million cases and 135,900 deaths (WHO, 2020) where 76.3% of the cases were caused by *Salmonella enterica serovars typhi*. Despite a decrease in the morbidity and mortality associated with EF in industrialized countries, EF is one of major public health problems in sub-Saharan countries having 2.6 times more TF incidence than the overall incidence in low and middle in-come countries. Besides, because of low safe water access and sanitary facilities, EF is a common health problem in Ethiopia (WHO, 2021). It is difficult to estimate the real impact of the disease as the clinical symptoms may be confused with other febrile illnesses and specific laboratory confirmation may not be available in these areas (Sudharshan, 2014). Children, the elderly and immune-compromised individuals are the high-risk groups and case fatality rates of 38% in children and 47% in adults were recorded in some regions (Tadesse, 2014). The disease is observed at a great frequency in acquired immunodeficiency syndrome (AIDS) patients than the general population. The prevalence rate of TF varies in different region of Ethiopia; it also varies in different age group, sex due to different types of research design conducted by different researchers. For example, a case fatality rate of 15.7% reported in hospital admitted Ethiopian children (Worku, 2016). In another study on patients with febrile illnesses, typhoid fever was recorded in 5.85% of

patient with a higher occurrence in children aged 3 to 14 years (6.6%) compared to children aged 15 to 17 years (1.1%) (Animut *et al*. 2018). Definitive diagnosis of typhoid is by isolation of bacteria from blood, bone marrow or other study fluids, most developing nations like Ethiopia due to limited access to laboratory facilities, use the old widal test (Beyene *et al*., 2008).

According to the Ethiopia Federal Minister of Health (FMOH) report, two percent of males and three percent of females died because of typhoid fever (WHO,2021). Most typhoid-patients are characterized by many symptoms such as; fever, a headache, nausea, abdominal pain and low WBC count (Moser *et al.,* 2019). Positive blood and stool culture are gold standard for diagnosis of *S.typhi* that cause typhoid fever (Kumar, 2017). A study by Agwu found that typhoid is highly (39.6%) prevalent among febrile patients aged (10- 29 years old) attending clinics in Bushenyi (Agwu, 2017). Bearing in mind, in Ethiopia typhoid fever is an endemic disease, and the burden and consequence of the disease vary with different ecology, climate, and population groups. So Communicate the latest new information concerning the distribution of typhoid fever in the catchment area have valuable significance for early and prioritized interventions (Yehualashet, 2018).

Typhoid fever is common amongst crowded and impoverished populations in communities with poor hygiene and sanitation, and is spread commonly by eating food or drinking water contaminated with faces or less commonly by urine of an infected person (Akoachere *et al*,. 2010). Typhoid fever can also be gotten from eating poorly prepared poultry products such as eggs, and dairy products (Nzouankeu *et al.,* 2010) . Other studies carried out on Prevalence and antimicrobial susceptibility patterns of Salmonella isolates in association with hygienic status from butcher shops in Gondar town, Ethiopia, revealed that animal sources of contamination such as swine and cattle are very common in poor hygienic conditions (Eguale, 2018). Typhoid fever (TF) is almost always acquired by ingestion of food or water contaminated with excreta from a patient with typhoid or from chronic carriers. The disease is communicable for as long as the infected person excretes *S. typhi* or *S. paratyphi* in the feces or urine. A study done by Beyene (2008) showed *Salmonella typhus* is widespread in the community. Being an important communicable disease in the national list, typhoid fever has received considerable control efforts at national, regional and District levels. However, It is obvious that TF is among the top health challenges in Ethiopia, like any other sub-Saharan African country. But studies on the magnitude of TF burden and associated socio-demographic or environmental factors are limited Thus, this

study was designed to generate a preliminary data on the status of TF in Gumer District, Gurage Zone, Ethiopia.

1.2 Statement of Problem

Incidence of typhoid can be reduced through improved sanitation and hygienic behaviour and access to clean water yet it is reported that typhoid prevalence is high. Increased health and disease awareness and improved attitude of residents do indeed reduce the prevalence of typhoid but typhoid prevalence is said to be high. Typhoid fever is confirmed through proper medical laboratory tests using viable reagents though wrong diagnoses do lead to wrong reporting. If clean water system, sanitation facilities and hygienic practices are not sustained it would be difficult to control and prevent typhoid effectively. The global burden of the disease in low- and middle-income countries in 2010 was estimated to be 11.9 million cases, including 129,000 fatalities, after adjusting for water-related risk factors (Mogasale, *et al.,* 2014). The new data from Africa give further evidence to the need to move swiftly toward interventions to address this problem. Broad economic development, sustained improvements in water, sanitation, strengthened health systems and food safety policies went a long way toward reducing the burden of typhoid fever (Steele, 2016). There is no doubt as to the endemicity of Typhoid fever in Ethiopia, but precise estimate of prevalence of typhoid fever among patient is unavailable and there is no coordinated epidemiological surveillance (Beyene, 2018). Similarly, there was very little information on the prevalence and epidemiology of typhoid fever in the current study area. Therefore, the present study will designed to assess the prevalence of TF case and associated factors among patients treated in Gumer District health center

In Ethiopia, many researchers were interested to study about drugs to limit Salmonella typhi and how the bacteria resist the drug rather than prevalence of the disease, different risk factors, opportunistic disease that aggravate the disease, life styles of people that is poor or rich and types of test for the disease. Published data regarding about prevalence and determinant factors of TF among people in all age were limited in Ethiopia especially in Gurage zone, particularly in Gumer district was totally absent. It shows that, there is a research gap on prevalence of TF, different risk factors, related disease that aggravate TF and types of test that indicates test positive and test negative which are applied on people in all age in Ethiopia. The bacteria use human as a reservoir host which makes it worse. So that, the emphasis of this research is onto screen out which age and sex more susceptible to typhoid fever, risk factors of each location, life styles of people (feeding habit) in all ages of people that attend between February, 2023 and

May, 2023 in Gumer District health center, Central Ethiopia regional state, Ethiopia. It is obvious that TF is among the top health challenges in Ethiopia, like any other sub-Saharan African country. But studies on the magnitude of TF burden and associated socio-demographic or environmental factors are limited. Thus, this study was designed to generate a preliminary data on the status of TF in Gumer District, Gurage zone. Central Ethiopia regional state, Ethiopia.

1.3 Research Question

The research questions of the study are:

1. What is the level of typhoid fever cases among patients attending at Gumer District health center?
2. Which age and sex groups are most affected by typhoid infections in the study area?
3. What are the risk factors associated with typhoid infections in the study area?
4. What are the association between typhoid fever and socio-demographic, dietary and sanitary variables?

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of this study was to assess the prevalence of TF and associated factors among people attending Gumer District Health Center Gurage zone, Central Ethiopia regional state, Ethiopia

1.4.2 Specific Objectives

1. To determine the prevalence of typhoid infections attending at Gumer District health center
2. To estimate the prevalence of TF case among different age- and sex- groups in the study area
3. To identify the risk factors associated with typhoid infections in the study area.

1.5 Significance of the Study

There is no research work available in the prevalence and associated risk factors of typhoid fever in Gumer District, Central Ethiopia regional state, Ethiopia. The findings of this study will fill the research and knowledge gap. This study will generate information that may be useful in policy development and review of policies on licensing of prevalence and associated risk factors of typhoid fever. The research was provided relevant recommendations and suggestions in

accordance to the nature of the findings as well as relating it to the current national prevalence and associated risk factors of typhoid fever. Also the results of this study are intended to be utilized by the interested parties such as MoH and other government institutions that are concerned with provision of services in Gumer District. It is hoped that the study findings would contribute to the understanding of the risk factors that influence the spread of typhoid fever in the informal settlements. It is hoped that the results would be of great use to programme planners, academics, policy formulators and implementers, donors, curriculum developers and other service providers in control of typhoid fever. It is also important to the researchers and academicians as it will be a useful guide for future researchers interested in undertaking a study on the prevalence and its risk factors influencing the occurrence of typhoid fever in other parts of Ethiopia.

1.5 Scope of the Study

1.5.1 Geographical Scope

Gumer Ditrict is found in Central Ethiopia region one of the 15 Districts that constitute in Gurage Zone, Central Ethiopia regional state, Ethiopia. The relative location of Gumer District is from South Geta District, from North Eza District, from West Cheha Woreda, from East Silti Zone The altitude of Gumer District is between 2551 to 3137m.a.s.l. The peasant settlement and their farm land have dominated by gentle slopes, which are relatively steep hills. (Central Ethiopia regional state , Bureau of Finance and Economic Development, 2012) . Arekit is the administrative Town of Gumer District. This is located at the distance of 220km and 60km from Addis Abeba the capital city of Ethiopia and Wolkite that is administrative zone of Gumer respectively. Gumer District constitutes 18 rural kebele and 2 municipal. (Gumer District Communication Office, 2023).

1.5.2 Content Scope

This study was carried out on patients attending to selected health center in Gumer District that was be meet the inclusion criteria. The study was focused on prevalence and the personal hygiene, home sanitation, water related and food hygienic factors in homes of these patients that may predispose them to typhoid infection.

1.5.3 Time Scope

This research was carried out between the month of October 2022 and September 2023. This time duration covers for proposal development, data collection and analysis, and compiling of the report.

1.6 Limitations

One possible limitation of this study was the limited number of participants. This which could greatly affect the statistical power of the study. Responses provided in the questionnaire for age group below 18 years was provided by parents and guardians which could introduce recall bias as regards the study. This study has some limitations in light of which results need to be interpreted. First, as a hospital-based study that enrolled participants in the outpatient department, typhoid patients that don't seek healthcare at the selected Gumer Distric health center were missed. Second, identification of species by anti-sera and antibiotic susceptibility test for isolated pathogen was not done. Another limitation of the study was related to the duration of time for which the subjects were asked about the associated risk factors of typhoid fever and the prevalence period is short; in Gumer Distric health center Gurage Zone, Central Ethiopia regional state, Ethiopia. But access to safe water, toilet, environmental sanitation and occurrence of the outbreak was assessed during the study period. And the study was conducted almost throughout the four month and use of the gold standard method for diagnosis may ensure the quality of the generated data.

1.7 Operational definition of terms and Concepts

Some of the most significant terms related to the study, in our study the following definitions was used:

1) A risk factor is a characteristic, condition, or behavior that increases the likelihood of getting a disease or injury (Mathers, 2006).
2) Catchment kebeles refers to Place where patients come to study health center for examination of typhoid fever
3) Epidemiology is scientific study of infectious diseases and their causes.
4) Morbidity - Relating to or caused disease
5) Mortality -The number of deaths within a particular area or group of people over a specified period of time.
6) Environmental sanitation- Conditions and processes relating to people health and their surroundings especially the system that supply water and deal with human waste.

7) Enteric fever is a generic term for infections caused by both *S. typhi* and *S. paratyphi* (Buckle, 2012).
8) Incidence refers to the number of individuals who develop a specific disease or experience a specific health-related event during a particular time period (such as a month or year). (Garrett, 2020).
9) Prevalence refers to the total number of individuals in a population who have a disease or health condition at a specific period of time, usually expressed as a percentage of the population (Verhgen, 2004).
10) Sanitation refers to public health conditions related to clean drinking water and ' treatment and disposal of human excreta and sewage (WHO-UNICEF, 2017).
11) Salmonella enterica *subsp enterica, serovar typhi* -Causative agents of typhoid fever (WHO, 2020).
12) Typhoid fever is a systemic prolonged febrile illness caused by certain Salmonella serotypes (Crump, 2019).

2. LITERATURE REVIEW

Typhoid fever is an acute illness associated with fever caused by *Salmonella enterica serotype typhi* bacteria. It can be also caused by *Salmonella paratyphi* a related bacterium that usually causes a less severe illness. Typhoid fever is almost always acquired by ingestion food or water contaminated with excreta from a patient with typhoid or from chronic carriers. Human beings are the only reservoirs of *salmonella typhi,* and control of typhoid fever has been achieved in many countries by limitation of the faecal-oral transmission of the organism. Nevertheless, the disease continued to be a major health problem in developing countries (Worku, 2016).

2.1 Typhoid fever

Typhoid fever is an infectious disease caused by bacteria "Salmonella Typhi" (Wain *et al*., 2015). This bacterium is also known as the *Salmonella enterica serotype Typhi*, these organisms grow in the intestines and blood. This highly adapted, human-specific pathogen has evolved remarkable mechanisms for persistence in its host that help to ensure its survival and transmission (Sattar *et al*.,2012). The bacterium, *Salmonella typhi* (Salmonella enteric serotype typhi), causes typhoid fever. *Salmonella typhi* is an obligate, motile, gram-negative, rod-shaped enteric bacillus and belongs to entero bacteriaceae family. The intestines of humans are known to be its principal habitat. The major route of transmissions of enteric fever (typhoid fever) is either through faeco-oral route or urine-oral route (Mtove *et al.,* 2010).

Typhoid is a bacterial infection caused by the Gram-negative bacterium Salmonella enterica subspecies *enterica serovar Typhi* (*S. Typhi*). Typhoid fever is usually contracted by ingestion of food or water contaminated by faecal or urinary carriers excreting *S. Typhi* (Parry, 2021). The predominant symptom of infection is high fever, with other symptoms including nausea, abdominal pain and abnormal bowel movements (Haselbeck, 2017). Typhoid is caused by *Salmonella typhi,* which is exclusive to humans and may lead to severe symptoms in the digestive system in the second phase of the illness. Without therapy the illness may last between three to four weeks and death ranges between 1% and 30% (WHO, 2005). Persons with typhoid fever usually have a sustained fever as high as 1030 to 1040F (390to 400 C). Once prevalent worldwide, improvements in the provision of clean water and sewerage systems has led to a dramatic decrease in the incidence of typhoid fever with the burden of disease now predominantly residing in low- and middle-income countries where sanitary conditions may be poor (Parry,2021). Transmission to a new host occurs directly or indirectly through contaminated food, fluid, fingers, fomites and flies. In 90% of the cases,, infection is indirectly by ingestion of

water or food soiled with excrement from infected subjects. *Salmonella typhi* discharged in faeces and urine is disseminated into water, milk, or other foodstuffs. Infection follows ingestion of contaminated material. Such a contamination may occur by any one of the following agents (WHO,2018). Typhoid fever is an acute, generalized infection of the reticulo-endothelial system, intestinal lymphoid tissues and gallbladder caused by *Salmonella typhi* (Myron *et al.,* 2010).

2.2 Epidemiology of typhoid fever

Typhoid fever is prevalent in areas that are characterized by overcrowding and at the same time have poor access to proper sanitation (Charles *et al*., 2012). Estimates by the WHO depict South East Africa, South Central Asia and Southern Africa as having high incidences of *Salmonella typhi* infection i.e. more than 100 cases per 100,000 persons per year (Crump *et al.*, 2004). Those with medium incidences include the Caribbean, Latin America among some other regions of Asia as well as Africa (10-100 cases per 100,000 persons per year) (Bhutta, 2006).

The factual incidences of typhoid fever are however, difficult to estimate especially in developing countries due to what Hook (2005) terms as lack of rapid inexpensive diagnostic tools, poor disease reporting systems, laboratory testing infrequency and the often common confusion between the clinical presentation of the disease and other common febrile illness. In developed countries for example UK, typhoid fever incidences are low as a result of proper sanitation, safe drinking water and also hygiene education. The rare cases reported are mostly from travellers returning from endemic areas or contact with carriers (Francis *et al.,* 2008). California and Nerada state in India were in 2010 hit by an outbreak of typhoid fever. United States reports approximately 200-300 cases of *S. typhi* annually (WHO, 2021).

This is especially among travellers that is about 80% of the total cases, who travel to countries which have been hit by the typhoid fever endemic, particularly the South Central Asian countries (Hohman, 2011). Tajikistan was also hit by a large typhoid outbreak between 2011 and 2012 which affected more than 24,000 people with cases of fatality rate of around 1%.Central and southern Africa states such as Uganda, DRC, Zambia and Zimbabwe have had an inrush of typhoid fever outbreaks form early November 2011. According to WHO, approximately 21.6 M cases of typhoid in school and pre-school children and 200,000 deaths of the same has been reported. All these cases are attributed to problems with getting safe water and accessing proper sanitation. For example, in Kikwit DRC, typhoid is termed as endemic due to contamination of local water source that caused a spike of cases to thousands resulting in life threatening intestinal

perforation, severe cases of peritonitis and death (Olopoenia and King, 2004). All Salmonella serotypes are considered potentially pathogenic and host-specific, but the majority can affect different hosts. *S. Typhi* and *S. Paratyphi* A, B and C are the most common causes of enteric fever in humans. Salmonella species are found in faeces, blood, bile, urine, food and feed and environmental materials. The type of species is S. enterica (WHO, 2021). *S. enterica subsp. enterica, serovar Typhi* is a human-restricted pathogen and which is transmitted primarily through the fecal-oral route. Asymptomatic carriers may play an essential role in the evolution and global transmission of *S. enterica* (Roumagnac, 2006).

Typhoid fever is almost always acquired by ingestion of food or water contaminated with excreta from a patient with typhoid or from chronic carriers. As man is the only host for *S. enterica*,, transmission is by ingestion of contaminated food or water by human feces. The exact determinants and factors associated with endemic disease and outbreaks of drug-resistant causes of typhoid are uncertain, there does seem to be an association with crowding, lack of sanitation and access to street foods and the infection is transmitted directly by feco-oral route or urine-oral route with feces or urine or indirectly by ingestion of contaminated water, milk, food, or through flies. Contaminated ice, ice cream, and milk products are a good source of infection (Levantesi *et al*,. 2012).

2.3 Pathogenesis of TF

Following ingestion, the organism passes the gastric barrier and reaches the duodenum where it invades the intestinal epithelium and is engulfed by phagosomes in the Peyer's patches and the bacilli multiply and enter the bloodstream and cause transient bacteremia which then dissemination throughout the body, and other phagosomes, via the lymphatics and colonize tissues/organs of the reticuloendothelial system such as the liver, spleen, lymph nodes and bone marrow (House *et al.*,2001). The infectious dose of *S. enterica* varies between 1000 and 1 million organisms (House *et al.,* 2001). Signs and symptoms result when a critical number of bacteria have replicated. Major clinical expressions include prolonged fever and abdominal pain, sustained bloodstream infection (bacteremia and septicemia), activation of the endothelial system, metastatic infection and immunologic problems due to immune complex deposition leading to multi-organ dysfunction (Teh *et al.,* 2014, Denise *et al.,* 2004). In short salmonella has many virulence factors that enable to it to cause disease like acid resistant cell wall, fimbriae for cell mediated attachment, toxin production, antigen variation, and biofilm development. Infection may become persistent and invade the gallbladder that shows clinical phase of disease

depending on host defense and bacterial multiplication. Chronic carriers are the source of transmission by harboring the organisms in their gallbladder (especially in the presence of gallstones) and rarely at other sites (House *et al.*, 2001).

