Prevalence and Antimicrobial Susceptibility Patterns of *Salmonella* serovars and *Shigella* species

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**Abstract**

**Background:** Salmonellosis and shigellosis are global human health problems, especially in developing countries such as Ethiopia, where substandard hygiene and unsafe water supplies prevail which is aggravated by multidrug resistance. We determined the prevalence and antimicrobial susceptibility patterns of *Salmonella* and *Shigella* isolates among diarrheic patients. Which helps in disease management by showing the disease burden and allowing for selection of appropriate antibiotics for empiric treatment in rural communities of resource limited countries such as Ethiopia.

**Result:** Forty (10.5%) *Salmonella* and 17 (4.5%) *Shigella* strains were isolated from 382 patients. The *Salmonella* strains isolated were 6 (15%) group A (Somatic antigen O, O:2), 5 (12.5%) each of group B (O:4), D1 (O:9) and D2 (O:9,46) and 3 (7.5%) group C (O:7/O8) isolates while 16 (40%) could not be typed with the available antisera. Among 17 *Shigella* species *Shigella boydii* founded as 6 (35.3%) followed by *Shigella flexneri* 5 (29.5%), *Shigella dysenteriae* 3 (17.6%). High frequency of resistance for both *Shigella* and *Salmonella* isolates was observed to tetracycline (82.4%, 52.5%), co-trimoxazole (76.5%, 37.5%) and ampicillin (47.1%, 60%), respectively. All isolates were sensitive to ceftriaxone except 6 intermediate level *Salmonella* isolates. Fifty three percent of *Shigella* isolates were Multi-Drug Resistant (MDR) (≥ 3 drugs) as compared to 27.5% of *Salmonella* isolates.

**Conclusion:** *Salmonella* and *Shigella* species cause a significant amount of morbidity in rural communities. It is essential for rural hospitals to establish antimicrobial resistance monitoring policies and enforce them to prevent exacerbation of resistance.

**Keywords:** *Salmonella; Shigella; Diarrhea; Antibiotic Resistance; Antimicrobial Susceptibility; Ethiopia*

**Abbreviation:** API: Analytical Profile Index; ATCC: American Type Culture Collection; MDR: Multi-Drug Resistant; SOPs: Standard Operating Procedures

**Background**

Acute gastroenteritis is one of the leading causes of illness and death in infants, children, immuno-compromised and aged individuals throughout the world, especially in developing countries. Asia, Africa and Latin America, had an estimated 2.5 million deaths each year in children under 5 years of age [1-4]. Among the enteric pathogens *Salmonella* and *Shigella* species are of particular concern as causes of enteric fevers, food poisoning and gastroenteritis [5]. Although more prevalent in developing countries, shigellosis is a worldwide problem [6,7] with *Shigella sonnei* in predominating in Europe and US and *Shigella flexneri* more prevalent in Asian and African countries [8]. *Salmonella*, with its more than 2500 different serotypes, is a leading cause of foodborne infections worldwide [9]. *Salmonella* can be divided into two major groups of clinical importance: typhoidal salmonellosis (*Salmonella Typhi* and *Salmonella Paratyphi*) and non typhoidal salmonellosis (*all Salmonella serovars*) [10].

Antibiotic therapy for *Salmonella* gastroenteritis has long been a debated matter because of the idea that antibiotic administration prolonged *Salmonella* excretion [11] unlike that of shigellosis which needs antibiotic therapy [12]. In recent years, an increase in the occurrence of antimicrobial resistance, among *Salmonella* has been observed in many countries, such as Asia, Africa [13] and China [9] that includes resistance to quinolones and third generation cephalosporin’s. The progressive increase in antibiotic resistance because of overuse and misuse of antibiotics in the treatment of diarrhea in developing countries is becoming a critical area of concern [2,14,15].

Although most of Ethiopian studies conducted retrospectively, the prevalence of *Salmonella* (5.3% -15.4%) [15-17] and *Shigella* (5% - 7.5%) [15,16,18,19] was high with antibiotic resistance pattern ranged from 0% in case of ciprofloxacin and nalidixic acid to 100% in case of ampicillin [15,16,18]. This study fills the knowledge gap on the prevalence of salmonellosis and shigellosis and antimicrobial susceptibility patterns in the study area based on controlled prospective study. Periodic epidemiological surveillance in the area among humans is of vital importance to detect outbreaks and control the diseases caused by these pathogens.

