The burden of Shigella and Salmonella, Antibiotics Susceptibility Pattern and Associated Risk Factors among Diarrheic Children visited Alamura Health Center Southern Ethiopia: a cross-sectional study

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Research

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Abstract

**Background:** *Salmonella* and *Shigella* is a major health problem worldwide, in developing countries like Ethiopia, it is responsible for high morbidity and mortality of children. This study aimed to determine the prevalence of *Salmonella* and *Shigella* infection, their antibiotic susceptibility pattern and associated risk factor among the diarrheic paediatrics patients that visited Alamura Health Center in southern Ethiopia.

**Method:** A facility-based cross-sectional study was conducted at Alamura Health Center from April 2018 – July 2019. The study was performed on paediatrics below the age of 14 years in which consecutive children with diarrhoea were included for the study. A structured questionnaire was used to collect socio-demographic and clinical data after assent and consent obtained from parents or caretaker. The stool sample cultured as per the standard operating procedure (SOP) of the microbiology laboratory. Antibiogram was performed by Kirby-Bauer disc diffusion method and was interpreted based on the Clinical and laboratory standard institute guideline (CLSI) version 2018.

**Results:** Out of 263 children enrolled in the study, 50.5 % were females. The overall, 21/263 (8 %) 95% CI, (4.6 - 11.4%) *Shigella* and *Salmonella* was isolated. *Shigella dysenteriae* was dominantly isolated 11 (4.2%) followed by 9(3.42%) *Shigella* spp, and 1(0.38%) *Salmonella* typhi. Highly resistance to ampicillin (71.4%), augmentin and tetracycline (61.9%) each, whereas highly sensitive to ciprofloxacin (95.2%), ceftriaxone & ceftazidime (85.9%) each, gentamycin (81%), chloramphenicol (76.2%), cefuroxime (66.7%) and cotrimoxazole (52.4%) identified. Those with habit of washing the hands of children after toilet sometimes (AOR = 235.1, 95% CI, 20.9 - 2643.3, P = .000) and store cooked food in open container for later use (AOR = 36.44, 95% CI, 5.82 - 228.06, P = .000) showed statistically significant association.

**Conclusion:** High level of *Shigella* spp and one *Salmonella* was isolated from diarrheic children at Alamura Health Center. *Shigella dysenteriae* was the most dominantly isolated. Ampicillin, augmentin and tetracycline are with high resistance and ciprofloxacin, ceftriaxone, ceftazidime, gentamycin, chloramphenicol, cefuroxime and cotrimoxazole relatively sensitive. Those practised hands wash for their child after defecation for sometimes was 235.1-fold at risk of infection. Similarly, those store foods for later use in an open container was 36.44 times at risk of infection. Therefore, to alleviate this infection the concerned body should focus on giving health education for hand wash after defecation and storing food in a closed container later use is mandatory.

**Background**

Diseases caused by the enteric pathogens are common public health problems in many parts of the world including Ethiopia(1, 2). *Salmonella* and *Shigella* are associated with a high burden of illness among children in the developing world (3). Children are one of the victims to these infections accounting for approximately 8 per cent of all deaths among children under age 5 worldwide in 2017. This interpreted to over 1,300 young children passed away each day, 480,000 children a year, regardless of the availability of humble active treatment. Most of these deaths due to diarrhoea is in South Asia and sub-Saharan
Africa (4). Studies in Ethiopia from different regions reported 4.3-17-45% (5–8) *Shigella* and 1-12.6% (6–8) *Salmonella* infection.

They are species of particular concern as causes of enteric fevers, food poisoning and gastroenteritis (9). They are Gram-negative rods which commonly inhabit intestinal tracts of humans and many animals (10). It was estimated worldwide about 1.8 million cases of children died from diarrheal illness, a large proportion of which were attributed to *Shigella* and *Salmonella* spp.(11). Different studies have reported that *Shigella* spp. were associated with the majority of cases of bacillary dysentery which is prevalent mainly in developing nations. Whereas, *Salmonella* spp. were the most common cause of food-borne infection outbreaks in almost all over the world (12). In recent year the emergence and global dissemination of *Salmonella* and *Shigella* species resistance to ampicillin, chloramphenicol, tetracycline and co-trimoxazole increasingly documented in developing countries (13).