Salmonella is an intracellular pathogen that causes a variety of diseases termed salmonellosis, ranging from gastroenteritis to enteric fever in humans and animals (Lan *et al.*, 2007). Its genus comprises of two distinct species which are Salmonella bongori and Salmonella enterica, the former is a commensal to cold-blooded animals while the latter comprises six subspecies; enterica, salamae, arizonae, diarizonae, indica, and houtenae (Levantesi *et al.*, 2011). These subspecies are further divided into 50 serogroups characterized based on O (somatic) antigen and more than 2600 serovars by H (flagellar) antigens in the genus (Sabbagh *et al.*, 2010). However, only 50 serovars within the subspecies enterica are known for common cause in infections in humans and warm-blooded animals (Levantesi *et al.*, 2011). Different serovars of Salmonella constitute diverse geographical distribution, different host specificity and impose different syndromes during infections (Levantesi *et al*., 2011). In clinical settings, Salmonella infections are distinguished into typhoidal and nontyphoidal Salmonella serovars (Pond, 2005; Levantesi *et al.*, 2011).

2.4 Taxonomy

Salmonella are gram-negative, rod-shaped bacilli that can cause salmonellosis, a diarrheal illness in humans, they have a cell wall composed of a thin layer of peptidoglycan, covered by a membrane. There are over 2,300 subtypes of the Salmonella enterica bacterium, including serovars enterititis, Salmonella Agbeni, and typhimurium. Salmonella Typhi is serological positive for lipopolysaccharide antigens O9 and O12, protein flagellar antigen Hd and polysaccharide capsular antigen Vi. The significant fact is that the Vi capsular antigen is restricted to S. enterica serotype typhi (Parry *et al*., 2021). Salmonella are rod-shaped, flagellated (motile) bacteria with diameters of around 0.7-1.5μm and lengths of 2-5μm, with a few exceptions. They are gram-negative and non-spore-forming. The TF agent is assembled under kingdom bacteria, phylum: proteobacteria, class gammaproteo bacteria, order entero bacteriales, family entero bacteriaceae, and genus: Salmonella, species *S. enterica*, subspecies *S. enterica* subsp. enterica, *serovar typhi* (Langridge *et al.*, 2014). Salmonella species are classified and identified into serovars (or serotypes) and so far there are more than 2,500 serovars (Wattiau *et al*., 2011). New serovars are being discovered each year, adding to the complexity of this large bacterial population. Primary subdivision is into O serovars (those which share a common

somatic antigen), and these are then subdivided on the basis of H (flagella) antigens (Wattiau *et al.,* 2011). Of these several Salmonella species and subspecies and serovars the one that can cause TF commonly is *S. enterica subsp. enterica, serovar Typhi* (WHO, 2021). *Serovar Typhi* may produce Vi antigen, which is an acidic polysaccharide layer outside the cell wall. When fully developed, it renders the bacteria agglutinable with Vi antiserum and inagglutinable with O antiserum. Antigens similar to Vi may also be found in some serovars of *S. Paratyphi* C and S. Dublin (Park *et al.,* 2009).

2.5 Salmonella typhi infection

S. Typhi is the main causative agent for typhoid fever, a systemic illness contracted mainly via ingestion of contaminated food or water (Abdoel *et al.,* 2017). Unlike the other serovars of Salmonella such as *S.Typhimurium* and S. Enteritidis which often associated with gastroenteritis and can infect a wider host range, *S. Typhi* infection is specific to humans (Song *et al.,* 2010). *Salmonella typhi* is the causative agent of typhoid fever. The global burden of typhoid fever is estimated at 13.5 million cases and 100,000 deaths annually (Buckle *et al.,* 2012). In Africa, the overall burden of *S. typhi* is unknown partly because the facilities capable of the blood culture tests essential for diagnosis of *S. typhi* are lacking in many regions or health facilities across the continent (Crump *et al.,* 2004).

Salmonella typhi infections are more common in densely populated areas where sanitation and hygiene is compromised with high number of infection occurring in children living in densely populated areas (Crump *et al.,* 2004). A population-based study in a rural site in Africa reported high incidence of typhoid fever (Breiman *et al.,* 2012). But knowledge on the role of host traits such as age and gender on *S. typhi* infection. Transmission of *S. typhi* occurs when the bacterium enters the host system upon ingestion of food or water that has been contaminated with infected feces. The bacteria use the intestine as a portal entry and pass through the intestinal mucosal layer and ultimately enter macrophages and multiply (Ryan & Ray, 2004). Thereafter, the bacteria are carried through the reticulo endothelial tissues where they continue to multiply and eventually release lipopolysaccharide endotoxins that result in typhoid fever (Ryan & Ray, 2004). Within 1-3 weeks after exposure to *S. typhi*, symptoms of high fever, malaise, headache, constipation or diarrhea, rose-colored spots on the chest and enlarged spleen and liver are observed and about 5% of typhoid patients become chronic carriers and present with persistent gall bladder infection (Bhan *et al.,* 2005). Without prompt treatment, *S. typhi* infection can cause serious complications that can be fatal (Parry *et al.,* 2021); mortality rates range from 12-30%

(Pollack, 2003). Much research has been on *S. typhi* as a single infection (Crump *et al,* 2004; Ryan & Ray, 2004)

2.6 Clinical presentation of typhoid fever

The incubation period of *S. Typhi* is 7 to 14 days, after this period the onset of bacteremia is expressed with fever, malaise, headache, anorexia, nausea, abdominal discomfort, dry cough and myalgia. The common symptoms are coated tongue, tender abdomen, hepatomegaly and splenomegaly in severe cases (Parry *et al.,* 2021). Typhoid presents more complications in children younger than 5 years and required to hospitalization like diarrhea, toxicity and disseminated intravascular coagulation are very often in infant (Parry *el al*.,2021).

In pregnancy typhoid presents more complication with miscarriage, otherwise vertical intrauterine transmission from mother may come out to neonatal typhoid, some cases it become as life threatening condition (Parry *et al.,* 2021). after 2 to 3 weeks of resolution of fever almost 5 to 10 percent patient shows relapses, this infection might be milder than original onset, they carry similar antibiotic susceptibility (WHO, 2017). moreover, almost 5% patients become long term carrier, it may be for one year (WHO, 2021) and more common chronic carrier are young women, elderly patients who are suffering from cholelithiasis and schistosomiasis (Pegues *et al*.,2008). Patient do not die due to intestinal hemorrhage or peritonitis; 15% patient are died with chronic fever and undiagnosed reason.

The clinical symptoms for typhoid and paratyphoid fever are very similar, therefore a better diagnosis is needed (Sánchez *et al.,* 2011). However, complications may also occur mainly in endemic regions involving between 10% - 15% of patients. Most common complications are gastrointestinal bleeding, hepatitis, pancreatitis, seizures which in some cases are fatal (Sánchez *et al.,* 2011). Early treatment with antibiotics has shown to be highly effective in fighting infections but improper administration of the antibiotics has led to emergence of multidrug-resistance strains of the pathogen (Deng *et al.,* 2003). The course of typhoid fever occurs in phases which last approximately one week (Hook, 2005). In the course of these phases, patients appear worn out and wasted. The patient has high fever, malaise, leucopenia, headache, bradycardia (faget sign), abdominal pain, cough, bloody nose, eosinopenia and relative lymphocytosis (Mweu, 2008). Rose spots are visible on the lower chest and also on the abdomen. The lung bases have rhonchi. The abdomen is stretched or becomes swollen and hurts at the right lower quadrant, where borborygmi can be heard. The patient trots frequently and suffers from

hepatosp lenomegaly (Prajapati *et al.*, 2008). Many other complications may occur during the third week of infection e.g. congested peyer's bleeding that results in intestinal hemorrhage, intestinal perforation, encephalitis, symptoms of neuropsychiatry, metastatic abscesses, cholesystitis, endocarditis and osteitis (Hook, 2005). Dehydration ensures and the patient is delirious (typhoid state). Platelet level goes down (Francis *et al.,* 2008).

2.7 Measuring burden of Typhoid fever

Typhoid fever is a global health problem(WHO, 2020), which causes around 11-21 million cases and 128, 000-161 000 deaths annually where the majority of cases and deaths occurring in Asia and sub-Saharan (WHO, 2021). Assessment of the burden of disease caused by Typhoid fever, can be done using three indicators: (1) prevalence (defined as the number of cases of typhoid fever at a given point in time), (2) incidence (defined as the number of cases of Typhoid fever arising during a given time period, usually one year), and (3) mortality (defined as the number of deaths caused by Typhoid fever in a given time period, usually a year) (WHO, 2020).

There is high burden of Typhoid fever in the Sub-Sahara Africa region, which could be related to lack of access to clean water and poor sanitation (Crump, 2019). The burden of *S. Typhi* is affected by different geographical areas, times, persons, and places (WHO, 2020). Besides lack of access to safe water, poor sanitation, poor hand washing practices (after using toilet, before eating food, and before preparing food), eating raw foods (milk, vegetables, and meat), improper disposal of human and other wastes, close contact with TF cases or carriers, and low level of education increased the risk of acquiring *S. Typhi* (WHO, 2020)

2.7.1 Prevalence of typhoid fever

Recent studies done on the burden of TF in low- and middle-income countries revealed an increasing trend of TF in Africa (WHO, 2020).. Though different laboratory test methods and clinical specimens are used, the prevalence of *S. Typhi* is variable among different countries in Africa (Kim, 2019) and among different geographical locations in Ethiopia (Tadesse, 2014). Previous studies done showed a heterogeneous prevalence of *S. Typhi* in African countries ranging from 5%–69.6% (Abioye,2017). Similarly, TF, one of the major public health problems, showed 5%-56.2% S. Typhi prevalence at different times and geographical areas of Ethiopia (Deksissa, 2019). Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year (James, 2002). Visiting or living in areas where the disease occurs is a risk (Miriam, 2005). An estimated 17 million cases of typhoid fever and 610,000 deaths occur worldwide, annually (WHO, 2022).

Globally, there are four billion cases of diarrhea among children; cholera water borne bacteria infected 120,000 people in 2002 and in the same year there were 50,000 cases of guinea worm in thirteen African countries. Six million people are blind because of trachoma and twelve million people are infected with typhoid annually (WHO, 2014). In Maina slum the prevalence of typhoid fever was estimated to be five percent by the year 2005 despite provision of treated water, and sanitation services by Nyahururu Municipal Council (DMOH, 2005). The effects of typhoid fever range from negative socio-economic impact to the majority of the patients who require several weeks to recover, and hence is a major public health concern (WHO, 2014. Typhoid is usually contracted by ingestion of food or water contaminated by fecal or urinary carriers excreting *S. enterica serotype typhi* (Parry *et al.,* 2021).

Only a few quantitative studies have been made of the prevalence of chronic typhoid and paratyphoid carriers in less-developed countries. One such survey carried out in Santiago, Chile, during a period when typhoid fever was highly endemic, estimated a crude prevalence of 694 typhoid carriers/10^5 population (Levine, 2019) . This high prevalence was related to the high overall prevalence of cholelithiasis in the adult female population of Santiago, as well as the high prevalence of chronic *S. Typhi* and *S. Paratyphi* carriers documented among 1000 consecutive patients with gallbladder disease undergoing cholecystectomy (Levine *et al*., 2019). Among 404 patients (316 female and 88 male) with gallbladder disease undergoing cholecystectomy in Kathmandu, Nepal, a high prevalence of S. *Typhi* (3.0%) and *S. Paratyphi* A (2.2%) was also documented (Khatri, *et al.,*2009). However, since the overall prevalence of cholelithiasis in the Kathmandu population was not known, an overall prevalence of chronic carriage in that population could not be calculated. In the US: From 1900-1960, the incidence of typhoid fever declined steadily and has remained low in the United States. Improved sanitation and successful antibiotic treatment led to this decline. Averages of 245 cases have been reported annually, with an incidence of 0.2 per 100,000 populations since 2019 compared with 35,994 reported cases in 2020 (Parry *et al.,* 2021).

2.7.2 Incidence of Typhoid Fever

Typhoid fever was an important cause of illness and death in the overcrowded and unsanitary urban conditions of the United States and Europe in the 21th century (WHO,2020). The provision of clean water and good sewage systems led to a dramatic decrease in the incidence of typhoid in these regions. Today most of the burden of the disease occurs in the developing world, where sanitary conditions remain poor. Reliable data from which to estimate the burden of

disease in these areas are difficult to obtain, since many hospitals lack facilities for blood culture and up to 90 percent of patients with typhoid are treated as outpatients. Community based studies have consistently shown higher levels of typhoid than public health figures suggest (Parry *et al.*, 2021).

Annual incidence rates of 198 per 100,000 in the Mekong Delta region of Vietnam (Lin *et al*, 2000) and 980 per 100,000 in Delhi, India (Sinha *et al.,* 2015) have recently been reported. According to the best global estimates, there are at least 16 million new cases of typhoid fever each year, with 600,000 deaths (Ivanoff, 2016). We now face the very real prospect that untreatable typhoid fever will re-emerge (Parry *et al.,* 2002). The persistence of this fever remains a problem in these developing countries by which prolonged use of antibiotics together with misapplications and self-prescribing of the antibiotics lead to a higher health concern of drug resistance and dissemination of resistant strain in the area (Levantesi *at al.,* 2011).

2.7.3 Mortality and Morbidity

Typhoid fever has been recognized as a major cause of morbidity and mortality in humans for centuries. However, the global burden of typhoid fever through human history is uncertain and has only been determined in a limited number of locations Global Burden of Disease (2017). Early antibiotic therapy has transformed a previously life-threatening illness of several weeks' duration with an overall mortality rate approaching 20.0% into a short-term febrile illness with negligible mortality. Case fatality rates of 10.0-50.0% have been reported from endemic countries when diagnosis is delayed (Parry *et al.,* 2002). Race ,No racial predilection exists (Parry *et al.,* 2021). ,Sex No sex-related predilection exists (Parry *et al.,* 2021). Age Attack rates are highest in persons younger than 20 years or older than 70 years; however, the highest rate is found in infants (130 isolates per 100,000) (Parry *et al.,* 2002). Neonates are at a greater risk to fecal-oral transmission secondary to relative decreased stomach acidity and buffering of ingested breast milk and formula. Elderly persons are at a relative greater risk to infection secondary to chronic underlying illness and weakened immunity. Nursing home residents have a particularly higher risk (Owens, 2008). In endemic areas, children aged 1-5 years are at the highest risk of infection, morbidity, and mortality because of waning of passively acquired maternal antibody and a lack of acquired immunity. In young children, the clinical syndrome is often a nonspecific febrile illness that is not recognized as typhoid fever (Parry *et al*., 2002). In more recent years, prospective studies have shown that, although the incidence of classic typhoid fever in patients is highest in adolescents and young adults, the overall incidence of blood culture–confirmed

disease is generally highest in children aged 3-9 years and declines significantly in late adolescence (Parry *et al.,* 2002).

2.8 Characteristics and identification

The symptoms of typhoid fever, caused by ingestion of the bacterium *Salmonella enterica serovar Typhi (S. Typhi),* include prolonged fever, abdominal discomfort, and malaise, which can be serious and progress to include complications such as intestinal perforation. Salmonella can be detected and identified directly from water, food, feces and other related body fluids including urine. Various methods and techniques can be used to recover the bacilli from target samples. The gram-negative bacilli can be detected and identified by the gram stain using light microscopy. Further, the bacteria in clinical samples can be cultured and isolated using primary isolation media like blood agar,cystine-lactose-electrolyte-deficient agar, xylose-lysinedesoxycholate agar, desoxycholate citrate agar, brilliant green agar and other commercial validated media (WHO, 2021).

2.8.1 Widal agglutination test

Widal test is belong to serological test and it is more than 100 years old diagnostic method. This test detects agglutinating antibodies against the O and H antigent of S. Typhi (Jason *et al*., 2015). Infection with typhoid and paratyphoid bacilli, antibodies against flagellar antigen of S. Typhi H, S. Paratyphi A (AH), S.paratyphi B (BH) and Somatic Antigen of S.Typhi O generally detectable in blood after 7 days of infection. Though this method is simple to perform, it has moderate sensitivity and specificity like 70 to 80% (Chowdhury *et al.*2014). Widal agglutination test is a serologic reaction between an antigen and an antibody that results in agglutination of cell suspension (William *et al*., 2001). A killed suspension of *S. typhi* is used to detect typhoid fever in serum of patients presenting with febrile illness. Salmonella typhi bacteria is treated to retain only ‘O’ (somatic) or ‘H’ (flagella) antigens and these antigens are used to detect specific antibodies in serum of patients suspected to be suffering from typhoid fever (Youssef *et al.,* 2010). Agglutination is a positive test and suggests that the patients serum has the antibodies to ‘O’ and ‘H’ antigens hence shows infections with typhoid fever. Lack of agglutination is a negative test that implies that the patient is not suffering from typhoid fever. The initial serologic response in acute typhoid fever is represented by appearance of IgM somatic O antibody, while the IgG flagella H antibody develops more slowly but persists for longer (Parry *et al.,* 2021). The agglutination techniques that are commonly used include the slide test and the tube test. Widal slide test is a rapid diagnostic test and is used as a screening procedure. The tube test is a

macroscopic test and serves to confirm the result of the slide test (Bhutta, 2006).The tube test clarifies erratic or equivocal agglutination reaction of more rapid slide test (Parry *et al.*, 2021).

A mixture of antigen and antibody is incubated at 370C for 24 hours in a water bath. Agglutination is visualized in form of pellets, clumped together at the bottom of the test-tube. Results are scored from 0 to 4+ positive agglutination. Since agglutination involves formation of antigen antibody complexes, cross reaction occurs when antibody produced by non-typhoid antigens reacts with typhoid-specific antigens. Diseases that are caused by non-Salmonella organisms for example Malaria, dengue fever, military tuberculosis, endocarditis, chronic liver disease, brucellosis etcetera exhibit this cross reactivity in typhoid endemic region and those cross reactions may produce false positive results leading to misdiagnosis of typhoid fever (Olopoenia and King, 2004). Lack of standardization of antigens also compromises this technique (Gilman *et al*., 2011).