**Methods and Materials**

**Specimen and data collection**

A cross-sectional study was conducted in Butajira, central Ethiopia.

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Patients who visited the outpatient departments of Butajira health center for diarrhea (at least three loose stools or one watery diarrhea in a day) from October 2011 to June 2012 were consecutively enrolled into the study upon informed consent. Three hundred eighty two stool specimens were collected in clean, sterile, wide-mouthed containers, without disinfector or detergent residue and tight-fitting leak-proof lids. Participants already on antibiotic treatment were excluded. Socio-demographic data using questionnaire based interview, clinical data based on signs and symptoms of patients suspected by handling clinicians were collected.

Isolation and identification of bacteria

For detection of *Salmonella* and *Shigella* isolates, specimens were plated directly on Oxoid primary media (Oxoid, England): MacConkey agar, Xylose Lysine Deoxycholate (XLD) and *Salmonella-Shigella* (SS) agar and Selenite F enrichment broth with in two hours of collection. For those negative specimens on primary sold media, sub-culturing from enrichment broth to primary media was performed to improve recovery of the isolates. All of the inoculated media were incubated at 37°C for 18-24 hours.

Using Analytical Profile Index (API) 20E (BioMerieux, France) a total of 20 biochemical tests were performed and the isolates were identified with the help of Bergey’s manual of Systematic Bacteriology (2007) [20], API Web identification software version 4 (BioMerieux, France) and the manual leaflet of the kit supplied by the company [21]. The biochemical tests included in the kit were Ortho-Nitrophenyl-β-galactoside (ONPG), Arginin-dehydroase (ADH), Lysine decarboxylase (LDC), Ornithine decarboxylase (ODC), Sodium Citrate utilization (CIT), H2S production (H2S), Urease (URE), Tryptophane deaminase (TDA), Indole production (IND), Acetoin production (VP), Gelatinase (GEL), Glucose (GLU), Manitol (MAN), Inositol (INO), Sorbitol (SOR), Rhamnose (RHA), Saccharose (SAC), Melibiose (MEL), Amygdaline (AMY) and Arabinose (ARA) [21]. Isolates were typed by serological agglutination with specific antisera (Denka-Seiken, Japan) against somatic (O) antigen of *Salmonella* serovars and *Shigella* species according to manufacturer’s instructions [22].

Antimicrobial susceptibility testing

Disk diffusion assay was performed to assess the antibiotic resistance/ susceptibility pattern of *Salmonella* and *Shigella* isolates. The antimicrobial susceptibility testing of all strains were carried out on Muller-Hinton agar (Oxoid, England) with antibiotic discs (Oxoid, England) using the single disc diffusion [23] technique against ampicillin (10 µg), trimethoprim/sulphamethoxazole (co-trimoxazole, 1.25/23.75 µg), chloramphenicol (30 µg), ciprofloxacin (5 µg), ceftriaxone (30 µg), nalidixic acid (30 µg), gentamicin (10 µg) and tetracycline (30 µg) based on the Standard Operating Procedure (SOP) adapted from Clinical and Laboratory Standards Institute (CLSI) and results were reported as sensitive, intermediate and resistance. To standardize the inoculum density for a susceptibility test, a BaSO₄ turbidity standard, equivalent to a 0.5 McFarland standard was used by strictly following the SOP for the preparation and standardization [23]. An isolate was defined as being multidrug resistant if it is resistant to three or more of the antimicrobial agents tested [24].

Quality control

A standard bacteriological procedure was followed to keep the quality of all laboratory tests [25]. American Type Culture Collection (ATCC) strains (E. coli ATCC 25922, S. Typhi ATCC 13311, *Entertidis* ATCC 13076, *S. sonni* ATCC 25331, *P. aeruginosa* ATCC 27853 and *P. mirabilis* ATCC 35659) were used as controls for culture and sensitivity testing.