Infections of *Shigella* and *Salmonella* can be asymptomatic and can be treated with rehydration solutions unless the infection is by invasive strains (14). Prescribing antibiotics might shorten the extent of diarrhoea and control the shedding of the organisms which otherwise might continue to spread among people and into the environment and further pose a risk of spread of infections (15). Children are at high risk of these infections due to their weekend immune status and ease of contamination(16). In developing countries, this increased due to poor sanitation, personal hygiene and lack of appropriate food supply that leads children to contaminate themselves (17). Therefore, this study aimed to identify *Shigella* and *Salmonella* infections, their antibiotics susceptibility and associated risk factors among children with diarrhoea that visited Alamura health centre.

**Method And Materials**

**Study Area and Period**

The study was conducted in the southern nation, nationalities and peoples region (SNNPR) at Hawassa Alamura Health Center. Hawassa is the capital city of Southern Nation Nationality People Region (SNNPR), located in the Southern part of Ethiopia, on the shores of Lake Hawassa which is one of the Great Rift Valley lakes and 270 km from the capital city of Ethiopia. Mean annual rainfall of about 950 mm, the temperature of 20°C and humidity of 70% – 80%. The mean rainy season generally extends from June to October (18), gives the estimated population of Hawassa for 2015 as 351,469, with annual population growth, rate of just over 4%. The Hawassa city has seven sub-cities with five privates, one general and one comprehensive specialized Hospital and ten health centres. Alamura Health Centers was located in the Tabor sub-city and borderline between Fara and Hitata kebele near Alamura Mountain.

**Study Design and population**

A facility-based cross-sectional study conducted at Alamura Health Center. A convenient sampling technique was employed in which diarrheic paediatrics patients that their family or guidance is volunteer to participate in the study were consecutively included until the calculated sample size was achieved. All
diarrheic paediatrics patients that were visited Alamura Health Center for the diarrheal case of illness. Selected diarrheic paediatrics patient that visited Alamura Health Center during the study period was the study population. Paediatrics patients under 14 years of age whom his/her parents or guardians consented for the participation of the study included for the study. That parents/caretaker is involuntary to sign consent and paediatrics refuse for assent excluded from the study.

Variable of the Study
The dependent variables were the presence of Salmonella and Shigella. The independent variables were sociodemographic factors that are age, sex, place of residence, educational status of the mothers, marital status, family size, monthly income, occupation of the family. Clinical and behavioural factors are history and type of diarrhoea, drinking water source, washing of child’s hand after toilet, food/drink taken before illness, storage of cooked food for later use, the habit of handwashing before and after meal, washing habit of food containers, history of malnutrition and history of contact with domestic animals were assessed with a structured questionnaire.

Data Collection
The socio-demographic and clinical data collected after the parents/ caregiver informed about the aim of the study. Face-to-face interview conducted to collect the data with a structured questionnaire from parents or caretaker of the children who complained of diarrhoea after they signed the consent and the child accepted the assent.

Laboratory diagnosis
The stool was collected using a screw cup container. The parents/caregiver instructed to bring a fresh stool sample before 30 minutes of collection and avoid contamination with urine and other materials. All stool specimens placed into Carry Blair transport medium & transported to the microbiology laboratory of Hawassa University Comprehensive Specialized Hospital (HUCSH). The stool was inoculated on prepared culture media that is MacConkey, Xylose lysine deoxycholate (XLD) and selenite F-broth (Abtek, UK). The culture plates incubated aerobically at 37°C for 24 hours.

Bacterial identification
The colonies examined morphologically for size, shape, and ability to ferment lactose. Those bacterial colonies with non-lactose fermenting characteristics with H₂S for Salmonella and without H₂S for Shigella picked for biochemical identification. Indole test, urease production, mannitol fermentation, hydrogen sulphide, gas production test, citrate utilization test, motility test, carbohydrate fermentation test, lysine decarboxylase test (LDC) and oxidase test were used to differentiate to genus and species level (19).