2.9 Risk factors associated with prevalence of typhoid fever

Transmission of *S. typhi* is associated with poverty, poor hygiene practices, lack of clean water and inadequate waste disposal and sanitation (Bethony *et al.,* 2006). At the individual level, host factors that influence susceptibility to infection by *S. typhi* are mainly age and gender (Sayasone *et al.*, 2011). Children and adolescents experience the greatest burden of illness by *S. typhi* infection with individuals in regions with poor sanitation and unsafe food and water mostly affected (Crump *et al.,* 2004). Children aged less than 5 years and individuals aged 70 years and above are more prone to *S. typhi* infection (Ryan & Ray, 2004). Old aged individuals have higher incidences of infection and their higher susceptibility to infection has been attributed to age-associated deregulation of immune system to pathogens (Misra *et al.,* 2016). Typhoid fever is mainly predominant in rural areas where the likelihood of infection is due to exposure to predisposing factors (Butler *et al.,* 2017). The transmission routes of this pathogen involve in many factors like hygiene, water quality, food handling and sanitation system (Karkey *et al.,* 2010), close contact with carrier person (Tran *el al.*,2005), education level, household hygiene, flooding (Vollaard *et al.* 2004), personal hygiene, close to waterbodies and travel to endemic areas (Whitaker *et al*.,2009). furthermore, variable of climates like monsoon rain, vapor pressure and temperature show a significant impact on the transmission and having typhoid infection in the population (Wang *et al*.,2012). Likely, Pakistan has the highest incidence 451.7 per 100,000 persons/years and India ha 214.2 per 100,000 persons/year; the mean age of infected with typhoid is 7.0 years and 15.5 years respectively (Ochiai *et al.*,2008).

Common risk factors in the development of typhoid fever are travel to endemic areas, poor hygiene habits, poor sanitation conditions, proximity to flying insects feeding on feces, contact with someone who recently suffered from typhoid fever, recent use of antibiotics, achlorhydria, immunosuppressive illnesses such as AIDS, crowded housing, consumption of raw fruits and vegetables contaminated with sewage, and childhood. Risk factor studies have been conducted in a variety of locations, including both endemic and outbreak settings, to better understand the dominant drivers of transmission. Previously identified risk factors for typhoid include recent contact with individuals diagnosed with typhoid or enteric fever (Luxemburger, 2001), food, including consuming flavored ices and ice cream or ice cubes buying lunch at school or eating roadside or outdoor vended food and drinking unsafe or untreated water at home (Ram, 2007) or drinking water at work. Exposure to water used for purposes other than drinking has also been identified as a risk for typhoid, such as bathing and brushing teeth (Gasem, 2001).

2.9.1. Socioeconomic Factors Associated with Typhoid Fever

Improved socioeconomic circumstances in South Africa have been temporally associated with decreasing incidence rates of typhoid fever over a 35-year period. However, ongoing challenges remain including potential for large outbreaks, a large immigrant population, and emerging antimicrobial resistance (Karen *et al.,*2018). It was evident from the study by Kibiru in Maina Slum in Kenya that majority of adults who suffered from typhoid fever (78.29%) lived in temporary houses, 15.14% in semi-permanent houses while minority (6.57%) lived in permanent houses. This indicated that three-quarter of the Maina slum residents were poor and could afford neither a semi- permanent nor a permanent house. Those respondents who were staying in temporary houses were the most infected with typhoid fever. There was a significant relationship between poverty levels depicted by the nature of houses in place and the prevalence of typhoid fever (Kibiru, 2016). The susceptibility of suffering from typhoid was more to those with low level of education than those who had attained a higher level of education. This meant that education played a key role in the prevalence of typhoid in Maina slum. Those who were self-employed and un-employed suffered from typhoid fever in one time or another in their lifetime for both categories were above as compared to those who were employed (Kibiru, 2016). The age distribution data of incidence represent that the infection was lower in older age group 0.9/1000 persons-year than the young children group (Naheed *et al.*, 2010). Another important finding was that the incidence of Typhoid fever is higher than the incidence of paratyphoid in the slum Dhaka, Bangladesh (Naheed *et al.,* 2010);. The income level has the impact on the

incidence of typhoid fever such as the children of low in comed group has higher incidence rate than the higher income families in a semi-urban setting (Rahman *et al*.,2011). The lower socioeconomically condition became a life threatened property for the inhabitants (Forster,2021).. They are separated from the basic social facilities such as sterile water supply, sewerage system, they live unhygienic lifestyle with contaminated food and water, low literacy rate, and unawareness of the health (Hossain *et al.*,2010).

2.9.2. Sanitation factors associated with typhoid Fever

Jakopo Zorodzail in his study found that 80.2% of the residents with temporary houses, 14.4% with semi-permanent houses and 5.4% with permanent houses suggesting that most of the residents were poor and vulnerable to poor housing which could promote poor state of sanitation. Poor sanitation practices are a cause of bacterial, viral, protozoa, and helminthic infections (Jakopo, *et al.*,2013). Typhoid fever was associated with poor housing and inadequate food and personal hygiene (Gasem, 2011). According to Khan *et al,* (2012), typhoid fever affects younger children living in areas of high population density and lack of access to safe water in Pakistan. Breiman also confirmed that young children are at the greatest risk of typhoid fever in densely populated urban areas with poor hygiene and sanitation infrastructure (Breiman *et al.,* 2012). Unsafe disposal of excreta and solid wastes are significant factors that contribute to contamination of ground water in Kampala City as observed by Ndugwa (2015) after an outbreak of typhoid fever.

Furthermore, young children are the most likely to be exposed to fecal contamination in the immediate environment surrounding their household as observed by Ngeno *et al.,* (2015). A study by Jakopo in Zimbabwe reveals that open defecation, lack of hand washing facility and poor hygiene were the main risk factors for typhoid fever (Jakopo *et al.,* 2013). Jakopo reported that 82.9% households in Zimbabwe were dissatisfied with waste collection, and 17.1% were satisfied and typhoid fever is more common in areas with poor sanitation practices with only 25.2% of the respondents living near a clean drainage. Their study found that 62% of the residents did not have proper solid wastes disposal and only 38% had. The state of drainage was associated with the prevalence of 63% typhoid fever in regions with poor sanitation. *Salmonella typhi* often spreads after water supplies are contaminated by human waste. This act of not exhausting filled up pit latrines compromised the health of the residents for wastes were spilled in the environment causing blockages of drains, contamination of surface water sources, and

even emission of foul smell in the atmosphere. Where sanitation and garbage disposal are lacking, typhoid fever continues to destroy life (Jakopo, *et al.*, 2013).

2.9.3 Food hygienic factors associated with Typhoid Fever

Food is defined as any substance that is edible and portable too, originating either from plant or animal source. (David *et al.*, 2012) Food is ingested by each and every living being on the planet Earth and that is why it poses a great threat for disease transmission. Food acts as a vehicle for transmission of diseases specially when gets contaminated with harmful microbes, microbial toxins and other environmental contaminants. (Alum *et al.*, 2016) Spoilage of food has always been a challenge to mankind and this is because food nutrients act as a great source to microbes for their growth (Ram, 2020)

Food contamination is defined as the spoilage of food due to bacterial growth or toxic substances present in it. In simple words, any substance in food that reduces the safety or quality of food is called food contamination. Food contaminants are in almost every foodstuff including fruit, baked goods, vegetables, poultry, meat, and dairy products (Kantiani *et al.*,2010). Food contaminants typically include environmental contaminants, food processing contaminants, unapproved adulterants and food additives, and migrants from packaging materials (Mastovska, 2013). Environmental contaminants are impurities that are either introduced by human or occurring naturally in water, air or soil. Food processing contaminants include those undesirable compounds, which are formed in the food during baking, roasting, canning, heating, fermentation, or hydrolysis (Schrenk, 2004). The foods which are at high risk of contamination includes poultry, eggs, dairy, sea foods, green leafy vegetables & fruits, rice, sprouts and deli meats. Proper cooking of food also eliminates bacteria and viruses. However, toxins produced by contaminants may not change to non toxic ones by heating or cooking. Foods such as meat and meat products have rich nutrient content and are able to get contaminated easily. (Das, *et al.*, 2019). The contamination of these products can occur at any stage of production. In some countries, meat product's slaughtering is done on unhygienic equipments and environment conditions which lead to contamination. (Das, *et al.*, 2019).

2.9.4 Water Related Factors Associated with Typhoid Fever

In developing countries, where safe water and sanitation systems have not been well-established, large-scale typhoid and paratyphoid outbreaks sometimes occur (Walters *et al.*, 2015) reported that during a previous typhoid outbreak in Kasese and Bundibugyo districts of Uganda in 2009–2011, which affected 8092 persons, the vehicle of transmission was found to be

unclean water. According to the study conducted by Steven Ndugwa, he reported that the outbreak of typhoid fever in Kampala city was likely caused by consuming contaminated water from unprotected ground water sources. He continued by saying that Kampala city has more than 200 unprotected ground water sources, most of which serve as unprotected sources of water for economically disadvantaged people in the city (Ndugwa, 2015). Almost 30% of people living in urban areas and more than 60% of those living in rural areas do not treat their water before drinking (UBOS *et al.*, 2011).

Barriers to safer drinking water include the cost associated with establishing a piped treated water system or purchasing water treatment products for household use and the false perception that naturally occurring water sources could be safe (Merkel *et al*., 2012). A study by Kibiru, 2011) showed that 39.4% of people did not wash their hands because of unavailability of adequate water and 28% did not wash their hands due to the cost of water, while 23.7% did not wash hands because they had not suffered from typhoid fever before.

According to (Dewan,2013), a statistically significant inverse association was found between typhoid incidence and distance to major water bodies. (Khan *et al.*,2012) reported that typhoid fever was found to be lower in the households using a safe drinking-water source and also reported that typhoid fever affects younger children living in areas of high population density and lack of access to safe water in Pakistan. Surface and ground water without guaranteed safe supply for fecal matter could gain access into the water through water borne sewage system, through flush toilets, and pit latrines as found by (Pruss *et al.*, 2006).

2.10 Prevention of typhoid fever

It is clear that, urbanization is rapidly developing in Ethiopia compared to other countries of the world. According to the several studies it has been established that typhoid fever incidence rate is higher in urban areas. The main causes that are seemed to be responsible for illness are unplanned water supply system and inadequate sanitation, sewerage system. To reduce the number of cases in inhabitants needs the provision of safe drinking water and hygienic sanitation system. The sewerage system will be required more protective and secure that ensure of no contamination. By washing hand and maintaining hygienic life-style can prevent transmission with food and drink. Drinking water should be boiled before properly and avoid street food. Most of the urban grew nearby river and they use surface water for drinking and daily household purpose where S. Typhi can survive for days, so contaminated surface water act as etiological

agents of typhoid (Dewan *et al.*,2013). As indicated by World Health Organization (WHO, 2020), TF can be prevented by maintaining food safety, safe water supply, proper sanitation, vaccination, and health education to create public awareness and induce behavioral change after identifying knowledge, attitude, and practice (KAP) gaps and by adapting it to local conditions in the study area.

2.10.1 Safe water and food

Eating food or drinking water contaminated with S. typhi are the major modes of transmission of typhoid fever. Transmission can hence be prevented by having access to safe water and proper food handling practices. Public awareness should be raised on modes of transmission through health education and this may induce behavior change (Omuse *et al.*, 2010). Water may be disinfected by bringing it to a rolling boil. Chemical treatments such as the use of chlorine dioxide are very effective at inactivating parasites. Portable, battery operated devices utilizing UV light can also be used to purify water (Pang *et al.*, 2010).

Wells in rural areas must be screened for pathogens and treated if necessary. Basic hygiene measures must be reinforced during food processing and handling. Hands must be washed with soap before preparing or eating food and raw food must be avoided especially during epidemics. Travellers should be advised to choose recently prepared food that is thoroughly cooked and served hot. Nyahururu water and Sanitation Company Limited is the one which carry out waste disposal in Maina slum and was incorporated as a private company in accordance with the company Act Cap 456 of the Laws of Kenya in February 2002 and became fully functional by July 2003. The objective of the company was to provide quality affordable water and expand water distribution and sewerage networks in order to deliver sewerage services to all consumers. The company is also improving on water revenue collection since the company was started, consumers' complaints have reduced drastically and billing is up to date and the rate of payment has increased, boosting the revenue collection up to 30 percent. Water theft has reduced from 70 per cent to 40 per cent. The management of the company claims that water quality has improved, hence reducing water borne diseases (MD, 2021).

2.10.2 Proper sanitation

Typhoid fever is transmitted through faeco-oral route, therefore, proper sanitation is paramount to preventing its spread (Parry *et al.*, 2002). Due to this, facilities for disposing human waste must be provided. Sewage must be collected and treated especially during the rainy season. In endemic areas, the use of human waste as fertilizer must be avoided (Mweu, 2008).

2.10.3 Health education

Awareness must be raised through public education. Preventive measures must be emphasized. Those measures include personal hygiene, setting up and maintenance of facilities for disposing waste, isolation measures for typhoid fever patients and the importance of disinfection (Mtove *et al.,* 2010). Therefore, community must be involved in order to instill behavior change with regard to hygiene.

2.10.4 Typhoid fever vaccines

Due rapid growing of urbanizattion, incidence of typhoid show high infection rate in this over crowded population (Brooks *et al*.,2005). To reduce this prevalence almost all researcher mentioned that vaccination against S. Typhi would be an emergent step (Alexander *et al,*2018,). In 1896, first vaccine was introduced in England and Germany and it was parental whole-cell typhoid vaccine, but this procedure had been withdrawn due to strong side effects (Marathe *et al.,* 2014). Two anti-salmonella vaccines have been developed and functioned, live oral vaccine based on Ty21a (an attenuated strain of *S. Typhi*) that is well-tolerated and the other is Vi-based parenteral subunit vaccine (based on the purified capsular polysaccharide *S. Typhi* Vi antigen). Both these vaccines are well-tolerated but are only moderately protective (Garmony *et al*. 2002). A number of vaccines are available that offer protection against typhoid fever. Heatphenol inactivated whole-cell vaccine is administered subcutaneously and it has a protective efficiency rate of 51-67% though its reactogenicity is relatively high (9-34%) (Parry *et al*., 2009).

2.11 Conceptual Framework on prevalence of typhoid fever and its risk factors

According to wood, 1992, Lack of water can lead to poor environmental hygiene and also poor environmental hygiene can lead to water contamination. In the same way, food can be contaminated by either contaminated water or untidy environment and poor personal hygiene; also poor socioeconomic status can lead to food contamination, water contamination and poor sanitation. These factors interact together and contribute to the prevalence of typhoid fever. However, proper water treatment and treatment of people suffering from typhoid, and vaccination of healthy people would reduce the prevalence rate of typhoid fever (Figure 2.2)

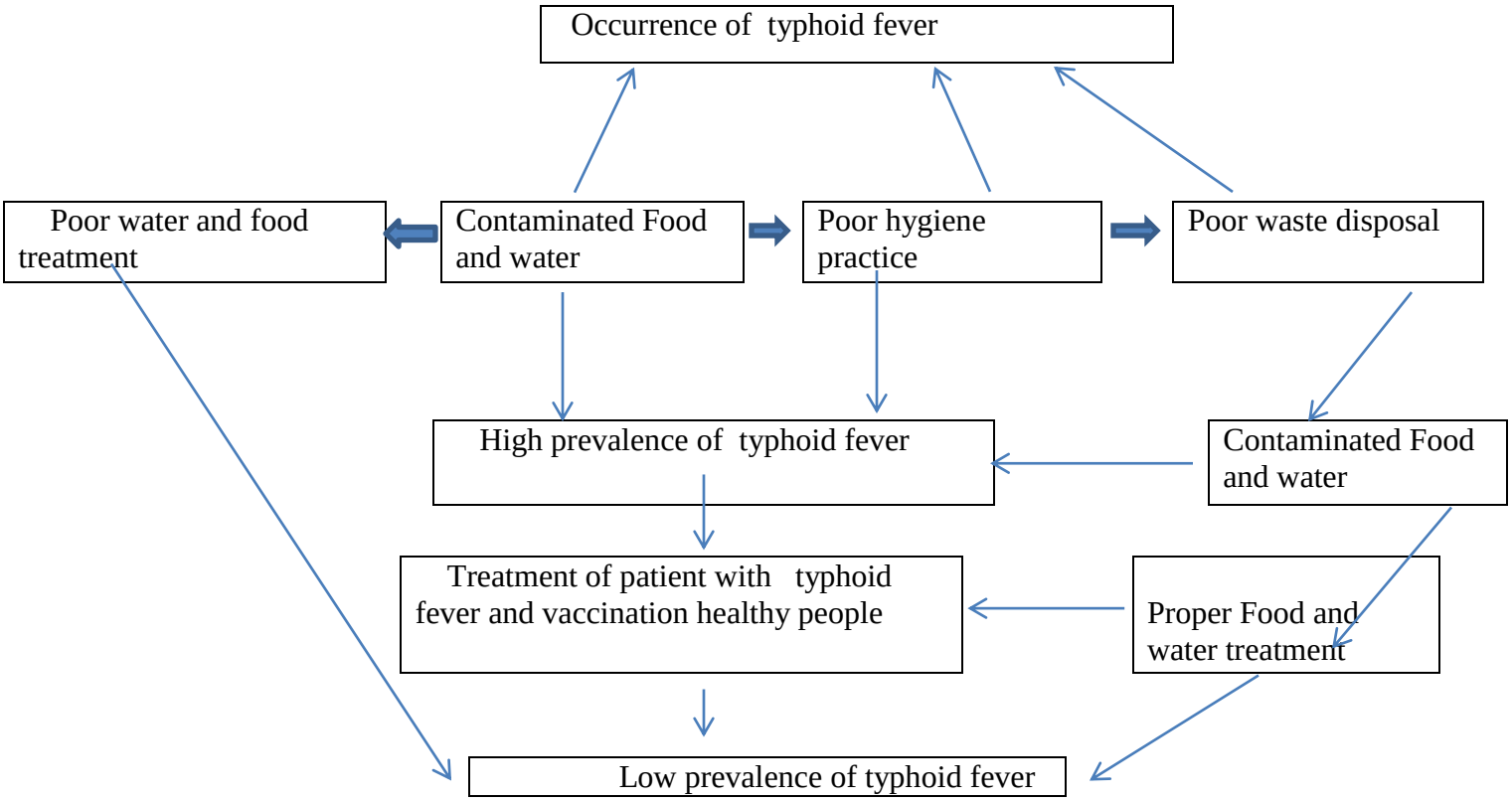


Figure 2.1 Conceptual Framework (woods,2004)

3. Materials and Methods

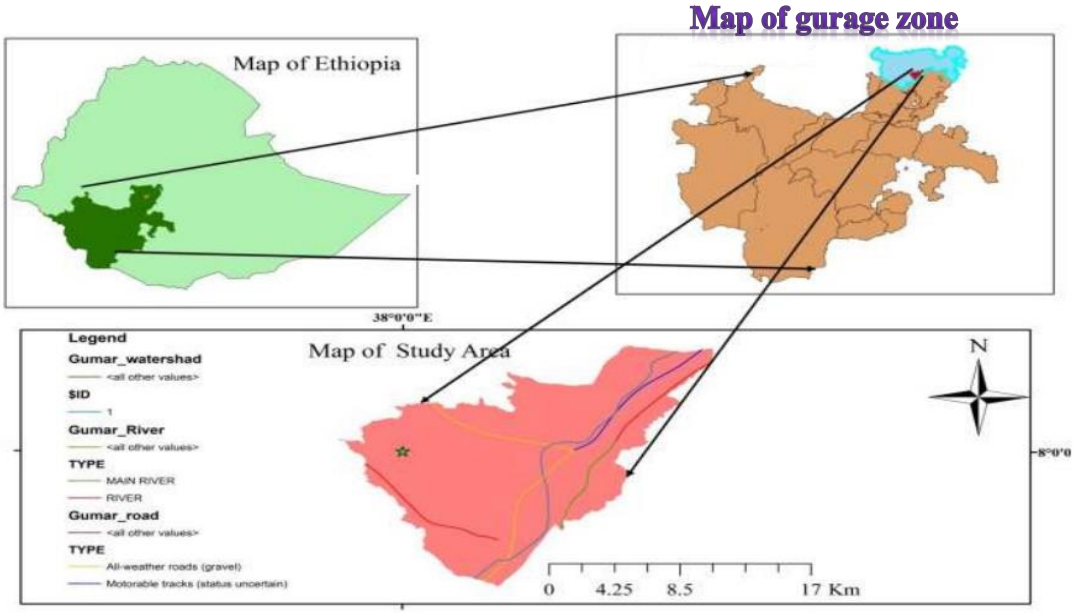
3.1. Description of the Study Area

The study was carried out in Gummer District, Gurage zone, Central Ethiopia regional state of Ethiopia. The geographical location of this woreda's is approximately 8° 2' 17"N, 38° 19' 30" E (maphill.com accessed in June 2019), with altitudinal range from 2700—3078 meter above sea level. (Gumer District report 2014). Based on the information from Central Statistical Agency 2017 report. The woreda has a total area coverage of 234.04 square kilometers .The population density of the woreda is 419.55 people per square kilometer. Arekit is the administrative Town of Gumer District. This is located at the distance of 220km and 60km from Addis Abeba the capital city of Ethiopia, and 60 kilometers from Wolkite, the capital of Gurage Zone (Figure 3. 1). Gumer District constitutes 18 rural kebele and 2 municipal. (Gumer District Communication Office, 2014). and has an elevation range of 2400-3400m above sea level. The total area of this District is about 24,604.78 hectares. This District is named after one of the sub-groups of the Sebat Bet Gurage, found of 165 kilometers of the Gurage zone and bordered on the southeast by the Silt'e Zone, on the southwest by Geta District, on the northwest by Cheha District, and on the north by Ezha District.