Data analysis

The data were entered and analyzed using the SPSS statistical package version 20 (IBM SPSS Statistics, USA) and Microsoft excel 2010 (Microsoft corporation, USA) statistical software.

Ethical clearance

The study was reviewed and approved by Departmental research and ethical review committee of school of medical laboratory sciences, College of Health Sciences, Addis Ababa University and Armauer Hansen Research Institute / All Africa Leprosy, Tuberculosis and Rehabilitation Training center (AHRI/ALERT) ethical review committee. All results were sent to the handling physician timely to address ethical considerations. Before the study was begun, a detailed discussion was made with participants and/or guardians/parents about objective of the study. Patients were enrolled upon informed consent or assent.

Result

The patients included were from rural and urban residents and clients of diverse socioeconomic and ethnic backgrounds. Stool specimens from 382 patients were examined by culture and among them 40 (10.5%) were positive for *Salmonella* and 17 (4.5%) had *Shigella* spp confirmed by biochemical and serotyping tests. The *Salmonella* strains isolated were 6 (15%) group A (O:2), 5 (12.5%) each of group B (O:4), D1 (O:9) and D2 (O:9,46) and 3 (7.5%) group C (O:7/O8) isolates while 16 (40%) could not be typed with the available antisera. Serogroup D (*S. sonnet*) was the most frequently isolated *Shigella* species 6 (35.3%) followed by serogroup B (*S. flexneri*) 5 (29.4%), serogroup A (*S. dysenteriae*) 3 (17.6%), and serogroup C (*S. boydii*) 3 (17.6%).

Distribution of *Salmonella* and *Shigella* isolates by age and gender is shown in Figure 1. The mean age of the patients from whom either *Salmonella* or *Shigella* microbes were isolated was 17.8 years (SD ± 15.5) and median age of 18 with (IQR= (5-23)) years with children less than 15 years of age comprising of 45.6% and a male proportion of 57.9%. There was one infant (6 months old) and one elder woman (80 years old) with *Salmonella* serogroup A and *S. boydii*, respectively. The age ≤ 15 years were 58.5% and 58.9% for females and males respectively and age > 15 years were 41.5% and 41.1% for females and males respectively. The distribution between the two genders was 41.2% Female and 58.8% Male. The patients included were from rural and urban residents and clients of diverse socioeconomic and ethnic backgrounds.
were found among all isolates of different antibiogram patterns. A total of ten distinct antibiograms to 3 and 2 isolates (5.0%) to 4 drugs were resistant, with one or more antimicrobial agents was detected in 16 (94.1%) of the isolates (2.5%). Only 1 Salmonella isolate was resistant to six antimicrobial agents, 11 Salmonella spp. and ampicillin 24 (60%) and tetracycline 21 (52.5%) by Salmonella spp. In other hand, the highest level of Salmonella resistance was detected for tetracycline 14 (82.4%) and co-trimoxazole SXT; and 85% (34) and 92.5% (37) of the Salmonella isolates (Table 2).

A total of thirteen distinct antibiograms (resistance patterns) were found among all isolates of Salmonella serovars (Table 3). Only 1 (2.5%) Salmonella isolate was resistant to six antimicrobial agents, 11 isolates (27.5%) to 3 and 2 isolates (5.0%) to 4 drugs were resistant with different antibiogram patterns. A total of ten distinct antibiograms were found among all isolates of Shigella species (Table 3). Resistance to one or more antimicrobial agents was detected in 16 (94.1%) of the Shigella strains, of which 9 (56.25%) showed multi-resistance patterns.

Discussion

The isolation rate of Shigella species (4.5%) in our study was comparable to the study done in Jimma and Addis Ababa (5%) [16] and another African country, Ghana (4.04%) [26]. Our result is lower when compared to the study conducted in Eastern Ethiopia (2011) (6.7%) [15], Jimma (2002) (20.1%) [17], Gonder (2009) (7.5%) [18], North West Ethiopia (2006) (8.7%) [27], and other countries such as, South Africa (2009) (8.5%) [28] and South America (2008) (6%) [29]. There is no research conducted around Butajira on identification and characterization of Shigella isolates to see prevalence variation over time. But, the low isolation rate of Shigella in our study relative to the time. But, the low isolation rate of Shigella in our study relative to the previous studies done in Addis Ababa found 68.9% of Sh. flexneri, 9.8% S. boydii, and 21.3% S. sonnei [16]; and another study from Ghana by Opintan et al. found 70.8% S. flexneri, 16.7% S. dysenteriae, 8.3% S. sonnei and 4.2% S. boydii [26].