Antibiotics susceptibility testing
A pure colony of isolated bacteria was mixed with normal saline to make a 0.5 McFarland standards suspension for susceptibility testing then swabbed on Mueller Hinton agar. The susceptibility pattern of the isolates was determined for ciprofloxacin-CIP (5 µg), augmentin -AUG (30 µg), gentamicin - GEN (10 µg), chloramphenicol - CAF (30 µg), co-cotrimoxazole-COT (25 µg), tetracycline - TAT (30 µg ), ampicillin - AMP ( 10 µg), ceftriaxone - CRO (30 µg), cefuroxime - CRX (30 µg) and ceftazidime - CAZ (30 µg). After incubation for 24 hours at 37°C, the diameter of each zone of inhibition was measured with a ruler in mm. The results then interpreted according
to CLSI guidelines antimicrobial susceptibility breaking points 2018 and recorded as sensitive (S), intermediate (I) or resistance (R) (20).

Data analysis
Data was entered to statistical package for the social science (SPSS) versions 20 and was analyzed to make inferences on the frequency of occurrence of enteric pathogens associated with diarrhoea and to show bacterial resistance pattern to locally prescribe antibiotic substances. Descriptive statistics were performed to get the frequency of dependent and independent variables. Binary logistic regression analysis was conducted to identify real predictor of Shigella and Salmonella. The strength of association was presented by odds ratio at 95% confidence interval and p-values ≤ 0.05 was considered as a statistically significant association.

Ethical Consideration
The study was conducted after formal permission was obtained from Southern Nation Nationality and People Regional Health Office, Hawassa city administration health office, Alamura Health centre manager and laboratory head. The patients were included in the study if their parents or caretaker sign the consent. Culture results and antimicrobial susceptibility results were communicated to the concerned bodies of in health centre within 72 hrs and treatment accordingly.

Result

Socio-demographic characteristics
A total of 263 diarrheic pediatric patients from Alamura Health Center was enrolled for the study with a mean and standard deviation of age 6.8 ± 3.7 years. The frequency and percentage of paediatrics age range enrolled for the study were, 0–4, 88(33.5%), 5–9, 103(39.2%) and 10–14, 72 (27.4%). The almost equal ration of male to female enrolled for the study (130:133). Regarding the residence, most of the study subjects 155(58.9%) were from Urban area and 108(41.1) was from rural. Concerning the paediatrics’ mother educational status most of them (81%) were educated which was included from reading and writing to university graduate level the rest 19% are illiterates. The marital status of their mother 178 (67.7%) was married, 43(16.3%) divorced and 41(15.6%) widowed. The mean and standard deviation of the family size was 5.6 ± 1.9 persons. The average income of the family was 3743.3 ± 2568.1 Ethiopian birr. Most of the study participants have a large family size with relatively low income earned < 1500 birr per month from this number diarrhoea positive was 12(57.1%) (Table 2).

The magnitude of Shigella and Salmonella
The overall magnitude of Shigella and Salmonella among diarrheic paediatrics patients in Alamura Health Center was 8.0% (21/263) 95% CI (4.6–11.4%). Shigella spp isolated from 7.6% (20/263)95% CI [4.6–11.0] of children. Shigella dysentery was frequently isolated from 4.2% (11/263) 95% CI [1.9–6.8] followed by other Shigella spp 3.42% (9/263), 95% CI [1.5–5.7] and Salmonella spp 0.4% (1/263) 95% CI [0-1.1]. In the rest, 92% (242/263) diarrheic paediatrics patients’ Shigella and Salmonella were not isolated (Fig. 1).
Antimicrobial susceptibility pattern

*Salmonella typhi*

There was only one *Salmonella typhi* isolated. It was sensitive for ciprofloxacin, gentamicin, ceftazidime, chloramphenicol, cefuroxime, ceftriaxone and co-trimoxazole and resistance for ampicillin and tetracycline.

Other Shigella species

*Shigella spp* isolate was 100.0% sensitive to both ceftriaxone and ciprofloxacin, 77.8% for both ceftazidime and chloramphenicol, were as 66.7% for cefuroxime and 55.6% for gentamycin. Resistance was seen 81.8% for ampicillin, 72.7% for tetracycline, and 55.6% for both co-trimoxazole and augmentin.