The administrative town of this District is Arekit found at 220 kilometers to the south west of Addis Ababa the capital city of Ethiopia. Figure 3.1 shows the map of the study area. According to the 2007 Ethiopian National Census result, the total population of the Gumer District is 80,178, 37,495 are male and 42,683 women. Gumer District has the highest population pressure with average density of 344 persons per km² and this is found to be the highest for the District. The average family size of the households was seven persons. Most of the people in this District have been lived to different part of the country.

Gumer District is subdivided into 18 smaller units named kebeles. At the time of this study there were 3 health centers serving the population in the entire district by clustering the kebeles and attaching specified appropriate health centers. GHC is located in Gumer district Arekit town which is the administrative center of Gumer District and 2 rural health center were selected for the current study purposely based on its comparative better transport facility, laboratory service, and higher populations clustered to it but other 4 health centers were not will organized, recently build, inadequate professional personnel, laboratory service and others . The District has about 18 government health stations and 6 private health station (CSA, 2018)..Gumer District has only one type of agro climatic zone, 100% Wet/Dega/. The annual average rainfall of Gumer District

is ranges from 1001mm to 1400mm. Mean annual rainfalls 1275mm. The mean annual temperature is ranging from 10.1°C to 17.5°C. (Central Ethiopia region, Bureau of Finance and Economic Development, 2012)) . The vegetation covers of the District mainly the result of the climate distribution and human activities. Since it is one of the densely populated areas of the Gurage zone, forest cover has been minimized from time to time due to various purposes. The main reason for cutting of trees in the District' includes: - for domestic purpose especially for fire, for generating incomes, construction of house, construction of house furniture's, for expanding agricultural farmland and pastures. The plant types are typically the result of climatic variation includes mainly eucalyptus tree (Bihirzafe) and *junipers procera* (tid). (From field observation, DAs and focal person in kebele). The main means of livelihood in the Gumer District is agriculture, which is based on mixed farming by the small- landholders. Agriculture in Gumer District is predominantly rain-fed and the amount, reliability and distribution of rainfall are important determinants for crop yield. Majority of the farmers are depending on fruit (Apple), Potato, Enset, Barley, pea, bean, and Flowering plants. Enset is the main staple food for rural population of the study area (Gumer District Agricultural Office, 2023).



Source: Administrative Map of Gumer Woreda, Septmber 2022

Figure 3.1 the map of the study area

3.2 Study design and population

Health center based cross sectional study was conducted at Gumer District health center, Gurage Zone, Central Ethiopia regional State, Ethiopia. The design was appropriate to this study which

was on the prevalence of typhoid fever and its risk factors in Gumer District during the period between February to May 2023 formed the source population formed the source population with the goal of determining the prevalence and associated risk factors of typhoid fever because it was descriptive in nature. The study sought to describe the state of affairs as they existed in the study area (Orodho, 2003). Patients who have been in the town for less than past six months and those who was residing out of the cluster was excluded. From the source population those suspected of TF and prescribed for blood test was prospectively recruit.The source of population was all patients having symptoms of typhoid fever attending in one of the three health centers (Arekit, Bad and Bole) and who was willing to give verbal consent and blood sample.

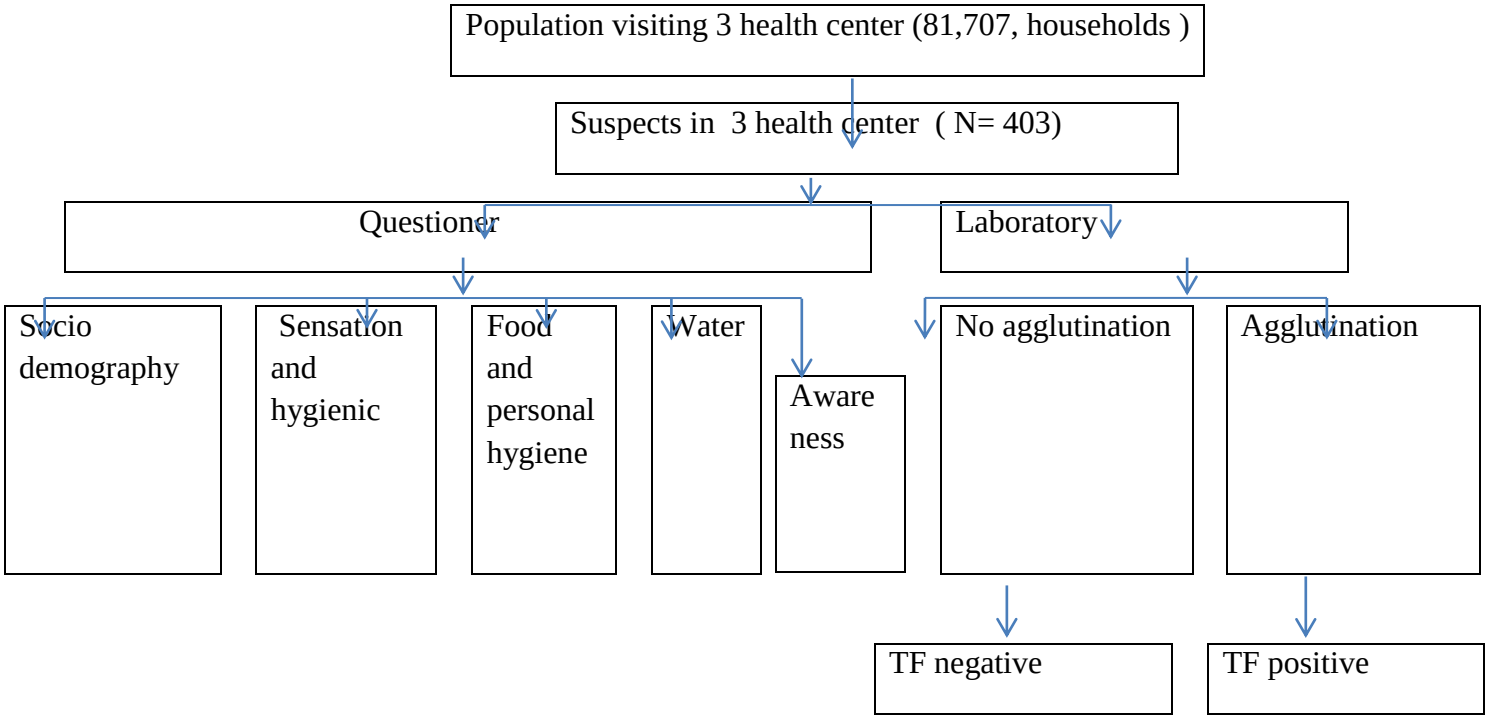


Fig 3.2 Study framework (developed by researchers)

3.3 Patient recruitment and socio-demography

Following patient recruitment, questionnaire/ was used to collected individual and household socio-demographic data such as age, sex, family size, occupation, education, residence, marital status, sanitation and hygiene, food and hygine, dietary habits, safe water source and toilet access. In addition, treatment-seeking behavior and application of health package practices, awareness of TF transmission, symptoms/signs and prevention.

3.4 study population and Source of population

The source of population consisted of all age and sex groups of Gumer District. The study population was all patients having symptoms of typhoid fever attending in one of the three health

center (Arekit, Bad and Bole health center and who were willing to give verbal consent and blood sample.

3.5 Inclusion Criteria and Exclusion Criteria

3.5.1 Inclusion criteria

The following patients who fulfilled all of the following criteria was included in the study:

1). All patients having signs and symptoms of TF including fever (axillary temperature >37.5 °C), abdominal pain or discomfort, headache and constipation or diarrhea 2). Those all age and sex group. 3). Those whom the treating physician suspected may have typhoid fever (demonstrated by the ordering of the "Widal test" with its' known limitations.) 4) Those able and willing to consent to participation.

3.5.2 Exclusion criteria

The following patients were excluded from the study: 1) Those unable to consent to participation due to severity of illness. 2) Those who had received antibiotics within the 2 weeks prior to presentation. 3) Those presenting on more than one occasion during the study period had their first attendance included only. As well as homeless respondent or individual who moves from place to place was excluded based on a study (Getachew, 2018).

3.6 Study Variables

3.6.1 Independent Variables

- Socio-demographic characteristics related variable: Sex, Age, Residence, Parental educational status, occupation and Family size
- Environmental related variable: Water source, Availability of water & Soap, and Toilet facility
- Personal practice related variable: Hand washing habit, Eating raw /uncooked, Medical check-ups
- Awareness related variable: Information, Transmission, Prevention, Treatment, Contamination

3.6.2 Dependent Variable

Typhoid fever infection status

3.7 Sample size determination and sampling techniques

3.7.1 Sample Size

The sample size was determine based on statistical formula developed by Cochran (1977), according to this formula to calculate representative sample for proportions as where, n_o is the sample size, z is the selected critical value of normal distribution at 95% confidence level, p is the proportion of the target population estimated to have the desired characteristics that is 50% for this survey, q=1-p and e is level of precision with ±5%,p = 0.5, q =1-0.5 = 0.5, e = 0.05 and z=1.96 then the required sample size (n_o):

$$n_o = \frac{z^2\, pq}{e^2}$$

$$n_o = \frac{(1.96)^2(0.5\times0.5)}{(0.05)^2} = 384$$

Hence, once the minimum sample size was obtained, a contingency of 5% was added and then the total sample size was made 403. Among these participants whose sample size determined to be 403, 19 participant had unable to give stool sample and only 384 students were participated on this study.

3.7.2 Sampling technique and procedure

Systematic random sampling method was used to recruit patients attending outpatient department of selected Gumer District Health centers. Considering a four month study period, an estimated of 19000 patients visited the outpatient department according to Health plan and the past five months performance document review. This estimate was divided by the sample size to determine the sample interval (k value), which would be 3. The 1stserved patient was selected by lottery method and every 3rd patients thereafter was invited to participate in the study until the required sample size was obtain. Finally, a systematic random sampling technique was used in each health center based on their attendance as a sample frame. The total number of Catchment population visiting in three sampled health center was 81707 (44564 from Arekit, 10963 from Bad and 26180 from Bole).To determine the number of people from each sampled health center, a simple proportion formula adopted from Cochran (1977), was applied as:-

$$ni = n\times\frac{Ni}{N},$$

Where i=1, 2, 3...,

ni =sample size of each *health centers*,

Ni=population size in each *health centers*,

n=total sample size,

N=population size of sampled *health centers*

$$C = \frac{384}{81707,} \times 100\% = 0.47\%(0.0047)$$

Where C represents proportionality

Then the number of sampled respondent was 210 from Arekit health center, 51 from Bad health center and 123 from Bole health center

Table 3. 1: Sample size of the study area in three Sampled health center

Health center	Sex	*Total population*	Proportionality	Sample size(n)	Sample size (%)
	Male	*21836*	*21836*×0.0047	103	26
1,Arekit	Female	*22728*	*22728*×0.0047	107	29
	Total	44564	44564×0.0047	210	55
	Male	5372	5372×0.0047	44	6.5
2,Bad	Female	5591	5591×0.0047	26	6.8
	Total	10963	10963×0.0047	7 0	13.3
	Male	12828	12828×0.0047	60	15.6
3,Bole	Female	13352	13352 ×0.0047	63	16.4
	Total	26180	26180×0.0047	123	32.0
Total		81707	81707×0.0047	403	100

3.8 Methods of data Collection

In this study, data were collected using questionnaire microscopic examination of stool samples. Structured questionnaire was used to assess the major socio-demographic characteristics and hygienic practice risk factors associated with the prevalence of TF infections among participants in the study area. Stool samples were also collected and observed under microscope for parasites to identify the parasites and determine the prevalence of TF infection in the study area.

3.8.1 Laboratory examination

3.8.1.1 Widal test procedure

Three procedures was used for the identification of Salmonella typhi. These are Widal test, Gram staining and biochemical tests. Widal test was used as a quick presumptive serological test, while stool culture using Salmonella/Shigella Agar, Gram staining and biochemical tests were

used to confirm isolation of *Salmonella typhi* Cheesbrough. (2005).A drop of the appropriate well-shaken suspension of the antigen was added to each circle next to each sample to be tested and mixed the content of each circle with a disposable stirrer and spread over the entire area enclosed by the ring with separate applicators for each mixture. Afterwards, the slides were shake gently by hand or by means of a mechanical rotator (100 rpm) for 1 minute. Finally, the test was observed immediately under a suitable light source for any degree of agglutination and qualitative results recorded (Fig 3,2).

3.8.1.2 Serological test

Widal slide agglutination test was done using *S. Typhi* O and H antigens according to the instructions of the manufacturer. The antigen suspension commercially available in 5 ml volume from SPINREACT Reagent Ltd. (Spain) was used. Blood samples (1-3 ml) was draw by puncturing superficial veins (mainly from median cubital, cephalic or basalic veins) of the upper limb using 3/5 cc needle. Sera serum/plasma separated following centrifugation. Widal test kits containing the O and H antigens of S. typhi obtained from SPINREACT (Barcelona, Spain) was used. The slide agglutination test will perform as per the manufacturer's instruction. Briefly, the antigen vial was gently mixed saline by an aspirate dropper multiple times to make a thorough mixture. A 50 µl serum sample was added into a row of circles on the test card. Drops (one drop each) of positive and negative control sera was dispense into respective circles.

A direct slide agglutination technique was used in this study for qualitative determination of the agglutination ability of sera. In brief, the test was done by mixing one drop of serum with one drop each of O and H antigens separately on slide. After shaking the slide back and forth for 1 min, the mixture was observed for macroscopic agglutination. If there was agglutination within 1 min it was reported as reactive, otherwise, non- reactive. Those cultured bottle which showed growth was further sub cultured on MacConky agar (Deben diagnostic Ltd) and blood agar media (Biomark, India laboratories) after 48 h. Negative broth culture were incubated for seven days and sub cultured before reported negative. Suspected colonies obtained will screen by biochemical test using triple sugar iron agar (TSI), citrate utilization test, SIM (sulfide indole motility test), urease test and lysine decarboxylation test. Specific antisera will use to determine *S.typhi.*

3.8.2 Questionnaire survey

The data collected was both quantitative and qualitative. Qualitative data was collected through interviewed. A pre-tested and pre-structured questionnaire was use to collect information on

socio-demographic characteristics (age, sex, residence, marital status, and educational level) and associated factors (toilet availability, hand wash after toilet, water source, eating habit, history of EF). In all groups there was equal numbers of males and females. Quantitative data was collected using interviewer-administered questionnaire that was administer to 384 respondents. Participants of the study was interviewed face to face by trained laboratory technicians using pre-tested structured questionnaire aimed to gather information on potential risk factors such as agro-ecology, age, sex, level of education, hand washing practice after visiting bath room (yes/no), use of toilet (yes/no), source of drinking water (pipe, stream/river), habit of drinking raw milk (yes/no), habit of eating raw meat (yes/no), habit of eating raw vegetables (yes/no), family size, marital status (single, married, widowed, divorced), occupation (government employee, self-employee, house wife, student), previous history of typhoid treatment (yes/no). Other risk factors like aware of typhoid fever prevention, aware of typhoid fever transmission mechanism, medication and health education

3.9. Data Quality control

Prior to data collection the questionnaire which was prepared in English was translate into the patients' vernacular language (Guragegna) to ensure reliable information. Before data collection, the questionnaire was pre-test and every questionnaire was check for completeness after collection Standard operating procedures was used for sample collection and processing. The result of laboratory examination was recorded on well-prepared format carefully. The collected information was reviewed and any errors cross-checked on daily basis.

3.10 Data analysis

Collected data was center and analyzed using Statistical Package for Social Science(SPSS) Version 25 software. Descriptive statistics was used to describe the demographic & other characteristics of the study participants as well as inferential statistics like chi-square test was used to check whether or not there exists a significance difference between the socio demographic groups, personal and food hygienic factors, sanitary factors, the availability of clean and safe water and knowledge-related variables of the respondents. A p value ≤ 0.05 was considered to be statistically significant. Univariate and multivariate logistic regression models were used to test the association between the dependent variable (TF serology) and independent variables. Odds ratios (OR), crude and adjusted was calculated at 95% confidence interval (CI) and a p-value ≤ 0.05 taken as statistically significant.

3.11 Ethical Consideration

The study was supported by letters from Department of biology postgraduate, Hawassa University (RERC ref №: CNCS – REC 018 /2023). Permission was obtained from Gumer District Health Office. Local administrators were consulted and approval granted. Moreover before data collection, written informed consent was obtained from each study participant with age greater than or equal to 18 years. Furthermore, from study participants with age less than 18 years, a written informed assent was obtained from their parents or legal guardian. The confidentiality of collected information was ensured throughout the process. Blood samples were collected by qualified laboratory technicians and TF sero positives were treated as per the health center's routine service to its patients.

