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EDITORIAL

ORIGINAL ARTICLES

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Address All Correspondence
Ethiopian Journal of Translation Sciences, Amhara Public Health Institute
P.o. Box: 477
E-mail: ejts@aphi.org.et
Telephone: +251 583209654
Bahir Dar
Ethiopia

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EDITORIAL

Health under Siege: The Far-Reaching Impact of Conflict on Health Services

Adane Nigusie[1*], Seid Legesse[1], Gizew Desie[1], Belay Bezabih[1], Taye Zeru[1], Mezgebu Yitayal[1&2]

[1]Health Research Development Directorate, Amhara Public Health Institute, Bahir Dar, Ethiopia
[2]Department of Health Systems and Policy, Institute of Public Health, University of Gondar, Gondar, Ethiopia
[*]Corresponding Author: Adane Nigusie: C-phone: +251913673758; Email: adane2009ec@gmail.com; P.o.box: 477,

In recent years, the Amhara region has faced unprecedented challenges in its healthcare delivery system. This special issue of the Ethiopian Journal of Translational Science focuses on the impact of conflict on healthcare. Health during a siege presents severe challenges and humanitarian crises, as prolonged blockades or military encirclements restrict civilians' access to essential healthcare services, medicines, and facilities. This exacerbates existing health vulnerabilities, particularly among women, children, the elderly, and those with chronic illnesses who struggle to obtain necessary health care services. The lack of adequate food, water, and sanitation further worsens health issues, leading to malnutrition, dehydration, and increased susceptibility to infectious diseases like cholera and respiratory infections. The psychological toll is also significant, with civilians experiencing fear, anxiety, and trauma due to the ongoing threat and uncertainty[1-3].

Addressing health needs during a siege necessitates urgent humanitarian response efforts to provide medical supplies, food, and essential aid. International organizations and humanitarian agencies are crucial in mitigating health crises, supporting communities, and safeguarding public health under these dire circumstances[4]. The conflict in the Amhara region has resulted in the displacement and illness of many children, with a significant number not receiving treatment, experiencing various forms of violence, and suffering from severe acute malnutrition. Additionally, there has been a high incidence of gender-based violence[5]. The articles in this issue highlight critical areas such as the consequences of war on the TB program and violence against healthcare during the war. For example, Melashu et al., 2024 analyze the impact of war on the tuberculosis program in war-affected zones of the Amhara region, noting that TB case detection and treatment outcomes were severely disrupted due to looted medicines, displacement of TB patients and healthcare providers, and the destruction of healthcare infrastructure. Similarly, Molalign et al., 2024 emphasize the significant damage to health services and the disruptions caused in the Amhara region's war-affected zones.

In summary, addressing these complex issues requires collaboration and innovation among researchers, policymakers, and practitioners. We hope this issue inspires further research and action to improve health outcomes in conflict-related settings. The findings highlight the urgent need for humanitarian response efforts to mitigate health crises in conflict-affected areas, underscoring the essential role of international organizations and humanitarian agencies in providing medical supplies, food, and essential aid to protect public health and support communities in the Amhara region.

Figure 1 Illustrate the multifaceted impact of conflict on health services, highlighting both the challenges and the urgent need for humanitarian intervention.

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ORIGINAL ARTICLES

War and its implications for the tuberculosis program in the Amhara Region

Melashu Balew[1*], Mastewal Worku[1], Belay Bezabih[1], Getu Degu[2], Mezgebu Yitayal[1,3], Asrat Agalu[2], Betelihem Belete[1], Daniel Mekonnen[2], Desalegne Amare [2], Desalew Salew [1], Girum Meseret Ayenew[1], Kassawmar Angaw[2], Melkamu Mitiku[1], Molalign Tarekegn[1], Taye Zeru[1], and Gizachew Yismaw[1]

[1]Amhara Public Health Institute, Bahir Dar, Ethiopia
[2]School of Public Health, College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar Ethiopia
[3]Department of Health Systems and Policy, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
[*]Corresponding Author: Melashu Balew, Email: bmelashu@gmail.com Bahir Dar, Ethiopia,

ABSTRACT:

Background: *War is one of the most significant factors exacerbating tuberculosis (TB) epidemics, increasing both morbidity and mortality rates. Direct attacks on healthcare facilities and medics, displacement of millions of people, and challenges with access to and delivery of medicines disrupt patients' treatment. This study aimed to assess war and its implications for the TB control program in the Amhara region.*

Methods: *Retrospective data archived in the regional Health Management Information System (HMIS) database were extracted to understand the regional TB program in the prewar period and forecast the impact of war on the TB control program. Four years of secondary archived data (July 2019 to December 2022) were used to forecast TB incidence and treatment outcomes in war-affected zones in 2022. To validate the model, the results were compared with actual observed TB incidence data. Line graphs and bar charts were used to compare the incidence of TB across age and sex categories.*

Results: *The TB incidence rate in North Wollo, Waghimira, and North Gondar (war-affected zones) was 198.7, 169.7, and 142 per 100,000, respectively. Among females, the proportion of extrapulmonary TB (EPTB), clinically confirmed TB cases, and pulmonary TB cases were 49.3%, 26.6%, and 24.0%, respectively. In the region, 204 drug-resistant TB cases were notified. TB patients, including those with multidrug-resistant TB (MDR-TB), were left without care and were forced to flee to internally displaced persons (IDP) centers. Of the 116 drug-susceptible TB patients identified during the war, 85 (73.3%) were from IDP sites. According to the six months HMIS report, Zones had zero TB case notification. The TB control program was interrupted for nine months in war-affected zones and severely attenuated in other zones.*

Conclusion: *The incidence of TB in war-affected areas was high. Severe types of TB and under-diagnosed cases were more prevalent, which could lead to high TB transmission, reactivation, and drug resistance development in both war-affected and non-affected zones. Therefore, strengthening active and passive case finding, restoring diagnostic capacity, providing Bacillus Calmette-Guérin (BCG) vaccination, conducting rigorous TB screening and surveillance, and managing TB, including severe forms such as MDR-TB and Extensively drug-resistant tuberculosis (XDR-TB), are crucial measures to enhance the regional TB control program.*

Keywords: *War, TB, implication, Amhara.*

አጎጽሮተ ጥናት

የጥናቱ ዳራ፡- *የቲቢ በሽታ ወረርሸኝን ከሚያባብሱ በጣም አሳሳቢ መንስኤዎች አንዱ ጦርነት ነው። ጦርነት በቲቢ ምክየት የሚመጣ የበሽታ መከሰትና ሞት መጠንን በእጅጉ ያባብሳል። በጤና ተቋማትና ሠራተኞች ላይ በሚደርስ ቀጥተኛ ጥቃት እንዲሁም የሚሊዮኖች መፈናቀልና በመድኃኒት አቅርቦትና ተደራሽነት ላይ በሚፈጠሩ ችግሮች የታማሚዎች ህክምና ይስተጓጐላል። ይህ ጥናት ዓላማ አድርጎ የተነሳው ጦርነቱ በአማራ ክልል የቲቢ በሽታ ቁጥጥር መርሐግብር ላይ ያደረሰውን ተፅዕኖ መመርመርና በክልሉ ያሉ ችግሮችን ለመቅረፍ ሳይንሳዊ ይሁንታዎችን መጠቆም ነው።*

የጥናቱ ዘዴ፡- *በቅድመ ጦርነት ወቅት የነበረውን የአማራ ክልል የቲቢ በሽታ ቁጥጥር መርሐግብር ለመገንዘብና ጦርነቱ በቲቢ በሽታ ቁጥጥር መርሐግብር ላይ ያሳደረውን ተፅዕኖ ለመተንበይ ከክልሉ የጤና አስተዳደር መረጃ ሥርዓት (HMIS) የመረጃ ቋት ውስጥ የኋላ ታሪክ መረጃ ተወስዷል። በዚህም እ.አ.አ. በ2022 በጦርነት የተጐዱ ዞኖች ውስጥ የቲቢ በሽታ መከሰትና የተሰጡ ህክምናዎችን ውጤቶች ለመተበንይ የአራት ዓመታት (ከሐምሌ 2012 አስከ ታኅሳስ 2014 ዓ.ም) ዳኅራይ የሰነድ መረጃዎች ጥቅም ላይ ውለዋል። ሞዴሉን ለማረጋገጥ ደግሞ የሞዴሊንግ ውጤቱ ከታየው ትክክለኛ የቲቢ በሽታ ክስተት መረጃ ጋር በንጽጽር ቀርቧል። በተጨማም የቲቢ በሽታ ክስተት በጾታና በእድሜ ምድቦች ላይ ያለውን ሰርጭት ለማነጻጸር የመስመር ግራፎችና የባር ቻርቶች ጥቅም ላይ ውለዋል።*

የጥናቱ ውጤት፡- *በጦርነቱ በተጐዱ ሰሜን ወሎ፣ ዋግ ኽምራና ሰሜን ጎንደር ዞኖች የቲቢ በሽታ መከሰት መጠን ከ100000 ሰዎች መካከል በቅደም ተከተል 198.7፣ 169.7 እና 142 ነው። ከሳንባ ውጭ ያሉ አካላትን የሚያጠቃ ቲቢ በሽታ መከሰቶች፣ በህክምና የተረጋገጡ የቲቢ በሽታ መከሰቶች፣ እና ሳንባን የሚያጠቃ የቲቢ በሽታ መከሰቶች በሴቶች መካከል*

ያላቸው ስርጭት በቅደም ተከተል 49.3 በመቶ፣ 26.6 በመቶ እና 24 በመቶ ነበር። በክልሉ ውስጥ 204 መድኀኒት የተላመደ የቲቢ በሽታ ተጠቂዎች ተመዝግበዋል። ብዙ መድኀኒቶችን የተላመደ የቲቢ በሽታ ታማሚዎችን ጨምሮ እነዚያ በሽተኞች ያለምንም ክትትልና ጥንቃቄ ተትተዋል፣ የሀገር ውስጥ ተፈናቃዮች ወደ ሚገኙባቸው መጠለያ ጣቢያዎች እንዲሸሹ ተገድደዋል። በጦርነቱ ወቅት ከተለዩ 116 ለመድኀኒት መላመድ ተጋላጭ የሆኑ የቲቢ በሽታ ታማሚዎች ውስጥ 85 (73.3 በመቶ) ታማሚዎች ከሀገር ውስጥ ተፈናቃዮች መጠለያ ጣቢያዎች የተለዩ ናቸው። በስድስት ወሩ የጤና አስተዳደር መረጃ ሥርዓት ዘገባ መሠረት በህወሓት ከተወረሩ ዞኖች ውስጥ ምንም የቲቢ በሽታ መከሰቶች አልተገለጸምም። የቲቢ በሽታ ቁጥጥር መርሐግብር በጦርነት በተጎዱ አካባቢዎች ለ9 ወራት ተቋርጦ የነበረ ሲሆን በሌሎች አካባቢዎች ደግሞ እጅግ በጣም ተዳክሞ ነበር።

የጥናቱ ማጠቃለያ፦ በየጦርነቱ በተጎዱ አካባቢዎች የቲቢ በሽታ መከሰቱ ከፍተኛ ነበር። ለከፍተኛ የቲቢ ስርጭት፣ ማገርሸትና የመድኀኒት መላመድ እድገቶች የሚዳርጉ ከባድ የቲቢ በሽታ ዓይነቶችና ያልተመረመሩ ህመሞች በጦርነቱ በተጐዱም ሆነ ባልተጐዱም በሁለቱም አካባቢዎች በጣም ተስፋፍተው ነበር። ስለዚህ አዲስ ህመምተኞችና ታመው የነበሩን መለየት ማጠናከር፣ መልሶግንባታ፣ የቲቢ ክባት ማቅረብ፣ ጠንካራ የቲቢ ታማሚዎች ልየታና ቅኝት፣ እና ብዙ መድኀኒት የተላመደ ቲቢን (MDR-TB)ና ሁለተኛ ደረጃ ላይ ያሉ መድኀኒቶችን የተላመደ ቲቢ (XDR-TB) ጨምሮ ከባድ የቲቢ በሽታ ዓይነቶችን ማስተዳደር ክልላዊ የቲቢ በሽታ ቁጥጥር መርሐግብርን ለማሳደግ ሊተገበሩ የሚገባቸው ርምጃዎች ናቸው።

ቁልፍ ቃላት፦ ጦርነት፣ ቲቢ፣ መከሰት፣ የህክምና ውጤት፣ አማራ

BACKGROUND

War and armed conflicts have both direct and indirect effects on public health. They deteriorate the health of the population by causing the breakdown of the healthcare system, creating shortages of medical supplies, and leading to the relocation of healthcare personnel. Additionally, conflicts disrupt food and clean water sources[1]. Tuberculosis remains a major cause of morbidity and mortality. According to the World Health Organization (WHO) 2020 report, the global TB incidence was 127 per 100,000, and TB-HIV mortality was 214,000 [2]. TB is one of the world's main health challenges, with 10 million new cases and nearly 1.5 million deaths each year [3]. Due to the COVID-19 pandemic, there was a sharp decrease in TB detection by 18%, from 7.1 million cases in 2019 to 5.8 million cases in 2020. In the 2020 COVID-19 era, TB ranked as the 13th leading cause of death and the second leading infectious killer after COVID-19 [2].

In Ethiopia, one of the 30 high TB burden countries, the incidence of TB was 132/100000. Specifically, TB/HIV co-infection rate reached to plateau of 26.7% in Amhara National Regional State (ANRS) [4]. The treatment success rates for first and second-line TB treatment were 90% and 70%, respectively[2]. The sudden attack by the Tigraian invading force, known as Mebrekawi Tikat, on the Ethiopian national army stationed in Tigray, precipitated a new war that forced the displacement of the Amhara people. As a result, health facilities were purposefully destroyed. These conditions significantly increase the risk of infectious diseases such as tuberculosis among people living in war-affected areas and those displaced from their villages [5].

TB is one of the most frequent and most dangerous diseases that is further complicated by war. It was a major health disaster during World War II. As has been seen, the longer and more widespread a war, the greater the increase in tuberculosis cases [6,7]. In war zones, the treatment of TB patients is disrupted by direct attacks on healthcare facilities and medical personnel, as well as by the displacement of millions of people and challenges in accessing and delivering medicines [8].

During emergencies such as conflict-related humanitarian crises and migration crises, delivering public health services to meet the healthcare needs of affected populations becomes extremely challenging. While relocation to camps or other temporary settlements is a common solution after displacement, it can exacerbate vulnerability to TB due to overcrowding, malnutrition, disruption of regular healthcare services, poor health-seeking behavior, and inadequate adherence to TB treatment medications [9].

During emergencies, the collapse of health systems reduces access to TB awareness, prevention, and continuous care at origin points, during transit, at destinations, and upon return across borders. Addressing critical concerns includes limited TB case identification, inadequate TB services, drug supply interruptions, irregular drug intake, increased treatment defaults, low cure rates, higher rates of patient relapse, and the rise of Multidrug-resistant (MDR) TB, among other challenges [10,11].

Before the war, the treatment success rates for first- and second-line TB treatment were 90% and 70%, respectively, in the Amhara region. However, the region has been severely affected by the war for over a year, with eight zones invaded and people displaced from their homes by the TIF. In this war zone, the healthcare system collapsed, leaving TB patients without access to anti-TB drugs. As a result, these patients not only had to interrupt their medication but also became potential sources of TB infection to others, contributing to the rapid spread of TB, including drug-resistant strains. This situation poses a critical public health problem. However, the impact of the war on tuberculosis in the Amhara region has not

been documented, and evidence is limited. Thus, this study aims to determine the effect of the war on TB in affected areas and the overall burden in the region.

METHODS

Study settings

The study was conducted in the Amhara National Regional State (ANRS) with a special emphasis on war-affected areas. ANRS is one of the eleven regional states in Ethiopia. The regional state comprises 22 zones and 216 woredas. ANRS is the second most populous region in Ethiopia. Based on 2022 projections, the population of ANRS is 22,286,999, with 11,400,762 males and 11,476,236 females. ANRS covers a land area of 154,709 km² and is located at the geographic coordinates 11.3494° N, 37.9785° E.

The region has 110 hospitals (100 Public and 10 private). Among the public hospitals, [8] are comprehensive specialized hospitals, 13 are general hospitals, and 65 are primary hospitals. Additionally, there are 874 public health centers, 3,561 health posts, and over 1,300 other private health facilities. However, 5 (31%) zonal health departments, 52 (24%) district health offices, 40 (41%) public hospitals, 453 (49.4%) health centers, and 1,850 (49.7%) health posts were destroyed to varying extents by the TIF. This destruction severely impacted service provision as well as the TB detection and control system.

Study design and period

A cross-sectional study design was employed to determine the effect of war on TB in war-affected areas. The study was conducted from March 1-31, 2022, using secondary data archived from July 2019 to December 2021 for projection, and primary data collected from December 24, 2021, to January 14, 2022, from war-affected health facilities for comparison with actual TB incidence cases.

Study population

All TB-screened patients in the war-affected areas of the Amhara region

Inclusion and exclusion criteria

All screened patients in the war-affected areas of the Amhara region were included in this study. However, patients with incomplete secondary data records were excluded.

Sample size and sampling technique

Eight war affected zones (North Wollo, South Wollo, North Shewa, Dessie City Administration, South Gondar, Waghimra, North Gondar and Oromo special zones) and one hundred thirteen accessible health facilities in the war-affected zones were recruited by purposive sampling.

Data collection and measurement

Both primary and secondary data were collected from recruited zones and health facilities. All TB cases registered in Health Management Information System/District Health Information Software 2 (HMIS/DHS2) and LIS, including rifampicin resistance (RR)/MDR-TB and treatment outcomes, were described in the study. The national and regional TB programs are supported by various laboratory techniques, including solid and liquid culture, line probe assays, Expert MTB/RIF assays, fluorescence microscopy, and Ziehl-Neelsen (ZN) microscopy. TB patients were classified as bacteriologically confirmed Pulmonary TB (PTB+), clinically diagnosed PTB (PTB-), and extrapulmonary TB (EPTB). A bacteriologically confirmed PTB case refers to a patient from whom at least one biological specimen is positive for MTB by smear microscopy, Xpert MTB/RIF, or culture. A clinically diagnosed TB case refers to a patient who does not meet the criteria for a bacteriologically confirmed case but has been diagnosed with active TB by an experienced clinician and has been determined to require a full course of TB treatment 12. EPTB refers to any bacteriologically confirmed or clinically diagnosed case of TB involving organs other than the lungs. Diagnosis should be based on at least one specimen with confirmed MTB or histological or strong clinical evidence consistent with active EPTB, followed by a decision by a clinician to treat with a full course of TB chemotherapy. Patients with rifampicin resistance defined as RR-TB cases [12]. The study included a rapid assessment during the pre- and post-war periods to evaluate the trends of TB and its types over time. Additionally, the total TB data were analyzed by disaggregating them according to age and gender.

Data quality management and assurance

The HMIS system is currently well-integrated and utilized health information reporting and archiving system in Ethiopia. The HMIS system is a well-integrated and widely utilized health information reporting and archiving system in Ethiopia. Data quality assurance is conducted at both the facility and woreda (district) levels. Lot quality assurance sampling (LQAS) methods are employed on a monthly basis at the facility level and quarterly at the woreda level to ensure high standards of data quality 12. Moreover, the quality of TB data in the Directly Observed Therapy Shortcourse (DOTS) program is maintained through continuous training and supportive supervision. Taken together, several lines

of measures were in place to maintain data quality and avoid systematic bias.

Data management

All TB cases were retrieved from HMIS/DHIS2 and LIS databases and included in the analysis. Additionally, a rapid assessment was conducted at 113 health facilities to evaluate their status before and after the war.

Authors had full access to the HMIS database. After transferring the required data from the database to the new Excel sheet, data owners cleaned and formatted the imported dataset. This included converting numbers stored as text into numbers, removing duplicate, spacing, merging lines and deleting unnecessary variables. The study included zonal level data archived in a single HMIS database classified with reporting period. Separate Excel datasets from four years were merged using the consolidate data wizard.

Data analysis

The data were analyzed using Excel spreadsheets. Descriptive statistics were employed to characterize based types of data. Trend analysis and forecasting of tuberculosis were conducted using linear and poly models. Additionally, choropleth mapping was utilized to visualize the TB burden across zones using ArcGIS 3.4. Spatial data for the maps were sourced from the Map Library, a public domain accessible at www.maplibrary.org. Finally, the data were presented using proportions, line graphs, and bar graphs.

RESULTS

Tuberculosis incidence and diagnostic capacity

In war affected areas, 111,056 TB cases were notified from July 2011 to 2014 E.C. The cases were detected by microscopically, GenXpert, culture and clinically. There was a total of 141569 TB cases in 3 years period from which 50444 cases were in 2011 E.C, 47354 cases were in 2012 E.C, and 43771 TB cases were in 2013 E.C. Those cases notified in 2013 E.C were from West Gojjam (4594 cases), South Wollo (4530 cases) and Central Gondar (4202 cases).

According to the annual TB reports submitted to HMIS/DHIS2 and LIS, a total of 111,056 TB cases were notified from July 2019 to 2022. These cases were detected using microscopy, GenXpert, culture, and clinical methods. Over a three-year period, there were a total of 141,569 TB cases, with 50,444 cases reported in 2019., 47,354 cases in 2020., and 43,771 cases in 2021. Specifically, in 2021, significant numbers of cases were reported from West Gojjam (4,594 cases), South Wollo (4,530 cases), and Central Gondar (4,202 cases) (Table 1).

Table 1 Tuberculosis incidence and types of TB, Amhara region, 2021

Zones	Pulmonary positive TB	Pulmonary Negative TB	EPTB	Relapse	Total	Incidence/100,000 pop.
Awi	490	706	1330	42	2568	194.1
Bahir Dar City	175	237	532	27	971	249.5
Central Gondar	1172	1050	1846	134	4202	184.4
Dessie City	76	128	203	15	422	154.4
East Gojjam	1096	942	1934	66	4038	147.3
Gondar City	190	187	287	46	710	164.3
North Gondar	396	268	550	66	1280	142.1
North Shewa	1082	1070	735	178	3065	131.3
North Wollo	740	772	1434	90	3036	169.7
Oromo Special	362	348	444	66	1220	206.2
South Gondar	674	1084	2088	108	3954	151.1
South Wollo	1168	1172	2082	108	4530	146.3
Waghimera	152	454	462	50	1118	198.7
West Gojjam	814	1028	2620	132	4594	166.5
West Gondar	486	314	746	58	1604	357.4

In 2021, West Gondar, Bahir Dar, and Oromia Special Zones reported TB incidence rates of 357.4, 249, and 206.2 cases per 100,000 population, respectively. Before the Tigray invading force (TIF) disrupted health services and destroyed health facilities in North Wollo, Waghimira, and North Gondar, the TB incidence rates were 198.7, 169.7, and 142 per 100,000 population, respectively (Table 1).

Over the past 7 years, Rifampin Resistant (RR) TB was detected in 1,178 cases (5.04%) out of 321,568 clients tested using GenXpert. The utilization of Xpert was reported in 4 years, with the highest utilization

rate observed in 2010 (88.6%) and the lowest in 2020.
(45%) (Table 2).