*Shigella dysentery*

*Shigella dysentery* isolate was 100% susceptible for gentamicin, 90.9% for ciprofloxacin, 90% for ceftazidime, 72% for both ceftriaxone and chloramphenicol. Resistance was seen 45.5% for ampicillin, 55% for co-trimoxazole, 72.7% for tetracycline and 91% for augmentin (Table 1).

### Table 1

antimicrobial susceptibility profile of *Salmonella* species, *Shigella* spp and *Shigella* dysentery isolated from diarrheic paediatrics patients in Alamura Health Center, South Ethiopia, 2019.

| Antibiotics | *S. Typhi* (1) | *Shigella spp* (9) | *S. dysentery* (11) | Total (21) |
|-------------|---------------|-------------------|---------------------|-----------|
| AMP         | S: 0 | R: 1 | S: 0 | R: 4 | S: 2 | R: 9 | S(0.0) | R: 15 | (71.4) |
| COT         | 1     | -    | 5    | 0    | 4    | 0    | 3     | 3     | 11(52.4) | 7(33.3) |
| CIP         | 1     | -    | 9    | 0    | 0    | 10   | 1     | 1     | 20(95.2) | 0(0.0)  |
| CRO         | 1     | 0    | 9    | 0    | 0    | 8    | 0     | 3     | 18(85.7) | 1(4.8)  |
| CAZ         | 1     | 0    | 7    | 1    | 1    | 10   | 1     | 1     | 18(85.7) | 2(9.5)  |
| GEN         | 1     | 0    | 5    | 0    | 4    | 0    | 11    | 0     | 17(81.0) | 0(0.0)  |
| CAF         | 1     | 0    | 7    | 1    | 1    | 8    | 2     | 1     | 16(76.2) | 3(14.3) |
| CRX         | 1     | 0    | 6    | 2    | 1    | 7    | 1     | 3     | 14(66.7) | 3(14.3) |
| AUG         | 0     | 1    | 1    | 4    | 0    | 4    | 0     | 8     | 1(4.8)   | 7(33.7) |
| TAT         | 0     | 1    | 0    | 5    | 4    | 0    | 3     | 8     | 0(0.0)   | 8(38.1) |

Associated risk factors

Among the study participant, 162 (61.6%) of them had a history of diarrhoea, of this 17(81.0%) were positive for current infection. Of all diarrheic children, the type of diarrhoea was watery for 111(42.2%), mucoid for 103(39.3%) and bloody for 49(18.6%). Children with mucoid diarrhoea affected more that are 13 (61.9%) as compared to the rest patients. Most of the children 170(64.6%) had diarrhoea once in a day and most of the bacteria 11(52.4%) was isolated form this patient. Most of the children used a piped water 159 (60.9%), similarly, the children in these categories were infected more 17 (81.0%).

Regarding hand wash, after defecation, most of the children practised hand wash after toilet always 221 (84.0%) but those who practised hand wash sometimes was infected more 20 (95.2%). Most of the food taken by the children before the illness was cooked food 82(31.2%) even if the bacterial infection was dominantly isolated from children that feed overnight food 8(38.1%). Most of the children enrolled for the study was those who store their food in closed container 223(84.8%), lack habit of hand wash before and after meal 178(67.7%), had a habit of washing of food container 157(59.7%), those are well-nourished 238(90.5%), those who had vaccinated 202 (76.8%), and had animal contact 137(52.1%). Correspondingly, most of the bacteria were isolated from those who store food in an open container.
16(76.2%), lack of habit of hand wash after or before meal 15 (71.4%), washing of food container for sometimes 17(81.0%), well-nourished 18 (85.7%), vaccinated 14(66.7%) and had animal contacts 13(61.9%) (Table 2).
Table 2
bivariate analysis of socio-demographic characteristics and clinical data of diarrheic paediatrics patients in the Alamura Health Center, southern Ethiopia, 2019.