4.RESULTS OF THE STUDY

In this chapter, the results of the study "prevalence of TF and Factors Contributing to the Prevalence of Typhoid Fever among Patients Attending to Health Center in Gumer District, Gurage zone, Central Ethiopia regional state, Ethiopia" are presented in form of tables, graphs and charts, followed by a brief description of the presentation.

4.1 Study population

During the study period, Selected health center in Gumer District, was visited by a total of 81,707 patients for any health problem. From this catchment population, 53,707 individuals came from 12 rural kebeles and 28,000 from 3 urban kebele. The number of TF suspects visited the selected health center daily during the 4-month period ranged from 0-28 and overall, the largest number of patients was in February (106(27.6%).

Table 4.1: Monthly numbers of patients examined during the study period

Diagnostic result	Months				Total
	February	March	April	May	
	01-30	03-28	05-25	01-30	
Positive	87	68	63	60	278(72.4%)
Negative	19	21	29	37	106(27.6%)
Total	106	89	92	97	384(100%)

Source: Field data, 2023

A total of 384 individuals suspected of TF and who fulfilled the inclusion criteria were recruited and diagnosed for TF 214 males and 170 females) (Table 4.2). Among the TF suspected and examined patients; 80, 202,58 and 44 belonged to age groups (years) 1-15, 16-31,32-47 and over 48 and above year respectively. The majority of the participants 240(62.5%) were rural dwellers and only 144(37.5%) were urban.

4.2 Social-Demographic Description of the Study Population

4.2.1 Age and Gender

During the study period, in the three health centers a total of 384 patients for typhoid fever suspected patients were selected. From these patients, 240 individuals came from rural surrounding kebeles and 144 from urban. A total of 384 patients were tested of which 106 (62.4%, 106/170) were females while 172(80.3%, 172/214) were males. Of this, 80 (20.8 %)

were in the group of below 16 years of age, 202 (52.6 % were in the range of 16 to 31 years, 58 (15.1%) were in the range of 32 to 47 years and finally 44 (11.5%) were in the group of 48 and above years old (Table 4. 2). Mean age of patients was 2.17 years, 167(43.5%) were married and 217(56.5%) were single, separated or divorced. The majority of the participants 240(62.5 %) were rural dwellers and only 144 (37.5 %) were urban. Regarding the job condition of patient, the majority of the respondents 133(34.6%) are farmers and 60 (15.6%)are merchant, 33(8.6 %) were house wife 118(30.7%) were students and 40(10.4%) were governmental officer

As indicated in table 4.2, 110 (28.6%) of the respondents had Illiterate levels of education, while 91(23.7 %) had Read and write level, 118(30.7 %.) Grade 1- grade 12 and 65(16.9 % grade 12 complete and above. These results suggested that more than half of the respondents had attained primary and nonformula levels of education indicating a low level of education in the study area.

Table 4.2. Socio-demographic characteristics of the study population

Variable		Number of respondent	Percentage (%)
Sex	Female	170	44.3
	Male	214	55.7
	Total	384	100
Age group	1-15	80	20.8
	16-31	202	52.6
	32-47	58	15.1
	48 and above year	44	11.5
	Total	384	100.0
Marital status	Married	167	43.5
	Single	217	56.5
	Total	384	100.0
Resident	Rural	240	62.5
	Urban	144	37.5
	Total	384	100.0
Occupation	Farmer	133	34.6
	civil servant	40	10.4
	Merchant	60	15.6

	Student	118	30.7
	House wife	33	8.6
	Total	384	100.0
Educationa	Illiterate	110	28.6
l status of	Read and write	91	23.7
patient			
	Grade1-grade 12	118	30.7
	grade 12 complete and above	65	16.9
	Total	384	100.0

Source: Field data, 2023

4.3. Clinical presentations

Concerning their clinical presentation at the time of diagnosis, the majority of the participants was febrile for at least 4 days and had a headache. The majority of patient were 149 (39%) presented with fever greater than 4 days, headache 41 (11%) and Constipation 27(7%); with weakness and fatigue, 36 (9 %) diarrhea, 27 (7%) Anorexia was presented respectively. So that, in this study fever, headache, weakness and fatigue, loss of appetite and sweating were the major sign and symptom of typhoid infection observed.(figure 4.1)

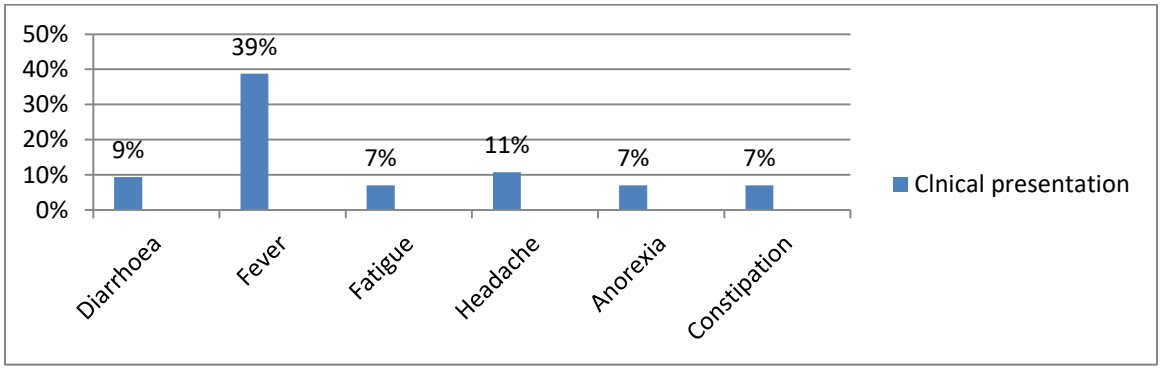


Figure 4.1: Clinical sign and symptom observed among typhoid suspected patients

4.4 Prevalence of typhoid fever in the study population

The results in figure 4.2 show that out of 384 suspected patient 278 (72.4%) showed positive and 106(27.6%) showed negative medical laboratory results and were on medication during the time of data collection hence the prevalence of typhoid in the area.

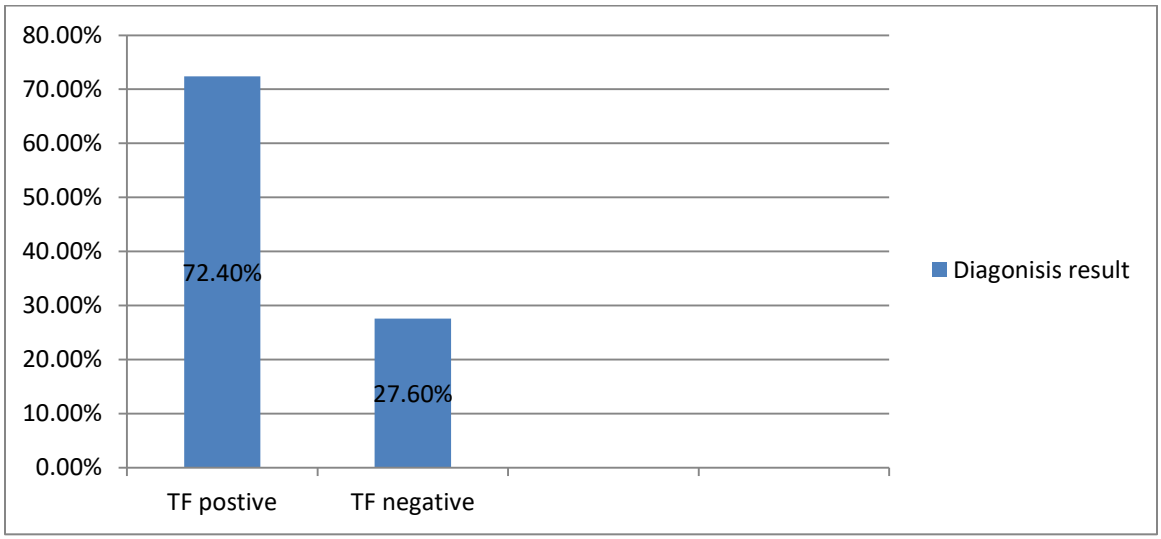


Figure 4.2 Blood result of study population

4.4.1 Occurrence of typhoid and Social-demographic characteristics

4.4.1,1 Occurrence of typhoid in Age and Gender

These study results revealed that a total of 384 patients were tested positive of which 106(62.4%: 106 /170) were females while 172(80.4%: 172/214) were males. In this study and most of the male affected with typhoid relatively higher than that of female participants.($p \geq 0.05$). ($\chi 2 = 15.396$ df = 1 p= 0.000 (figure 4.3). The findings presented in figure 4.3 showed that gender determined the prevalence of typhoid and its patterns.

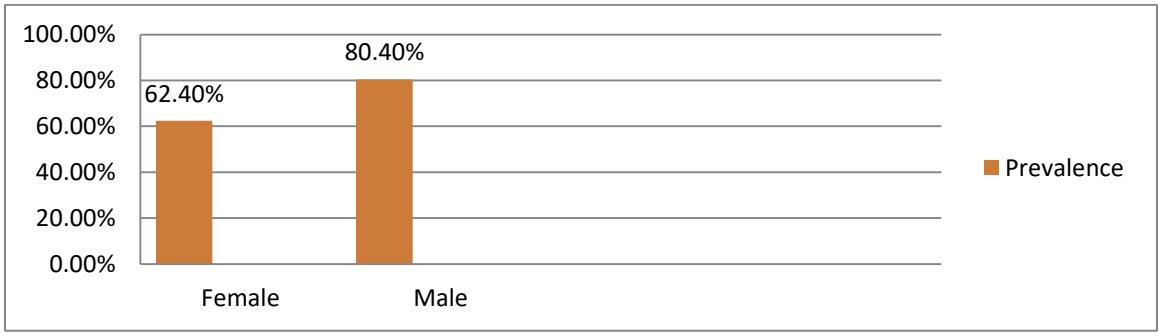


Figure 4.3 Occurrence of typhoid in Gender

These study results revealed that a total of 384 patients were tested positive of which 80 (20.8 %) were in the group of below 16 years of age, 202 (52.6 % were in the range of 16 to 31 years, 58 (15.1%) were in the range of 32 to 47 years and finally 44 (11.5%) were in the group of 48 and above years old (figure 4.4). Mean age of patients was 2.17 years, The prevalence of typhoid fever infections were statistically significant (P<0.05) sex and age group (Figure 4.4). The majority (81.2%) aged 16-31years suffered from typhoid than others in other age brackets in the study area (χ 2 = 20.55 df = 3 p= 0.000)

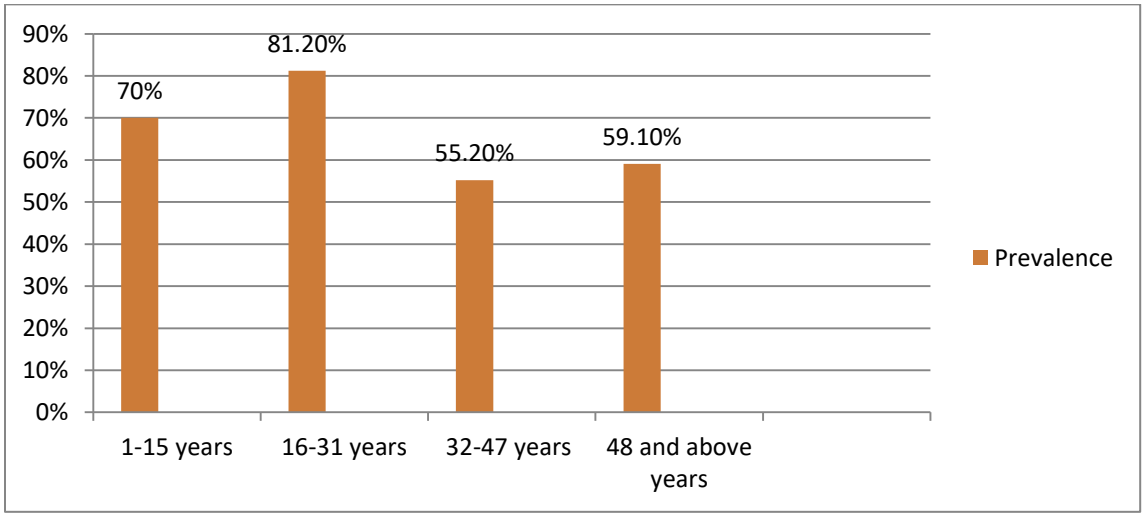


Figure 4.4 Positive case among different age groups.

4.4.1,2 Occurrence of typhoid in occupation, marital status and resident

Typhoid positives (77.1%), and (64.6%) belonged to resident rural (n=185) and urban (n=93) respectively Concerning occupation of these TF positive, the highest number was recorded from farmer (80.5%, n=133), student (70.3%, n=83), merchant (66.7% n=40), civil servant (70% n=28) (Table 4, 3). and A significant number of unmarried individuals were TF positive (77% n=167) (χ2 =7.003 df=4 p=0.005)(Table 4.3). 111(66.5%) were married and 167(77%) were single, separated or divorced. The majority of the participants 185(77.1%) were rural dwellers and only 93 (64.6) were urban. Regarding the job condition of patient, the majority of the respondents (80.5%) are farmers and 66.7% are self-employed, 60.5% were house wife while the remaining 70.% are governmental officer.

Table 4.3. Occurrence of typhoid in occupation, marital status and resident

Variable	Alternatives	positive, n(%)	Negative, n (%)	χ^2	P value
Marital status	1. Married	111(66.5)	56(33.5)	5.198	0.015
	2. Single	167 (77)	50 (23)		
	Total	278(72.4)	106(27.6)		
Resident	Rural	185 (77.1)	55 (22.9)	7.037	0.006
	Urban	93 (64. 6)	51 (35.4)		
	Total	278(72.4)	106 (27.6)		
Occupation	Farmer	107 (80.5)	26 (19.5)	7.003	0.005
	civil servant	28 (70)	30 (12)		
	Merchant	40(66.7)	20 (33.3)		
	Student	83 (70.3)	35 (29.7)		
	House wife	20(60.6)	13 (39.4)		
	Total	278(72.4)	106 (27.6)		

Source: Field data, 2023

4.4.1,3 Occurrence of typhoid in educational status

The study also revealed that those with low level of education suffered from typhoid more than those who had attained a lower level of education and therefore education played a key role in the prevalence of typhoid in Gumer District health center. Moreover, enteric fever was more prevalent on participants who cannot read and write (81.8%) than participants who are educated. In figure 4.5 it is shown that the lower the level of education the more the typhoid prevalence decreased among the adults as in primary, secondary and college levels respectively. The distribution of TF infections among Level of education was statistically significant ($p<0.05$). In figure 4.5 it is shown that the higher the level of education the more the typhoid prevalence decreased among the adults as in primary, secondary and college levels respectively ($\chi 2 = 9.013$ df=3 P=0.029) (figure 4.5)

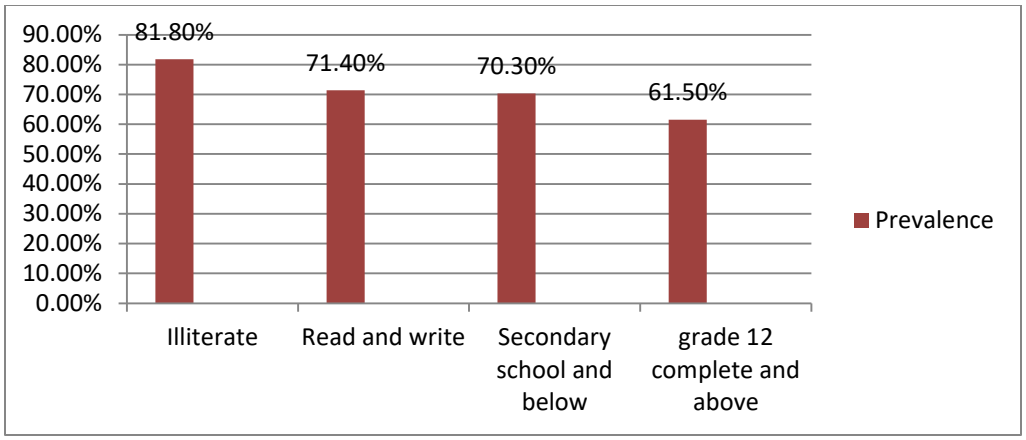


Figure 4.5: Occurrence of typhoid in Level of education

4.5 Risk associated to occurrence of typhoid fever

4.5.1 Sanitation Related Factors Associated with Typhoid Fever

The table 4.4 below is a table showing the proportion of respondents with get safe toilet access; the majority of respondents have no safe toilet at home (55.5%) and few respondents have safe toilet at home (44.5%). From the table below; 42.2% of respondents don‟t control flies from their toilets, followed by 16.4% who control flies by other methods (like smoking the toilet, use of fly traps and direct killing of flies), and followed by 23.2% who control flies by covering pit latrine holes, then 18.2% who control flies by spraying with insecticides ($\chi 2$ = . 12.400 df = 3 p = .004). .From the table 4.4 below; 75.3% of respondents wash hands but without soap after visiting the latrine, followed by only 24.7% wash hands with soap after visiting the latrine. Those who washed their hands after visiting a toilet did not suffer much as those who did not wash hands after going to the toilet ($\chi 2$ = 7.315 df = 1 p = .000). From the table below 4..4; 30.7% of respondents have rubbish pits at their homes while 69.3% don‟t have rubbish pit at homes.