Table 2 Tuberculosis and rifampicin resistance detection, Amhara region, 2015-2022

Indicators	Year							
	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)	2020 N (%)	2021 N (%)	2022 N (%)
Number of Xpert sites	14	18	23	24	55	55	53	50
Number of Xpert tests	7208	16018	25579	56246	61864	55769	66382	32502
Number of MTB+ identified	1022 (14.2)	1690 (10.6)	1952 (7.6)	3777 (6.7)	4037 (6.5)	3740 (6.7)	4859 (7.3)	2282 (7.0)
Number of RR+ identified	118 (11.5)	133 (7.9)	127 (6.5)	154 (4.1)	192(7.8)	184 (4.9)	198 (4.1)	72(3.2)
Number of Indeterminate results,	46 (0.6)	65 (0.4)	30 (0.1)	46 (0.1)	61 (0.1)	55 (0.1)	126 (0.2)	61 (0.2)
Number of unsuccessful tests	747 (10.4)	1195 (7.5)	1950 (7.6)	4024 (7.2)	3379 (5.5)	3540 (6.4)	4257 (6.6)	2328 (7.2)
- With Error	234 (31.3)	618 (51.7)	757 (38.8)	2188 (54.4)	1731 (51.2)	1933 (54.6)	2578 (60. 6)	1168 (50.2)
- With Invalid	334 (44.7)	473 (39.6)	766 (39.3)	1003 (24.9)	238 (7.0)	208 (5.9)	203(4.8)	76 (3.3)
- With No result	179 (24.0)	104 (8.7)	427 (21. 9)	833 (20.7)	1380 (40.8)	1399 (39.5)	1476 (37.7)	1054 (45.3)
Utilization rate (%)	No data	No data	67.6	88.6	No data	45	54.52	49.42

Distribution of TB types by sex and age

The severe form of TB disproportionately affects women and children in the region. Among females, the proportion of EPTB cases was 49.32%, followed by clinically confirmed TB cases (Pulmonary negative) at 26.64% and bacteriologically confirmed TB cases (P_POS) at 24.04%. Similarly, among males, the proportion of EPTB cases was 43.72%, with pulmonary negative and Pulmonary positive cases at 29.34% and 26.93%, respectively. Across all zones, there is an increasing trend in TB cases among males for all types of TB. Regionally, males were affected more than females by 0.6%, 2.0%, and 4.2% for pulmonary positive, pulmonary negative and extrapulmonary tuberculosis, respectively. The relapse rate was also 4.2% higher in males compared to females in the region. The distribution of TB types varies across age groups and by gender (Figure 1 and Figure 2).

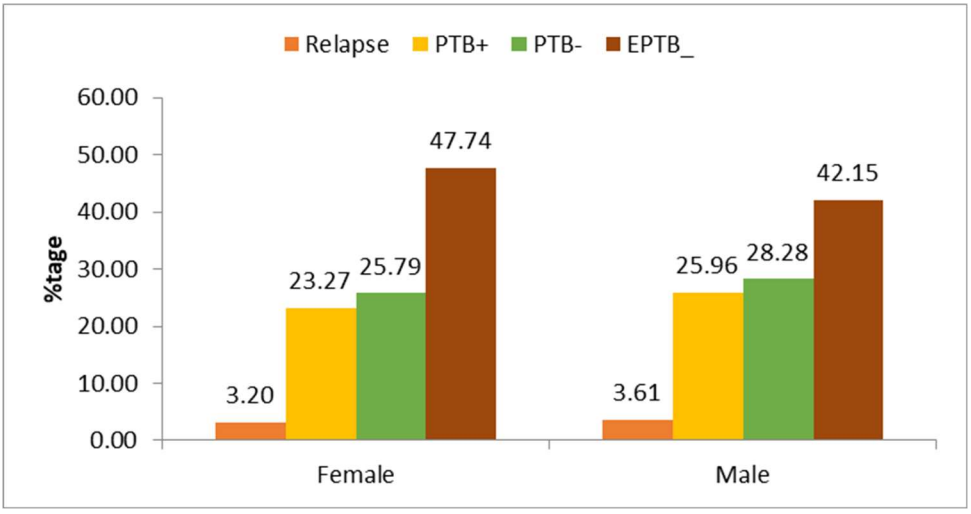

Figure 1 Distribution of Type of TB by Sex

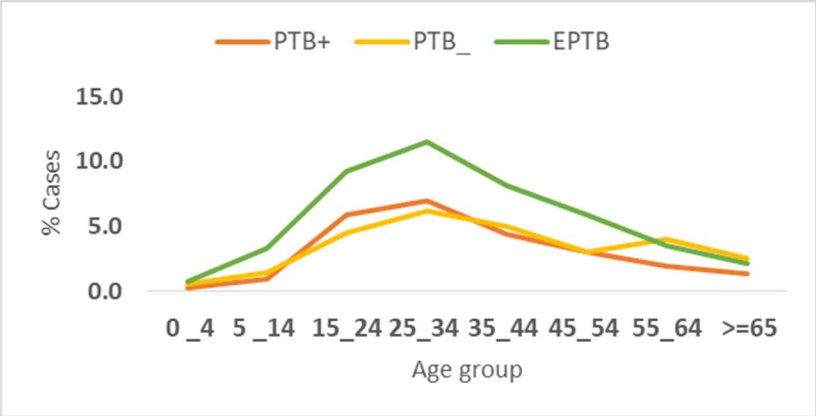

Figure 2 Distribution of types of TB by age group

Tuberculosis in the pre-war and post-war

In the prewar period, 204 drug resistant TB cases were notified in the region. However, reports on TB case detection and treatment outcomes were missed in war conflict areas because of the TB care service was completely disrupted, medicines including anti-TB drugs were looted, the population including TB patients and healthcare providers who had worked in TB clinic were displaced. In this humanitarian challenging situation, not only unable to screen new incidence cases, but also TB patients who were on anti-TB treatment were forced to interrupt their medication. Moreover, due to this protracted conflict, millions including new cases and interrupters aggregated in different internal displacement (IDP) centers.

It was anticipated that TB patients in TIF-occupied zones, who were displaced to other areas, would seek and be connected to alternative TB care sites. Additionally, an increase in TB incidence was expected in IDP areas due to displacement and new notifications. However, upon comparing the half-year TB reports from non-invaded areas, TB case notifications remained unchanged, and in some zones, there was even a decrease in notifications (Figure 3).

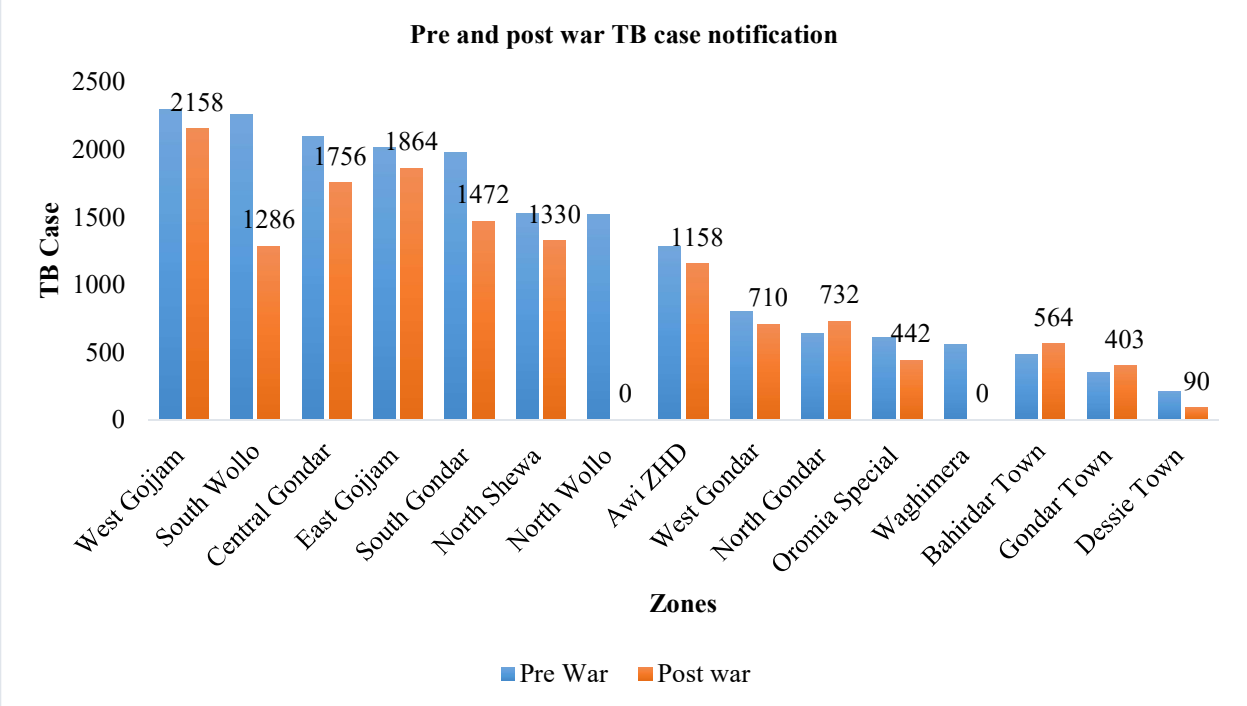

Figure 3 Pre and post war half year TB case notification in ANRS

In war-affected zones, TB notifications were either absent or decreased by half. This indicates that the impact of the war extended beyond zones directly affected by TIF, severely affecting the TB programs in other zones of the Amhara region. Additionally, 4,806 TB patients were unable to access their treatment, among whom four cases were diagnosed with multidrug-resistant TB and defaulted on their treatment, posing a significant safety risk to the community.

TB transmission modelling

Based on the 2021 annual TB report, the incidence of TB in the post-war period was estimated for the war-affected zones. Initially, the projection indicated a slight increase in TB cases under normal circumstances. However, due to the destruction and looting of health centers, health posts, and hospitals by TIF, services were interrupted for more than six months, with potential exacerbation in areas where conflict persisted. After factoring in these conditions, the projected number of TB cases was expected to triple. In 2021, assuming normal conditions, the total TB notifications were projected as follows in the war-affected zones: 7,065 in North Gondar, 2,962 in South Wollo, 3,711 in North Wollo, 1,474 in Oromo special zone, 1,543 in Waghimra, and 392 in Dessie town (Figure 4).

For instance, in North Gondar, one of the war-affected areas there was a decreasing trend in TB cases from 2015 to 2018, except for TB relapse cases which showed consistent numbers. However, from 2019 to 2021, there was a slight increment in TB cases. The projection for extra-pulmonary tuberculosis (EPTB) cases was 550 in 2021, but it was estimated to increase from 396 in 2021 to 1,360 in 2022. Similarly, PTB positive and PTB negative cases were projected to increase from 396 and 268 in 2021 to 756 and 835 in 2022, respectively. Overall, the trend in TB case notifications showed a sharp decrement from 2018 to 2019 and an increasing tendency from 2020 to 2021. The estimated total number of all forms of TB case notifications for 2022 is 1,270. However, despite projections showing an increasing trend since 2020, actual case detection is expected to decrease due to internal displacement, lack of access to health services, and interruptions in service delivery (such as inability to access anti-TB drugs, lack of screening and diagnosis services) in conflict areas.

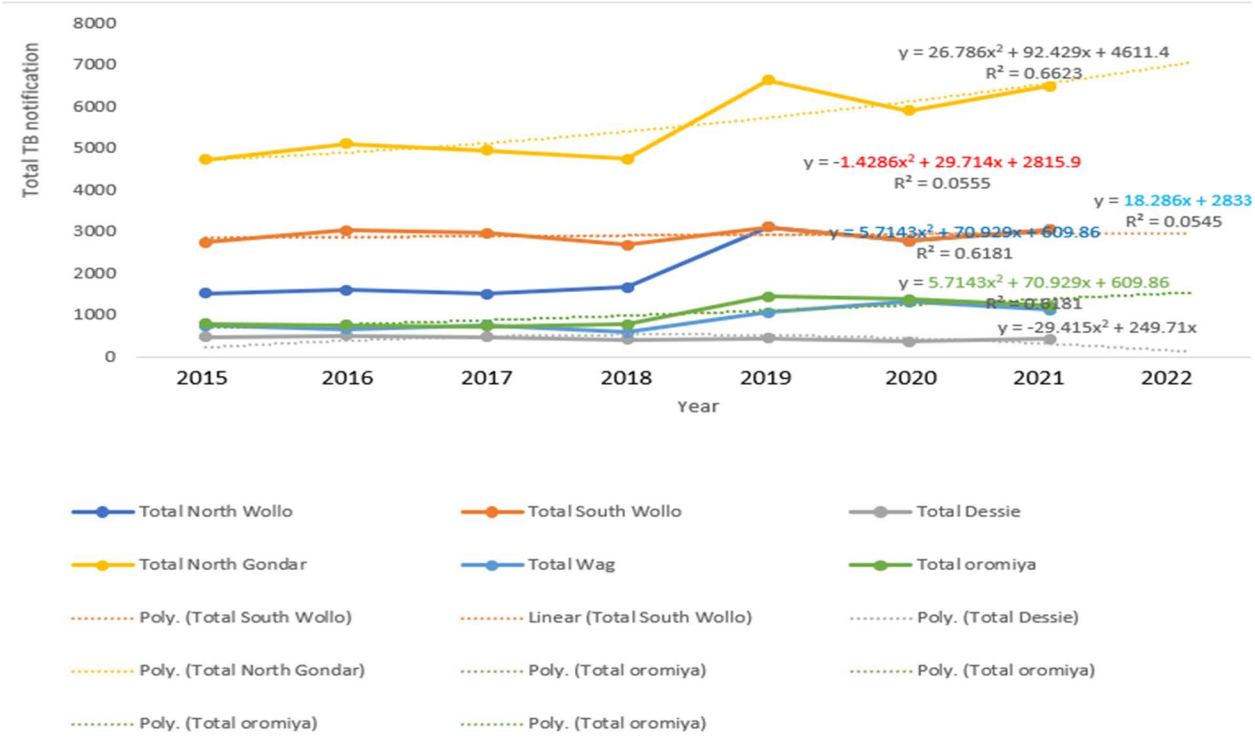

Figure 4 Forecasting of total TB case notifications in war affected zones of Amhara national regional state: 2015 -2022

North Wollo, one of the highly affected zones in ANRS due to war, showed stable TB case detections from 2015 to 2018, except for relapse TB cases. There was a rapid increase from 2018 to 2019 in all forms of TB, followed by a decreasing trend from 2019 to 2020. A one-year projection indicates that all forms of TB

case notifications were expected to increase, except for relapse TB cases. However, due to internal displacement, overcrowding, hunger, and the absence of TB preventive and control measures in war-affected zones, the number of TB infections was projected to triple or quadruple. Despite our estimations suggesting an increase in TB case detection in all forms of TB in 2022 the destruction of health infrastructure, looting of laboratory materials, medical equipment, and imaging materials, as well as the cessation of services for months, led to a significant decline in TB case detection rates, approaching zero (Figure 5)

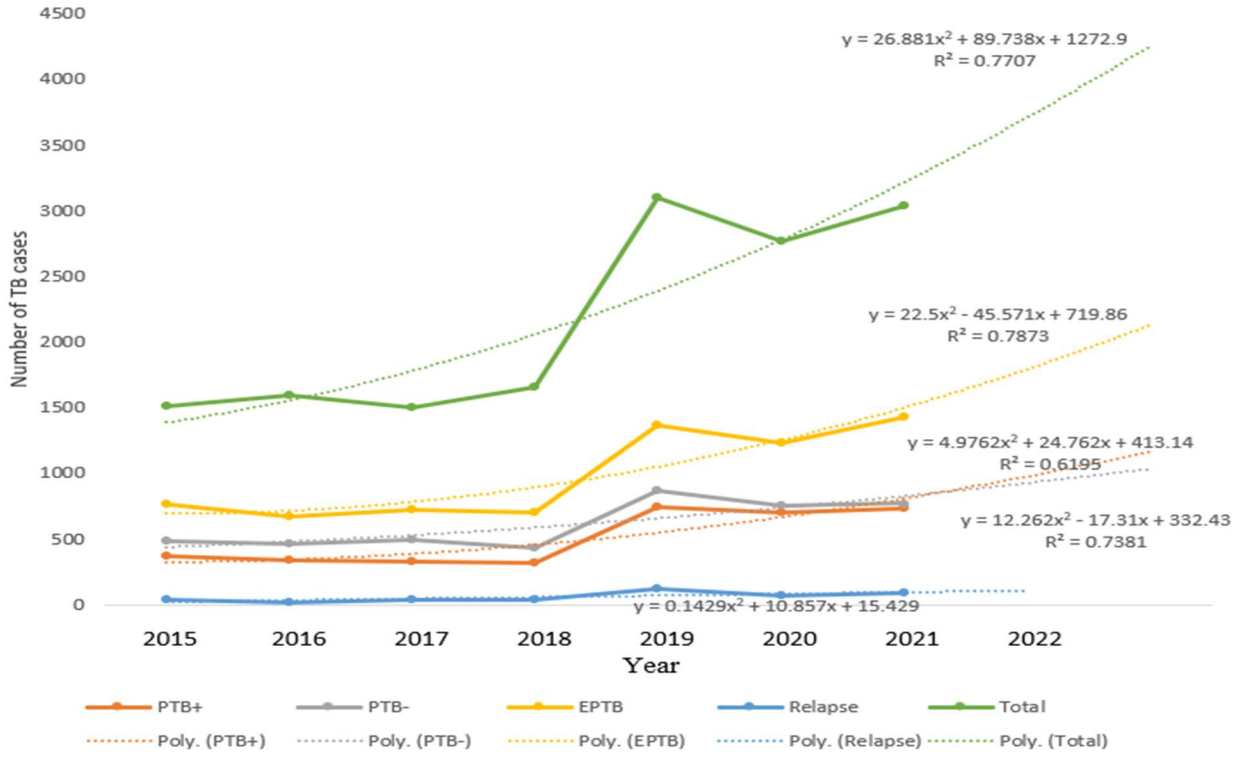

Figure 5 Trends in types of TB and projection in North Wollo Zone from 2015 to 2022

TB transmission in IDPS

Over 5 million people were internally displaced in the region. The South Gondar IDP site sheltered displaced people from Wag Hemra and North Wollo. Bahir Dar also saw an influx of thousands of IDPs from East Amhara and Gondar. West Gojam and Awi Zones continue to host thousands of IDPs from Benishangul Gumuze and Oromia (Wollega). This situation is expected to increase the number of new TB cases in zones with IDPs. The environment in the IDP sites and the war-affected community was conducive to TB outbreaks. Of the 116 drug-susceptible TB patients identified, 85 (73.3%) were from IDP sites. The number of known drug resistant TB patients who had their treatment interrupted and then traced back for continued /restarted treatment/ or declared outcomes, was 8 in the IDP sites and 43 in the war-affected community (Table 3).

Table 3 Number of TBL/ DR TB Cases identified in IDPs and war affected community, Amhara region March 2022

Indicators	IDPs (collective/ Host community)	War affected community	Total
Number of drug susceptible TB patients newly identified & started treatment	85	31	116
Number of known drug susceptible TB patients interrupted and trace back for continued / restarted treatment / declared out come	350	1387	1737
Number of Newly identified drug resistance TB (DRTB) linked to TIC & started treatment	5	2	7

Indicators	IDPs (collective/ Host community)	War affected community	Total
Number of known drug resistant TB Patients interrupted and trace back for continued /restarted treatment/ declared out come	8	43	51
Number of leprosy pts newly identified & started treatment	9	0	9
Number of known Leprosy pts interrupted and trace back for continued / restarted treatment/ declared outcome	17	165	182

TB Treatment outcomes

TB treatment outcomes can be classified as treatment success (cure and completed), relapse, failure, death, loss to follow-up, move to drug resistance (DR), not evaluated, and unknown treatment outcome. In general, treatment outcomes have slightly decreased over the last three years. Treatment success rates were 38,905 in 2019, 37,043 in 2020, and 34,592 in 2021. Similarly, relapsing cases showed a slight decrease from 1,394 in 2019 to 1,180 in 2021 The total deaths over three consecutive years remained similar: 1,115 in 2019 and 2020, and 1,019 in 2021. According to 2022 predictions, treatment success did not significantly change. However, due to the distraction of health facilities and the looting of anti-TB drugs, patients may not complete their treatment. The treatment success rate is expected to drop significantly, and relapsed TB cases are likely to increase dramatically. With internal displacement, there will be poor treatment adherence, increased loss to follow-up, treatment failure, and relapsed TB cases. Additionally, TB-related complications, deaths, and the transition to MDR-TB will increase exponentially due to service interruptions (Figure 6

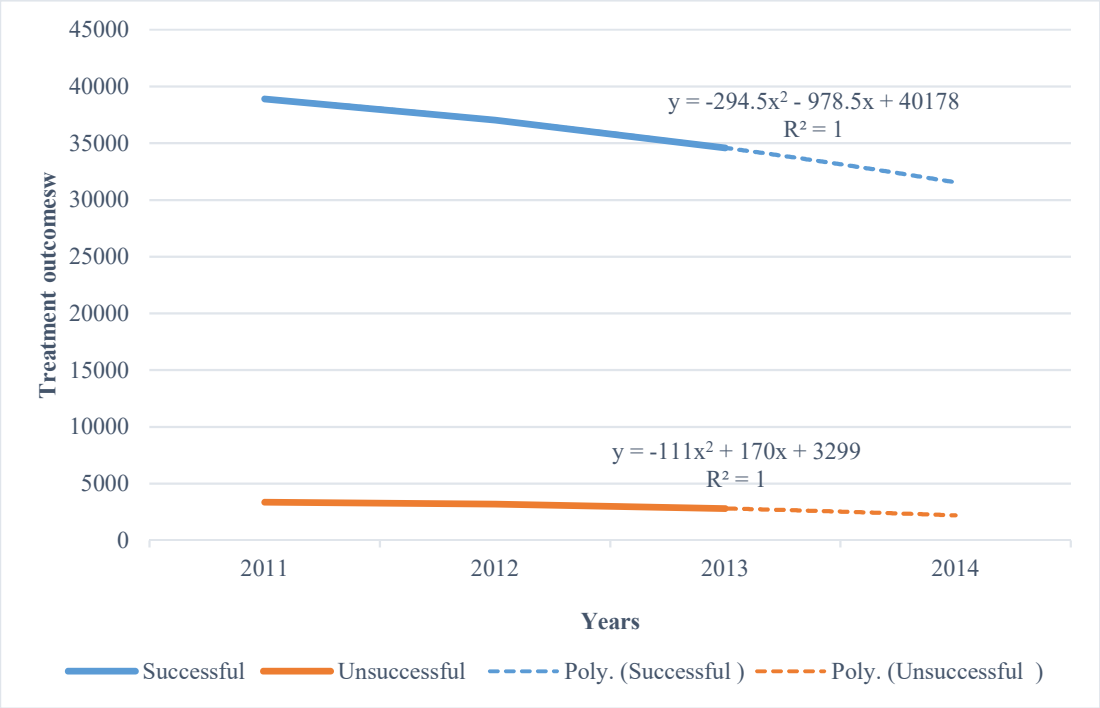

Figure 6 Tuberculosis treatment outcomes in Amhara region 2019 to 2022

DISCUSSION

In this study, the incidence of TB in almost all zones of the Amhara region is much higher than the national TB incidence rate of 132 per 100,000 [2]. This could exponentially increase the burden of TB infection, transmission, and complications in the Amhara region, where the destruction of health facilities, looting of medical equipment and supplies including anti-TB drugs, and frequent internal displacement occur. The present study also pointed out that TB patients, including those with MDR-TB, were left without any care and forced to flee to IDP centers. This could have resulted in a rapid increase in morbidity and mortality from tuberculosis, including augmented transmission among populations most severely affected by the war and in IDP centers, as well as the surrounding

populations [13]. Similarly, autopsy, imaging, and molecular evidence showed that among people who died due to war-related displacement and battles, there was a high incidence of pulmonary tuberculosis [14].