| Variables                          | Frequency (% | Shigella/SalmonellaCOR 95%CI | p-value | AOR 95%CI | p-value |
|-----------------------------------|--------------|-------------------------------|----------|-----------|----------|
|                                   | Yes (%)      | No (%)                        |          |           |          |
| Age in group (years)              |              |                               |          |           |          |
| 0–4                               | 7(33.3)      | 9(42.9)                       | 1        | 1.158(.35-3.82) | .809    |
| 5–9                               | 5(23.8)      | 5(23.8)                       | 1        | 1.283(.41-4.00) | .668    |
| 10–14                             | 5(23.8)      | 5(23.8)                       | 1        | 1.283(.41-4.00) | .668    |
| Sex                               |              |                               |          |           |          |
| Male                              | 8(38.1)      | 12(61.9)                      | 1        | 1.652(.66-4.13) | .283    |
| Female                            | 122(50.4)    | 120(49.6)                     | 1        | 1.652(.66-4.13) | .283    |
| Residence                         |              |                               |          |           |          |
| Rural                             | 8(38.1)      | 14(70.9)                      | 1        | 1.874(.35-2.2) | .773    |
| Urban                             | 100(41.3)    | 142(61.1)                     | 1        | 1.874(.35-2.2) | .773    |
| Mother’s educational              |              |                               |          |           |          |
| No formal education               | 2(9.5)       | 48(19.8)                      | 1        | 1.125(0.10-12.99) | .925    |
| Read and write                    | 9(42.9)      | 47(19.4)                      | 1        | 1.125(0.10-12.99) | .925    |
| Elementary school                 | 4(19.0)      | 49(20.2)                      | 1        | 1.125(0.10-12.99) | .925    |
| Secondary school                  | 1(4.8)       | 27(11.2)                      | 1        | 1.125(0.10-12.99) | .925    |
| Collage/university                | 50(19.0)     | 48(19.8)                      | 1        | 1.125(0.10-12.99) | .925    |
| Mothers marital status            |              |                               |          |           |          |
| Married                           | 14(67.7)     | 164(67.8)                     | 1        | 1.057(.37-3.044) | .919    |
| Divorced                          | 9(42.3)      | 38(15.7)                      | 1        | 1.057(.37-3.044) | .919    |
| Widowed                           | 21(9.5)      | 39(16.1)                      | 1        | 1.057(.37-3.044) | .919    |
| Family size (person)              |              |                               |          |           |          |
| 2–3                               | 2(9.5)       | 21(8.7)                       | 1        | 1.077(2.3-5.163) | .926    |
| 4–5                               | 12(57.1)     | 117(48.5)                     | 1        | 1.077(2.3-5.163) | .926    |
| ≥6                                | 7(33.3)      | 103(42.7)                     | 1        | 1.077(2.3-5.163) | .926    |
| Monthly income birr/ETB           |              |                               |          |           |          |
| 500–1500                          | 7(33.3)      | 44(18.2)                      | 1        | 4.444(.169-11.66) | .099    |
| >1500                             | 2(9.5)       | 198(81.8)                     | 1        | 4.444(.169-11.66) | .099    |
| Previous diarrhoea                |              |                               |          |           |          |
| Yes                               | 170(64.6)    | 145(59.9)                     | 1        | 2.843(.928-8.706) | .067    |
| No                                | 77(29.3)     | 76(51.4)                      | 1        | 2.843(.928-8.706) | .067    |
| Type of diarrhoea                 |              |                               |          |           |          |
| Bloody                            | 111(42.2)    | 76(51.4)                      | 1        | 11.69(9.9-138.44) | .051    |
| Watery                            | 49(18.6)     | 13(8.8)                       | 1        | 11.69(9.9-138.44) | .051    |
| Mucoid                            | 103(39.2)    | 59(39.9)                      | 1        | 11.69(9.9-138.44) | .051    |