Table 4.4: Sanitation Related Factors and occurrence of typhoid

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Do you get safe toilet access?	Yes	171 (44.5)	112(65.5)	59 (34.5)	7.342	0.005 *
	No	213 (55.5)	166(77.9)	47 (27.6)		
How do you control	Cover the hole	89(23.2)	52(58.4)	37(41.6)	12.400	0.0

flies from your latrine?	Spray with insecticides	70(18,2)	51(72.9)	19(27.1)		00 *
	Do not control flies	162(42.2)	124(76.5)	38(23.5)		
	Others	63(16.4)	51(81.0)	12(19)		
Do you wash hands with soap before and after visiting the latrine?	Yes	289 (75.3)	199 (68.9)	90(31.1)	7.315	0.0 04 *
	No	95 (24.7)	79(83.2)	16(27.6)		
Where do you pour your rubbish?	Rubbish pit	118 (30.7)	80(28.8)	38(81.2)	9.881	0.0 05 *
	Along the road	206 (53.6)	162(58.3)	44(51.7)		
	Anywhere	60(15.6)	36(12.9)	24 (81.1)		
Is it important to wash hands before and after visiting toilet?	Yes	313 (81.5)	138(44.1)	175(45.6)	4.854	0,0 25 *
	No	71 (18.5)	30(55.9)	41(54.4)		
why is it important to wash hands?	To feel good habit	271(70.6)	199(73.4)	72(26.6)	495	0.2 80
	To control typhoid	113 (29.4)	79(69.9)	34(30.1)		

*Bolded values are significant at p-value <0.05

4.5.2 Food Related Factors Associated with Typhoid Fever

Among TF suspected individuals 219(57%) reported that they consume uncooked green vegetables. From (Table 4. 5) ; 49% of respondents eat food from the restaurant, followed by 20.1% who prepare food and eat at home,9.4% reported eat other way and lastly 21.6% eat food sold along the road were also tested positive ($\chi 2 = 11.413$ df = 3 p = .010). Those who ate from such food outlets suffered from typhoid more than those who did not, as indicated in table 4.9 below ($\chi 2 = 4.472$ df =1 p= 0.034) From the table 4.9 below; most of the respondents (54.4%) of them who sometimes wash their hands before preparing food, and only 45.6% wash hands always before preparing food. From the table 4.5 below; the majority of the respondents preserve their cooked food for use in Leave food uncovered (58.97%), followed by those that leave cooked food Well covered in saucepan (33.9%) and only a very few preserve their cooked food in a refrigerator (1%).From the table below; 38.3 % of respondents (majority) just eat their fresh fruits from the source straight away without doing anything about it, 22.9% first wash their fresh fruits with clean safe water before eating, and only 38.8% peal their fresh fruits before eating. Few respondents (46.6% and 45.6%) of the respondents did not have a hand washing habits before meals .Majority (64.1 %) of sampled respondents eats raw vegetables but (35.9%) do not eat raw vegetables. The results of this study showed a statically significant relationship between

hand washing and being tested positive for typhoid fever ($\chi 2 = 3.939$, df = 1 p = . 0.030) (Table 4. 5). It was seen that those who do not and those who wash their hands only sometimes before serving food were more infected.

Table 4.5: Food Related Factors and occurrence of typhoid

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Do you eat uncooked green leafy vegetables?	Yes	219 (57)	168 (76.7)	51 (23.3)	4.752	0.002
	No	165 (43)	110 (66.7)	55 (33.3)		
Where do you get your meals?	Prepare and eat at home	77(20.1)	44 (57.1)	33(42.9)	11.413	0.010
	Eat from the restaurant	188(49)	145(77.1)	43(22.9)		
	Buy already cooked food along the road	83(21.6)	62(74.7)	21(25.3)		
	Others	36(9.4)	27(38.9)	9(29.4)		
How often do you wash your hands before preparing your food?	Always	175 (45.6)	118 (67.4)	57(32.6)	3.939	0.030
	Some times	209 (54.4)	160(76.6)	49(23.4)		
How do you keep your cooked food for use in a later time?	Well covered in saucepan	130 (33.9)	80(61.5)	50(38.5)	11.730	0.008
	In a refrigerator	4(1)	3(75)	1(25)		
	Leave food uncovered	226 (58.9)	177(78.3)	49(21.7)		
	others specify	24 (6.3)	18(75)	6(25)		
How do you prepare fresh fruits before you eat?	Wash with clean water	88 (22.9)	68(44.1)	20(45.6)		0,006
	Peal	149 (38.8)	30(77.3)	41(22.7)	5.378	
	I just eat straight away	147(38.3)	98(65.8)	51(34.2)		
Do you have eating-place in this area where food is sold?	Yes	200 (52.1)	158(79.0)	42(21)	9.109	0.002
	No	184 (51)	120(65.2)	64(34.8)		
Do/did you consume raw, unpasteurized milk and dairy products?	Yes	196(48.2)	153(78.1)	43(29.1)	6.430	0.008
	No	188(49)	125 (66.5)	63(33.5)		
Do/did you consume raw, uncooked meat or eggs?	Yes	217(56.5)	168 (77.4)	49(22.6)	11.486	0.000
	No	167(43.5)	110(65.9)	57 (34.1)		

Source: Field data, 2023

4.5.3 Water Related Factors Associated with Typhoid Fever

Among TF suspected individuals, (57% n=219) were not obtained safe water source, most respondents get their water from the river (35.4%), followed by tap water (23.7%), followed by other sources like rain water and swamp (19,8%), and, then steam (18%) ($\chi 2=4.486$ df=2

p<0.025).The majority of respondents drink water untreated from the source (63.5%), those that boil water for drinking are 21.6%, about 14.8% treat water using tablets like aqua safe or water guard for drinking and lastly 11.25% use other means to make water safe for drinking like storing for a long time before use and filtering water. Household water treatment methods outlined in the questionnaire included; boiling of water, filtering of water using purchased water filters and use of cotton wool as local household filters. Significant difference was recorded among participants on use of treatment methods.

Majority of the respondents did not use any treatment method on water before drinking. Others used either boiling or filtering of the water as their water treatment technique. Domestic water treatments in Gumer District were not effective interventions in control of typhoid fever for there was no significance between the treatments and the prevalence of typhoid fever(χ 2 =5.816 df=3 p=0.258 (Table 4.6).

Table 4.6 below shows the majority of the respondents store their water in jerrycans (52.3%), followed by those that store water in pots (38.3%) and, lastly those that store water in other containers like large source pans and tanks (9.4%). These results shows that there was statistical relationship between water keep and prevalence of typhoid fever (χ 2 =5.816 df=2 p=0.053) (Table 4.6).The table 4.6 below shows most of the respondents fetch water from sources more than 30 meters away from any nearby latrines (15.6%), followed by those who estimated the distance of their water sources to be about 30 meters away from the nearby latrine were about 37.2 per cent and finally 47.1% estimated distance of their water sources to be less than 30 meters from the nearby latrine. This shows that there was an association between the distance of their water sources from toilet and prevalence of typhoid (χ2 =13.677 df =3 p=0.001) (Table 4.6). It can be deduced that the risk factor of contracting typhoid fever in this area is high as most residents drink untreated water collected from bore holes and swamps, and respondents with their water sources distance 30 meters or less from a nearby latrine are at risk of consuming contaminated water.

Table 4.6: Water Related Factors and occurrence of typhoid in Gumer District health center

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Do you get safe water source?	Yes	165 (43)	110(66.7)	55 (33.3)	4.752	0.020

	No	219 (57)	168(76,7)	51 (23.3)		
What is the source of your drinking water?	River	136(35.4)	107 (78.7)	29(21.43)	4.486	0.025
	Tapped Water	91(23.7)	55 (60.4)	36(39.5)		
	roof	76(19,8)	56(73.7)	20(26.3)		
	Steam	69(18)	49(71)	20(29)		
	Others	12(3.1)	11(0.02)	1(0.002)		
What do you do to make water safe for drinking?	Boil	83(21.6)	57 (68.7)	26(31.3)	5.816	0.053
	Drink without boiling	244 (63.5)	186 (76.2)	56(23.8)		
	Treat with tablets (aqua-safe, water guard, etc	57(14.8)	35 (61.4)	22(38.6)		
Where do you keep your water?	Jerrycans	201(52.3)	155(77.1)	46(22.9)	8.691	0.013
	Pots	147 (38.3)	94(63.9)	53(36.1)		
	Other	36 (9.4)	29(80.6)	7(19.4)		
What is the distance of the nearest latrine from your water source?	< 30 m	181(47.1)	147(81.2)	34(18.8)	13.677	0.001
	about 30 m	143 (37.2)	94(65.7)	49(34.3)		
	> 30 m	60 (15.6)	37(61.7)	23(36.3)		
Is there anything that this community is doing together towards clean water provision?	Yes	181 (47.1)	142(72.4)	54(27.6)	0.001	0.536
	No	203(52.9)	136(72.3)	52(27.7)		

Source: Field data, 2023

4.5.4 Participant's awareness about typhoid fever, its transmission and control

The study findings revealed that (40.9%) had knowledge about typhoid. The residents were informed and far much knowledgeable on typhoid suggesting that control of typhoid would be easy for them if such knowledge is applied. the residents while 59.1% did not. Majority of participants seemed to be remarkably aware of the typhoid fever and some of them associated it with drinking of un boiled water. However, very few participants were aware of mode of transmission and control of typhoid disease. 167(43.5%) of the respondents were aware of typhoid disease prevention while 217 (56.5%) were not.. Majority (69.4 %) of the respondents had had at least a laboratory test before medication, whereas, 30.6% of the respondents had never

had laboratory testing before medication when they required medical services .of respondents relied on untreated water for drink in Among typhoid fever suspected individuals (74.9% n=197) did not obtain health education, (67.5% n=208) had no awareness about TF transmission, (68% n=225) did not know TF prevention mechanism and 66.8% (n=195) did not seek medication (Tables 4.7).

The present study results also found out that majority had informed about typhoid fever through health extension workers and community activity mobilization while minorities of the residents had not. These results showed that health education was being given some times as a typhoid preventive measure in Gumer District ($\chi 2$=4.577 df=1 p=0.032). These showed that the majority of the resident though had heard about the disease, proper action against typhoid prevention had not taken. Preventive measures must be emphasized and community must be involved in order to encourage behavioral change with regard to hygiene. These results showed that health education was being carried out immensely as a typhoid preventive measure in Gumer District.($\chi 2$=7.098 df=1 p=0.006) (Table 4.7). In the course of this study, we asked the question; have you ever heard about typhoid fever before? From the answers, it was evident that a majority 203(52.9 %) of the respondents did not about typhoid fever while 181 (47.1 %) knew about typhoid fever

Table 4.7 Local awareness of typhoid fever, its transmission and control in Gumer District health center

Risk factors	Responses	Frequency n (%)	Positive n (%)	Negative n (%)	χ^2	p-value
Know TF prevention	Yes	157 (40.9)	104 (66.2)	53(33.8)	5.033	0.017
	No	227 (59.1)	174(76.7)	53(23.3)		
Health education	Yes	107(27.9)	67(62.3)	40(37.4)	7.098	0.006
	No	277(72.1)	211 (76.2)	66(26.8)		
Aware of TF transmission	Yes	167(43.5)	112(67.1)	55(32.9)	4.201	0.027
	No	217 (56.5)	166 (76.5)	51(23.5)		
medication when sick	Yes	239 (62,2)	167(69.9)	72(30.1)	2.957	0.085
	No	145 (37.8)	111(76.6)	34(23.4)		
have you heard about	Yes	313 (81.5)	219(70)	94(30)	4.993	0.016
	No	71 (18.5)	59(83.1)	12(16.9)		

typhoid fever

Source: Field data, 2023

4.6 TF serology

Out of the 384 patients tested, 278(72.4%) were positive and the rest 106 (27.6%) negative (Table 4.8). positive males were 172(80.4 %) and females 106 (62.4%) with male-female ratio of 2.56:1 for positive.

4.6,1 Univariate analysis on risk factors of TF infection

Univariate analysis results showed that typhoid fever prevalence was significantly higher among individuals who did not Safe toilet access (COR 1.532 CI1.131-2.310, p= 0.000), uncooked green vegetable eaters (COR 0.432 95% CI 1.037-2.104 p = 0.000), male individuals (COR 1.671, 95% CI 1.307-2.646, p= 0.005), age group 16-31 (COR 1.861, 95% CI 1.131-2.124, p =0.000) illiterate (COR 1.556, 95% CI 1.066-4.622, p= 0.000 and Source of drinking (river) (COR 1.874, 95% CI 0.331-1.541, p 0.012) in summary, all sociodemographic had significant association with TF in the univariate analysis (tables 4.8).

Table 4.8 Univariate logistic regression analysis of socio-demographic variables in TF suspected and seropositive patients at Gumer District health center, February 2023 – May 2023 (N=384)

Variable	Alternatives	N	Positive, n(%)	COR	95% CI	P-value
Age	1-15	80	56 (20.1)	1.643	2.131-3.162	0.134
	16-31	202	164 (58.9)	1.861	1.141-2.162	0.000*
	32-47	58	32 (11.5)	1.75	1.010-2.791	0.029
	48 and above year	44	26 (9.3)	1.00		
Sex	Female	170	106 (62.4)	1.00		
	Male	214	172 (80.4)	1.671	1.307-2.646	0.001*
Residence	Rural	240	185 (77.1)	1.456	0.431-1.541	0.567
	Urban	144	93 (64. 6)	1.00		
Safe toilet access	Yes	171	110(66.7)	1.00		
	No	213	168(76,7)	1.432	1.141-2.310	0.000*
Eat uncooked	Yes	219	168 (76.7)	1.00		
vegetables	No	165	110 (66.7)	0.532	1.037-2.104	0.000*
Source of	River	136	107 (38,4)	1.874	0.331-1.541	0.002

drinking water	Tapped water	91	55 (19.7)	1.00		
	Roof	76	56(20.1)	0.768	0.011-1.541	0.343
	Stream	81	60(21.5)	0.467	1.056-2.647	0.274
Occupation	Farmer	133	107 (80.5)	1.567	1.327-4.306	0.000*
	civil servant	40	28 (70)	1.876	2.325-7.659	0.245
	Merchant	60	40(66.7)	0.89	1.092-2.329	0.134
	Student	118	83 (70.3)	1.674	2.092-5.329	0.321
	House wife	33	20(60.6)	1.00		
Educational	Illiterate	110	90(81.8)	1.556	1.066-4.622	0.000*
status	Read and write	91	65 (71.4)	0.567	2.196-5.622	0.324
	Secondary school and below	118	83 (70.3)	1.630	1.136-2.622	0.234
	grade 12 complete and above	65	40 (61.5)	1.00		
Health education	Carried out	107	67(62.6)	1.00		
	Not Carried out	277	211 (76.2)	1.890	1.230-2.957	0.000*
Aware of TF	Yes	167	112(67.1)	1.543	2.033-5.158	0.000*
transmission	No	217	166 (76.5)	1.00		
Know TF	Yes	157	104 (66.2)	1.523	1.327-2.208	0.000*
prevention	No	227	174(76.7)	0.67	1.237-2.308	
Seek medication	Yes	239	167(69.9)	1.634	1.007-2.208	0.021
	No	145	111(76.6)	1.00		
Marital status	Married	167	111(66.5)	1.00		
	Single	217	167 (77)	1.670	1.6507-2.258	0.567

Source: Field data, 2022

COR: crude odds ratio, CI: confidence interval, n: number of people, N: total participants, %: percent, GDHC: Gumer District health center, *: Statistically significant, typhoid fever:, N=384 participants eligible for some.

4.6.2 Multivariable analysis on risk factors of TF infection

Multivariate analysis revealed that age 16- 31 (AOR 0.861, 95% CI 0.131-1.172, p= 0.000) years young patients were at higher risk of getting typhoid fever compared to over 48 patients (tables 4.9). Using the male sex as a reference, maleness was three times at higher risk for typhoid fever

(AOR 3.471, 95% CI 1.507-3.846 p = 0.000). Illiterate patients were almost two times at increased risk of typhoid fever than those who got some kind of education (AOR 2.756 95% CI 1.416-4.322, p= 0.004) Safe toilet did not access patients were at increased risk of typhoid fever than those who got some kind of Safe toilet did not access (AOR 1.612 95% CI 0.161-1.710, p=0.000), did not got safe Source of drinking water patients were at increased risk of typhoid fever than those who got some kind of Source of drinking water (AOR 0.654 95% CI 0.141-1.541 p = 0.000) in summary, all sociodemographic dietary and sanitation variables, water and awareness had significant association with typhoid in the Multivariate logistic regression analysis (tables 4.9).

Table 4.9: Multivariate logistic regression analysis of socio-demographic, Dietary and sanitation variables in TF suspected and seropositive patients at Gumer District health center, February 2023 – May2023 (N=384)

Variable	Alternatives	N	Positive, n(%)	AOR	95% CI	P-value
Age	1-15	80	56 (20.1)	2.843	1.131-2.162	0.024
	16-31	202	164 (58.9)	0.861	0.131-1.172	0.000*
	32-47	58	32 (11.5)	1.650	0.010-1.491	0.015
	48 and above year	44	26 (9.3)	1.00		
Sex	Female	170	106 (62.4)	1.000		
	Male	214	172 (80.4)	3.471	1.507-3.846	0.000*
Safe toilet	Yes	240	185 (77.1)	1.00		
access	No	144	93 (64. 6)	1.672	0.161-1.710	0.000*
Eat uncooked	Yes	171	168 (76.7)	2.132	1.017-2.604	0.010*
vegetables	No	213	110 (66.7)	1,00		
Source of	River	136	107 (38,4)	0.654	0.141-1.541	0.000*
drinking water	Tapped water	91	55 (19.7)	0.568	0.011-1.641	0.123
	Roof	76	56(20.1)	1.00		
	Stream	81	60(21.5)	0.467	1.056-2.647	0.004*
Occupation	Farmer	133	107 (80.5)	1.567	1.327-4.306	0.000*
	civil servant	40	28 (70)	2.276	2.325-7.659	0.245
	Merchant	60	40(66.7)	0.690	1.092-2.129	0.134
	Student	118	83 (70.3)	1.674	2.092-5.329	0.021
	House wife	33	20(60.6)	1.00		

Educational	Illiterate	110	90(81.8)	2.756	1.416-4.322	0.004*
status	Read and write	91	65 (71.4)	0.867	2.196-4.622	0.104
	Secondary school and below	118	83 (70.3)	2.930	1.336-4.622	0.004
	grade 12 complete and above	65	40 (61.5)	1.00		
Health	Carried out	107	67(62.6)	1.00		
education	Not Carried out	277	211 (76.2)	1.890	1.430-2.757	0.000*
Aware of TF	Yes	107	112(67.1)	2.543	2.533-4.138	0.000*
transmission	No	277	166 (76.5)	1.00		
Know TF	Yes	83	104 (66.2)	1.00		
prevention	No	244	174(76.7)	0.870	1.337-2.408	0.000*
Seek	Yes	163	167(69.9)	1.434	1.004-2.308	0.001*
medication	No	219	111(76.6)	1.00		

Source: Field data, 2023 AOR: adjusted odds ratio, CI: confidence interval, n: number of people, N: total participants, %: percent, GDHC: Gumer district health center , *: statistically significant, TF: typhoid fever, N=384 participants eligible for some.

5. DISCUSSION

Most respondents were males and not married. 52.6% of respondents were of age 16-31 years old and the majority of respondents attained only grade 1- 12 level and few respondents attained secondary education. Most of the respondents were unemployed, while the few were employed. Most of the respondents were involved in peasant farming as source of income.

The findings of this study showed that out of 384 samples 278 (72.4%) of the residents had suffered from typhoid fever and only 27.6 % had not. This figure is much higher than other results from other parts of Ethiopia (Andualem *et al.*, 2014 (2.6%), Abera *et al*. 2010 (1.6%), Beyene *et al.*, 2011 (11.5%) and Reda *et al.*, 2011 (11.5%).Similarly a lower prevalence (1.6%) was reported by a study from Mekelle, Ethiopia (Gebreyesus,2020). On the other hand, relatively closer finding of Deksisa and Gebremedhum (2019), Mawazo *et al.*, (2019) and (Yousifi, 2018) who obtained 71.4 %, 68 % and 58 %, respectively. But compared to other reports outside Africa a high prevalence (83.0%) was recorded (Khanum *et al* 2015). 84(87.50%) patients were suffering from typhoid fever assured by clinical examination and serological test result,

The discrepancy in the prevalence estimates between different studies can be due to differences in the study design (community-based versus health facility-based), sample size, socioeconomic-demographic or environmental and associated sanitary practices, seasonality of the study period, TF diagnostic methods and sample type used among others (Admassu.,2019). Therefore, just comparing numbers from such varying studies may not prove much useful.