In the region, 204 drug-resistant TB cases were reported. As stated earlier, the DOTS, ambulatory, and hospital-based services were interrupted or compromised in all war-affected zones. These patients have a significantly higher risk of transmitting TB to others due to displacement and disruption of the DOTS system. Additionally, the likelihood of developing new drug resistance is high due to drug interruption. With the unprecedented struggle, the transmission of drug-resistant forms of TB was very low over the years in Ethiopia. According to the 2021 WHO Global TB Report, Ethiopia was removed from the list of high MDR-TB burden countries [2]. However, the war caused treatment interruptions for thousands of people. This situation is expected to increase the incidence of drug-resistant TB in the country. Taken together, war creates perfect evolutionary pressure for TB transmission and resistance. Unless concerted efforts are made to trace cases and contacts, the situation will paralyze the national health system.

Tuberculosis is a major cause of preventable suffering and death among women [15]. In this study, severe forms of TB disproportionately affect women and children. In the region, the proportions of EPTB, clinically confirmed TB cases, and pulmonary TB cases among females were 49.32%, 26.64%, and 24.04%, respectively. Evidence also documents that women are at an increased risk of disease progression during their reproductive years [16]. Biological mechanisms may account for most of this difference. Tuberculosis control programs should be sensitive to the constraints faced by women in accessing healthcare. However, significant under-detection of TB is more common in females than in males [17]. Moreover, a major challenge in estimating the burden is under-reporting and diagnostic uncertainties [17].

In this study, severe TB mainly affects the economically disadvantaged segments of the population, specifically children and women of reproductive age. The morbidity and mortality resulting from the indirect and lingering effects of wars are approximately equal to those incurred directly and immediately from all wars. This impact manifests through specific diseases and conditions, disproportionately affecting women and children 18. The Bacille Calmette–Guérin (BCG) vaccination is administered to children to prevent severe forms of TB. It is claimed that mass BCG vaccination, especially at school-leaving age, can yield benefits not only directly by protecting individuals from TB but also indirectly by breaking the chain of transmission and preventing the spread of tuberculosis [19]. However, BCG vaccination coverage is low or even zero in conflict-affected zones. This situation might exacerbate the emergence of severe forms of TB (EPTB) in the region, surpassing its pre-war status.

The war in the Amhara region has significantly impacted tuberculosis case notification and treatment. Before the conflict, there was a steady increase in TB treatment outcomes and a stable case detection rate in the war-affected areas of the Amhara National Regional State. However, due to interruptions in TB care in these zones, the TB notification rate and treatment outcomes have dramatically decreased. This situation could lead to a manifold increase in TB transmission in war-affected areas and IDP centers, where more than five million people reside. For instance, there were 85,403 TB cases in the war-affected areas, and individuals were displaced without triaging their TB status, potentially spreading the disease among healthy individuals. Moreover, out of 116 drug-susceptible TB patients identified, 85 (73.3%) were from IDP sites. This creates a conducive environment for TB transmission in IDP sites and the war-affected community. Evidence suggests that an individual with TB could transmit the disease to approximately 15 healthy persons. Based on this calculation, more than one million new TB cases could potentially be added to the existing TB burden [20]. The number could potentially exceed fifteen in IDP centers due to delays in diagnosis and treatment initiation, as well as unsuccessful outcomes in TB treatment [11]. Amid the ongoing war and conflict, forced displacement is widespread, leading to overcrowded detention centers. The development of chronic malnutrition and hunger is inevitable, drug interruptions are likely, and infection prevention mechanisms are likely compromised [21]. These collective conditions not only facilitate transmission and reactivation but also increase the likelihood of mortality and the development of multidrug-resistant (MDR) and extensively drug-resistant (XDR) TB. The majority of patients with drug-resistant TB also face various psychosocial and economic challenges [22,23].

In the present study, five patients with drug resistance were diagnosed. The quality of life of MDR-TB patients was compromised across physical, psychological, environmental, and social domains. Additionally, a study indicated that 23% of MDR-TB patients had defaulted on treatment due to financial constraints [24]. Collectively, TB, especially drug-resistant TB, significantly impacts the productivity of the population. These challenges underscore the profound implications of the war on TB control programs in the Amhara region.

CONCLUSION

The incidence of TB was notably high in war-affected areas. Severe forms of TB and underdiagnosed cases were more prevalent, contributing to increased TB transmission, reactivation, and the development of drug resistance in both affected and unaffected zones. The regional TB prevention and control program faced severe limitations and was overwhelmed by forced displacements. Therefore, enhancing active and passive case finding, restoring diagnostic capabilities, ensuring BCG vaccination, implementing rigorous TB screening and surveillance, and managing TB, including severe forms like MDR-TB and XDR-TB, are crucial measures to strengthen the regional TB control program.

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ABBREVIATIONS

ANRS…Amhara National Regional State

BCG… Bacillus Calmette-Guérin

DOTS…Directly Observed Therapy Short course

HMIS…Health Management Information System

IDP…Internally Displaced Persons

LQAS…Lot Quality Assurance Sampling

MDR…Multidrug-resistant

MDR-TB… Multidrug-resistant TB

PTB+…Pulmonary TB positive

RR…Rifampicin Resistance

TB…Exacerbating Tuberculosis

WHO…World Health Organization

ZN…Ziehl-Neelsen

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Prior to the study, ethical approval was obtained from the Ethical Review Board of Amhara Public Health Institute. Permission to access data was granted through written letters from APHI. Informed written consent was obtained from respondents who participated in the post-war assessment. Data were solely used for the purpose of the study, and all personal identifiers were removed to ensure confidentiality and anonymity.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

All the datasets analyzed during the current study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

Authors have no competing interests

FUNDING

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CONTRIBUTION OF AUTHORS

All authors contributed equally

AUTHOR'S INFORMATION

MB: MSc in Infectious and Tropical Diseases, MW: MPH in Field Epidemiology; BB: MPH in Field Epidemiology, GD: PhD in Public Health and Professor, MY: PhD in Public Health and Professor of Health Systems and Policy, AA: MSc in Pharmacy, BBA: MPH in Field Epidemiology, Daniel Mekonnen: PhD in Health Biotechnology; DA: MSc in Pediatric and Child Health; DS: MSc in Biomedical Sciences, GMA: MPH, KA: MSc in Epidemiology and Biostatistics, MM: MSc in Information Technology, MT: MPH, TZ: MPH, and GY: PhD in Medical Sciences

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Violence against Healthcare during the War in the Amhara Region of Ethiopia

Molalign Tarekegn Minwagaw[1*], Kebadnew Mulatu[2], Achenef Motbainor[2], Muluken Azage[2], Taye Zeru[1], Desalew Salew[1], Girum Meseret Ayenew[1], Melashu Balew[1], Betelhem Belete[1], Zena Ameha[1], Simeneh Ayalew[1], Belay Bezabih[1], Mezgebu Yitayal[1], Gizachew Yismaw[1]

[1]Amhara Public Health Institute, Bahir Dar, Ethiopia
[2] College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar, Ethiopia
[*]Corresponding Author: Molalign Tarekegn Minwagaw, email: tamolalign@gmail.com,

ABSTRACT:

Background*: Depriving health care through damaging the health facilities' infrastructure, supplies, warehouses, and transport, and targeting the health workforce during war is a serious violation of international humanitarian law. This survey was conducted to assess the damages and service interruptions to the health services in the Amhara region's war zones following the broke out of the war between Ethiopia's central government and the Tigray forces in late 2020.*

Methods*: The survey was carried out in seven zones and one city administration of the Amhara region. Quantitative data on the extent of destruction were collected from 113 accessible hospitals and health centers using a semi-structured checklist. Furthermore, qualitative data were obtained from twenty-one local administrative heads of zonal health departments, district health offices, hospitals, and health center administrators. The quantitative data were coded, cleaned, and analyzed using SPSS version 24 software. The transcribed qualitative data were translated, coded, and thematically analyzed.*

Result*: Deliberate destruction of buildings, electrical power supplies, and water sources was noted in 92%, 85%, and 64% of the health facilities respectively. Medical equipment, computers, and other devices were looted from 94% of the health facilities. In addition, 24 ambulances were damaged, and 34 were looted. Healthcare services were disrupted in the majority of health facilities. The healthcare workforces were compelled to evacuate, and experienced kidnappings, torture, and fatalities.*

Conclusion*: The war broke out in the northern part of Ethiopia deprived the healthcare service of the community. The health workforces were intentionally attacked, and many of the health facilities' infrastructure, ambulances, and medical equipment were looted and destroyed requiring urgent and collective efforts to restore the health service.*

Keywords: *Violence against health care, war, health facilities damage, health care service interruptions.*

አጎድሮተ ጥናት

የጥናቱ መግቢያ፡ *በጦርነት ወቅት የጤና ተቋማትን ያለመ ጥቃት ማድረስ ዘላቂ የእድገት ግቦች ለማሳካት ከሚደረጉ ጥረቶች የሚገታ እንዲሁም ከባድ ዓለም አቀፍ የሰብዓዊነት ህግ ጥሰት ነው። ይህ የዳሰሳ ጥናት የተካሄደው እ.አ.አ. በ2020 መጨረሻ ላይ በማዕከላዊ የኢትዮጵያ መንግሥትና በህወሓት መካከል በተከሰተው ጦርነት በአማራ ክልል በጦርነት የተጐዱ ዞኖች በሚገኙ ጤና ተቋማት ላይ የደረሰውን ውድመትና የጤና አገልግሎት መቋረጥ ለመግለጽ እና ለመተንተን ነው።*

የጥናቱ ዘዴ፡- *ይህ የዳሰሳ ጥናት በጦርነት ጉዳት በደረሰባቸው ሰድስት ዞኖችና አንድ የከተማ አስተዳደር የተካሄደ ሲሆን ተደራሽ በሆኑ 113 ሆስፒታሎች እና ጤና ጣቢዎች መጠናዊ እና አይነታዊ መረጃዎች ተሰብስበዋል።*

የጥናቱውጤት፡-*በጥናቱ ከተካተቱት ጤና ተቋማት መካከል 92 በመቶ የህንጻ፣ 85 በመቶ የኤሌክትሪክ መብራት መስመር እና 64 በመቶ የውሀ መስመር ዝርጋታ ጉዳት ደርሶባቸዋል። በ 94 በመቶ የጤና ተቋማት የህክምና መሳሪያዎች፣ ኮምፒውተሮች እንዲሁም ሌሎች አስፈላጊ ህክምና ቁሳቁሶች ተዘርፈዋል። ሀያ አራት አምቡላንሶች ጉዳት ሲደርስባቸው ሰላሳ አራቱ ተዘርፈዋል።*

የጥናቱ ማጠቃለያና ምክረሐሳብ፡ *ከጦርነቱ ጋር በተያያዘ በርካታ የጤና ተቋማት ወድመዋል። የጤና ባለሙያዎች ከስራ ቦታቸው ለመሸሸ፣ለመታገት፣ ለስቃይ እንዲሁም ለሞት ተዳርገዋል። በዚህም በጤና ተቋማቱ የህክምና አገልግሎት ተስተጓጉሏል፣ ተቋርጧል። ስለሆነም የወደመውን የጤና መሠረተ-ልማት መልሶ በመገንባት እና ለህክምና ባለሙያዎችን የአእምሮ ጤና ስልጠና በመስጠትና የህክምና አገልግሎቱ በሙሉ አቅም እንዲጀመር ለማድረግ በርብርብ መስራት ያስፈልጋል።*

ቁልፍ ቃላት፡ *ጦርነት፣ ጤና ተቋም፣ ውድመት፣ ዝርፊያ፣ የጤና አገልግሎት*

BACKGROUND

Targeting healthcare during conflicts by damaging facilities, depleting supplies, destroying warehouses, and disrupting transport is a severe breach of international humanitarian law. It undermines the global endeavor to achieve health for all, justice, and peace [1]. Some scholars have characterized such actions as practices of a 'dirty war [2].

Despite constituting serious violation of human rights and international humanitarian law, the use of violence against healthcare has become an increasingly common approach, effectively weaponizing it by denying medical care to affected populations [3]. Conflict reports from various regions have described targeted actions against health workers, facilities, and ambulances.

The Safeguarding Health in Conflict Coalition's report, which surveyed 43 countries, recorded 128 health facilities damaged, 51 health transports destroyed or damaged, and 26 hijacked or stolen [4].

In Syria's conflict, the pattern of targeting health services is alarmingly repetitive. Around 44% of hospitals and 5% of all primary care clinics have been attacked. And, 243 ambulances were intentionally damaged during the hostilities[5].

Similarly, the conflict in Afghanistan led to the closure of 140 health facilities that served two million people, enforced by armed factions [6]. During the conflicts in Yemen and Chechnya, 102 and 124 healthcare facilities were damaged, respectively [7].

Ethiopia is the second-most populous country in Africa, next to Nigeria, with an estimated population size of 120,116,835 in 2022 [8]. The government has been enacting policies aimed at enhancing the population's health, which includes decentralizing health service delivery, expanding the primary healthcare network, and fostering public-private partnerships [9]. The number of health services facilities has grown from a total of 2,600 in 1997 to 21,154 (which included 314 hospitals, 3,678 health centers, and 17,162 health posts and private health facilities) in 2019 [10].

The Amhara region is Ethiopia's second-most populous region, with an estimated population of 22, 876, 999[11]. It is composed of 22 zones and city administrations. In 2022, it had 99 hospitals, 924 health centers, and 3679 health posts[12].

The armed conflict in Ethiopia broke out in late 2020 between the central government and the Tigray People's Liberation Front. It has been ongoing ever since with battles spreading out to the Amhara region. All the districts in Waghimira, North Wollo zones, and Dessie city administration were entirely conflict zones. In addition, most of the South Wollo and North Gondar districts partly experienced the conflict. Within these impacted zones, the healthcare network comprises 38 hospitals, 406 health centers, and 1,634 health posts [13]. Therefore, this assessment aimed to describe the extent of the damage inflicted upon health facilities and the health service provision in the conflict-ridden areas of the Amhara region.

METHODS

Study Design, Period, and Site

A mixed study approach was used to address the study's objective from December 24, 2021, to January 14, 2022, in the war-affected seven zones of the Amhara region. This includes North Wollo, South Wollo, North Gondar, South Gondar, Oromo special Zone, North Shoa, Wagehimera Zone, and Dessie Town.

Source Population

The source population for the assessment encompassed all health facilities within the war affected zones of Amhara region.

Study Population

The study population consisted of all hospitals and health centers accessible in the war zones of the Amhara region.

Sample Size Determination and Technique

One hundred thirteen accessible health facilities in the war-affected zones were identified and twenty-one Key Informant Interview (KII) participants were recruited through purposive sampling.

Inclusion and Exclusion Criteria

Initially, all war-affected areas were planned to be included. However, North Gondar and part of Waghemira zones were excluded due to security concerns during the study period (December 24, 2021, to January 14, 2022).

Data Collection Tools and Technique

The quantitative assessment tool and key informant interview guide were initially prepared in English, translated into the local language, Amharic, and then back-translated into English. Each data collector verified questionnaire completeness at the completion of each visit to the health facilities under study. Each questionnaire was reviewed daily for completeness and clarity. For the qualitative component, key informant interviews were conducted post obtaining written informed consent from each participant, using a structured guide. A digital audio recorder was used to capture participants' own words. In addition, notes were taken to capture the feelings and expressions of the participants. Participants were encouraged to share using conversational prompts. Transcriptions of audio records were done daily. All data collectors and supervisors were second and third-degree holders in health-related fields and had rich experience in data collection.

Data Quality Assurance

To maintain quality, a comprehensive two-day training session was provided to data collectors and supervisors prior to commencing data collection, with rigorous supervision throughout the process.

Trustworthiness was upheld by adhering to the principles of credibility, transferability, dependability, and confirmability. To establish credibility, the researchers employed triangulation, iterative questioning, member checking, and debriefing. Additionally, data collectors possessed a deep understanding of the cultural and social contexts related to the topics. Different participant groups, including health institution authorities at different levels, offered diverse perspectives on the research topics, leading to triangulation. Member-checking sessions were arranged to present initial findings to participants, giving them the opportunity to validate and adjust the data. To enhance transferability, the study included thorough descriptions to offer comprehensive insights into the research context, facilitating the application of findings across various settings, circumstances, and scenarios. To ensure dependability and consistency, overlapping methods like key informant interviews were utilized.

Data Processing and Analysis

The collected data was entered coded, cleaned, and analyzed using SPSS version 24 software. Descriptive analysis was done and results were presented in frequency tables, graphs, and statements. For qualitative analysis, key informant interviews were transcribed verbatim in Amharic, the local language, and later translated into English for analysis. Thematic analysis was employed for data analysis, starting with multiple readings of transcripts to deeply grasp content and context. Initially, the transcripts were read multiple times to gain a thorough understanding of the content and context. Following this, meaning units were extracted from the transcripts, representing distinct segments of text that captured specific ideas or themes. These meaning units were then condensed, reducing the length of the original text while preserving the core meaning. Subsequently, codes were assigned to these condensed meaning units, and these codes were grouped into categories based on shared themes. This systematic approach facilitated the identification and organization of overarching themes within the data.

RESULTS

The results were categorized into the following three themes:

Theme One: Health facilities' infrastructure and medical equipment

Theme Two: Health workforce

Theme Three: Health service Provision

Theme One: Health Facilities' Infrastructure and Medical Equipment

In war-affected areas of the Amhara region, most health facilities' infrastructure and medical equipment were damaged. The buildings of one hundred and three (91.2%) health facilities were damaged (Table 1). As participants explained, there were health facilities destroyed by heavy weapons.

"The armed groups built their fortress in the health center compound. It was heavily attacked during the war. Maternity and emergency unit buildings were entirely damaged. Most of the roofs were also distracted." (Source: 35 years old, male, district health office)

"…You can see the broken doors and windows of the OPDs and other offices; you can't lock them." (Source: 32 years old male, Hospital)

In the war-affected zones of Amhara region, damage to essential infrastructure like electricity and water supply systems was significant. Electricity systems were affected in 96(85%) health facilities, while water supply systems were also damaged in 73 (64%) facilities. Additionally, 22 generators were looted, and 48 facilities lost their power sources completely (Table 1). Some of this damage, as described by a key informant interview participant, was attributed to gun attacks.

"… huge guns had damaged the water supply lines in health facilities." (Source: 33 years old male, Zonal health department)

The Health Management Information System (HMIS) faced challenges, with 94(83%) health facilities experiencing damage (Table 1). Qualitative insights from a study participant could provide further context or details regarding the impact on HMIS functionality and data management in these facilities as follows:

"There is no patient medical data; all are damaged. The hard disks of office computers' are looted." (Source: 43 years old, male, district health office)

Table 1 Health infrastructure damage by zone and health facilities in the war-affected areas of the Amhara region, 2022

Zone	Facility (n)	Damage type			
		Building	Electric power	Water source	HMIS
Dessie town	HC (7)	7(100.0%)	6(85.7%)	3(42.9%)	6(85.7%)
	Hospital (2)	2(100.0%)	2(100.0%)	1(50.0%)	1(50.0%))
North Shewa	HC (12)	11(91.7%)	11(91.7%)	6(50.0%)	12(100.0%)
	Hospital (5)	5(100.0%)	4(80.0%)	3(60.0%)	5(100.0%)
North Wollo	HC (19)	14(73.7%)	18(94.7%)	16(84.2%)	14(73.4%)
	Hospital (6)	4(66.7%)	5(83.3%)	5(83.3%)	5(83.3%)
Oromo Special Zone	HC (3)	2(100.0%)	2(100.0%)	1(50.0%)	2(66.7%)
	Hospital (2)	2(100.0%)	1(50.0%)	1(50.0%)	1(50.0%)
South Gondar	HC (8)	8(100.0%)	7(87.5%)	4(50.0%)	7(87.5%)
	Hospital (1)	1(100.0%)	1(100.0%)	1(100.0%)	1(100.0%)
South Wollo	HC (38)	37(97.4%)	29(76.3%)	14(36.8%)	34(89.5%)
	Hospital (3)	3(100.0%)	2(66.7%)	2(66.7%)	2(66.7%)
Waghimira	HC (5)	5(100%)	6(100.0%)	3(50.0%)	3(60.0%)
	Hospital (2)	2(100.0%)	2(100.0%)	2(100.0%)	1(50.0%)
Total	HC (95)	84(91.3%)	79(85.9%)	47(51.1%)	81(85.3%)
	Hospital (18)	19(90.5%)	17(81.0%)	15(71.4%)	13(72.2%)
	Total	103(91.2%)	96(85.0%)	73(64.6%)	94(83.2)

The war in the region also resulted in significant damage to costly medical equipment (Figure 1). Essential spare parts were deliberately removed, rendering the equipment non-functional and impacting the ability to provide adequate healthcare services.

"All medical equipment like ultrasound, microscope, hematological analyzers, gen-expert machine and other medical equipment in our district were damaged." (Source: 40 years old, male, district health office)

"If you observe Tefera Hailu Hospital, the damage looks simple from the outside, but the microscope, X-ray machines, and other medical equipment are dismantled, and its main parts are looted. You can also observe the case in Ziquala Hospital. It is the same." (Source: 38 years old, male, Zonal health department)

Some participants described the contamination of service delivery rooms and medical equipment with human fecal matter.