In this study, the most frequently isolated Shigella species were S. sonnei (35.3%) followed by S. flexneri (29.4%); while S. dysenteriae and S. boydii have shown the same frequency (17.6%). Shigella sonnei (75%) and S. flexneri (19%) accounts the first and the second predominant Shigella species, respectively in the South America study conducted by Orrett [29] which is comparable to this study, even though S. dysenteriae (1.8%) was the least prevalent species followed by S. boydii (4.1%) unlike that of this study.

The distribution is different when compared to the study conducted by Asrat in Addis Ababa with a proportion of 54.0% S. flexneri, 22.4% S. dysenteriae, 19.8% S. sonnei and 7.8% S. boydii [30]; whereas Tiruneh in Gonder found 72.2% S. flexneri, 10% S. dysenteriae, 8.9% S. boydii, and 8.9% S. sonnei [18]. A study done by Beyene et al. in Jimma and Addis Ababa found 68.9% S. flexneri, 9.8% S. boydii, and 21.3% S. sonnei [16]; and another study from Ghana by Opintan et al. found 70.8% S. flexneri, 16.7% S. dysenteriae, 8.3% S. sonnei and 4.2% S. boydii [26].

Shigella dysenteriae was the second most prevalent Shigella species in the previous studies done in Addis Ababa (22.4%) [30] and Gonder (10%) [18] unlike that of this study which is the third by accounting equal percentage with S. boydii (17.6%). On the other hand, no S. dysenteriae was reported from other study conducted at Jimma and Addis Ababa in 2006 [16]. In general, S. flexneri was the most prevalent Shigella species in the previous studies from different corners of Ethiopia unlike to this study which is dominated by S. sonnei. The difference in the pattern of species may be due to ecological or geographical differences, study time or human host differences.

In this study, children age ≤ 15 years had less risk of getting

**Discussion**

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<table>
<thead>
<tr>
<th>Consistency of the Stool</th>
<th>Types of Isolate</th>
<th>Salmonella (n, %)</th>
<th>Shigella (n, %)</th>
<th>Total (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucoyd</td>
<td>20 (50.0)</td>
<td>6 (35.3)</td>
<td>26 (45.6)</td>
<td></td>
</tr>
<tr>
<td>Unformed</td>
<td>9 (22.5)</td>
<td>4 (23.5)</td>
<td>13 (22.8)</td>
<td></td>
</tr>
<tr>
<td>Mucoid &amp; Watery</td>
<td>5 (12.5)</td>
<td>3 (17.6)</td>
<td>8 (14.0)</td>
<td></td>
</tr>
<tr>
<td>Watery</td>
<td>4 (10.0)</td>
<td>3 (17.6)</td>
<td>7 (12.3)</td>
<td></td>
</tr>
<tr>
<td>Bloody &amp; Mucoid</td>
<td>1 (2.5)</td>
<td>1 (5.9)</td>
<td>2 (3.5)</td>
<td></td>
</tr>
<tr>
<td>Bloody</td>
<td>1 (2.5)</td>
<td>0 (0.0)</td>
<td>1 (1.75)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40 (100.0)</td>
<td>17 (100.0)</td>
<td>57 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1:** Consistency of diarrhea in patients with Salmonella and Shigella infection in Butajira health center, Ethiopia from October 2011 to June 2012.
shigellosis unlike to other studies conducted in Ethiopia [31]. Because children do not spend more time outside of the house, drank and eat foods properly prepared by their parents/guardians may prevent acquiring the disease. This idea is strengthen by the study conducted on foodborne outbreaks of shigellosis from multiple restaurants [32].