Enteric fever is a widespread public health problem in low and middle income countries including Ethiopia, where 88% urban and 92% rural residents don't treat drinking water and only 6% of households use improved toilet facilities (Browne, 2020). In order to achieve this purpose, specific objectives were raised in the study. Based on the analysis of the data, the researcher describes the reality of the case herein below categorizes its age association and sex association. A total of 278 people were found to have suffered from typhoid fever during the study period. Of these numbers, 172 (80.4%) were males and 106 (62.4%) females. Similarly , the trend for greater susceptibility of male children to typhoid is consistent with other studies in which gender was considered as a risk factor for contracting enteric fever (Vighio,2021) This may be associated with gender differences relating to level of exposure, wherein boys spend more time playing and eating outdoors.

This study found a male-to-female ratio of 2.36:1 for the study population as whole and 2.04:1 for seropositive patients. The proportion of TF seropositive males (80,4%) to females (62.4%) showed variability from other studies conducted in Ethiopia. For instance, in a study from north Ethiopia, the proportion of TF seropositive females was 52.3% which was nearly comparable (47.7%) to that of males (Wasihun *et al.*,2015) in Mekele. Similarly, Kefelew *et al*.,2014 found 58.6% of female and 41.4% male TF seropositives in Gondar town, north Ethiopia. Furthermore, a retrospective study in a tertiary care center in Addis Ababa showed that there were 38% female and 62% male TF positive patients in 2007 and 42% females and 58% males in 2010 (Weyesa 2012).

Outside Ethiopia, there are certain studies that reported a male-to-female ratio of up to 6.41:1 (Ayaz *et al*.,2006) for TF seropositive cases. This study is in contrast to the study finding by (Youssef *et al.*,2010; Eba and Bekele, 2019) showed that males and females were at risk with relatively equal chances of being infected by the disease and therefore equally susceptible. Other study reported that high prevalence among female than male (Crump and Mintz, 2010).

Apparent sex-based differences (males more implicated) among TF patients and suspects might be due to poor hygienic practice, habit of eating hawked food, patronizing restaurants and cafeterias where basic hygienic practices are most times compromised during food preparation, exposure of traditional agricultural practice than females. In addition unmarried males are highly vulnerable than married. In contrast, still there are some other reports that revealed females experiencing a higher TF attack rate than males accounting for 55.6% of the patients in Harare, Zimbabwe (Polonsky, 2014). Regarding the age groups, typhoid infection was recorded from all age groups in the study area. However, the rate of infection was high in the age groups 16-31 years old followed by 1-15 years old. On the other hand, the selected studies conducted in different parts Dhaka showed the opponent results. The highest risk of typhoid fever in age group was children under 5 years old (Khanum *et al*.,2015). Widal test where prevalence of enteric fever was high almost 66.67% among the school going children group 6 to 20 years old. (Rahman *et al*.2011). The reasons of infection were considered as habituated with unsafe drinking water and unhygienic junk food 58.33% and 72.92% respectively (Rahman *et al.*,2011). Additionally, the another causes of getting frequent and high level of typhoid fever infection in young children group was in low education level parents, they remain outside during the maximum time of the day for work (Rahman *et al.*,2011). Similar findings were out from earlier studies. (Kidgell, 2002).

The researchers considered that more chances of getting infection in school going children group might be due to having unsafe drinking water and contaminated street food. This study also shows the similar finding with the school going children group, if it was combined with two groups like the age group 6 to 10 and 11 to 20 group; 46% patients having typhoid fever. The most vulnerable age group was found between 16-31 years. In addition unmarried males are highly vulnerable than married. The variations might be due to different demographic characteristics, study setting, their perceptions and economic status of the country.

Out of the total population 93 (64.6%) patients were from urban where as 185 (77.1%) patients were come from rural area of Gumer District . In this study, the prevalence of typhoid fever was higher among rural as compared to the urban. Regarding residence of study participants, it had significant association with *S.typhi* infection where patients living in rural area had 1.456 higher risk of having *S.typhi* compared to those who live in urban area. This might be due to lack of access to safe water and hygienic edification, lack of toilet and/or hand washing exercise after toilet, open defecation practices near to the springs and rivers, insufficient medical care, low socio-economic status, poor personal hygiene are possible reason (Dewan, 2013). This is due to use of unsafe drinking water, improper sanitation and inadequate medical care, using raw fruits and vegetables by those people, unhygienic conditions in their surrounding environment. Although studies reported that there is no significant difference in the occurrence of typhoid between urban and rural environments (Whitaker *et al.,* 2009). Although studies reported that there is no significant difference in the occurrence of typhoid between urban and rural environments. In this study, since most of the patients are from rural resident's higher risk of typhoid fever was occurring as compared to urban residents. This could be explained by suboptimal access to safe water and lack of hygienic education which was supported by the high prevalence of typhoid among farmers with no formal education (Andualem, *et al.,* 2014).. Moreover, the reason why the prevalence of typhoid lower in urban area is since there is a greater centralization of services and many clinics are associated with large hospitals. The results of this study concur with the study carried out (Breiman *et al.,* 2012; Eba and Bekele, 2019), where a high prevalence of typhoid fever occurred due to overcrowding with poor access to clean water and sanitation.The major characteristic presenting the clinical features of typhoid in our study was Fever (>37.5 ℃) (39%), headache (11%), weakness and fatigue (7%),, diarrhea (7%), Anorexia (7%). And Constipation 27(7%); Otherwise typhoid fever presented with low grade of dry cough, muscle ache and nausea was also presented with the typhoid patients this is

agreed the study reported by (Kakaria *et al*.,2017). which is fever 100%, anorexia36%, headache 26%, diarrhea 28%, vomiting 44%, cough (5%) (Ashish , 2014) (.The other study conducted inIndia by (Jeeyani *et al*.,2017). was showed that the patient with high-grade fever was 94.6 %, vomiting and cough were the most common associated symptoms seen in 47.6%, and 54.6% patients respectively.

This study demonstrated that the most common factors that facilitate TF dissemination are highly prevailing in the study area. For example the proportions of participants being gender (male), age (among age group,16-31) illiterates, resident rural and farmers were 80.4, 81.2, 81.8, 77.1 and 80.5% respectively. All of these factors were significantly associated with TF in this study and several other similar ones (Allen and Honest 2010, Abera *et al.,* 2010). Nevertheless, the figure found in this study may be higher than expected and it may not show a more accurate picture for various reasons. The diagnostic technique used has its own limitations and is not definitive test of the target bacteria and is not supported by tube agglutination, stool culture, blood culture and biochemical tests. Although the widal test has negative predictive value it is widely criticized for its less specificity and cross-reaction with several other enteric bacterial antigens is common (Borg, 2014). This study was an indicator for forwarding bench marks for further investigation and it is an alarm for the town government and health administrators.

Depending on different factors such as clinical specimen and laboratory method used, the prevalence of TF is different globally ranging from 0.53 to 10.6%(Prasad, N. *et al.* 2018). Previous studies in Ethiopia indicated a prevalence of 2.7–11% (Deksissa, & Gebremedhin, 2019). Furthermore different factors such as drinking unprotected or untreated water, eating unwashed foods, having unimproved or damaged sanitation facilities were associated with TF infection (Adesegun, *et al.* 2020). From this study, over 45.5% of respondents have get safe toilet access at home while the remaining majority respondents have not get safe toilet access at home. This study also revealed that over 42% of respondents don‟t control flies densities from their latrines and only 16.4% control flies by smoking the toilet, use of fly traps and directly killing the flies. A further 23.2% control flies by covering pit latrine holes while about 18.2% control flies by spraying with insecticides and about 75.3% of respondents include those who either wash hands without soap after visiting the latrine, or totally don‟t wash hands after visiting the latrine with only 24% washing hands with soap and safe clean water after visiting the latrine. Furthermore, up to 53.6% of respondents do not have rubbish pits at home. Despite the majority of the households having latrines and a modest number having rubbish pits, there is still

significant risk of getting into contact with fecal matter and exposure to typhoid fever among the respondents in this study.

These study findings agree with Ndugwa‟s and Jacopo‟s findings; According to a study by Ndugwa (2015), unsafe disposal of excreta and solid wastes are significant factors that contribute to contamination of ground water in Kampala. Furthermore, young children are likely to be exposed to fecal contamination in the immediate environment surrounding their household (Ngeno *et al*, 2015). A study by Jakopo revealed that open defecation, not having a hand washing facility and poor hygiene were the main risk factors for contracting typhoid fever in the community (Jakopo, *et al*, 2013). The study also agrees with that of Pruss *et al.*, (2006), who asserted that, surface and ground water without guaranteed safe supply for fecal matter could gain access into the water through water borne sewage system, through flush toilets, and pit latrines.

This study finding indicates that most of the respondents sometimes wash their hands before preparing food 54.4%) and only 45.6% always wash hands before preparing food while a further 38.3% eat fruits without washing. It also shows that 49% of respondents eat food from the restaurant and 21.6% eat food sold along the road. Further 33.9% of respondents preserve their cooked food for use in a later time by covering in source pans while 58.9% leave cooked food uncovered and only a very few preserve their cooked food in refrigerator (1%). From this study finding therefore, the risks of eating contaminated food by respondents is high as many do not wash their hands before preparing food and many do not wash fresh fruits and vegetables before eating. Furthermore, a significant number of respondents leave cooked food uncovered where flies and other household creatures like rats and cockroaches can easily get access to and contaminate it. Thus this findings are also similar to Gasem‟s findings.This finding also agrees with Kungu‟s and Gasem‟s findings that; eating food prepared in hotels is a risk factor towards suffering from typhoid fever (Kungu *et al*, 2009). Further analysis by Hussein, 2011) showed the risk factors for typhoid fever as being never or rarely washing hands before eating, eating outdoors at a street food stall or mobile food vendor, consuming ice cubes in beverage and buying ice cubes from a street vendor. From this study, a majority of respondents drink untreated water direct from the source 244 (63.5%) and only 83(21.6 %) boil drinking water while 57(14.8%) treat water for drinking using aqua safe or water guard. Most respondents also get water from rivers 136(35.4%) and rain water and swamps (76(19,8 %) and (57%) without safe potable water source Concerning sources of drinking water, UNICEF categorized water sources

as improved drinking water source or unimproved drinking water source (UNICEF, 2020). Piped water in dwelling, yard or public taps was classified under improved drinking water source while unprotected springs and dug wells were classified as unimproved source of water. This classification was used to distinguish safe water sources from unsafe sources (UNICEF, 2020).It can be deduced that the risk factor of contracting typhoid fever in this area is high as most residents drink untreated water collected from bore holes and swamps, and respondents with their water sources distance 30 meters or less from a nearby latrine are at risk of consuming contaminated water. This study also shows similar findings to Walters‟, Merkel‟s and Ndugwa‟s findings; (Walters et al., 2015) reported that during a previous typhoid outbreak in Kasese and Bundibugyo districts in 2009–2011, the vehicle of transmission was unclean water. According to a study by Ndugwa, the outbreak of typhoid fever in Kampala city was likely caused by consuming contaminated water from unprotected ground water sources and continued that Kampala city has more than 200 unprotected ground water sources, most of which serve as unprotected sources of water for economically disadvantaged people in the city (Ndugwa, 2015). Merkel *et al*., (2012) observed that almost 30% of people living in urban areas and more than 60% of those living in rural areas do not treat their water before drinking (UBOS *et al*., 2011) and continued that barriers to safer drinking water include the cost associated with establishing a piped treated water system or purchasing water treatment products for household use and the false perception that naturally occurring water sources could be safe. Hence, my study agrees with Merkel‟s and Ndugwa‟s findings. The study also showed that most respondents collect water from sources more than 30 meters away from nearby latrine 60 (15.6 %), while 143 (37.2%) estimated the distance of water sources to be about 30 meters away from a nearby latrine and 181(47.1 %) estimated the distance of their water source to be less than 30 meters from a nearby latrine. Most of the respondents also store their water in jerrycans (201(52.3%), and 36 (9.4 %) store water in pots after collection. Drinking water storage containers varied widely in capacity and type. In our study all the participants used barrels for storage of drinking water which disagreed with a community base cross sectional study among rural communities of Dire Dawa Administrative Council, Dire Dawa, Ethiopia (Amenu, 2013) that showed 66.2% of households used clay pots for households water storage, while the remaining (33.8%) stored water in jerrycans, and it also contrasts with study conducted in Mangalore, South India (Mynit et al.,2015) which documented that the storage of drinking-water was done in clay pots (28%), plastic bottles of 20-litre capacity (44.1%), and ceramic jars (23.7%).

These results concur with the study carried out in Kibera (Breiman *et al.,* 2012), where a high prevalence of typhoid fever (24.7%) occurred due to overcrowding with poor access to clean water and sanitation. According to (Ashebir *et al.,* 2013), the health extension workers promote the awareness among the rural communities to construct latrines but have been less active in teaching proper use and maintenance.

Unsafe drinking water and inadequate sanitary conditions increase the risk of various public health hazards such as typhoid fever. Outside of faucal contamination of drinking water, a statistically high-incidence of typhoid has been associated with local climate, elevation, and proximity to altered land and hydrologic systems (Jenkins, 2016). In addition, household features have been frequently associated with increased risk, including the use of untreated surface waters (e.g., rivers, streams, wells) as drinking water (Prasad, 2018); poor water storage practices(Prasad,2018); the use of contaminated bathing water; the condition of the toilet or latrine; and crowding of people and houses. Inadequate drainage around the house and community has been significantly associated with increased risk of several enteric and diarrhoeal diseases(Prasad, 2018); All of these factors were significantly associated with TF in this study and several other similar ones (Allen and Honest 2010, Abera *et al.* 2010, Wen *et al.* 2010, Ibegbulam-Njoku *et al.* 2014). The results of this study showed that 57% had no reliable water sources while 43% had reliable water sources. A study by (MOW,2018) had shown that access to safe water was a requirement for hand washing and other hygienic practices which were still insufficient in both rural and urban areas. Regarding residence of study participants, it had significant association with S.*typhi* infection where patients living in rural area had 1.5 times higher risk of having *S.typhi* compared to those who live in urban area. This might be due to lack of access to safe water and hygienic edification, lack of toilet and/or hand washing exercise after toilet, open defecation practices near to the springs and rivers, insufficient medical care, low socio-economic status, poor personal hygiene are possible reason (WHO. 2020)

The study finding revealed that majority (76.9%) of the respondents had knowledge about typhoid fever. Majority of the study population also, knew that typhoid fever is preventable disease. This study is agreed with the study of (Kumsa and Damtew.2019) in which about 63.8% of respondents had good knowledge related to typhoid fever. The difference might be due to the effort of health extension workers implementation in Ethiopia. However, it was noticed that, despite the participant's awareness on typhoid fever, most of them 59% did not know how an individual can be infected with typhoid fever. This suggests that, necessary healthcare

doctrine on the prevention of the disease is needed in the Health District. Knowledge of local TF burden, AMR profle of *S. Typhi* and *S. Paratyphi* together with identifying risk factors for infection acquisition are essential in developing proper strategies for typhoid and paratyphoid fever prevention and control (WHO, 2020)since there is considerable incidence variations in time and space (Adesegun,. *et al.* 2020). Drinking safe and healthy water is the right of every human being.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Most respondents were males aged between 16- 31 years and most of them were not married. Most of them attained only primary education and a few secondary educations, and the majority was unemployed but involved in peasant farming as a source of income. TF is an important public health concern in Gumer District and its environs. Age, sex, education, family size, lack of toilet and illiteracy were statistically significant predictors of TF

In this study, few respondents have safe latrines at home but most of them do not control flies densities from their latrines. Most of them also wash hands without soap or totally do not wash hands after visiting the latrine. Furthermore, most of the respondents do not or seldom wash their hands before preparing food and just eat fresh fruits after gathering without washing or pealing

A significant number of the respondents also eat food from hotels and restaurants, or food sold along roadside. a low number cover cooked food for use later. About half of the respondents do not have rubbish pits at home and drink untreated water from boreholes or rain water or water from swamps collected from sources at or less than 30 meters away from any nearby latrine.

There are therefore very significant high risks of eating contaminated food, getting into contact with fecal matter or drinking contaminated water and thus exposure to typhoid fever among the respondents.Water quality has a great contribution on the burden of typhoid fever among study participants. The identification of risk factors associated to the disease is of great importance in the development of rational control strategies of the disease. Moreover, ensuring access to safe water and delivering health education to drink treated water particularly for rural residents could reduce typhoid fever transmission.

Our findings show an increase risk of contracting typhoid fever in resident, sanitation and untreated water sources. The results from the study have a lot of significance to health experts. Firstly, it highlights improvement of sanitation and hygiene as the most effective way to prevent the spread of the disease especially in rural. Nonetheless, our findings also highlight the need for more sensitization of the public concerning the mechanism of transmission and effective control or preventive methods of the disease.

Typhoid fever is endemic in Gumer District. Hot weather and the frequent interruptions of electricity and water supply during the summer months have resulted in increased incidence. Increased health and disease awareness and improved attitude of residents do indeed reduce the prevalence of typhoid. In addition to improving sanitation facilities and protecting stored water and water sources from human feces, interventions in this residential setting should also include vegetation of exposed soil to reduce erosion and runoff, removing household gardens from toilet drainage areas and improving household storm water and wastewater drainage.

6.2 Recommendations of the study

- Scaling-up of toilet coverage, provision of safe drinking water supply and health education including proper documentation of cases is required.
- Residents should also be sensitized on the importance of having pit latrines at home for proper disposal of fecal matter.
- Residents should be sensitized on control of fly densities from their latrines, through covering of pit latrine holes, use of insecticides, or smoking of pit latrines to avoid flies contaminating food and water.
- Residents should also be sensitized on the importance of washing hands with soap and clean safe water after visiting the latrine and before preparing or eating food.
- They should also be sensitized on the importance of washing and pealing fruits before eating.
- Local health and law enforcement authorities should strengthen and enforce food preparation and safety in hotels, restaurants and roadsides a significant number eat food from restaurants or food sold along roadsides.
- Local law enforcement and health authorities should also enact and enforce laws requiring households in this area to have rubbish pits.
- Health campaigns should be carried out by all the stakeholders with a view of creating awareness to the residents of Gumer District on the importance of control and prevention of typhoid and seeking early treatment from health facilities.
- There is need to create projects and programmes that will help educate the residents on how to control and prevent typhoid fever effectively in the area.
- Lastly, but not least residents should be sensitized on how to treat water at home before drinking using cheap, simple and effective methods like filtration, boiling and using water treatment agents like aqua safe and water guard.