"The maternity and child health care delivery units were targeted. The labor and delivery rooms are damaged, and it is filled with human fecal matter." (Source: 43 years old, male, district health office)

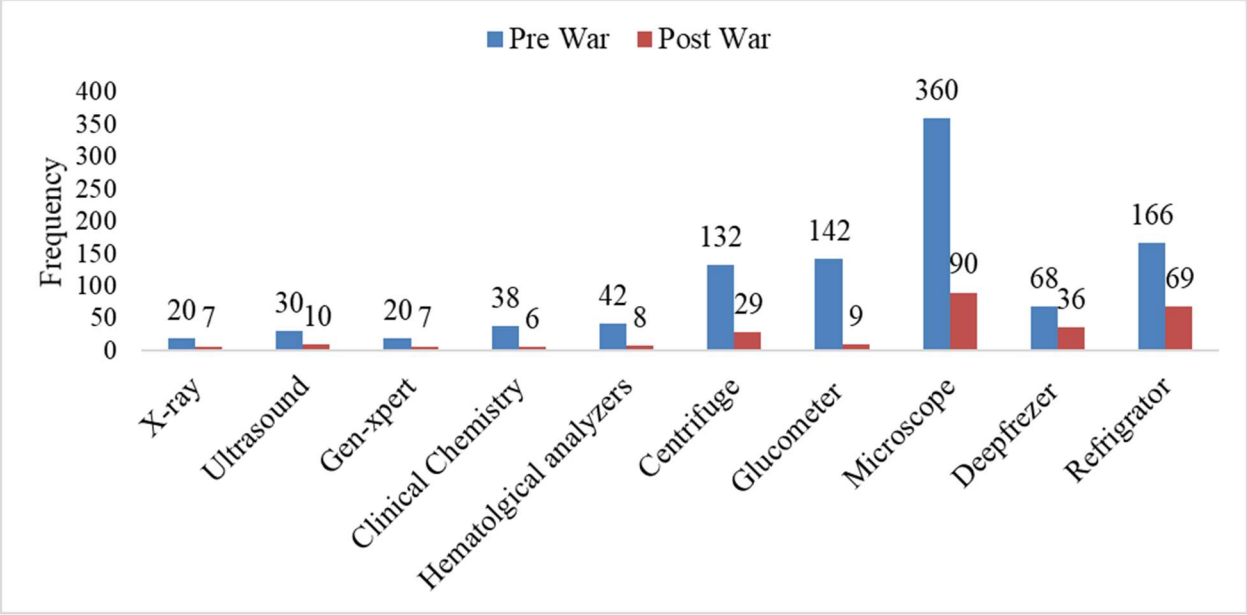

Figure 1 The number of functional medical equipment in the health facilities of the Amhara region, 2022

Theme Two: Health Workforce

With the exception of a few, the majority of health professionals were forcibly displaced from their localities for extended periods. They were killed, kidnapped and tortured. In addition, most of the healthcare workers' properties were lost.

"...One of the critical issues after the war was gathering the healthcare workers from the place they hide'. Totally, 9 health professionals were injured, and 5 died." (Source: 33-year-old male, Zonal health department).

"...The houses of three health professionals were completely damaged". (Source: 32 years old male, district health office).

"... We have lost one health worker at Kombolcha 03 health center [either kidnapped or killed], and similarly, the ambulance driver at Kombolcha 05 health center was injured''. (Source: 35 years old male, district health office).

Theme Three: Health Service Provision

In the war-affected areas of the Amhara region, services were disrupted for an extended period. Despite the return of most healthcare workers to their healthcare facilities after the conflict, service restoration was delayed in these regions.

"When the armed groups entered the town, we were attending a laboring mother. We tried to help by moving her to an individual's house, but the armed group followed us there. Due to these, we were forced to send her to Tulu Awlia Health Center [25 km away]. However, at that time, the health center was under the control of the armed groups. We heard that after some follow up there, both the mother and her child died" (Source: 27 years old, male, health center)

"HIV patients who discontinue their treatment were traced to come back. However, still 50 patients remain" (Source: 30 years old male from Gazo Woreda health office)

"Since both of the glucometers were looted, we are currently referring suspected cases and those on the follow-up to Adjibair Kollo Genet HC and Tenta hospital [17 km far]." (Source: 45 years old, male, health center head)

DISCUSSION

Amhara region is known for communicable diseases such as malaria, tuberculosis, and HIV [14-16]. It harbors the largest population of individuals living with HIV in the country [17]. Addressing malnutrition remains a significant challenge in the region [18].

Despite such huge health problems, tremendous efforts were made to decrease morbidity and mortality and improve the region's health status. Expansion of the health facilities was one of the major efforts and achievements made in the region. The number of health facilities in the region increased rapidly throughout the region [19, 20]. There are 90 hospitals, 890 health centers, and 3679 health posts in the region[12]. In the current health tier system of Ethiopia, the number of people expected to be served is 15,000 -25,000 (health center), 60,000-10,000 (primary hospital), 1-1.5 million (general hospital), and 3.5-5 million (specialized hospital) people [21].

However, the war between the Ethiopian government and the armed Tigray forces which started in late 2020, posed a significant challenge to the effort made to reduce morbidities and mortalities and improve the health of the people in the region [22].

The war lasted months in the Amhara region of Ethiopia, specifically in the six zones. The seven war affected zones contained 38 hospitals, 406 health centers, and 1634 health posts[12]. The current study included one hundred thirteen accessible health facilities in these areas, from these, 91.2%, 85%, and 64% of the health facilities' electricity and water supply systems were destroyed. Overall, the current finding showed that many of the health facilities' infrastructure, such as the walls, doors, windows, and roofs, were targeted and damaged during the war, indicating that the war was against international humanitarian law and health for all, justice, and peace [23]. Similar findings were reported in Mozambique where many health centers were destroyed/ looted and/or forced to close. In addition, in Myanmar, frequent attacks and closing of health facilities were reported because of the establishment of the military base near the clinic[24]. A study in South Sudan also reported hospital attacks [25].

In addition, the result showed that many expensive diagnostic equipment and OR tables, anesthesia machines, and other important medical equipment were dismantled, and their important spare parts were carefully taken out of it, indicating that the practice was used as a weapon that deprived the health care of the people[4]. Such kinds of war practices were observed during the conflict in Syria, Afghans, Yemen, and Chechnya [8].

According to the study, the war interrupted all kinds of health service provisions. It indicated that a high number of mothers and individuals with communicable and non-communicable disease problems would suffer from complications. Other findings have also showed that populations that have

experienced armed conflict often have the worst indicators of infant, child, and maternal mortality, as well as very high levels of psychological impairment. In addition, because of the breakdowns in health services and infrastructure, health and life expectancy declines can be expected to last and even increase in the years after the conflict ends [26].

Even though attacks on the health care workers are prohibited actions in the Geneva Convention[27], the International Committee of the Red Cross reported that violence against health workers in war-torn areas is 'one of the most crucial yet overlooked humanitarian issues of today' [28]. In the current finding, the health professionals were displaced far from their working areas since they were targeted in the war. There were also health professionals who were killed and kidnapped, and their properties were lost. Because of this, those who got jobs left the area permanently, and others were frustrated with doing their routine jobs. This was similar to the findings during the war in South Sudan and Syria where beatings and shootings were reported [25, 29], in Burma where arrest, intimidation, or threats were reported [30], and in Salvador where obstruction of daily operations was reported [31, 32]. Findings reported in Myanmar [24] and South Sudan[25], showed that the attacks on the health workers were ethnicity or locality based.

CONCLUSION

The war in the northern part of Ethiopia deprived the healthcare service of the community in the war-affected zone in the Amhara region. It interrupted health service provisions in most of the health facilities. The war resulted in massive destruction of the health system. The health workforce was displaced, kidnapped, and killed during the war. Many health facilities' infrastructures, including buildings, medical equipment, and health management information systems, were damaged. Diagnostic medical equipment, such as X-ray machines, Gen-expert machines, hematology analyzers, clinical chemistry machines, and microscopes, was damaged and looted in most health facilities. The patient's medical record management system and the telecommunication system were disrupted.

RECOMMENDATION

To resume health service delivery in the war zone, the Amhara National Regional State Health Bureau, in collaboration with partners, must work on restoring the damaged health facilities' infrastructure and medical equipment. In addition, frequent mental health training should be provided for healthcare professionals working in the region's war zones. Further studies are required to estimate the impact of those service interruptions on the community's health outcomes, including maternal death, pregnancy outcomes, and communicable and non-communicable disease outcomes.

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ABBREVIATIONS

KII: Key Informant Interview

SPSS: Statistical Package for the Social Sciences

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance and approval were obtained from the institutional review board of Amhara National Regional State Public Health Institute with reference number No.H/R/T/T/D/5/24 In addition; a support letter was obtained from the respective zonal health departments.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

The data is available upon reasonable request.

COMPETING INTERESTS

The authors declare no competing interests.

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CONTRIBUTION OF AUTHORS

MTM, KM, TZ, DS, GMA, MB, BB, ZA, SA, BB, MY, and GY conceptualized and developed the protocol. MTM, KM, and AM are involved in data analysis and draft manuscript preparation. All the authors reviewed the manuscript.

AUTHOR'S INFORMATION

MTM has Master's degree in Public Health.

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Influence of Mass Media on Institutional Delivery Service Utilization among Ethiopian Women: Insights from the 2016 Demographic and Health Survey

Adane Nigusie Weldeab*[1] and Amlaku Nigusie[2]

[1]Health Research Development Directorate, Amhara Public Health Institute, Bahir Dar, Ethiopia
[2]Department of Health Promotion and Health Behavior, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia.
*Corresponding Author: Adane Nigusie; Email: adane2009ec@gmail.com, Phone: +251-913673758, P.O.Box: 477,

ABSTRACT:

Introduction: *Globally, the rapid advancement of technology has significantly expanded the reach of mass media, exposing a large portion of the world's population to diverse information sources. Mass media encompass various technologies that distribute information, ideas, and opinions to broad and targeted audiences. In this context, mass media can play a critical role in addressing significant issues, such as the low utilization of institutional delivery services, which remains a major challenge in developing countries like Ethiopia.*

Objective: *This study aims to assess the influence of mass media on the utilization of institutional delivery services among women in Ethiopia, utilizing data from the 2016 EDHS.*

Methods :*The study used data from the published reports of Ethiopian Demographic and Health Surveys-2016.*

Results: *Nearly twenty-eight percent (27.7%) of the respondents were exposed to radio, followed by television (19.6%) and newspapers (7.1%). Multivariable logistic regression analyses showed that mothers exposed to mass media were more likely to utilize institutional delivery services (AOR 1.25; 95% CI 1.10, 1.42). Place of residence, specifically rural areas (AOR 0.20; 95% CI 0.16, 0.25), educational status (primary school: AOR 1.98; 95% CI 1.76, 2.24; secondary school: AOR 6.12; 95% CI 4.59, 8.17; higher education: AOR 8.21; 95% CI 4.72, 14.30), and wealth index (poorer: AOR 1.72; 95% CI 1.44, 2.06; middle: AOR 1.97; 95% CI 1.65, 2.36; richer: AOR 2.11; 95% CI 1.76, 2.54; richest: AOR 3.19; 95% CI 2.52, 4.03) were significantly associated with institutional delivery service utilization.*

Conclusion: *The study reveals that exposure to mass media significantly increases the likelihood of utilizing institutional delivery services among women in Ethiopia. Additionally, factors such as urban residency, higher educational attainment, and greater wealth are positively associated with higher rates of institutional delivery service utilization. These findings highlight the importance of mass media and socio-economic factors in improving maternal health service uptake.*

Keywords: *Institutional delivery, Mass media, Ethiopia.*

አጎድሮተ ጥናት

የጥናቱ መግቢያ:- *በዓለም አቀፍ ደረጃ፣ የቴክሎጂ ፈጣን እድገት የብዙኀን መገናኛ ተደራሽነትን በከፍተኛ ሁኔታ እንዲጨምር አድርጓል፤ ሰፊውን የዓለም ህዝብ ከፍል ለመገናኛ ብዙኀን እንዲጠቀም አስችሏል። መገናኛ ብዙኀን መረጃዎችን፣ ሐሳቦችንና አስተያየቶችን ለውስን እና ሰፊ ታዳሚዎች ለማሰራጨት የተለያዩ የሚዲያ ቴክሎጂዎችን ይጠቀማል። ኢትዮጵያን ጨምሮ በማደግ ላይ ባሉ ሀገሮች የተቋማዊ ወሊድ አገልግሎት አጠቃቀም አሁንም በጣም ዝቅተኛ ነው።*

የጥናቱ ዓላማ:- *የዚህ ጥናት ዓላማ ከ2016 ዓ ም የኢትዮጵያ ዲሞግራፊክና ጤና ዳሰሳ የተገኘውን መረጃ በመጠቀም የመገናኛ ብዙኀን በኢትዮጵያ ውስጥ ባሉ ሴቶች የተቋማዊ ወሊድ አገልግሎት አጠቃቀምን ላይ ያለውን ተፅዕኖ ማጥናት ነው።*

የጥናቱ ሰልት:- *ይህ ጥናት የ2016 ዓ ም የኢትዮጵያ ዲሞግራፊክና ጤና ዳሰሳ መረጃን በመጠቀም የተሰራ ነው።*

የጥናቱ ውጤት:- *ወደ 28 በመቶ (27.7 በመቶ) የሚሆኑት መረጃ ሰጪዎች ሬዲዮ፣ 19.6 በመቶ የሚሆኑት ደግሞ ቴሌቪዥን እና 7.1 በመቶ መረጃ ሰጪዎች ጋዜጦችን ተጠቃሚ ነበሩ። ሁለገብ የሆነዉ ሎጂስቲክስ ሪግሬሽን እንደሚያሳየው (multivariable logistic regression) ትንታኔዎች የመጨረሻ ውጤቶች እንደሚያሳዩት ለመገናኛ ብዙኀን የተጋለጡ እናቶች የተቋማዊ ወሊድ አገልግሎት የመጠቀም እድላቸው ከፍተኛ ነው (AOR1.25፤ 95% CI 1.10፣ 1.42)። የመኖሪያ ቦታ በተለይም የገጠር አካባቢዎች (AOR 0.20፤ 95% CI 0.16፣ 0.25)፣ የትምህርት ደረጃ (የመጀመሪያ ደረጃ ትምህርት:- AOR 1.98፤ 95% CI 1.76፣ 2.24፤ ሁለተኛ ደረጃ ትምህርት:- AOR 6.12፤ 95% CI 4.59፣ 8.17፤ ከፍተኛ ትምህርት:- AOR 8.21፤ 95% CI 4.72፣ 14.30)፣ እና የሀብት ደረጃ (ደሃ:- AOR 1.72፤ 95% CI 1.44፣ 2.06፤ መካከለኛ:- AOR 1.97፤ 95% CI 1.65፣ 2.36፤ ሀብታም:- AOR 2.11፤ 95% CI 1.76፣ 2.54፤ በጣም ሀብታም:- AOR 3.19፤ 95% CI 2.52፣ 4.03) የተቋማዊ ወሊድ አገልግሎት አጠቃቀም ጋር በእጅጉ የተያያዙ ናቸው።*

የጥናቱ ማጠቃለያ:- *ጥናቱ በኢትዮጵያ ውስጥ የሴቶች ለመገናኛ ብዙኀን መጋለጥ የተቋማዊ ወሊድ አገልግሎት የመጠቀም እድልን በከፍተኛ ሁኔታ እንደሚጨምር አሳይቷል። በተጨማሪም እንደ የከተማ ነዋሪነት፣ ከፍተኛ የትምህርት ደረጃና ከፍተኛ የሀብት መጠን ያሉ ምክንያቶች ከከፍተኛ የተቋማዊ ወሊድ አገልግሎት አጠቃቀም መጠን ጋር አዎንታዊ ቁርኝት አላቸው። እነዚህ ግኝቶች የእናቶች የጤና አገልግሎትን ለማሻሻል የመገናኛ ብዙኀንና ማኅበረ-ኢኮኖሚያዊ ምክንያቶች አስፈላጊ መሆናቸውን አሳይተዋል።*

ቁልፍ ቃላት፡- የተቋማዊ ወሊድ አገልግሎት ፣ መገናኛ ብዙኀን ፣ ኢትዮጵያ

INTRODUCTION

In 2020, there were an estimated 287,000 maternal deaths globally[1]. Developing countries bear a disproportionate burden of maternal deaths, with about 87% of these deaths occurring in Sub-Saharan Africa and South Asia[2]. Ethiopia experiences a high maternal mortality rate of 412 deaths per 100,000 live births. However, with the implementation of effective interventions, this rate has the potential to decrease significantly[3].

For improved maternal and newborn survival outcomes, timely and appropriate healthcare during pregnancy and childbirth is crucial. Studies indicate that mass media is a potent and effective tool for health education and behavioral change [4, 5]. For instance, research conducted in Tanzania demonstrated that mass media campaigns influenced intentions to use female condoms [6]. A study in Nigeria indicated that individuals exposed to mass media were more likely to engage in discussions about HIV/AIDS with a partner and to understand the role of condom use in reducing HIV transmission risk, compared to those who were not exposed [7].

Furthermore, research on maternal health in Indonesia, Bangladesh, and India showed that exposure to mass media campaigns correlated with increased utilization of prenatal, postnatal, and delivery care services [8-11]. Mass media encompasses a range of technologies used to disseminate diverse information, ideas, and perspectives to broad and specific audiences through publishing, broadcasting, or spoken communication [12].

Improving public health through mass media can often feel like navigating a vast network of roads without road signs, prompting questions about whether you are progressing in the right direction toward your destination [13]. Mass media plays a pivotal role in disseminating information about health and medical treatments, with considerable attention given to the relationship between clinical trial investigators and pharmaceutical manufacturers [14, 15].

However, mass media can also play a beneficial role in public health [16, 17]. Its influence is rapidly expanding, promoting ongoing social change, particularly in developing nations. Mass media serves as a crucial tool for public health by disseminating information on health and maternal health [18-21]. Researchers have identified various influences and factors associated with mass media that can affect people's perceptions and behavior [22]. However, to the best of our knowledge, no previous study has investigated the influence of mass media on institutional delivery service utilization in Ethiopia.

The aims of this paper were to assess the influence of mass media on the utilization of institutional delivery services among women in Ethiopia, to examine the evolving familiarity status with notable differences, and to identify areas where exposure to mass media needs improvement. Additionally, we aimed to discern best practices in mass media usage through its trends.

METHODS

Data description and sampling procedure

Ethiopia is located in the eastern region of Africa and has a population of over 100 million, divided into 11 administrative provinces known as regions. The country falls into the low development category according to recent socioeconomic assessments. Approximately 85% of the population resides in rural areas, with agricultural trade emerging as the dominant sector of the economy[23].

The data utilized in this study were sourced from the 2016 Ethiopian Demographic and Health Survey (EDHS), which is a component of the global Demographic and Health Surveys (DHS) project funded by the United States Agency for International Development (USAID). The survey was carried out by the Federal Ministry of Health and the Central Statistical Agency (CSA) of Ethiopia from September 2015 to June 2016. It involved interviews with a nationally representative sample of 7,193 women from 16,650 households. The final analysis included 7,193 women who had given birth at least once within the two to five years preceding the survey.

The Ethiopian Demographic and Health Survey (EDHS) is a nationally representative survey designed to meet the monitoring and evaluation requirements of the Health, Population, and Nutrition Sector Development Program. Its principal objective is to furnish data to program managers and policymakers for effective intervention strategy formulation and implementation. The survey aims to collect evidence on critical national indicators of social progress, encompassing fertility rates, childhood mortality rates, maternal and child health, as well as the nutritional status of mothers and children. Additionally, it assesses factors such as exposure to mass media and awareness of, and attitudes towards, communicable and non-communicable diseases.

The survey employs a population-based, cross-sectional data collection method. For the 2016 EDHS, the sample was designed to provide population and health indicators at both national and regional levels. The sample was representative of Ethiopia's 11 geographic/administrative regions and was selected using a stratified, two-stage cluster design. In the first stage, Enumeration Areas (EAs) served as sampling units, with 645 EAs selected (including 202 urban and 443 rural areas). In the second stage, households were sampled, resulting in a total of 16,650 households being selected. All women aged 15–49 years who had given birth within the five years preceding the survey and were permanent residents of the selected households were eligible for interview. Data collection utilized a structured and pretested questionnaire, and interviews were conducted in the local language [3].

Variable definition

The dependent variable in this study is institutional delivery service utilization, defined as women aged 15–49 years who utilized delivery services for their most recent birth. The independent variables include exposure to mass media through television, radio, newspaper, and contact with a health worker. Additionally, socio-demographic variables such as age, sex, marital status, religion, ethnic group, residence, family size, wealth index, education, occupation, experience of maternal health service, husband's education, and decision-making for maternal health service use are considered.

Data analysis

Data analysis was conducted using STATA version 14 software. The unit of analysis comprised women who had given birth at a health facility with the assistance of health professionals within the five years prior to the data collection period. The analysis utilized weighted data to adjust for sample design effects and non-response rates, ensuring accurate estimates of standard errors. Bivariate analysis was performed to identify associations between dependent and independent variables, with all variables having a p-value of ≤0.2 in the bivariate analysis included in the multivariable logistic model to assess the independent effect of each variable. Adjusted odds ratios (AOR) with a 95% confidence interval and a p-value < 0.05 were used to ascertain the presence of associations between dependent and independent variables.

RESULTS

Descriptive findings of predictor and outcome variables

Approximately 27.7% of the participants reported exposure to radio, followed by television at 19.6%, and newspapers at 7.1% (Table 1).

Table 1 Women exposure to mass media as a source of information about health (weighted), EDHS 2016.

Mass media	Frequency	Percentage
Television	1488	19.6
Radio	2099	27.7
Newspaper	540	7.1
Non-users	4969	65.5

Most of the mothers (69.7%) were within 20 to 35 age group. Over half of the mothers (63.1%) had no formal education. A small percentage of mothers participated from Harari (0.23%), Gambela (0.27%), and Dire-Dawa (0.44%). The vast majority of participants (87.23%) resided in rural areas (Table 2).

Table 2 Characteristic of the women with exposure status of mass media (Weighted), EDHS 2016.

Characteristics		Number (%)	Exposed (n=2620)	Non-exposed (n=4969)	P-value*
Age	<20	339(4.5%)	115	224	0.000
	20-35	5291(69.7%)	1966	3325	
	>35	1959(25.8%)	538	1421	
Region	Tigray	537(7.1%)	238	299	0.000
	Afar	71(0.94%)	23	48	
	Amhara	1632(21.5%)	501	1131	
	Oromia	3129(3.5%)	1083	2046	
	Somali	269(3.5%)	34	235	
	Benishangul	81(1.1%)	21	60	
	SNNPR	1601(21.1%)	497	1104	
	Gambela	21(0.27%)	8	13	
	Harari	17(0.23%)	9	8	
	Addis Abeba	198(2.6%)	189	9	
	Dire-Dawa	33(0.44%)	17	16	
Educational status of the	No education	4791(63.1%)	1123	3668	0.000

Characteristics		Number (%)	Exposed (n=2620)	Non-exposed (n=4969)	P-value*
respondent	Primary	2150(28.3%)	935	1215	
	Secondary	420(5.5%)	343	77	
	Higher	230(3.02%)	220	8	
	No education	3,346(47.07%)	739	2607	0.000
Educational status of the husband	Primary	2731(38.42%)	1004	1727	
	Secondary	613(8.62%)	377	236	
	Higher	419(5.89%)	346	73	
Number of families	<5	3636(47.9%)	1423	2213	0.000
	>5	3954(52.09%)	1197	2757	
Wealth Index combined	Poorest	1651(21.76%)	232	1419	0.000
	Poorer	1654(21.79%)	305	1349	
	Middle	1588(20.93%)	429	1159	
	Richest	1427(18.80%)	643	784	
	Richer	1269(16.72%)	1011	258	
Place of residence	Urban	969(12.77%)	782	187	0.000
	Rural	6621(87.23%)	1838	4783	

Residence, respondent's education level, family size, and wealth index demonstrated significant associations with exposure to mass media in the univariate analysis. The final results of the multiple logistic regression analyses indicated that mothers exposed to mass media were more likely to utilize institutional delivery services (AOR 1.25; 95% CI 1.10, 1.42). Additionally, rural residence (AOR 0.20; 95% CI 0.16, 0.25), primary school education level (AOR 1.98; 95% CI 1.76, 2.24), secondary school education level (AOR 6.12; 95% CI 4.59, 8.17), higher education level (AOR 8.21; 95% CI 4.72, 14.30), as well as poorer wealth index (AOR 1.72; 95% CI 1.44, 2.06), middle wealth index (AOR 1.97; 95% CI 1.65, 2.36), richer wealth index (AOR 2.11; 95% CI 1.76, 2.54), and richest wealth index (AOR 3.19; 95% CI 2.52, 4.03) were significantly associated with institutional delivery service utilization (Table 3).