Although untypable Salmonella spp. account to the highest percentage (40.0%), the predominant typable serogroup was serogroup A (O:2) (15.0%) followed by B (O:4), D1 (O:9) and D2 (O:9, 46) (12.5% each), and Group C (O:7/O:8) (7.5%). In earlier study from Jimma by Mache, serogroup B comprised 28.8% followed by S. Typhi (22%), serogroup C (22%), D (13.6%), A (8.5%) and E (5.1%) [17]. The same result was obtained from Addis Ababa’s study by Asrat; serogroup B (81.1%), D (S. Typhi) (10.8%) and group C (8.1%) [30]. The difference in the pattern of serogroup may be due to ecological (animal reservoirs) or geographical variation, differences in the human host or study time.

Fifty percent of Salmonella and 35% of Shigella positive cases were identified from mucoid diarrheic patients and this is comparable to the study done in Harar by Reda et al., Salmonella (42.8%) and Shigella (52.9%) [15]. Seven (17.5%) of Salmonella and 4 (23.5%) of Shigella isolates were found from watery diarrhea in contrast to a study done in Harar, by Reda et al. who reported that no Salmonella species and only 1 (5.9%) Shigella species was found from watery diarrhea [15]. But, our result was supported by study conducted in Addis Ababa which reported that 82.4% of Salmonella and Shigella species were isolated from watery diarrhea samples [30]. A study conducted in Washington State by Villar et al. showed that S. Typhimurium results in diarrhea (100%), abdominal cramps (93%), fever (93%) and vomiting (53%) [33], which is comparable to our study; abdominal pain (77.5%), fever (52.5%), vomiting (42.5%), tenesmus (39.8%) and frequent thirst (32.5%).

Shigella species invade and replicate in cells lining the colon and rectum, cause mucosal ulceration, characterized by lower abdominal cramps, tenesmus and fever [6,34], which is similar to our study where abdominal pain (88.2%), tenesmus (64.7%) and fever (58.8%) were the predominant symptoms of culture positive Shigella cases followed by vomiting (23.5%) and frequent thirst (17.6%).

In recent years, an increase in the occurrence of antimicrobial resistance, including resistance to quinolone’s and third generation cephalosporin’s, among Salmonella has been observed in many countries, such as Asia, Africa [13] and china [9]. Most of Ethiopian studies had shown emergence of drug resistant Salmonella and Shigella species which will be a challenging problem in the future [15,16].

Antimicrobial resistance pattern findings of this study are displayed against findings from other parts of the country and are shown in Tables 4,5. There is high resistance of Shigella to tetracycline (82.4%) in this study, which is in agreement with reports from other parts of the country (86.0% [19] and 90.0% [18]). High resistance was also observed to co-trimoxazole (76.5%), which agrees with the report from Gonder (73.4% [19] and 84.6% [18]) in contrast to study from Awassa (56.0%) [35] and Addis Ababa (45.7%) [30]. This increase of resistance from those reports indicated that aggravating problem of drug resistance by these microbes over the years. This may be due to misuse or inappropriate use of drugs [2,14].

None of the Shigella isolates were resistant to ceftriaxone in our study that is comparable to the study done in Gonder [18]. Gentamicin resistant Shigella isolates were not found in previous studies from Addis Ababa [30] and Harar [15] in contrary of our study (17.6%) which was supported by the study done in Gonder (12.2%) [18]. This indicates emerging of gentamicin drug resistance Shigella isolates over time. Low level of Shigella resistant for ciprofloxacin and nalidixic acid (5.9% each) were observed in this study like that of other studies in Ethiopia [18,19,30,35].