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Appendices

Appendix I Consent Form (English version)

Dear respondent, I am Lake Aynu a biology student of Hawassa university, carrying out a research on the topic " Prevalence and Factors Contributing to the Prevalence of Typhoid Fever among Patients Attending to Gumer District health centers". You have been chosen to participate in this research.

Purpose: To assess prevalence and its risk factors contributing to the prevalence of typhoid fever among patients attending to health center.

Benefits: It will provide information that will be important for improving health care services in this District and the country and provide information which will be a basis for other future studies.

Risks: Are limited if any, for example, some questions you may not expect or the way they may be asked, or they may make you feel bad, but in such a case, you are free not to answer them.

Confidentiality: This study will not require your personal identification and any information you give will be kept confidential. The information will only be accessible by the researcher and all records will be identified by codes and will be kept securely.

Voluntary consent: Your participation is entirely voluntary without any pay and you are free to opt out any time you wish. This study will not interfere with the ongoing services you are seeking.

Procedures: If you agree to participate in this study, it means you have consented and expected to sign this document. You will then be provided with a questionnaire to fill (or you will be assisted) and then it will be collected back.

Based on the laboratory investigation typhoid fever individual would be treated by low cost health insurance. You would be requested to give small amount of blood. Blood would be collected from your hand by using sterile 3-5cc needle. There will be some pain during pricking of your hand but not harmful to your health. If you are agree to give samples you will be requested to answer for questionnaire. Are you willing to participate with the study by giving blood sample and answer to the request?

A Yes B No

THANK YOU

Name of health institution_____ Patient name_____ signature_____ date_____ Name of data collector_____ signature_____ date_____

HAWASSA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES FACULTY OF BIOLOGICAL SCIENCE DEPARTMENT OF BIOLOGY

Appendix II: Questionnaire (English version)

I am Lake Aynu , a student of Hawassa University. I am carrying out a research on the topic: prevalence and factors contributing to the prevalence of typhoid fever among patients attending to health center in Gumer District. Your participation in the study will be highly appreciated and your responses shall be treated with utmost confidentiality. Respondents‟ number …….. Date ……/……/……..

English version of interview questions for typhoid fever patient

Section A: Demographic data (Tick correct option)

1. How old are you? A / 1-15 □ B/ 16-31 □ C / 32- 47 D), above 48years□

2. Sex: A) Male □ B) Female□

3. Occupation A/ Farmer □ B/ Civil servant □ C/ Merchant □ D/ Student □

4. Educational status A/ Illiterate□ B/ Red and writes□ C/ secondary school and below □ D/ grade 12 complete and above □

5. Where do you live? A/ Urban□ B/ Rural □

6. What is your marital status? A/ Married □ B/ Unmarried □

Section B: Sanitary and hygienic factors (Tick correct option)

7. Do you have a latrine at home? A),Yes □ B), No □

8 How do you control flies from your latrine? A) Cover the hole □ B) Use VIP-latrine □ C) Spray with insecticides □ D) Do not control flies □ E) others specify ……

9. Do you wash hands with soap before and after visiting the latrine? A) Yes□ B) No □ C) Wash, but without soap□

10. Where do you pour your rubbish? A) Rubbish pit □ B) Along the road □ C) Anywhere□

11. Is it important to wash hands before and after visiting toilet? A),Yes□ B), No □

12) If the answer in Q 12 above is yes, why is it important to wash hands? A),To feel good is a habit □ B), to control typhoid □

Section C: Food and personal hygienic factors (Tick correct option)

13. Do you eat uncooked green leafy vegetables? A/ Yes □ B/ No □

14. Where do you get your meals? A) Prepare and eat at home □ B) Eat from the restaurant □ C) Buy already cooked food along the road□ D) others specify ……...……

15. How often do you wash your hands before preparing your food? A) Always □ B) Sometimes □ C) Not at all □

16. How do you keep your cooked food for use in a later time? A) Well covered in saucepan B) In a refrigerator□ C) Leave food uncovered □ D) others specify ……..……

17. How do you prepare fresh fruits before you eat? A) Wash with clean water□ B) peal □ C) I just eat straight away□

18. Do you have eating-place in this area where food is sold? A), Yes □ B), No

19. Do/did you consume raw, unpasteurized milk and dairy products? A) Yes B) No

20. Do/did you consume raw, uncooked meat or eggs? A) Yes B) No

Section D: Water Related Factors (Tick correct option)

21. Do you get safe water source? A/ Yes □ B/ No □

22. What is the source of your drinking water? A), River □ B), Tapped Water □ C), roof □ D),Any other (Specify) ----------

23. What do you do to make water safe for drinking? A) Boil □ B) Drink without boiling□ C) Treat with tablets (aqua-safe, water guard, etc.) □ D) Others (specify)……

24. Where do you keep your water? A) Jerrycans □ B) Pots□ C) Others (specify)……

25. How often do you clean your water containers? ……..……

26. What is the distance of the nearest latrine from your water source? A) < 30 m □ B) about 30 m□ C) > 30 m□

27. Is there anything that this community is doing together towards clean water provision?

A),Yes □ B), No □

Section E: Awareness, control and prevention (Tick correct option)

28. Have you heard of typhoid fever A),Yes □ B), No □

29. Do you know typhoid fever prevention? A/ Yes □ B/ No □

30. Are you aware of typhoid fever transmission mechanism? A/ Yes □ B/ No □

31. Do you get medication when sick? A/ Yes □ B/ No □

32. Do you get health education? A/ Yes □ B/ No □

33 What are the signs and symptoms associated to typhoid fever? A. Diarrhea□ B. Fever □ C. Fatigue □ D. Headache □ Constipation □

The End, Thank You for Your Cooperation

Appendix 1II: Respondents consent form (Guragegna version)

ድበያ መግለጫ ኮንሰንት ፎርም

የትሸፐትሁ ትያ ጋሞ የቾትሁም ያገዘሁነድም ሰበና እያ ላቀው አይኑ ሀዋሳ ዩኒቨርሲቲ የስነ- ህይወት ተማሪ የኸተርሁ ታፎድ ባሸ ተራቆትም ድብሮትም መንሸ ቢኸሮ ዘንጋ በጉመር ወረዳ ባነቦ ጤና ጣቢያ ያነቦ ታካሚ የትኽታተሮት የባሸ ሁታ መንሸ የሃሮቱ

አላማ/ቡር ዘንጋ: ወሄ የኸረ የታየድፎይድ ተራቆትም ኧረሶትም ተራቆትም ብዘ ሰብ በዝ ባሸ የትጠበጦም የተድጠበጦትመር መንሸ የኸሮ ዘንጋ ታካሚ ህኖ በጉመር ባነቦ ጤና ጣቢያ ተኽታተሮት ይሀድረሸ

ጥቅመታ/ ፌደታ: ወሄ የኸረ ህክምና አቦትም ታፎድ ተራቆትም የሃሮትም የመጥሮትሙ

የጥናት ሁኔታ/ መርክ: ይመክክ ቃር ዌም ያንኺሪ ቃር በረፐረ ተሳሮት ይትቻል/ይትቾነቦም ጥያቂ ሰብ ጠይቁ/ቢትሰሪ የትገደበ ቃሩ/ይትሰሪ ሰብ ያህር ቃሩ

ሚስጥራዊነተታ: ያትቾነቡንኩ ጥያቂ ያሁ ሰብነት ሙራ በሙራ ያትየሸቃዌ?

ፈቃደኛ የህሮት ኮንሰንት: ያሁ እገገር ሙራ በሙራ በፈቃደኝነትም ቴትም ኤነት ብር ተካሶትም የኸረ ቃሩ

መመሪያ :የገዛ ገጋሁ ባብሁ በዝህ ጥናት ይትቾነብነሁ መጠይቅ የዘኘሮት የውል /ጉርዳ ስምምነተግ ያመሮቱ የዝክም ቅሪ የኸረ የህክምና እገገር □ምነት ይገወንኩቱ

የጤና ተቋም ሽም. ---------- የታካሚ ሽም---------- ፊርማ ----------

ከረ ----------

መረጃታ የስበሰ□ን ሰብ ሽም ---------- ፊርማ ---------- ከረ ----------

Appendix 1V: Questionnaire for respondents (Guragegna version)

\በሃዋሳ ዩኒቨርሲቲ የሳይንስ ፋካልቲ የስነ-ህይወት ትምህርቴ ክፍል ሙራ ገገህኖ ባቦ ሰብ የታይፎይድ ባሽ መንሸመታም የባሸመታ ምርጎት አቐፐሮም ይቦ ዘንጋ በትምለከተ ያወሪ ጥናት ያዝጋደዊ ጥናት (ዝህ ጥናት ያግዜ)ምደር ይሰሬዬ ይቦሜ ይትቐነብሎ የቃር ጥያቄ/ተሳሮትመልሰታ ይቦዊምየጥናት ሁታ ሙራ እገገፐ ይኸሮዊ ሙራ ገገሁና ይቦቴ.

ኦክ ኢብቴ ..... ቤታ ፈቃደኛ አንኸርሁ .....

የጤና ተቓም ሽም..... ፊርማ.....
ከረ.....

የጥናት ሁታ መልስ ያቦ ሰብ /ያገዞ ሰብ..... ፊረማ..... ከረ .....

ዘንጋ ሁት/መረጃታ የስበሰበ ሰብ ሽም ..... ፊርማ ..... ከረ .....

ክፍል/ ወኸት 1

የማህበረሰብ ሽረትም ደቡነት/እማትነት ያነኖ የማህበረሰበታ ዊም ሰበታ ያነኖ ጥያቄህኖ

1. ዘበራሁ ምራህሬው/ምራህሩ ? ሀ.1–15 ለ. 16– 31 ሐ. 32– 47 መ. በ48 በፎር
2. የርች ወርድነሁ? ዌሽ የገረድ ወርድ? ሀ. የርች ወርድ ለ. የገረድ ወርድ
3. ሜናሁ ምቃሩ/ታመረዊ ሜና ምቃሩ ? ሀ. ቸዋች/ገበሬ ለ የመንግስት ሜነነ ሐ. ነጋዴ መ. ተማሪ ሠ. እንጎድ ታመረዊ ሜና በረፐረ ድብሮ
4. ትምህርት ምራህሬ ዳር ተማርሁም? ሀ. አርብቦትም ጣፎትም አንኽርወ ለ. አርብቦትም ጣፎትም ይኸርኒ ሐ. 9– 10 መ. 12ኛ ተማርሁም ሠ. ተህም በፎር
5. ኤቴው ትረብሮ/ንብረታሁ ኤቴው ? ሀ. ገነ ለ. ጎረ
6. የቤታሁ የህሮት አንህሮት ዘንጋህ ? ሀ. የቤተና ኸርሁም ለ. የቤተና አንኸርሁ ሐ. የቤተና ኸርሁብ ባነ ገፈርሁም

ወኸት/ክፍል– 2 ንጥህናም ተንጥህናም የጣበጠ ጥያቄ በትምለከተ

7. በቤታሁ የስማት ቤት ነረዌ? ሀ. ኦክ ነረ ለ. ኤነ
8. ቡችር ቡችር ቆሻሻ በቤት ትቃሶዌ? ሀ. በምርየም መደር ለ. በቀርጫት ስበሰቢም ታነ ይሞክሪ ሐ. ጎጀ ኸነዊም ታነ በጎጀ ሠ. እንጎድ ቃር በረፐረ

9. ተስማት ቤት ይቸኖ ዝንብ መምር ትትክ ላከሎዮ? ሀ. ጎጀህኖ በሽፋፍሮት ለ. ጎጀህኖ በዝጎት ሐ. ኬሚካል በፈንቶት መ. አትቃር አንትጠቀምነ ሠ. እነጎድ ቃር በረፐረ

10.የስማት ቤት ወርኹም በቸነሁ አንቐ ወርሁም በቸነሁ ጋሞ አጃሁ በሳሙና ትታጠቦዌ? ሀ. ኦክ ንታጠብነ ለ. አንታጠብነ ሐ. እክም ብሀ ንታጠብነ

11.የስማት ቤት ቲያሪም ወርም በቸነዊ አነቐ ታጠቦት ጥቅም ነረንዌ? ሀ. ኦክ ነረን ለ. ጥቅም ኤነን

የጥያቄ 14 መልሰታ ኦክ ነረን በኽረ ምር ጥቅም ነረን ? ሀ. ወኼ ስሜት ይትሰማ ኽማ ያሜ ስሜት ይትሰማ ለ. ታይፎይድ ይውሪ ባሸ ይትክላከል ሐ. እንጎድም ቃር በረፐረ

12.ወኼ የኽረ የስማት ቤት ትረህቦ? ሀ. ኦክ ንረህብነ ለ. ቤታ አነህብነ

ባነኹከ ቀያ የንጥህና ቀሮት ቃር ምር አስተያየት / ትብረዊ ቃር በረፐረናኹ?

ወኽት/ክፍል– 3

የሸረትም የገግም ንጥህናኤረብር ኽማ ያመሮ የሰበታ ችግር

13.ያናፎሌ ኤብ ትሰጭዌ? ሀ. ኦክ ለ.አንሰጭ

14.እነቁራ ዌም በሰር ቴቸኩሪ ዌም ቴበስር ትበራዌ? ሀ ኦክ ለ. ቤታ አንበራ

15.ቴቴ የቸነ ሸረት ትበሮ? ሀ. በቤት የኾቺ ሸረት ለ.ተሸረት ቤት በሰሮት ሐ.በውቴል ቤት መ.በገበያ/ቤማ በሰሮት ሠ. እንጎድ ቃር ቴቴ የቸነ ሸረት ትበሮ

16.ሸረት ትትኾቶ መምራህር ግዝየ ኧጃሁ ትታጠቦ? ሀ. እንም ግዝየ ለ. አታት ግዝየ ሐ.አቸም አንታጠብነ

17.ሸረት በሸኮቺ አንቐ ጌፍ ግዝየ ስን ቴወሬ በቾና በምር ያወረዊ? ሀ. ገክሮት ቤፎት ለ. በፍሪጅ ደን ባውሮት ሐ. እክም ሙርጫመታ በታቦት ሠ.እነጎድህ በምር ያወሬ

18.ቡስር/ ፍራፍሬ ተብሮታሁ ይፍቴ በምር ታትቐንበዊ? ሀ. በንጡህ እሀ በጥቦት ለ. ሐራታ በምርጦት ሐ.እክም አትቃር ታናቤ ሠ.እነጎድ ቃር በምር ትበረዊ?

19.በገብያ የገፆ/የስራውዮ ሸረት ትበሮ? ሀ. ኦክ ለ. ቤታ አንበራ

20.ወኼ ሸረት የንቃር ትበሮ ? ሀ. ኑንድ የኽሬ ለ.የታይፎይድ ባሸ በስረፎት ሐ. የታይፎይድ ባሸ የትክላከሎት መ. እንጎድ ቃር በረፐረ ወድብር ይትቻል

ወኽት/ክፍል– 4

ትሐ ግዝየ እማትነት /ደቡነት ያነኖ ጥያቄ

24.ወኼ ይሰጪ እሓ ትረህቦዌ ? ሀ. ኦክ ንረህብነ ለ. ቤታ አነህብነ

25. ይሰጪ እሓ ቴቴ ያቸኒ? ሀ. ቶንዝ ይጎጄ ለ. ተምነጭ ሐ. ተባንባ መ የዝራብ እሓ ሠ. ብንጎዬ ቴቴ ይረህዊ

26. እሃ በምር አከሚምታ ትሰጦ? አትም ኤነት እክምና አንትጠቀምነ ለ. ባንሰርስሮት ሐ. ባጥርሮት ሠ. ተዘህኖ ውጤ በምር አበነዊምታነ እሃ ያሞጥሪ?

27. ይሰጪ እሓ ወኔ ቃር /የትመቾ ቃር ያምሮት ምቃር ታበረዊ ? ሀ. አንሰርስሮት ለ.እክም ይሰጪ ሐ. ይሃ አጋር በትጠቀሞት መ. እንጎድ ያበረዊ ቃር በረፐረ

28. እሃ በንቃር ታወሮ ? ሀ፣ በጀሪካን ለ. በትንክየ/ወሸር ሐ. እንጎድ በንምቃር ታወሮ

30. ትሰጠው እሃ ታወሮከ መደርም የስማት ቤታሁ ምርአህሬ ይትረረቆ? ሀ. ተ30 ሜትር ያርስ መደር ለ. 30 ሜትር ያህር ቃር ሐ. ተ30 ሜትር ይርቅም መደር

31. በቂያሁ ያነ እሃ ቤትብላሼ እማቱ ኸርሁም ትቅረቦዊ? ሀ. ኦክ ንቅየኔ ለ. ቤታ አንቅኔ

ወኸት/ክፍል– 5

ታይፎይድ ቤትስፋፌ/ቤትዝራኬ አወተራቸ የማህበረሰብ ያውይ ትምህርት ታይፎድ ትትክላከሎት ጋ□ የትጣበጠ ጥያቄ

32. የታይፎይድ ቃር ቲትጫወጂ ሰማሁም ትኺሮዊ? ሀ. ኦክ ለ. ቤታ

33. የታይፎይድ ባሸ መምር ወትክላከል ያነብሁ ኸማ ትኽሮ? ሀ. ኦክ ኧኽር ለ. ቤታ አንኽር

መልሳሁ ኦክ በኸረ የትክላከሎት ምቃር ታበሮ? ሀ. ምሳረ በትገተሮት ለ. በዝራብ ውጦት አንትፈቀሮት ሐ. አንፋተና ባናውጦት መ. የገግመና ይሃም ንጥህና በቀሮት ሠ እንጎድ በንቃር ትትክላከሎ

34. ታይፎይድ ቲጠብጥሁ እክምና ትረህቦዊ ? ሀ. ኦክ ኧረህብ ለ. ቤታ አነህብ

35. ና//ፍያ ቀሮት ትምህርት ትረህቦዊ ? ሀ. ኦክ ኧረህብ ለ. ቤታ አነህብ

36. የታይፎድ ባሸ መርኸተታ ምቃር ምቃርሎ ? ሀ. አትም ኤነት መር ኸት ኤነን ለ. ተጭቃጨቆት፡የጎመጀ ቾጭነር ፡ ሐ. ገግ መክሮት፡እነመቆቸ፡ፍርጠት መ. እነጎድህ ቃር ምር ነረ

የታይፎድ ባሸ የትክላከሎት ማህበረሰበታ ሚቃር ምቃ ይቾት?

37. የታይፎድ ባሸ ይትኩላኮልኩ ኤማታ ጀፕረኸ ትኽርዊ? ሀ. ኦክ ኧኽር ለ. ቤታ አንኽር