Table 3 Influence of mass media exposure on institutional delivery service utilization using a logistic regression model (weighted)

Variables		Institutional delivery		COR with 95%CI	AOR with 95%CI
		yes	No		
Media exposure	Not Exposed	1194	3775	1.00	1.00
	Exposed	1329	1291	3.26(2.94,3.60)	1.25(1.10,1.42)
Educational status	No education	1036	3755	1.00	1.00
	Primary	927	1222	2.75(2.46,3.07)	1.98(1.76,2.24)
	Secondary	346	74	17.01(13.11,22.08)	6.12(4.59,8.17)
	Higher	214	16	49.99(29.72,84.76)	8.21(4.72,14.30)
Family size	>5	1452	2184	1.00	1.00
	<5	1071	2882	1.79(1.62,1.97)	1.20(1.07,1.34)
Residence	Urban	816	153	1.00	1.00
	Rural	1707	4914	0.06(0.05,0.08)	0.20(0.16,0.25)
Wealth index	poorest	250	1402	1.00	1.00
	poorer	409	1245	1.85(1.55,2.20)	1.72(1.44,2.06)
	middle	449	1140	2.21(1.86,2.63)	1.97(1.65,2.36)
	Richer	485	942	2.89(2.43,3.44)	2.11(1.76,2.54)
	richest	931	339	15.43(12.85,18.54)	3.19(2.52,4.03)

DISCUSSION

The role of mass media in influencing institutional delivery service utilization is a critical aspect of our study's discussion, shedding light on its impact on healthcare decision-making among women. Our findings reveal intriguing associations between exposure to mass media and the likelihood of opting for institutional delivery services, prompting deeper exploration of this dynamic relationship. According to our research, 27.7% and 19.6% of the respondents reported exposure to radio and TV at least once a week, respectively. These figures are notably lower compared to national data gathered by the 2011

Nepal Demographic Health Survey, which estimated that 44% of women across the country listen to the radio, and 47% watch TV at least once a week [24]. This variance in exposure levels could be attributed to the greater spread of radio stations and TV channels in Nepal compared to Ethiopia.

The current study revealed that mass media had a positive impact on the utilization of institutional delivery services. These findings are consistent with other studies conducted in Ethiopia, Uganda, Bangladesh, and India, where women with access to media were more likely to use maternal healthcare services compared to those without access[25-27].

Respondents from urban areas had higher odds of seeking institutional delivery compared to those from rural areas. This finding is consistent with studies conducted in various regions of Ethiopia [28,29]. Possible reasons for these findings include higher levels of education among mothers in urban areas, better access to healthcare services and transportation, increased decision-making autonomy among mothers, greater awareness of pregnancy and delivery complications, and improved access to information compared to rural areas.

On the other hand, respondents' educational status—those with primary school, secondary school, and higher educational levels—showed higher odds of seeking institutional delivery compared to those with no education. This finding is consistent with studies conducted in various parts of Ethiopia, Nigeria, Pakistan, and Kenya[29-37]. The possible reasons for this trend could include factors such as better awareness and understanding of maternal health issues among educated individuals, improved access to healthcare services and information, increased decision-making autonomy, and greater ability to navigate healthcare systems among those with higher levels of education. Additionally, education may empower individuals to recognize the importance of seeking institutional delivery services and overcome barriers to accessing them[38].

The majority of study participants in the current study resided in rural areas. In these settings, reaching all participants through health workers is challenging. Therefore, mass media emerges as the primary option to reach families and communities, disseminating messages about the importance of institutional delivery and the availability of such services in their communities. The study findings revealed evidence that mass media has a positive effect on the utilization of institutional delivery services.

Limitations

A notable limitation of our study is the lack of correlation between education levels across regions and urban-rural divides in relation to wealth quintiles. Consequently, further research is warranted to explore variations across different geographic regions of Ethiopia.

CONCLUSION

Mass media, as a primary mode of information communication technology, holds significant influence over people's perceptions and behaviors. Exposure to mass media has the potential to bring about positive changes or prevent negative trends among large population groups. Our study indicates an association between exposure to mass media and the utilization of institutional delivery services, with mothers exposed to mass media being more inclined to seek delivery at health facilities. These findings highlight the potential benefit of utilizing mass media in rural settings to promote institutional delivery service utilization in Ethiopia.

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ABBREVIATIONS

AOR-Adjusted Odds Ratio

CI- Confidence Interval

COR-Crude Odd Ratio

CSA- Central Statistical Agency

EAs-Enumeration Areas

EDHS-Ethiopian Demographic and Health Survey

USAID -United States Agency for International Development

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Since this study involved a secondary analysis of publicly available survey data from the MEASURE DHS program, ethical approval and participant consent was not required. Permission to use the data was obtained from the DHS Program, and it was downloaded from http://www.dhsprogram.com with their authorization. The procedures for DHS public-use datasets, as approved by the Institution Review Board, ensure that respondents, households, or sample communities cannot be identified from the data. The data files do not contain names of individuals or household addresses. Therefore, ethical approval and consent to participate were not

applicable to this study, as it is based on nationally representative EDHS data.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

The 2016 EDHS data used in this study are third-party from the Demographic and Health Surveys Program website (https://dhsprogram.com/data/available-datasets.cfm) and can be accessed following the protocol outlined in the method section.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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CONTRIBUTION OF AUTHORS

AdN: contributes to the study design, data organization, analysis, and write-up; AmN contributes to the write-up and the overall supervision of the study from its inception. Both authors read and approved the final manuscript.

AUTHOR'S INFORMATION

AdN is a senior Public Health researcher at Amhara Public Health Institute

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Outcomes of Patients with Acute Chemical Poisoning in Public Referral Hospitals of Bahir Dar City, Ethiopia

Desalew Salew Tewabe[1*], Gizew Dessie Asres[1], Seid Legesse Hassen[1], Habtamu Alebachew Tegegne[1], Biresaw Tazaye Lake[1], Tiruneh Genet Meles[1], Damtie Lankir Abebe[1] Abrham Amsalu Berneh[1], Tesfahun Tadege Geremew[1], Fisiha Wale Tsegaw[1], Belay Bezabih Beyene[1]

[1]Amhara Public Health Institute, Bahir Dar, Ethiopia
[*]Corresponding Author: Desalew Salew Email: desalew131@gmail.com. Bahir Dar, Ethiopia.

ABSTRACT:

Background: *Acute chemical poisoning is a global public health concern. It is influenced by factors such as geographical differences, availability of chemical substances, occupation, and industrialization. Widespread pesticide use in developing countries increased its incident. There is insufficient epidemiological data in the region to manage and intervene the problem. The study aims to assess the outcome of acute chemical poisoning cases in two public specialized hospitals of Bahir Dar city, Ethiopia from May 2022 to November 2023.*

Method: *A retrospective cross-sectional study was conducted at the Emergency departments of the two public hospitals in Bahir Dar City from May 2022 to November 2023 to assess the outcome of acute chemical poisoning cases. A total of 619 registered patients diagnosed with poisoning were included in the study. Socio-demographic data were collected from the medical records of acute poisoning patients using a data collection checklist. Descriptive analysis was performed using statistical tools in Statistical Package for Social Science (SPSS), and the results were presented through tables and graphs. Ethical approval was obtained from the Amhara National Regional State Public Health Institute Research Ethics Review Board (ARRERB), and cooperation letters to the hospitals were requested.*

Results: *There was a higher incidence of chemical poisoning in females than in males. Seventy percent of the cases were between 15-29 years of age. 86.16% of the chemical poisoning cases were attributed to Organophosphates and Metallo Phosphides. The most reported complaints 97.4% cases were vomiting, and abdominal pain. Chemical poisoning cases were primarily intentional accounting for 93.3% of the cases. Twelve percent of acute chemical poisoning cases were died. The study indicates a higher (32.10%) cases in Spring and fewer (18.01%) cases in Autumn.*

Conclusion: *Acute chemical poisoning is more common in females and youths aged 11-30 years, primarily due to organophosphorus chemicals, often resulting from intentional poisoning. Effective strategies are essential for safely storing and distributing highly toxic chemicals, especially to prevent children from accessing them.*

Keywords: *Acute chemical poisoning; Bahir Dar; Ethiopia; hospital; outcome; patients; pattern.*

አጎጽሮተ ጥናት

የጥናቱ መግቢያ:- *አጣዳፊ የኬሚካል መመረዝ የዓለም የጎብረተሰብ ጤና አሳሳቢ ጉዳይ ነው። እንደ መልካምድራዊ ልዩነቶች፣ የኬሚካል ቁሶች ተደራሽነት (መገኘት መቻል)፣ ወረራና የኢንዱስትሪ መስፋፋት የመሳሰሉ ተላውጠዎች በአጣዳፊ የኬሚካል መመረዝ መከሰቶች ላይ ተፅዕኖ ያደርጋሉ። በማደግ ላይ ባሉ ሀገሮች የፀረ ተባይ ኬሚካሎችን በስፋት ጥቅም ላይ ማዋል አጣዳፊ የኬሚካል መመረዝ መከሰቶችን ይጨምራል። በክልሉ ችግሩን በአግባቡ ለመያዝና ለችግሩ ምላሽ ለመስጠት በቂ በአጣዳፊ የኬሚካል መመረዝ መከሰቶች ላይ የተኮረ ሳይንሳዊ የስርጭትና ቁጥጥር ጥናት መረጃ የለም። ይህ ጥናት እ.አ.አ. ከግንቦት 2022 እስከ ኅዳር 2023 በነበረው ጊዜ በባሕር ዳር ከተማ፣ ኢትዮጵያ ውስጥ በሚገኙ ሁለት የመንግሥት ስፔሻላይዝድ ሆስፒታሎች ውስጥ በአጣዳፊ የኬሚካል መመረዝ ታማሚዎች ላይ የተሰተዋሉ ፓተርኖችና የተገኙ ውጤቶችን መገምገም ነው።*

የጥናቱ ዘዴ:- *በአጣዳፊ የኬሚካል መመረዝ ታማሚዎች ላይ የተሰተዋሉ ፓተርኖችና የተገኙ ውጤቶችን ለመገምገም፣ እ.አ.አ. ከግንቦት 2022 እስከ ኅዳር 2023 በነበረው ጊዜ በባሕር ዳር ከተማ ውስጥ በሚገኙ ሁለት የመንግሥት ስፔሻላይዝድ ሆስፒታሎች ውስጥ በድንገተኛ ክፍሎች ላይ ዳኅራይ ተሻጋሪ ጥናት ተካሂዷል። በጥናቱ በመመረዝ ምርመራ የተመዘገቡ 619 ታማሚዎች ተካትተዋል። የማኅበረ ሥነ ህዝባዊ ተላውጦዎች መረጃዎች ቼክሊሰቶችን በመጠቀም ከአጣዳፊ የመመረዝ ታማሚዎች የሕክምና መዝገቦች ተሰብስበዋል። የተሰበሰበው መረጃ የኤስፒኤስኤስ (SPSS) ሲታቲስቲካዊ መሣሪያዎችን በመጠቀም በገላጭ ትንተና ቀርቧል። መረጃው ተተንትኖ የቀረበው ሰንጠረዦችንና ግራፎችን በመጠቀም ነው። የምርምር ሥነምግባራዊ ማረጋገጫ ከአማራ ክልል የምርምር ሥነምግባር ግምገማ ቦረድ ተገኝቶ የነበረ ሲሆን ለሆስፒታሎች የትብብር ደብዳቤ ተልኳል።*

የጥናቱ ውጤት:- *የጥናቱ ውጤት እንደሚያሳየው ከጾታ አንጻር የኬሚካል መመረዝ መከሰት ከወንዶች የበለጠ በሴቶች ላይ ከፍተኛ ነበር። ከእድሜ አኳያ ደግሞ 70 በመቶ የሚሆኑት የኬሚካል መመረዝ ታማሚዎች ከ15-29 ዓመት የእድሜ ክልል ያሉ ወጣቶች ነበሩ። 86.16 በመቶ የሚሆኑት የኬሚካል መመረዞች የተከሰቱት በኦርጋኖፎስፌት (Organophosphate)ና በሜታሊክ ፎስፋይድ (Metallo phosphide) አማካኝነት የተከሰቱ ነበሩ። 97.4 በመቶ የሚሆኑት ታማሚዎች ያሳዩዋቸው ምልክቶች ማስመለስና የሆድ ህመም ነበሩ። የኬሚካል መመረዞች የተከሰቱት በቀዳሚነት (93.3 በመቶ) ሆነ ተብለው ነው። 12 በመቶዎቹ የኬሚካል መመረዝ ታማሚዎች ሞተዋል። ጥናቱ ከፍተኛ የኬሚካል መመረዞች (32.1 በመቶ) የተከሰቱት በጸደይ እንደነበርና ዝቅተኛ የኬሚካል መመረዞች (18.1 በመቶ) ደግሞ የተከሰቱት በበልግ እንደነበር አሳይቷል።*

የጥናቱ ማጠቃለያና ምክረሐሳብ:- *አጣዳፊ የኬሚካል መመረዝ መከሰት ከ11-30ዓመት የእድሜ ክልል ባሉ ወጣቶች ከፍተኛ ነበር።*

ለመመረዙ በጣም የተለመዱት ኬሚካሎች ኦርጋኖፎስፌረስ የነበሩ ሲሆን ሆነ ብሎ መመረዝ ደግሞ ዋነኛው አጣዳፊ የኬሚካል መመረዝ መከሰት ምክንያት ነበር። በጣም መርዛማ የሆኑ ኬሚካሎችን አቀማመጥና ሥርጭት በተለይ ልጆች እንዳይደርሷቸው ውጤታማ የመመረዝ መከላከያ ስልቶች ያስፈልጋሉ።

ቁልፍ ቃላት:- *አጣዳፊ የኬሚካል መመረዝ፣ ባሕር ዳር፣ ኢትዮጵያ፣ ሆስፒታል፣ ውጤት፣ ተማሚዎች፣ፓተርኖች*

BACKGROUND

A poison is any substance that is harmful when ingested, inhaled, injected, or absorbed in to the body. Poisoning is a qualitative term that refers to a chemical substance's ability to have a negative or harmful effect on the body [1]. Poison can enter the body through various routes, leading to systemic and local effects. Poisoning can happen intentionally or accidentally, such as through occupational exposure, environmental contact, or everyday activities at home. Accidental or non-intentional poisoning refers to incidents where drugs or chemicals are used inadvertently, without purpose [2].

Acute chemical poisoning refers to the rapid onset of toxic effects, typically within 24 hours of exposure, regardless of the route of exposure, whether intentional or unintentional [3]. It is a frequent cause of emergency admissions and hospitalizations, often leading to illness and death. Poisoning represents a substantial global public health issue [4, 5]. According to World Health Organization (WHO) data from 2012, around 193,460 deaths worldwide were attributed to unintentional poisoning, with 84% of these occurring in low- and middle-income countries 4. The World Health Organization (WHO) estimates that deliberate ingestion of pesticides causes 370,000 deaths each year, ranking poisoning among the top 50 causes of death worldwide [6].

The actual number of incidents could be higher since many cases of poisoning go unreported [7]. Patterns and causes of acute poisoning vary across geographical regions, even within the same country or region [7]. Studies indicate that the incidence of poisoning in a particular area is influenced by the accessibility of toxic substances, the prevalent occupations within the community, and religious and societal factors [8]. The number of cases is increasing daily due to changes in lifestyle and social behavior [4]. The rapid expansion of industry and the widespread use of pesticides and drugs have resulted in increased incidents of poisoning and potential harm when used incorrectly [8, 9]. Agricultural pesticides and household cleaning agents are commonly used poisons in developing countries [10]. The increase in poisoning cases in developing nations is attributed to inadequate regulation of drugs and chemicals, weak surveillance systems, insufficient enforcement measures, and easy access to various substances [9].

Acute pesticide poisoning, especially in developing countries, results in substantial morbidity and mortality due to factors such as lack of standardized case definitions, underreporting, inadequate documentation, and a shortage of tools and expertise [11, 12].

In a study conducted at two hospitals in Ambo, Ethiopia, the hospital prevalence of acute poisoning was 1.7% [13]. It is notably more prevalent among females and individuals under 30 years of age 10. According to the Ethiopian Public Health Institute (EPHI), in their epidemiological bulletin for week 23, a total of 387 cases of chemical poisoning and 21 deaths were reported from January 1, 2022, to June 6, 2022. Among these, 216 cases (55.81%) and 11 deaths (52.38%) occurred in the Amhara region [14].

Although acute chemical poisoning is a prevalent health issue, it is often overlooked due to challenges in diagnosing poisoning cases [15]. Understanding current trends is essential for improving diagnosis, management, intervention, and prevention strategies. Therefore, this research aimed to investigate the patterns and clinical outcomes among acute poisoning cases treated at Felege Hiwot Comprehensive Specialized Hospital (FHCSH) and Tibebe Ghion Specialized Hospital (TGSH) over nineteen-month period from May 2022 to November 2023.

METHODS

Study Area and Period

Bahir Dar, the capital city of the Amhara Region, is located 567 km northwest of Addis Ababa, the capital city of Ethiopia. The city is situated at the geographical coordinates of 11° 35' 34" N and 37° 23' 03" E. The city administration includes three smaller urban areas: Zegie, Tis Abay, and Meshenti. According to the Bahir Dar administration's estimation for 2022, the city's total population was approximately 422,580, with females accounting for 51% (215,516 individuals). Bahir Dar is administratively divided into 20 kebeles, which are the smallest administrative units in the country. The area encompasses a total of 40,893 households, with an average of 4.47 persons per household. The population density is 753 persons per square kilometer. Approximately 81.2% of the population resides in urban areas, while the remainder lives in rural kebeles surrounding Bahir Dar[16]. The city hosts three public hospitals, 10 health centers, 15

health posts, four private general hospitals, and 16 private clinics. The study was conducted at the Emergency Departments (ED) of two selected public hospitals: Felege Hiwot Comprehensive Specialized Hospital (FHSRH) and Tibebe Ghion Specialized Hospitals (TGSH) in Bahir Dar city administration, located in the northwest region of Ethiopia, from May 2022 to November 2023.

Study Design and Study Population

An institutional-based retrospective cross-sectional study was conducted to assess the patterns and clinical outcomes of acute poisoning cases at the Emergency Outpatient Departments (EOPD) of the two selected hospitals.

Inclusion criteria

Patients of all age groups who presented with acute poisoning to the emergency department were included and listed in the registry of emergency cases during the study period.

Exclusion Criteria

Patients with recreational drugs of abuse (such as alcohol and cocaine), patients affected by natural poisons like stings and envenomation, and acute poisoning cases with incomplete information on the patient registry form were excluded from the study. Only one case of acute chemical poisoning was excluded due to incomplete data.

Sampling Technique and Sample Size

The sample size comprised all recorded data of acute chemical poisoning cases at the Emergency Departments (ED) of the two purposely selected high-volume specialized public hospitals in Bahir Dar city: Felege Hiwot Comprehensive Specialized Hospital (FHSRH) and Tibebe Ghion Specialized Hospital (TGSH). A total of 619 patients were registered in the Emergency Department of these hospitals with a primary diagnosis of acute chemical poisoning, and their histories were documented in the emergency registry forms. during the study period were included in the study.

Dependent Variables: Outcome of Acute chemical poisoning

Independent Variable: Age, sex, route of poisoning, type of chemical poisoning, poisoning situation, and season of poisoning.

Data Collection Tool and Procedure

A data collection checklist containing the variables to be collected from the patient registry was prepared and used for data extraction. The data were collected by two BSc nurses with experience in data collection, who were trained on the data collection process. Patients with acute poisoning were identified and selected from the patient registration books. Socio-demographic data (age, sex), route of exposure, clinical presentation/presenting complaint, type of poisoning, season of poisoning, and outcome of poisoning were extracted from the patients' medical records.

Data Quality Assurance, Data Processing, and Analysis

The data collection process was supervised and supported by supervisors. Data recorded in Microsoft Excel was immediately checked for completeness, accuracy, and consistency after collection, and was appropriately organized and stored for compilation and analysis. After reviewing and ensuring completeness, Statistical Package for the Social Sciences (SPSS) version 25 software was used to analyze the data. Descriptive statistical tools, such as percentages and frequencies, were employed to report the data. Results were presented using percentage breakdowns, frequency tables, and figures.

Operational Definition

- **Acute chemical poisoning**: Acute chemical poisoning occurs when toxic effects manifest immediately, typically within 24 hours of exposure to the chemical.
- **Intentional poisoning**: Poisoning occurs when a person ingests or administers a substance with the intent to cause harm.
- **Unintentional poisoning**: Poisoning can occur when a person ingests or administers a substance unintentionally or without apparent reason, resulting in harm.
- **Outcome is death**: A case of chemical poisoning in the emergency department of a hospital is considered acute when toxic effects manifest rapidly after exposure to the chemical. The clinical outcome is recorded as death if the patient succumbs to the poisoning before being discharged from the hospital.
- **Outcome is alive**: When a chemical poisoning case in the emergency department of the hospital is presented as an acute chemical poisoning and when the clinical outcome during discharge from the hospital is alive.
- **Left against medical advice**: When a case of chemical poisoning is presented in the emergency department of the hospital, and the patient is unable to follow the medical advice or treatment options provided by the healthcare providers.

RESULTS

Socio-demographic characteristics

The study revealed that acute chemical poisoning cases were more prevalent among females (66.56%) than males (33.44%). Most cases occurred in the age group 15-39 years, constituting approximately 70% of all acute chemical poisoning cases (22.1% aged 15-19, 29.8% aged 20-24, and 18.1% aged 25-29). The majority of cases were from Bahir Dar City Administration (358 cases, 57.84%). Awi, Bahir Dar, Central Gondar, East Gojjam, South Gondar, and West Gojjam were the residence zones of the cases among which 358 (57.84%) were from Bahir Dar, 117(18.9%) from West Gojjam, 117(18.9%) from South Gondar, 10(1.62%) from East Gojjam, 10(1.62%) from C. Gondar, 7(1.13%) from Awi zone (Table 1).