| Frequency of diarrhoea            |              |                               |          |           |          |
| Once                              | 170(64.6)    | 159(65.7)                     | 1        | 1.038(.125-8.598) | .973    |
| Twice                             | 77(29.3)     | 68(28.1)                      | 1        | 1.038(.125-8.598) | .973    |
| >three                            | 16(6.1)      | 14(5.8)                       | 1        | 1.038(.125-8.598) | .973    |
| Drinking H2O Sources              |              |                               |          |           |          |
| Pipe                              | 159(60.9)    | 142(58.7)                     | 1        | 2.993(9.78-9.162) | .055    |
| Other                             | 104(39.5)    | 220(80.9)                     | 1        | 2.993(9.78-9.162) | .055    |
| Child’s hand wash after toilet    |              |                               |          |           |          |
| Always                            | 221(84.0)    | 220(90.9)                     | 1        | 200(25.6-1562.35) | .000    |
| Sometimes                         | 42(16.0)     | 22(9.1)                       | 1        | 200(25.6-1562.35) | .000    |
| Variables                          | Frequency (%) | Shigella/Salmonella | COR 95%CI  | p-value | AOR 95%CI | p-value |
|-----------------------------------|---------------|---------------------|------------|---------|-----------|---------|
|                                  |               | Yes (%)             | No (%)     |         |           |         |
| Food has taken before illness     |               |                     |            |         |           |         |
| Cooked food                       | 82(31.2)      | 5(23.8)             | 77(31.8)   | .801(1.182-3.533) | .769     |
| Overnight food                    | 77(29.3)      | 8(38.1)             | 69(28.5)   | 1.430(3.358-5.716) | .613     |
| Raw vegetable                     | 64(24.3)      | 5(23.8)             | 5924.4     | 1.045(2.263-4.634) | .954     |
| Raw milk                          | 40(15.2)      | 3(14.3)             | 3715.3     | 1       |           |         |
|                                  |               |                     |            |         |           |         |
| Storage of cooked food            |               |                     |            |         |           |         |
| Open containers                   | 40(15.2)      | 16(76.2)            | 24(9.9)    | 29.1(9.78-86.372) | .000     |
| Closed containers                 | 223(84.8)     | 5(23.8)             | 218(90.1)  | 1       | 36.44(5.82-228.06) | .000     |
| Hand washing before & after a meal|               |                     |            |         |           |         |
| Yes                               | 85(32.3)      | 6(28.6)             | 79(32.6)   | 1       | 4.94(0.795-30.74)  | .087     |
| No                                | 178(67.7)     | 15(71.4)            | 160(66.1)  | 1.212(4.53-3.242) | .702     |
|                                  |               |                     |            |         |           |         |
| Cleaning of cooking containers    |               |                     |            |         |           |         |
| Always                            | 157(59.7)     | 4(19.0)             | 153(63.2)  | 1       | 7.306(2.38-22.4)  | .001     |
| Sometimes                         | 106(40.3)     | 17(81.0)            | 89(36.8)   | 1.67(0.46-6.121) | .441     |
| Malnutrition                      |               |                     |            |         |           |         |
| Yes                               | 25(9.5)       | 3(14.3)             | 22(9.1)    | 1       | 574(2.211-4.95)   | .256     |
| No                                | 238(90.5)     | 18(85.7)            | 220(90.9)  | 1.546(62.865) | .351     |
| Vaccination                       |               |                     |            |         |           |         |
| Yes                               | 202(76.8)     | 14(66.7)            | 188(77.7)  | 1       | 1.546(62.865) | .351     |
| No                                | 61(23.2)      | 7(33.3)             | 54(223)    | 1       |           |         |
| Contact with animals              |               |                     |            |         |           |         |
| Yes                               | 137(52.1)     | 13(61.9)            | 124(51.2)  | 1.546(62.865) | .351     |
| No                                | 126(47.9)     | 8(38.1)             | 118(48.8)  | 1       |           |         |