Low frequency of Salmonella resistance was observed relative to Shigella isolates in this study. Based on the result of our findings, high level of Salmonella resistance was observed to ampicillin (60%) and tetracycline (52.5%) which is comparable to the study done in Jimma (59.3% each) [17] and lower than the study from Addis Ababa (81.3% and 94.5%) [30] and Harar (100% and 71.4%) [15], respectively. Even though studies from Addis Ababa [30] and Jimma and Addis Ababa [16] reported resistance levels of 75.6%, and 74.3%, respectively Salmonella species in this study seem to be low resistant to gentamicin (2.5%). This is similar to reports from other parts of the country, Jimma (1.3%) [17] and Harar (3.6%) [15]. Unlike study from Jimma and Addis Ababa (78.8%) [16], Salmonella isolates from our study are completely susceptible to ceftriaxone.
Antibiotics have revolutionized the treatment of common bacterial infections and played a crucial role in reducing mortality. However, the progressive increase in antibiotic resistance among enteric pathogens in developing countries is becoming a critical area of concern. In addition, the overuse and misuse of antibiotics in the treatment of diarrhea could lead to an increase of antibiotic resistance [2,14] including Ethiopia [15]. Poor laboratory diagnosis in developing countries enforces physicians to syndromatic diagnosis and prescription of broad spectrum antibiotics that led to emerging of drug resistant bacterial strains [36].

Comparable level of *Salmonella* resistance to ciprofloxacin (2.5%) and nalidixic acid (5.0%) were observed from other parts of the country such as Jimma and Addis Ababa (0.9% and 8.0%) [16], respectively and Jimma (nalidixic acid, 5%) [17]. In contrast to other studies in Addis Ababa [30] and Jimma and Addis Ababa [16] which reported 83.7% and 81.4%, respectively low level of resistance of *Salmonella* isolates (10%) were detected to chloramphenicol. The variation in the resistance level of *Salmonella* to different types of antibiotics in this and earlier studies can be due to difference in serovars from place to place.

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The strength of this study compared with previous studies on *Salmonella* and *Shigella* is in the design of the study. Our study was conducted prospectively in a manner of controlled data collection and laboratory tests, whereas the other studies were conducted retrospectively (Awassa [35], Gondar [18,19], Jimma [17], and Jimma and Addis Ababa [16]). This study may not necessarily representative of the community prevalence of the disease, because not all cases from the area were included in the study since the enrolment was based on health center visit (not community survey with representative sampling).

**Conclusion**

Based on this study finding the overall prevalence of salmonellosis and shigellosis was 10.5% and 4.5%, respectively. Among the five identified serogroups of *Salmonella* isolates, serogroup A had the highest percentage (15%) although, 40% of the isolates were untypable by the available antisera. In the case of 17 *Shigella* isolates, *S. sonnei* account higher percentage (35.5%) compared to other *Shigella* species.

More than 40% of *Shigella* isolates were highly resistant to

### Table 4: Percentages of antimicrobial resistance of *Shigella* isolates, Butajira Health Centre, 2012 compared with selected previous reports from Ethiopia.

<table>
<thead>
<tr>
<th>Study area and time</th>
<th>No. of strains</th>
<th>AMP</th>
<th>C</th>
<th>CIP</th>
<th>CRO</th>
<th>SXT</th>
<th>TE</th>
<th>NA</th>
<th>GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awassa [35]</td>
<td>100</td>
<td>93.0</td>
<td>63.0</td>
<td>-</td>
<td>-</td>
<td>56.0</td>
<td>90.0</td>
<td>10.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Gondar [19]</td>
<td>214</td>
<td>79.9</td>
<td>52.8</td>
<td>8.9</td>
<td>-</td>
<td>73.4</td>
<td>86.0</td>
<td>-</td>
<td>7.9</td>
</tr>
<tr>
<td>Addis Ababa [30]</td>
<td>76</td>
<td>78.7</td>
<td>74.7</td>
<td>-</td>
<td>-</td>
<td>45.7</td>
<td>97.3</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Gondar [18]</td>
<td>90</td>
<td>78.9</td>
<td>67.8</td>
<td>2.2</td>
<td>0.0</td>
<td>84.6</td>
<td>90.0</td>
<td>0.0</td>
<td>12.2</td>
</tr>
<tr>
<td>Harar [15]</td>
<td>17</td>
<td>100.0</td>
<td>29.4</td>
<td>-</td>
<td>-</td>
<td>70.6</td>
<td>76.4</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>Butajira (This study, 2012)</td>
<td>17</td>
<td>47.1</td>
<td>29.4</td>
<td>5.9</td>
<td>0.0</td>
<td>76.5</td>
<td>82.4</td>
<td>5.9</td>
<td>17.6</td>
</tr>
</tbody>
</table>