Table 1 Socio-demographic characteristics of patients presenting with chemical poisoning cases at Felege Hiwot Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospitals from May 2022 to November 2023 (n=619)

Variable	Category	Frequency (n)	Percent (%)
Sex	Female	412	66.56
	Male	207	33.44
Age by 5-year Category	0-4	2	.3
	5–9	1	.2
	10-4	10	1.6
	15-19	137	22.1
	20-24	185	29.8
	25-29	112	18.1
	30-34	52	8.4
	35-39	35	5.6
	40-44	30	4.8
	45-49	22	3.55
	50-54	16	2.6
	55-59	8	1.3
	60-64	6	1.0
	>=65	3	.5
Residence of acute chemical poisoning cases	Awi	7	1.13
	Bahir Dar	358	57.84
	Central Gondar	10	1.61
	East Gojjam	10	1.61
	South Gondar	117	18.90
	West Gojjam	117	18.90

Proportion of acute chemical poisoning cases per age categories

The proportion of chemical poisoning cases among individuals aged 15-19, 20-24, 25-29, and 30-34 was 22.13%, 29.89%, 18.09%, and 8.40% respectively, collectively accounting for 78.5% of all chemical poisoning cases within the 15-34 age group. A similar trend was observed among residents of Bahir Dar, with percentages of 22.63%, 30.73%, 21.23%, and 8.10% in the respective age groups, totaling 82.69% of all cases among Bahir Dar residents.

Regarding age, acute chemical poisoning cases were similar among Bahir Dar city residents and the overall cases at the two hospitals. Most of these cases occurred in the 15–30 age group (Figure 1).

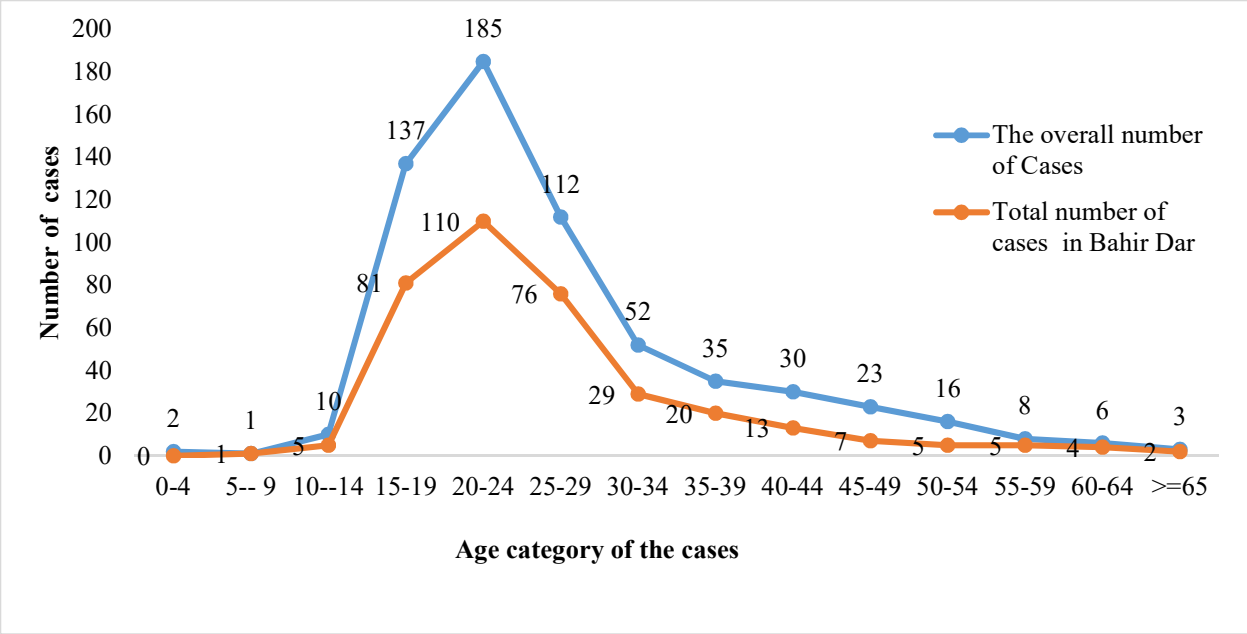

Figure 1 Acute Chemical Poisoning Cases by Age Group at Felege Hiwot Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospital, Bahir Dar City, Amhara Region, Ethiopia (May 2022 – November 2023)

Type of chemical poisoning agent and clinical presentations

The types of complaints commonly associated with chemical poisoning include vomiting, abdominal pain, difficulty breathing, burning sensation, chest pain, fatigue, and loss of consciousness. According to the study, vomiting was the most commonly reported symptom among poisoning cases, noted in 61.34% of cases, followed by abdominal pain, reported in 36.07% of cases. Furthermore, the study found that 95.4% of chemical poisonings were attributed to five types of chemicals: Organophosphates (57.95%), Metallo Phosphides (28.21%), rat poison (3.76%), drug overdose (2.74%), and bleach (2.74%) (Figure 2).

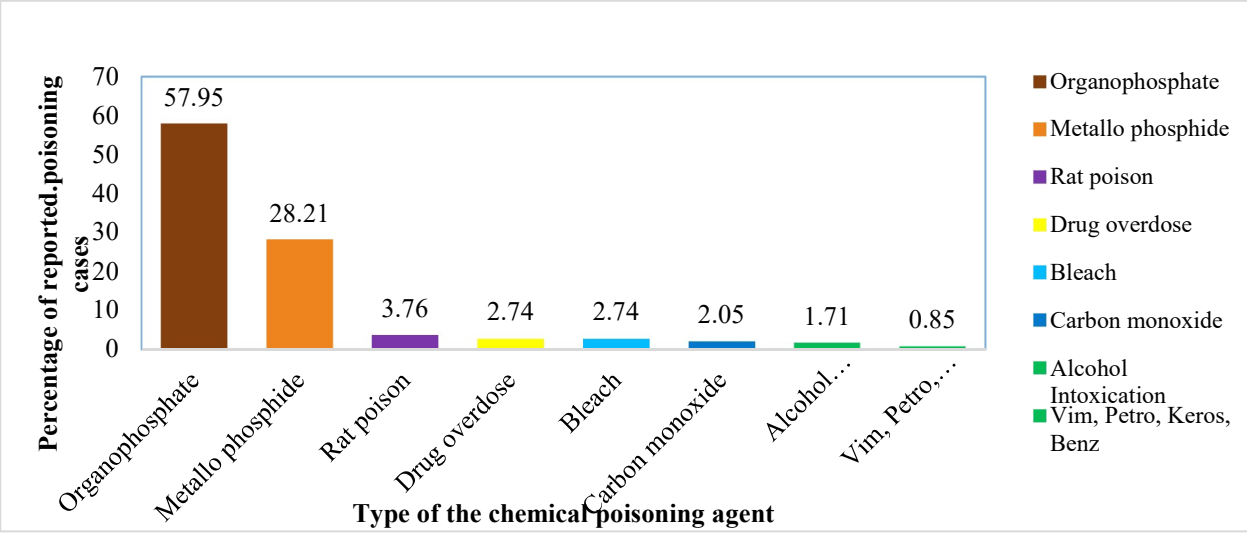

Figure 2 Distribution of chemical poisoning agents among patients presented at Felege Hiwot Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospitals, Bahir Dar City, from May 2022 to November 2023, Amhara Region, Ethiopia.

Outcome of acute chemical poisoning

The acute chemical poisoning cases were reported by two specialized public hospitals in the Amhara region: Felege Hiwot Comprehensive Specialized Hospital, which accounted for 80.3%, and Tibebe Ghion Specialized Teaching Hospital, which accounted for the remaining 19.7% of cases. Regarding the outcomes of poisoning, the majority (87.6%) of cases showed improvement and survival, while 12.1% of acute

chemical poisoning cases resulted in death, with only 0.3% leaving against medical advice (Figure 3).

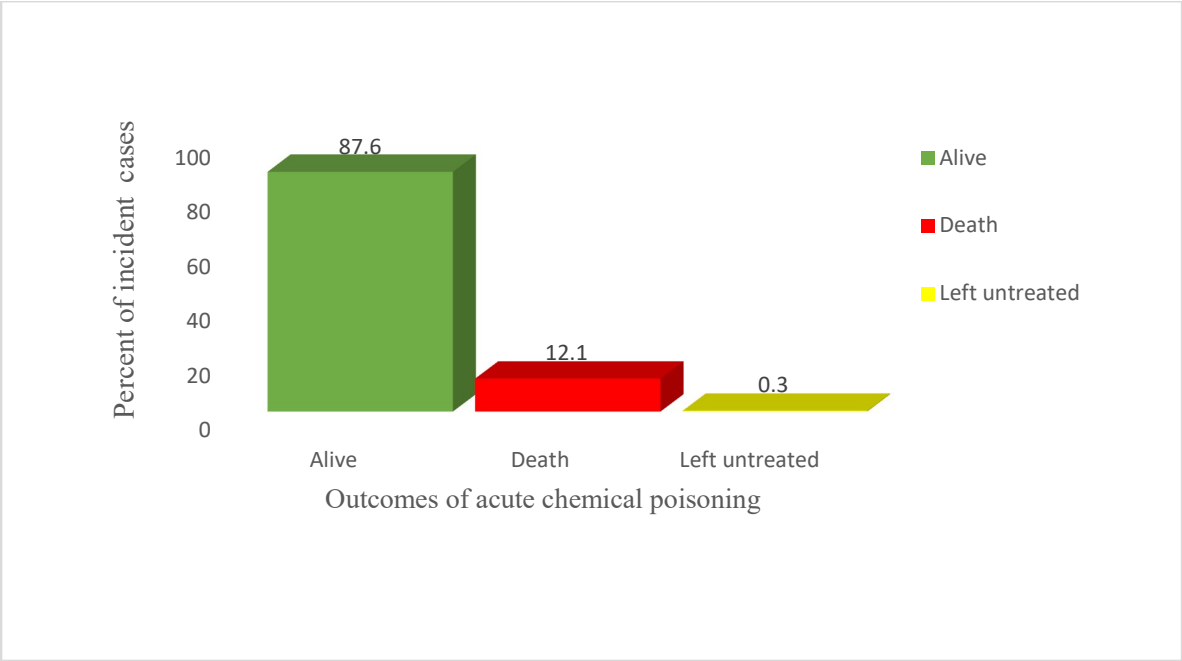

Figure 3 Outcome of chemical poisoning among cases presented at Felege Hiwot Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospitals, Bahir Dar City, Amhara Region, Ethiopia, from May 2022 to November 2023.

Pattern of Acute Chemical poisoning per season

The causes of acute chemical poisoning included both intentional and accidental occurrences. The study revealed that the majority, 97.3% of cases, were intentional, while the remaining 2.7% were accidental. A one-year data to illustrate seasonal variations showed a higher number of cases occurring in Spring, with proportions of 32.10% in Spring, 27.48% in Winter, 22.40% in Summer, and 18.01% in Autumn (Figure 4).

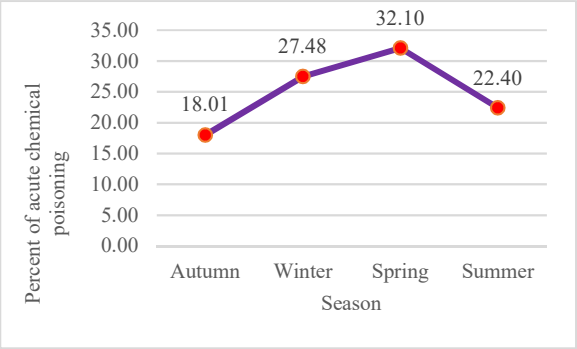

Figure 4 Trends in acute chemical poisoning cases by season among patients presented at Felege Hiwot Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospitals, Amhara Region, Ethiopia.

DISCUSSION

The study found that females accounted for 66.56% of poisoning cases, representing a ratio of 1.99:1 compared to males. This trend mirrors findings from other studies: in Wellega, Ethiopia, 59.2% of poisoning cases were females 9; a review across Ethiopia indicated rates as high as 78% of chemical poisoning cases in females[10]. Similar proportions were observed in Goztepe Training and Research Hospitals in Turkey (64.7%) [17], as well as in studies conducted in central and zonal district hospitals and a tertiary care hospital in South India [2, 18]. A possible explanation for these findings is the higher suicide rates among females in Ethiopia, influenced by cultural norms and practices. Young females in Ethiopia often experience close monitoring by their families, leading to behaviors such as concealing intimate relationships to avoid conflict. This can result in familial and personal discord, potentially prompting suicide attempts involving various poisons or drugs [19].

The average age of acute chemical poisoning cases by the current study was 26.45 years, with a standard deviation of 10.7 years. The finding was consistent with the findings of studies which found that the average age of acute chemical poisoning cases were: 25.5 years at University of Gondar Teaching Hospital[20], 25.18 years in Adama referral hospital[21], 24.36 years in teaching hospitals of Northwest

Ethiopia[19], 23.1 years in hospital of Adama medical college[22], 25 years in Tikur Anbessa specialized teaching hospital 23, and 27.4 years in Goztepe Training and Research Hospitals in Turkey [17]. It was also found that 77.38.5% of the cases were between 11 to 30 years. This finding was similar to a study conducted at Tikur Anbessa Hospital in Addis Ababa, where 87.9% of poisonings occurred among individuals aged between 13 to 30 years [23], 66.2% between age 12-29 years in two hospitals of Ambo 13, 70.4% in age between 11-30 years in Debre Markos [24], 76.7% between age group 11-30 years in Dessie Referral Hospital Ethiopia [25], 79.6% between age group 13-34 years in Addis Ababa Burn, Emergency, and Trauma Hospital [26], 88.42% between age group 11-30 years in University of Gondar teaching hospitals northwest Ethiopia [27]; 60.9% between 10-30 years in a tertiary care teaching hospital in Southern India [28]. In this study, the age group most vulnerable to acute chemical poisoning was young adults between 15-30 years of age. This finding aligns with similar studies conducted in Ethiopia [10], Kenya [29], India [30], Iran[31], and China [32]. The high incidence of acute chemical poisoning among young adults can be partially attributed to their susceptibility to stressful life circumstances and their emotional vulnerability, which may lead to suicidal tendencies. Additionally, this age group often experiences adjustment disorders, further predisposing them to suicidal behaviors [33]. moreover, young adults in this age group frequently encounter challenges such as romantic disappointments, job or academic failures, and the pressure of meeting parental expectations, all of which can contribute to their heightened risk of chemical poisoning and suicidal acts [31-33].

The study found that Organophosphate and Metallo Phosphide were the most common chemical agents involved in poisoning cases, accounting for 57.95% and 28.21% of cases, respectively. Specifically, the study confirmed the presence of 61.3% Organophosphate and 25.7% Metallo Phosphide at DMCSH [24]. This finding is aligned with studies in selected hospitals in Wollega Ethiopia[9], Ambo Ethiopia [13], Dessie Ethiopia [25], teaching hospitals in Lusaka, Zambia [34], urban referral hospitals in Lusaka, Zambia [35] which reported organophosphates were the most commonly used chemical poisoning. The prevalence of organophosphate poisoning may be attributed to their widespread use as chemical agents, with agrochemicals being the most commonly used for self-harm in developing countries [36, 37]. A study in Ethiopia (2016) found that pesticides, herbicides, and insecticides are the most common cause of poisoning in less industrialized countries, due to poor safety culture, illiteracy, ignorance, and lack of protective devices [38].

This study found that the cause for majority (97.3%) of chemical poisoning cases were intentional poisoning. This finding is similar with the finding of studies: 98.0% in Addis Ababa Ethiopia [26], Though relatively lower as compared to our finding, higher intentional poisoning cases were also reported 76.9% in Ambo Ethiopia [13], 77.8% in Nepal [38], and 96.6% in Tikur Anbesa Hospital Addis Ababa, Ethiopia [23,] which revealed intentional poisoning was the most common cause or manner of poisoning. The current findings indicate a higher incidence rate than those reported in Wollega, Ethiopia (46.45%) [9], Dessie, Ethiopia (64.2%)[25], and India (68.40%) [39]. The discrepancies observed may be from socioeconomic disparities, as well as the varying availability and accessibility of poisonous substances. Moreover, the high intentional poisoning rate can be attributed to various factors including familial, social, economic, psychological, personal challenges, and immaturity or inadequacy in coping with immediate situations.

The study indicated an overall mortality rate of 12.1%, which is higher than the rates observed in Dessie, Ethiopia (6.6%)[25], Southern India (5.32%)[28], Wollega, Ethiopia (7.10%) [9], and Jimma, Ethiopia (5.8%) [23]. However, this rate is low compared to studies conducted in Metu, Ethiopia 27.6% (8), in five public hospitals of Amhara Ethiopia 18% [40]. The variations in these rates may be attributable to factors such as the timeliness of diagnosis, the type of poison exposure, the patient's time of arrival at the hospital[13,24], the initial severity[41.] pre-hospital care and transportation services.

An analysis of the one-year trend in acute chemical poisoning cases revealed seasonal variations. Specifically, the percentages of cases in Spring, Winter, Summer, and Autumn were 32.10%, 27.48%, 22.40%, and 18.01%, respectively.

This study finding aligns with the finding from University of Gondar Ethiopia, which reported that 32.2% of cases were admitted during Ethiopia's spring season [27]. A similar finding was reported by a study in Wollega Ethiopia [9]. However, it was in contrast with the finding of a study in Dessie, Ethiopia, 31.7% of acute chemical poisoning cases were reported in autumn and 15.8% during spring [25]. Studies in Palestine and others also discovered similar seasonal variations in the number of poisoning cases [34]. Based on our observation the higher number of acute chemical poisoning cases in winter could be explained because of the easy availability and storage of agrochemical pesticides and insecticides of grains during the Ethiopian harvesting periods.

Limitation of the Study:

One of the limitations of this study is that it attempted to determine the pattern of the acute chemical poisoning cases using only the existing variables and it was difficult to get additional variables.

CONCLUSION

This study revealed that poisoning incidents were more frequent among females than males, with individuals aged 11 to 30 years being particularly vulnerable. Agrochemicals, especially organophosphorus insecticides, were identified as the most commonly used substances in these cases. Furthermore, the study found that nearly all cases of acute chemical poisoning were intentional and frequently associated with self-harm. A notably high mortality rate was also observed in attributed to chemical poisonings.

Recommendation

It calls for an urgent need to raise public awareness about the severity of this issue. Developing and implementing effective poisoning prevention strategies could significantly mitigate its impact on the health of the general population.

- Policies and regulations should be developed and strictly implemented to limit the access to toxic chemicals, especially among sensitive demographics such as young females.
- It is imperative to set up Poison Information and Control Centers that offer essential public and medical information, establish standard case definitions, provide treatment protocols, and facilitate training for prompt diagnosis and treatment to support informed decision-making.
- Healthcare facilities are encouraged to meticulously record and report instances of acute chemical poisoning, ensuring accurate data collection for evidence-based policy formulation.

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ABBREVIATIONS

EOPD: Emergency Outpatient Department of two selected public hospitals:

FHCSH = Felege Hiwot Comprehensive Specialized Hospital and

TGSH: Tibebe Ghion Specialized Hospitals Specialized Hospital

SPSS: Statistical Packages for Social Sciences

PIC: Poison Information Center

ACP: Acute Chemical Poisoning

ARRERB: Amhara Regional Research Ethics Review Board

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

An ethical approval letter was obtained from the Amhara National Regional State Public Health Institute Research Ethics Review Board (ARRERB with a Ref:NoH/R/T/T/D/07/78 on Date: 12/06/2024GC). Letters of cooperation were also sent to the respective hospitals involved in the study. After data collection, all personal identifiers were removed to ensure confidentiality and privacy of the data. Strict measures were taken to maintain the confidentiality of the information throughout the study.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

All the datasets analyzed during the current study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

Funding was not received from any organization.

CONTRIBUTION OF AUTHORS

DS, GD, SL, HA, and AA conceived the study, carried out the overall design, analyzed, and interpreted the data, statistical analysis. All Authors have reviewed the manuscript.

AUTHOR'S INFORMATION

DS had a Master's degree in Biomedical Science.

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Bacterial profile and antimicrobial susceptibility patterns of isolates from postoperative surgical site infections and hospital environment samples

Solomon Belay[1], Sirak Biset[1], Aklilu Ambachew[1], Wondwossen Abebe[1], FekaduWudie[2] Gizeaddis Belay[3*]

[1]Department of Medical Microbiology, University of Gondar, College of Medicine and Health Sciences, School of Biomedical and Laboratory Sciences, Gondar, Ethiopia.
[2] Department of Pathology, College of Medicine and Health Science, Bahir Dar University, Ethiopia
[3]Department of Medical Microbiology, Amhara National Regional State Public Health Institute, Bahir Dar, Ethiopia
[*]Corresponding Author: Gizeaddis Belay: Email: gizebetaddis@gmail.com, Mobile Number +251 935 48 1335,

ABSTRACT:

Background: *The occurrence of microorganisms especially antimicrobial-resistant bacteria in health facilities can cause infections among admitted patients. This increases the treatment costs, prolonged hospital stays, and significant morbidity and mortality for postoperative patients. Currently, there is insufficient evidence of surgical site infection and multidrug-resistant bacteria. Therefore, continuous surveillance is necessary to guide an appropriate therapy for surgical site infection and the rational use of antimicrobial agents. Thus, this study provides updated information on information about the bacteria, Multi-Drug Resistance bacteria species responsible for postoperative surgical site infection, and the etiologic agents in hospital environments.*

Objectives: *This study assesses bacterial profile and antimicrobial susceptibility patterns in samples collected from postoperative surgical site infections and the hospital environment at the University of Gondar Comprehensive Specialized Hospital, Gondar; Northwest Ethiopia.*

Materials and methods: *A cross-sectional study was conducted among patients with postoperative surgical site infections and hospital environment samples from February 1 to April 30, 2020. All postoperative patients suspected of having surgical site infections and hospital environments were included in the study. A total of 202 samples (52 from wounds and 150 from the environment) were examined. Socio-demographic characteristics were collected using a structured questionnaire. Swab samples were obtained and inoculated onto MacConkey agar, Mannitol salt agar, Blood agar plates, and Chocolate agar by rolling the swab over the agar surfaces. The inoculated plates were then incubated at 37 °C for 24 to 48 hours. Air culture samples from Blood agar plates were also incubated at 37 °C for 24 hours. Antimicrobial susceptibility testing was conducted using the disk diffusion method on Muller Hinton agar. Data were entered and analyzed using Statistical Package for the Social Sciences version 20. Descriptive statistics were employed to present the findings through words, percentages, and tables.*

Results: *Of 52 wound samples from surgical site infection, the most frequent isolates were S. aureus and Klebsiella species, each accounting for 11 cases (20%), followed by E. coli with 10 cases (18.2%). Among the S. aureus isolates, 63.6% were methicillin-resistant. The overall rate of multidrug resistance was 31 cases (56.4%). Regarding hospital environmental samples, of 150 samples, the most commonly identified isolates were coagulase-negative S. aureus with 57 cases (47.5%), followed by S. aureus with 35 cases (29.2%). The overall rate of multidrug resistance was 66 cases (55.0%).*

Conclusion: *Staphylococcus aureus, Klebsiella species, and E. coli were identified as the most prevalent bacteria from postoperative surgical site infections, with hospital environments serving as potential reservoirs for these pathogens in the study area. High prevalence rates of methicillin-resistant and multidrug-resistant were observed among both clinical and hospital isolates in this study. However, Amikacin and Clindamycin demonstrated the highest effectiveness in inhibiting the in vitro growth of Gram-negative and Gram-positive bacterial isolates, respectively. Therefore, updating treatment guidelines based on hospital formularies and susceptibility patterns is crucial to prevent the further emergence and spread of multidrug-resistant bacterial pathogens. Additionally, infection prevention practices should be strengthened.*

Keywords: *antimicrobial susceptibility; Environmental sample; surgical site infection; Gondar; Ethiopia.*

አጎጽሮተ ጥናት

የጥናቱ ዳራ፡- *በጤና ተቋማት ውስጥ፣ ረቂቅ ተሕዋስያን በተለይም ፀረ ተሕዋስያንን የሚቋቋሙ ባክቴሪያዎች መከሰት ወደ ተቋሙ በሚገቡ ታካሚዎች ላይ ኢንፌክሽን ሊፈጥር ይችላል። ይህ የሕክምና ወጪንን፣ የሆስፒታል ቆይታዎችን እና ከቀዶ ጥገና በኋላ ለታካሚዎች ከፍተኛ የሆነ በበሽታ የመያዝና ሞት ይጨምራል። በአሁኑ ጊዜ፣ በቀዶ ጥገና ቦታ ስለሚከሰት ኢንፌክሽንና ብዙ መድሃኒቶችን የተላመዱ ባክቴሪያዎችን በተመለከተ ምንም ማስረጃ የለም። በቀዶ ጥገና ቦታ ለሚከሰት ኢንፌክሽን ተገቢውን ህክምና ለመስጠትና ምክንያታዊ የጸረተሕዋሲያን አጠቃቀምን ለመምራት የማያቋርጥ ክትትል አስፈላጊ ነው። ስለዚህ ይህ ጥናት ስለባክቴሪያ ማለትም ድኅረ ቀዶ ጥገና ቦታ ላይ ለሚከሰት ኢንፌክሽን ምክንያት የሆኑና ብዙ*

መድሃኒቶችን የተላመዱ ባክቴሪያዎች እና በሆስፒታል አካባቢ በሽታ አስተላላፊ ቁሶችን በተመለከተ ወቅታዊ መረጃ ይሰጣል።

የጥናቱ ዓላማዎች፡- *ይህ ጥናት በሰሜን ምዕራብ ኢትዮጵያ፣ ጎንደር በሚገኘው የጎንደር ዩኒቨርሲቲ አጠቃላይ ስፔሻላይዝድ ሆስፒታል ውስጥ በቀዶ ጥገና ቦታ ላይ ከሚከሰት ኢንፌክሽን እና የሆስፒታል አካባቢ በተወሰዱ ናሙናዎች አማኝነት የባክቴሪያ ፕሮፋይል እና ፀረ ተህዋሲያን ተጋላጭነት ሁኔታን መገምገምን ያለመ ነው።*

የጥናቱ ዘዴ፡- *እ.አ.አ. ከየካቲት 1 አስከ ሚያዚያ 30፣ 2020 ድረስ በተወሰደ ናሙና በድኅረ ቀዶ ጥገና ቦታ በሚከሰት ኢንፌክሽንና በሆስፒታል አካባቢ በታመሙ በሽተኞች ላይ ተሻጋሪ ጥናት ተካሂዷል። በቀዶ ጥገና ቦታ ለሚከሰት ኢንፌክሽን ተጋላጭ የሆኑ የድኅረ ቀዶጥገና ታማሚዎች ሁሉም በጥናቱ ተካትተዋል። በዚህ ጥናት 52 ቁስለኞችና 150 አካባቢዎች በድምሩ 202 ናሙናዎች ተፈትሸዋል። የማኅበረ ሥነ ሕዝባዊ መገለጫዎች በዝግ የጽሑፍ መጠይቆች ተሰብስበዋል። ስዋብ (Swab) ናሙናዎች ተሰብስበው በማክኮንኪ አጋር፣ በማኒቶል ጨው አጋር፣ በደም አጋር ሳህን እና በቸኮሌት አጋር ውስጥ ስዋቡን በአጋር ላይ በማንከባለል ኢኖኩሌት ተደርገዋል። ኢኖኩሌት የተደረጉትን የአጋር ሳህኖችን በ37 ዲግሪ ሴንቲ ግሬድ ውስጥ ከ24-48 ሰዓታት በማቆየት ተላላፊ በሽታዎች እንዲያደጉ ተደርገዋል። የአየር ባህል የደም አጋር ሰሃንም በ 37 ዲግሪ ሴንቲ ግሬድ ውስጥ ለ 24 ሰዓታት እንዲቆዩ በማድረግ ተላላፊ በሽታዎች እንዲያደጉ ተደርገዋል። በሙለር ሂንተን አጋር ላይ ያለውን የዲስክ ስርጭት ቴክኒክ በመጠቀም የፀረ-ተህዋሲያን ተጋላጭነት ሙከራዎች ተካሂደዋል። መረጃው የገባ እና የተተነተነው በስታቲስቲክስ ፓኪጅ ለሶሻል ሳይንሶች ስሪት 20 በመጠቀም ነው። ግኝቶችን በቃላት፣ በመቶኛ እና በሰንጠረዦች ለማቅረብ ገላጭ ስታቲስቲክስ ጥቅም ላይ ውሏል።*

የጥናቱ ውጤት፡- *በቀዶ ሕክምና ቦታ ከሚከሰት ኢንፌክሽን የተገኙ በጣም የተለመዱ ተለይዎች (isolates) ኤስ. አውረስ (S. Aureus) እና ክለብሲየላ (Klebsiella) ዝርያዎች እያንዳንዳቸው 11(20 በመቶ) ፣ እና E.coli 10(18.2በመቶ) ነበሩ። ከኤስ. አውረስ (S. Aureus) ተለይዎች ውስጥ፣ 63.6 በመቶ ሜቲሲሊንን የተላመዱ ነበሩ። አጠቃላይ የብዝሃ-መድሀኒት መላመድ 31 (56.4በመቶ) ነበር። የሆስፒታል አካባቢያዊ ናሙናዎችን በተመለከተ፣ በጣም የተለመዱት ተለይዎች ኮአጉለስ የሌላቸው ኤስ. አውረስ (coagulase-negative S. Aureus) 57 (47.5በመቶ) እና S. Aureus 35 (29.2በመቶ) ናቸው። አጠቃላይ የብዝሃ-መድኀኒት መላመድ 66(55.0በመቶ) ነበር።*

የጥናቱ ማጠቃለያ፡- *ይህ ጥናት ስቴፊሎኮከስ አውሬስ (Staphylococcus aureus) ፣ ክሌብሲየላ (Klebsiella) ዝርያዎች እና ኢ. ኮላይ (E. coli) ባክቴሪያዎች በድኅረ ቀዶ ጥገና ቦታ ለሚከሰቱ ኢንፌክሽኖች ዋና ዋና መንስኤዎች መሆናቸውንና የሆስፒታሉ አከባቢዎች በጥናቱ አካባቢ ላሉ በሽታ አምጪ ተሕዋሲያን እምቅ ማጠራቀሚያ ሆነው እንደሚያገለግሉ አሳይቷል። በተጨማሪም በዚህ ጥናት ውስጥ ከፍተኛ ሜቲሲሊንን የተላመደና ብዙ መድሃኒቶችን የመላመድ ስርጭት በሁለቱም በክሊኒካዊ እና በሆስፒታል ውስጥ ተስተውሏል። ይሁን እንጂ አሚካሲንና ክሊንዳሚሲን የግራም-አሉታዊ እና አወንታዊ የባክቴሪያ መነጠልን በብልቃጥ እድገትን ለመግታት በጣም ውጤታማ መድሃኒቶች ሆነው ተገኝተዋል። ስለሆነም የመድኀኒት የተላመደ በሽታ አምጪ ተህዋሲያን የበለጠ እንዳይከሰቱና እና እንዳይስፋፉ ለመከላከል በሆስፒታሉ ፎርሙላሪ እና በተጋላጭነት ሁኔታ ላይ በመመርኮዝ የፀረ-ተባይ መድኀኒቶች አጠቃቀም የሕክምና መመሪያዎች መዘመን አለባቸው። በተጨማሪም የኢንፌክሽን መከላከያ ዘዴዎችን ማጠናከር ያስፈልጋል።*

ቁልፍ ቃላት:- *ፀረ-ተሕዋሲያን ተጋላጭነት፣ የአካባቢ ናሙና፣ በቀዶ ጥገና ቦታ ይሚፈጠር ኢንፌክ*

INTRODUCTION

Healthcare-associated infections (HAIs), also known as "nosocomial" or "hospital-acquired" infections, are infections acquired within 48 hours of hospital admission or up to three days after discharge from the hospital or surgical center [1,2]. Some examples of common healthcare-associated infections are catheter-associated urinary tract infections, ventilator-associated pneumonia, surgical site infections (SSI), and central line-associated bloodstream infections [3].

A surgical site infection is defined as an infection that occurs within 30 days of an operation at or near the surgical incision site, or within 1 year if an implant was placed. These infections can be classified into incisional SSI (superficial and deep) and organ/space SSI [4]. It is one of the most common healthcare-associated infections [5,6]. Approximately 80% to 90% of postoperative infections occur within 30 days following the operative procedure [7].

The preponderant bacteria most frequently associated with SSIs are Staphylococcus aureus, coagulase-negative Staphylococci (CoNS), Enterococcus species, Escherichia coli, Pseudomonas aeruginosa, Enterobacter species and Klebsiella pneumonia [8]. These pathogens causing SSIs are believed to originate from the patient's own body (endogenous flora), contact with healthcare staff (cross-contamination), contaminated hospital environments, and surgical instruments (exogenous flora) [9,10]. Contamination of the hospital environment contributes to the multiplication, dissemination, and transmission of pathogens to patients undergoing operative procedures [11]. Transmission of these microorganisms to patients mainly occurs through contact with contaminated hospital surfaces, particularly through hand contact [12].

Multidrug-resistant bacteria such as Methicillin Resistant S. aureus (MRSA), Vancomycin-resistant Enterococci, and multidrug-resistant Gram-negative bacteria are common causes of postoperative SSI [7]. Gram-positive bacteria like S. aureus can survive on dry surfaces, while Gram-negative bacteria like P. aeruginosa can survive in moist environments such as sinks for extended periods. Moreover, the infective dose of these bacteria appears to be very low, meaning that even slight environmental contamination is sufficient to cause infection. [13]. Even though modern techniques for instrument sterilization, improved operating rooms, and great efforts of infection prevention strategies used, still SSI remains as HAI [14].

The burden of SSIs is very high in developing countries, where limited resources, poor infection control practices, overcrowded hospital settings, and inappropriate antimicrobial use are common

challenges. Studies conducted in Ethiopia on postoperative SSI have showed the incidence of 9.8%, and 21% in Addis Ababa [15], and Mekelle [16] respectively.

Previously, the operating rooms at the University of Gondar Comprehensive Specialized Hospital were renovated, well-organized, and equipped. However, there is no evidence indicating whether there has been a decrease in surgical site infections or multidrug-resistant bacteria as a result.

Therefore, continuous surveillance is necessary to guide appropriate therapy for surgical site infections and ensure the rational use of antimicrobial agents. This approach is crucial for preventing the emergence of multidrug-resistant pathogens. A recent study is needed to update the current knowledge of etiologic agents and their antimicrobial susceptibility patterns of isolates. Such a study will support clinicians in selecting appropriate treatments and provide insight into the definitive diagnosis of surgical site infections based on local bacterial susceptibility profiles. Additionally, this information is vital for infection prevention and control efforts.

MATERIAL AND METHODS

Study area, study design, and period

A hospital-based cross-sectional study was conducted at the University of Gondar Comprehensive Specialized Hospital (UoGCSH) from February 1 to April 30, 2020. UoGCSH is one of the largest tertiary-level referral and teaching institutions in the Amhara region, located in Gondar town, approximately 750 km northwest of Addis Ababa, Ethiopia. According to the Central Statistical Agency of Ethiopia report in 2015, Gondar town comprises twelve sub-cities, twenty-two urban and eleven rural kebeles, with a total projected population of 323,900. UoGCSH, as reported by its admission and discharge office, has 700 beds and includes departments for surgical, medical, pediatric, gynecologic, obstetrics, fistula care, and intensive care units. The hospital serves residents of Gondar town, surrounding zones, and neighboring regions.

Population

The study population included all patients who had developed postoperative surgical site infections in the surgical, orthopedics, and gynecology & obstetric wards at UoGCSH during the study period. We collected environmental samples along with wound swabs to assess the similarity between the etiologies of wound isolates and environmental samples isolates. Our hypothesis was that the hospital environment serves as a source of surgical site infections. Therefore, environmental samples were collected from inanimate objects such as bed rails, tray tables, IV poles, bedside tables, room sinks, room light switches, door knobs, as well as air bacteriological samples.

Sample size determination and sampling techniques

All postoperative patients suspected of having surgical site infections and hospital environments during the study period were included in the study. A convenient sampling technique was employed to collect these samples.

Inclusion criteria

All postoperative patients suspected of having surgical site infections were included in the study.

Exclusion criteria

Patients who were very critical and difficult to take samples were excluded.

Data collection and laboratory methods

Socio-demographic characteristics were collected from each study participant through face-to-face interviews using a structured questionnaire. Wound swabs were collected aseptically using sterile cotton-wool swabs soaked in normal saline during dressing changes from the infected surgical site, prior to cleaning with an antiseptic solution. The swabs were then placed into sterile test tubes and immediately transported to the Bacteriology Laboratory [17].

Environmental samples were collected from frequently touched surfaces and equipment in the wards. A sterile cotton swab moistened with sterile normal saline was used for sampling high-touch surfaces. Swabs were taken in the morning, prior to the commencement of routine activities. Each site was swabbed in a close zigzag pattern covering an area of approximately 10 cm^2, with the swab rotated during sampling to ensure thorough surface coverage [18,19]. The swabs were securely placed in labeled sterile tubes and promptly transported to the Bacteriology Laboratory for further processing.

Indoor air samples were collected from the operating rooms and surgical ward units using a settling plate or passive air sampling method. In each operating room, sampling was conducted in the early morning before the start of surgical activities and during surgical procedures on the day. For the wards, air samples were collected in the morning (during healthcare worker rounds) and in the evening (when visitors are present). As per standard procedure, a sterile Petri dish with a diameter of nine centimeters containing 5% Sheep's blood agar was left open to the air for one hour. This dish was positioned one meter above the floor and one

meter from walls or any other obstacles during sampling [20-24].

The swabs collected from the infected surgical sites, surfaces, and equipment were processed immediately upon arrival at the laboratory following standard procedures. Swab samples were inoculated onto MacConkey agar, Mannitol salt agar, Blood agar plates, and Chocolate agar by gently rolling the swab over the agar surfaces. The inoculated agar plates were then incubated at 37°C for 24 to 48 hours. Air samples collected on Blood agar plates for air culture were similarly incubated at 37°C for 24 hours [17].

Identification of bacteria and antimicrobial Susceptibility Test

Presumptive identification of bacteria was done based on its Gram reaction and colony characteristics of the organisms. Confirmatory test was done by enzymatic and biochemical properties of the organisms. Gram-negative rods were identified by performing a series of biochemical tests which include triple sugar iron agar, citrate utilization test, lysine decarboxylase test, indole test, motility test, urease production, and oxidase test while Gram-positive cocci were identified based on their Gram reaction, catalase, coagulase, and bile esculin hydrolyze test [25].

The suspension was prepared from pure isolates using 0.85% normal saline, adjusted to a 0.5 McFarland standard for antimicrobial susceptibility testing. The suspension was evenly distributed on Muller Hinton agar using a sterile cotton applicator stick.

The antimicrobial susceptibility test was conducted using the Kirby-Bauer disk diffusion method, as recommended by the Clinical and Laboratory Standards Institute (CLSI). The following antimicrobials were tested: Cefoxitin (30 µg), Vancomycin (30 µg), Clindamycin (2 µg), Erythromycin (15 µg), Doxycycline (30 µg), Tetracycline (30 µg), Ampicillin (10 µg), Chloramphenicol (30 µg), Gentamycin (10 µg), Ciprofloxacin (5 µg); and Trimethoprim-sulphamethoxazole (1.25 / 23.75 µg) for Gram-positive bacteria.

Similarly, antimicrobial susceptibility test was performed for Gram-negative bacteria using the Kirby-Bauer disk diffusion method for the following antimicrobials: Amikacin (30 µg), Ceftazidime (30 µg), Cefotaxime (30 µg), Cefepime (30 µg), Tobramycin (10 µg), Piperacillin (100 µg) and Meropenem (10 µg), Doxycycline (30 µg), Tetracycline (30 µg), Ampicillin (10 µg), Chloramphenicol (30 µg), Gentamycin (10 µg), Ciprofloxacin (5 µg); and Trimethoprim-sulphamethoxazole (1.25 / 23.75 µg). After applying antimicrobials on Mueller Hinton agar, the plates were incubated for 16-18 hours at 37 °C.The diameter of the zones of inhibition was measured using a ruler. Finally, the results were interpreted as Susceptible, Intermediate, and Resistant using CLSI 2019 [26].

Laboratory tests for MRSA

The susceptibility of consecutive isolates of S. aureus to Cefoxitin was determined using Muller Hinton agar. Suspension of the overnight growth S. aureus isolate (0.5 McFarland turbidity) was evenly distributed onto Muller Hinton agar. The Cefoxitin (30 µg) disk was aseptically placed on the surface of the inoculated plate and incubated aerobically at 35°C for 16-18 hours. The diameter of the zone of inhibition was measured and compared with CLIS (2019). Cefoxitin (≤ 22 mm diameter) resistant isolates were termed as MRSA [26].

Quality control

The reliability of the study findings was ensured by implementing stringent quality control measures throughout the entire laboratory process. All materials, equipment, and procedures were thoroughly regulated. Quality assurance was maintained during the pre-analytical, analytical, and post-analytical stages. Additionally, all clinical and environmental specimens were collected in accordance with standard operating procedures. All media were prepared according to the manufacturer's instructions and standard operating procedures. The sterility of each batch of test medium was confirmed by visually inspecting for growth or discoloration after incubating 5% of uninoculated plates and tubes at 37°C for 24 hours. Media performance was verified by inoculating known control strains. The growth and hemolysis performance on blood agar plates were checked using Staphylococcus aureus ATCC 25923 (β-hemolysis).

MacConkey agar was checked by Staphylococcus aureus ATCC 25923 (no growth) and Escherichia coli ATCC 35218 (lactose fermenter). Mannitol salt agar was checked by Staphylococcus aureus ATCC 25923 (Mannitol fermenter). Additionally, all the aforementioned reference strains were used to checked the quality of the antimicrobial disks.[26].

Data analysis and interpretation

Socioeconomic and data obtained from laboratory results were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics were calculated to summarize demographic and clinical characteristics. Frequency distribution was used to compute the results. Study findings were presented in words, numbers, percentages, tables and graphs.

RESULTS

Socio-demographic and clinical characteristics of study participants

A total of 52 study participants who had developed postoperative surgical site infections were included in this study. Of the wound swabs collected, 44 (87.3%) were positive for bacteria, while 8 (12.7%) showed no bacterial growth. Twenty-nine (55.8%) participants were male. The mean age of the participants was 33.8 years with a standard deviation of 13.5 years, ranging from 17 to 75 years. Most participants (46.2%) were in the 21 to 30-year age group. The majority (63.5%) stayed in the hospital for 10-20 days. The abdomen was the most common surgical site (65.4%), and emergency surgeries were the most frequent type of case (67.3%). (Table 1).

Table 1 Socio-demographic and clinical characteristics of the study participants in UoGCSH, Northwest Ethiopia, February – April 2020 (n=52)

Characteristics		Surgical units			Total No (%)
		Surgical ward No (%)	Orthopedic ward No (%)	Gynecology & obstetrics Ward No (%)	
Sex	Male	15(28.8%)	14(26.9%)	0(0.0%)	29(55.8%)
	Female	8(15.4%)	0(0.0%)	15(28.8%)	23(44.2%)
Age in years	11-20	4(7.7%)	1(1.9%)	1(1.9%)	6(11.5%)
	21-30	8(15.4%)	6(11.5%)	10(19.2%)	24(46.2%)
	31-40	6(11.5%)	3(5.8%)	2(3.8%)	11(21.2%)
	>41	5(9.6%)	4(7.7%)	2(3.8%)	11(21.2%)
Residence	Rural	18(34.6%)	10(19.2%)	7(13.5%)	35(67.3%)
	Urban	5(9.6%)	4(7.7%)	8(15.4%)	17(32.7%)
Hospital stays (in days)	<10	10(19.2%)	4(7.7%)	3(5.8%)	17(32.7%)
	10-20	13(25.0%)	8(15.4%)	12(23.1%)	33(63.5%)
	21-30	0(0.0%)	2(3.8%)	0(0.0%)	2(3.8%)
Site of operation	Back	1(1.9%)	0(0.0%)	0(0.0%)	1(1.9%)
	Thorax	1(1.9%)	0(0.0%)	0(0.0%)	1(1.9%)
	Abdomen	16(30.8%)	4(7.7%)	14(26.9%)	34(65.4%)
	Leg	2(3.8%)	7(13.5%)	0(0.0%)	9(17.3%)
	Other*	3(5.8%)	3(5.8%)	1(1.9%)	7(13.5%)
Type of cases	Emergency	12(23.2%)	11(21.2%)	12(23.1%)	35(67.3%)
	Elective	11(21.2%)	3(5.8%)	3(5.8%)	17(32.7%)

Key: * Hand, inguinal area, and breast

Distribution of bacterial isolates in SSIs and hospital environments

Approximately 44 (84.6%) clinical samples were culture-positive. Among these, 33 (75%) had single isolates, while 11 (25%) had mixed isolates. The highest number of isolates was found in patients admitted to the surgical ward (24, 43.6%), followed by those in the orthopedics ward (16, 29.1%). Additionally, a total of 150 environmental samples (104 surface and 46 air samples) were collected from the wards, with 116 (77.3%) testing positive for bacterial culture. The predominant isolates were CoNS 57(47.5%) followed by S. aureus 35(29.2%), Klebsiella spp 7(5.8%) and P. aeroginosa and E.coli each 6(8.1%). Of those 46 air samples, 44(95.7%) were culture-positive. Similarly, CoNs were the most common isolates in air samples 22(47.8%), followed by S. aureus 17(37.0%), Enterococcus spp 3(6.5%), and E. cloacae 1(2.2%) (Table 2).