**Table 5: Percentages of antimicrobial resistance of *Salmonella* isolates, Butajira Health Centre, 2012 compared with selected previous reports from Ethiopia.**

<table>
<thead>
<tr>
<th>Study area and time</th>
<th>No. of strains</th>
<th>AMP</th>
<th>C</th>
<th>CIP</th>
<th>CRO</th>
<th>SXT</th>
<th>TE</th>
<th>NA</th>
<th>GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jimma [17]</td>
<td>59</td>
<td>59.3</td>
<td>35.6</td>
<td>-</td>
<td>-</td>
<td>40.7</td>
<td>59.3</td>
<td>8.5</td>
<td>1.3</td>
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<tr>
<td>Addis Ababa [30]</td>
<td>37</td>
<td>81.3</td>
<td>83.7</td>
<td>-</td>
<td>-</td>
<td>75.7</td>
<td>94.5</td>
<td>37.8</td>
<td>75.6</td>
</tr>
<tr>
<td>Jimma &amp; Addis Ababa [16]</td>
<td>65</td>
<td>82.3</td>
<td>81.4</td>
<td>0.9</td>
<td>78.8</td>
<td>80.5</td>
<td>39.8</td>
<td>8.0</td>
<td>74.3</td>
</tr>
<tr>
<td>Harar [15]</td>
<td>28</td>
<td>100.0</td>
<td>62.3</td>
<td>-</td>
<td>-</td>
<td>71.4</td>
<td>-</td>
<td>3.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Butajira, (this study, 2012)</td>
<td>40</td>
<td>60.0</td>
<td>10.0</td>
<td>2.5</td>
<td>0.0</td>
<td>37.5</td>
<td>52.5</td>
<td>5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Figure 2:** Antibiotic resistance patterns of 40 *Salmonella* and 17 *Shigella* isolates.
tetracycline, co-trimoxazole and ampicillin. Low resistance rate was observed for ciprofloxacin and nalidixic acid and there was no resistance detected against ceftriaxone. In Salmonella, more than 37% of the isolates were resistance to ampicillin, tetracycline and cotrimoxazole. Highest level of Salmonella serovars susceptibility was detected for ciprofloxacin, ceftriaxone and nalidixic acid. From this study relatively high level of MDR was observed in Shigella isolates (53%) than Salmonella (27.5%) isolates.

The current study suggested that, Salmonella and Shigella species are developing resistant to oral antibiotics and less resistant to intramuscular/intramuscular antibiotics, this indicated that patients may take oral antibiotic without any prescription. But, this should be verified by further studies on communities’ knowledge, attitude and practice of drug use or further epidemiological study should be done on drug dispensing by different governmental and private pharmacies. Emphasis also should be given towards in prevention of further antibiotic resistance, monitoring on proper utilization of drugs and vaccine development against MDR isolates.

It is recommended that an extensive study of the prevalence, antimicrobial susceptibility pattern and drug resistance mechanisms of Salmonella and Shigella isolates be conducted. In addition, accurate diagnosis during management of infection caused by Salmonella and Shigella spp. should be employed rather than currently practiced empirical treatment. Moreover periodic epidemiological surveillance among humans is of vital importance to control the diseases caused by these pathogens.

Competing Interests

Financial competing interests: All authors have no financial relationships relevant to this article to disclose.

Non-financial competing interests: The authors have no non-financial competing interests relevant to this article to disclose.

Authors’ Contributions

Getachew Mengistu: Mr. Getachew conceptualized and designed the study, conducted sample collection and performed the laboratory work, carried out the initial analyses and interpretation of data, drafted the initial manuscript, and approved the final manuscript as submitted.

Tsehaynesh Lema: Mrs. Tsehaynesh designed the study, supervised the data collection and laboratory analysis, revised the manuscript, and approved the final manuscript as submitted.

Gebru Mulugeta: Mr. Gebru designed the study, revised the manuscript, and approved the final manuscript as submitted.

Abraham Aseffa: Dr. Abraham conceptualized and designed the study, supervised the data collection and laboratory analysis, revised the manuscript, and approved the final manuscript as submitted.

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