Table 2 Distribution of isolated bacteria in different surgical units and hospital environments at UoGCSH, Northwest, Ethiopia, February – April 2020

Bacterial Isolates	Surgical units				Hospital environments			
	Surgical ward N (%)	Orthopedic ward N (%)	Gynecology & obstetrics ward N (%)	Total N (%)	Surfaces samples N (%)	Air samples N (%)	Total N (%)	Over All Total
S. aureus	4 (7.3)	1(1.9)	6(10.9)	11(20.0)	18 (24.3)	17(37.0)	35(29.2)	46(26.3)
CoNS	1(1.9)	2 (3.6)	2(3.6)	5 (9.1)	35 (47.3)	22(47.8)	57(47.5)	62(35.4)

Bacterial Isolates	Surgical units				Hospital environments			
	Surgical ward N (%)	Orthopedic ward N (%)	Gynecology & obstetrics ward N (%)	Total N (%)	Surfaces samples N (%)	Air samples N (%)	Total N (%)	Over All Total
Enterococcus spp	2 (3.6)	4 (7.3)	0 (0.0)	6 (10.9)	2(2.7)	3(6.5)	5(4.2)	11 (6.3)
Klebsiella spp	5 (9.1)	3 (5.5)	3 (5.5)	11(20.0)	4 (5.4)	3 (6.5)	7 (5.8)	18 (10.3)
E. coli	6 (10.9)	4 (7.3)	0 (0.0)	10(18.2)	6 (8.1)	0 (0.0)	6 (5.0)	16 (9.1)
E. cloacae	1 (1.9)	1 (1.9)	3 (5.5)	5 (9.1)	2 (2.7)	1(2.2)	3 (2.5)	8 (4.6)
P. aeroginosa	5 (9.15)	0 (0.0)	0 (0.0)	5 (9.1)	6(8.1)	0(0.0)	6 (5.0)	11 (6.3)
Acinitobacter spp	0 (0.0)	1 (1.9)	1 (1.9)	2 (3.6)	1 (1.4)	0 (0.0)	1 (0.8)	3 (1.7)
Total	24 (43.6)	16 (29.1)	15 (27.3)	55(100)	74 (100)	46 (100)	120(100)	175(100)

Thirty-three (60%) of the isolates were Gram-negative bacteria, while 22 (40%) were Gram positive. The most common isolates were S. aureus and Klebsiella spp., each accounting for 11 (20%) of the total isolates, followed by E. coli with 10 (18.2%) isolates (Figure 1).

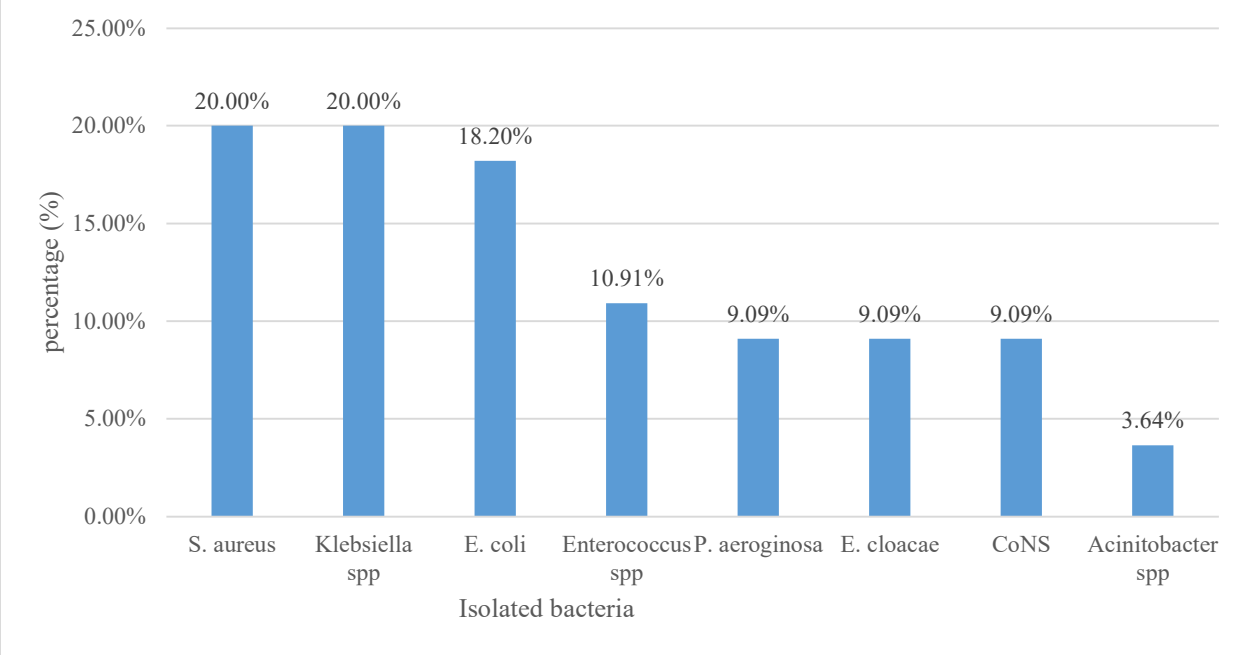

Figure 1 Frequency of bacterial species involved in surgical site infections in UoGCSH, Northwest Ethiopia, February - April 2020.

The distribution of bacterial isolates varied among the wards. Most isolates were obtained from surgical wards (38, 31.7%). Staphylococcus aureus (17, 14.2%) and E. coli (3, 2.5%%) were most frequently found in surgical wards compared to other wards respectively. Enterococcus species (4, 3.3%) and Klebsiella species (4, 3.3%) also isolated most frequently from surgical wards. Coagulase-negative staphylococci isolates were most frequently isolated from surgical ward (23, 19.1%) and orthopedic wards (19,15.8%) followed by gynecology and obstetrics ward (12.5%) (Table 3).

Table 3 Distribution of isolated bacteria from environmental samples among wards in UoGCSH, Northwest Ethiopia, February – April 2020

Isolated bacteria	Surgical units			
	Surgical ward N (%)	Orthopedic ward N (%)	Gynecology & obstetrics ward N (%)	Total N (%)
S. aureus	17(14.2%)	10(8.3%)	8(6.7%)	35(29.2%)

Klebsiella spp	4(3.3%)	1(0.8%)	2(1.7%)	7(5.8%)
E. coli	3(2.5%)	2(1.7%)	1(0.8%)	6(5.0%)
Pseudomonas spp	4(3.4%)	1(0.8%)	1(0.8%)	6(5.0%)
E. cloacea	1(0.8%)	1(0.8%)	1(0.8%)	3(2.5%)
Acinetobacter spp	1(0.8%)	0(0.0%)	0(0.0%)	1(0.8%)
Cons	23(19.1%)	19(15.8%)	15(12.5%)	57(47.5%)
Enterococcus spp	4(3.3%)	1(0.8%)	0(0.0%)	5(4.1%)
Total No. (%)	57(47.5%)	35(29.2%)	28(23.3%)	120(100%)

Antimicrobial susceptibility patterns

The antimicrobial susceptibility patterns of Gram-positive bacteria isolated from surgical sites and hospital environments are presented in Table 4. Staphylococcus aureus from surgical sites showed high resistance rates to Penicillin (90.9%), Tetracycline (90%), Erythromycin (72.7%), and Cotrimoxazole (72.7%). The MRSA isolation rate in this study was 63.6%, as indicated by Cefoxitin resistance. All six Enterococcus isolates were susceptible to Vancomycin.

Regarding environmental isolates S. aureus exhibited resistance to Cotrimoxazole (60%) and Penicillin (80%), while showing sensitivity to Clindamycin (100%) and Ciprofloxacin (91.4%). The prevalence of MRSA was 17(48.6). All of the five Enterococcus spps were Vancomycin susceptible (Table 4).

Table 4 Antimicrobial-resistant pattern of Gram-positive bacterial isolates from surgical sites and Hospital environments in UoGCSH, Northwest Ethiopia, February – April 2020

Antimicrobial agent	Gram-positive bacteria					
	***S. aureus* (N, %)**		**CoNS (N, %)**		***Enterococcus* spp (N, %)**	
	Patient (N, %)	**Hospital environment (N, %)**	**Patient (N, %)**	**Hospital environment (N, %)**	**Patient (N, %)**	**Hospital environment (N, %)**
Ciprofloxacin	4(36.4%)	3(8.6%)	3(60%)	9(15.8%)	_	_
Chloramphenicol	_	12(34.3%)	_	10(17.5%)	3(50%)	2(40.0%)
Gentamycin	6(54.5%)	12(34.3%)	1(20%)	18(31.6%)	_	_
Cotrimoxazole	8(72.7%)	21(60%)	4(80%)	35(61.4%)	_	_
Tetracycline	10(90.9%)		3(60%)		_	_
Erythromycin	8(72.7%)	12(34.3%)	3(60%)	25(43.9%)	_	_
Clindamycin	2(18.2%)	0(0.0%)	1(20%)	8(14.0%)	_	_
Penicillin	10(90.9%)	28(80%)	5(100%)	49(86.0%)	6(100%)	4(80.0%)
Ampicillin					5(83.3%)	1(20.0%)
Cefoxitin	7(63.3%)	17(48.6%)	3(60%)	25(43.9%)		
Vancomycin					0(0.0%)	0(0.0%)
Doxycycline	9(81.8%)	13(37.1%)	2(40%)	14(24.6%)	6(100%)	3(60.0%)

Table 5 presents the antimicrobial susceptibility patterns of Gram-negative bacteria isolated from surgical sites and hospital environments. Klebsiella spp. exhibited resistance rates of 100% to Cefotaxime and 81.8% to both Ceftazidime and Cotrimoxazole. E. coli showed 100% resistance to Cefotaxime and Cotrimoxazole, and 80% resistance to Ceftazidime. Pseudomonas isolates demonstrated resistance rates of 80% to Ceftazidime, and 60% to Ciprofloxacin, Gentamycin, and Tobramycin. In contrast, among environmental isolates, Klebsiella spp. showed high resistance rates of 100% to both Cotrimoxazole and Cefotaxime. Similarly, E. coli exhibited 100% resistance to both Cotrimoxazole and Cefotaxime. Pseudomonas isolates from the environment were resistant to Ciprofloxacin and Tobramycin, each at 83.3%.

Table 5 Antimicrobial resistant pattern of Gram-negative bacterial isolates from surgical sites and Hospital environments in UoGCSH, Northwest Ethiopia, February – April 2020.

Antimicrobial agent	Gram-negative bacteria									
	Klebsiella spp *N (%)*		*E. coli N (%)*		*P. aeroginosa* N (%)		*E. cloacae N (%)*		*Acinitobacter* spp N (%)	
	Patient N(%)	Evnt. N(%)	Patient N(%)	Envt. N(%)	Patient N(%)	Envt. N(%)	Patient N(%)	Envt. N(%)	Patient N(%)	Envt. N (%)
CIP	3(27.3)	2(28.6)	4(40)	4(66.7)	3(60)	5(83.3)	2(40)	0(0.0)	0(0.0)	_
CAF	3(27.3)	5(71.4)	2(20)	5 (83.3)	_	_	3(60)	1(33)	_	_
GEN	4(36.4)	5(71.4)	2(20)	4(66.7)	3(60)	3(50)	3(60)	2(66.7)	1(50)	1(100)
COT	9(81.8)	7(100)	10(100)	6 (100)	_	_	3(60)	1(33.3)	1(50)	1(100)
CAZ	9(81.8)	6(85.7)	8(80)	3(50)	4(80)	3(50)	2(40)	0(0.0)	1(50)	1(100)
CXT	11(100)	7(100)	10(100)	6 (100)	_	_	4(80)	3(100)	2(100)	1(100)
TOB	7(63.6)	4(57.1)	3(30)	6 (100)	3(60)	5(83.3)	4(80)	1(33.3)	1(50)	0(0.0)
AMK	1(9.1)	0(0.0)	1(10)	0 (0.0)	1(20)	0(0.0)	1(10)	0(0.0)	0(0.0)	0(0.0)
MER	7(63.6)	2(28.6)	2(20)	0(0.0)	2(40)	2(33.3)	3(60)	0(0.0)	1(50)	_
PEP	_	_	_	_	2(40)	3(50)	_		_	_
CEF	_	_	_	_	2(40)	4(66.7)	_		_	_

Key: CIP- Ciprofloxacin, CAF-Chloramphenicol, GEN-Gentamycin, COT-Cotrimoxazole, DOX-Doxycycline, CAZ-Ceftazidime, CXT-Cefotaxime, TOB-Tobramycin, AMK-Amikacin, MER-Meropenem, PEP-Pepracillin, CEF-Cefepim, Envt – Environment

The multidrug-resistant pattern of isolates

The overall MDR resistance from surgical sites was observed in 31 cases (56.4%). Among these, 15 (68.2%) were from Gram-positive isolates and 16 (48.5%) from Gram-negative isolates. Of the 11 S. aureus isolates, 9 (81.8%) were found to be MDR. (Table 6).

Table 6 The multidrug-resistant pattern of bacterial isolates from surgical sites in UoGCSH, Northwest Ethiopia, February – April 2020

Bacterial isolate	Total	Multidrug-resistant pattern						
		R0	R1	R2	R3	R4	≥R5	Total MDR
Gram-positive bacteria	22	0	2	8	4	2	9	15(68.2%)
S. aureus	11	0	1	1	0	2	7	9(81.8%)
Cons	5	0	0	2	1	0	2	3(60%)
Enterococcus spp	6	0	0	3	3	0	0	3(50%)
Gram-negative bacteria	33	3	5	11	9	4	3	16(48.5%)
Klebsiella spp	11	0	2	4	1	2	2	5(45.5%)
E. coli	10	0	1	3	5	1	0	6(60%)
E. cloacae	5	1	0	1	1	1	1	3(60%)
Pseudomonas spp	5	0	2	1	2	0	0	2(40%)
Acinetobacter spp	2	1	0	1	0	0	0	0
Total	55	3	7	19	13	6	12	31(56.4%)

Key: R0 – No antimicrobial resistance, R1 - Resistant to One, R2 - Resistant to Two, R3 - Resistant to three, R4 - Resistant to Four, ≥R5 – Resistant to Five and more antimicrobial classes, MDR - Multidrug-resistant, CoNS – Coagulase negative staphylococcus

The overall multidrug-resistant (MDR) resistance from hospital environments was 66 cases (55.0%). Among these, 53 (54.6%) were from Gram-positive isolates, and 13 (56.5%) were from Gram-negative isolates. More than 70% of Klebsiella isolates were multidrug-resistant (see Table 7).

Table 7 The multidrug-resistant pattern of bacterial isolates from environments at the UoGCSH, Northwest Ethiopia, February – April 2020

Bacterial isolates	Total	Multidrug-resistant pattern						
		R0	R1	R2	R3	R4	≥R5	Total MDR
Gram-positive bacteria	97	9	27	8	11	10	32	53(54.6%)

Bacterial isolates	Total	Multidrug-resistant pattern						
		R0	R1	R2	R3	R4	≥R5	Total MDR
S. aureus	35	2	11	3	4	3	12	19(54.3%)
CoNS	57	6	13	4	7	7	20	34(59.6%)
Enterococcus spp	5	1	3	1	0	0	0	0
Gram-negative bacteria	23	2	1	7	8	1	4	13(56.5%)
Klebsiella spp	7	0	0	2	3	0	2	5(71.4%)
E. coli	6	0	0	2	3	1	0	4(66.7%)
Pseudomonas spp	6	0	1	2	1	0	2	3(50.0%)
E. cloacae	3	2	0	1	0	0	0	0
Acinetobacter spp	1	0	0	0	1	0	0	1(100%)
Total	120	11	28	15	19	11	36	66(55.0%)

Key: R0 – No antimicrobial resistant, R1 - Resistant to One, R2 - Resistant to Two, R3 - Resistant to three, R4 - Resistant to Four, ≥R5 – Resistant to Five and more antimicrobial classes

DISCUSSION

The present study provides insights into the bacterial profiles and their antimicrobial susceptibility patterns in samples from postoperative surgical site infections and hospital environments, crucial for selecting appropriate antimicrobial agents and preventing future infections. The culture positivity rate for postoperative SSIs was 84.6%, with the main isolates being S. aureus (20%), Klebsiella spp. (20%), E. coli (18.2%), Enterococcus spp. (10.9%), and Pseudomonas spp. (9.1%). These findings are consistent with a study conducted six years ago at the same hospital in Gondar, Ethiopia, where S. aureus (22.4%) and Klebsiella spp. (20.4%) were the predominant isolates [27]. This result is also consistent with studies conducted in Hawassa, Ethiopia [28], Mekelle, Ethiopia [29], Pakistan [8,30], and Saudi Arabia 31 where S. aureus, Klebsiella spp, and E. coli were reported as major isolates of SSIs. However, this contrasts with findings from studies in Tanzania and India, where Pseudomonas species were found to be the predominant isolates [32,33].

In this study, Klebsiella species and E. coli also showed high prevalence, similar to S. aureus which could be due to contamination of the wound with the gastrointestinal tract in which they are normal floras and most operations were undertaken on the abdomen.

In the present study, Gram-positive bacteria were found in 40% and Gram-negative bacteria in 60% of culture-positive cases of SSIs. Similar studies conducted in different regions have also highlighted that Gram-negative bacteria are frequently identified as a more significant cause of SSIs compared to Gram-positive bacteria [31,34,35]. This could be attributed to the diverse habitats of Gram-negative bacteria, including inanimate surfaces in hospitals, and potential contamination from the intestinal tract during surgery. S. aureus typically plays a predominant role in HAI due to contamination of wounds with normal endogenous flora found on the skin and mucous membranes, or through environmental contamination. S. aureus can survive for extended periods on dry surfaces in hospital environments [36]. Due to its ability to survive for extended periods in hospital environments, it contributes to the emergence of drug-resistant strains.

The prevalence of MRSA in this study (63.6%) was consistent with a study conducted in Pakistan (65.7%) [8]. On the contrary, this finding was higher than the results of studies conducted in Gondar, Ethiopia (34.7%) [34], Debre Markos, Ethiopia (49.7%) [37], Addis Ababa, Ethiopia (10.5%) [15], Nepal (41.7%) [38] and India (48.8%) [39]. The high incidence rate of MRSA in this study could be attributed to improper antimicrobial use or the prophylactic use of antimicrobials, leading to the timely emergence of resistant strains. Most of the isolates of S. aureus (81.8%) were Clindamycin susceptible which is in agreement with the study conducted in Gondar [34] and Saudi Arabia [31] in which 88.5% and 97.2% of the isolates were clindamycin susceptible correspondingly.

Our results have shown that Amikacin was effective against more than 80% of Gram-negative bacterial isolates. However, these isolates exhibited high resistance rates to Cefotaxime, Cotrimoxazole, and Ceftazidime (ranging from 72.7% to 82.1%). Klebsiella species demonstrated high resistance rates to Cefotaxime (100%), Cotrimoxazole, and Ceftazidime (81.8% each). Similarly, E. coli was resistant to Cefotaxime and Cotrimoxazole (100% each) and Ceftazidine (80%). These findings are in agreement with the study done in Addis Ababa, Ethiopia [15] which showed that Klebsiella spp and E. coli were highly resistant to Ceftazidime (80%, 79.2). Another study done in Addis Ababa, Ethiopia [40] also showed Ceftazidime and Cotrimoxazole were not effective antimicrobials for E. coli and Klebsiella spp. Similarly, Pseudomonas isolates showed resistance to Ceftazidime (80%), Ciprofloxacin, Gentamycin, and

Tobramycin (60% each). It was observed that all surgery patients in the study area received Ceftriaxone as prophylaxis, which likely contributed to the emergence of resistant bacteria.

In the current study, 56.4% of the isolates were MDR. This result was lower than the result of the studies conducted in Addis Ababa [35], in which the MDR level was 65.5%, and Nepal [38] also showed 66.7% of MDR. This variation might be due to the difference in the definition of MDR between the two studies. In previous studies, MDR was defined as resistance to two or more classes of antimicrobials and improper antimicrobial usage practices in the respective areas.

Several studies have demonstrated that healthcare facility environments, including frequently touched surfaces and air, are contaminated by various types of bacteria, contributing to HAI [41-43]. In the current study, the overall contamination rate of the hospital environment was 116 (77.3%), with contamination rates of 69.2% among [44] inanimate surfaces and 95.7% among air samples. This finding aligns with studies conducted in Nepal and Brazil [45] which reported contamination rates of 78% and 83.3%, respectively. However, it was higher than studies conducted in Mizan Tepi, Ethiopia[43] (43.8%), Uganda [42] (44.2%), and Poland [19] (69.6%) (19). The variation may be due to differences in cleaning practices, decontamination of surfaces, and the effectiveness of disinfectant use.

In this study, hospital environment isolates of S. aureus showed 100% susceptibility to Clindamycin and 91.4% susceptibility to Ciprofloxacin. Of all S. aureus isolates, 17 (48.6%) were MRSA, which is higher than the rate reported in a study conducted in Bahir Dar (25%) [41]. The variation may be attributed to differences in infection prevention practices between the two settings or variations in antimicrobial use for treating bacterial infections across different hospitals. The overall MDR level of the isolates in this study was 66 (55.0%), which is lower than the study conducted in Bahir Dar [41], where more than 75% of isolates were reported to be MDR.

Furthermore, among the total Gram-positive bacterial environmental isolates, 53 (54.6%) were multidrug-resistant (MDR) in our study. Additionally, 13 (56.5%) of the gram-negative isolates were also MDR. Klebsiella spp. and E. coli isolates in our study showed resistance to Cotrimoxazole and Cefotaxime but were susceptible to Amikacin which the primary causative bacteria associated with postoperative surgical site infections (SSI), and hospital environments served as potential reservoirs for these pathogens in the study area.

CONCLUSION

Staphylococcus aureus, Klebsiella species, and E. coli were identified as the most prevalent bacteria from postoperative surgical site infections, with hospital environments serving as potential reservoirs for these pathogens in the study area. The study also revealed a high prevalence of methicillin-resistant and multidrug-resistant strains among clinical and hospital isolates. However, Amikacin and Clindamycin demonstrated effectiveness in inhibiting the in vitro growth of Gram-negative and Gram-positive bacterial isolates, respectively. To curb the further emergence and spread of multidrug-resistant bacterial pathogens, treatment guidelines for the use of antimicrobials should be updated based on the hospital formularies and the susceptibility patterns. Additionally, infection prevention practices should be strengthened.

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ABBREVIATIONS

CLSI: Clinical and Laboratory Standards Institute, CoNS: Coagulase-negative Staphylococci, HAIs: Health-care-associated infections, MDR: Multidrug-resistant, MRSA: Methicillin-resistant Staphylococcus aureus, SSI Surgical site infection, UoGCSH: University of Gondar Comprehensive Specialized Hospital, WHO: World Health Organization

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study received approval from the Ethical Review Committee of the School of Biomedical and Laboratory Sciences, University of Gondar. Informed consent was obtained from each study participant and their legal guardians after explaining the study's purpose. Participant information was treated confidentially, and specimens collected were used solely for the study's intended purposes. All procedures in this study were conducted in accordance with the amended Declaration of Helsinki.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

All the data sets analyzed during the current study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

There is no specific fund received for this study.

CONTRIBUTION OF AUTHORS

SB and AA contributed to conceiving the research idea, data collection, and data analysis. GB and WT contributed to the conception of the research idea, method rationalization, data analysis, interpretation of results, evaluation of scientific content, and manuscript preparation. GB, SB, FW, and WA were also involved in reviewing and editing the manuscript. All authors have read and approved the final manuscript for submission.

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Ethiopian Journal of Translation Sciences
Amhara Public Health Institute
P.o. Box: 477
E-Mail: ejts@aphi.gov.et.
Telephone: +251 583209654
Bahir Dar
Ethiopia