The bivariate analyses indicates that family with monthly income > 1500 (COR = 2.250, 95% CI, 0.86–5.902, p = .099), educational status of mother that can able read and write (COR = 5.170, 95% CI, 0.62–43.05, p = .129), those had previous history of diarrhea (COR = 0.35, 95% CI, 0.115-0.788, p = .067), watery diarrheal type (COR = 11.69, 95% CI, 0.988–138.44, p = .051), mucoid (COR = 16.75, 95% CI, 2.130-131.67, p = .007). Similarly, those who used pipe water source (COR = 2.993, 95% CI, 0.978–9.16, p = .055). Who wash the hands of their child sometime (COR = 200.0, 95% CI, 25.602-1562.348, p = .000). Store food in open containers (COR = 29.1, 95% CI, 9.78–86.37, p = .000) and had washing habit of food containers sometimes (COR = 7.306, 95% CI, 2.38–22.4, p = .001) was candidate variables for multivariable analysis with p-value ≤ 0.25 (Table 2).

However, in multivariate analysis, after adjustment, those who had a habit of washing the hands of children after toilet (AOR = 235.1, 95% CI, 20.9–2643.3, P = .000) and store cooked food in open container (AOR = 36.44, 95% CI, 5.82–228.06, P = .000) showed statistically significant association for Shigella and Salmonella infection with p-values ≤ .05. However, factors like the type of diarrhoea, history of contact with domestic animals, a habit of handwashing before meal and handwashing after a meal, and washing of food container were not statically significant associated factors (Table 2).

**Discussion**

Our study does not indicate the total prevalence of *Salmonella* and *Shigella* infection in Hawassa town were, it does not identify bacteria at species level this was due to lack of anti-sera in the market. The
study determined the prevalence of *Shigella* and *Salmonella*, their antibiotics susceptibility pattern and associated risk factor among pediatric patient at Altamura Health Center.

The overall prevalence of *Shigella* and *Salmonella* isolated in this study was 8.0% [4.6–11.4%] which is lower than compared with studies conducted in Tanzania 42.7% (21), Mozambique 27.2% (22), Ethiopia 22.3% (23) and 22.2% (24). It is comparable with a study reported from Ethiopia 9.0% (25) and 8.3% (6). The possible reason for such difference could be sample size, a method implemented and the age variation.

In this study 20 (7.6%) 95% CI [4.6–11.0] of *Shigella* spp was isolated which is comparable with a study conducted in Ethiopia 8.3% (6), 9.5% (26), in contrast to our finding a lower rate of Shigella species was reported from China 1.4% (27). Our study tried to identify *Shigella dysenteriae* from another *Shigella* app with available biochemical tests accordingly 11 (4.2%) 95% CI [1.9–6.8%] identified as *Shigella dysenteriae*. This rate is lower than a study reported from Nepal 14.5% (28), 12% Senegal. It is comparable with the finding from Central Africa 3% (29). The other nine (3.42%), 95% CI [1.5–5.7] was other species of *Shigella* was higher compared with results reported from China 1.4% (27), Nigeria 1.4% (30), Ethiopia 1.3% (31) and 1.1% (32). Our finding was lower than study reported from Jimma 20.1% (33), Gondar 16.9%(34), Bahir Dar 14.9% (35), Harar 14.6% (36), Bahir Dar 9.5% (37), Addis Ababa 9.1% (26), Iran 8.5% (38), Southwest Ethiopia 8.4% (39), Sudan 8% (40), Bahir Dar 7.8% (37), southern Ethiopia 7.0% (24), Eastern Ethiopia 6.9% (41) and Northern Ethiopia 6.9% (42). This variation is may be due to the geographical location, climatic change and the age variation of the participant. Comparable result was reported from Gondar 4.6% (43), Nepal 4.6% (44), Butajira 4.5% (45) and 4.0% Kenya(46), Turkey 3.2% (47), and Ethiopia 2.3% (39).

A single *S. Typhi* 0.4% 95% CI [0-1.1%] was isolated in this study which is in line with the findings reported from the same country in Addis Ababa, 0% (31), 1.1% (43), in contrast to our finding higher rates was reported from Sudan 4.0% (40), China 4.3% (27), Addis Ababa, Ethiopia 3.95% (26), Kenya 3.4% (46), Turkey 3% (47), Gondar 1.6%(48), and Hawassa 1.5% (24). This difference might be due to sampling size, weather condition and study subjects age differences.

Our study revealed that the highest rates of antibiotic resistance of *Shigella* spp were against Ampicillin 81.8% which is comparable with the study reported from a different area of Ethiopia 70.1% from Jimma (33), 79.9% Gonder (49), 86.7%(25), and 88.9% from Mekelle (50). Our study also showed relatively low resistance compared to findings from Nigeria 90.5% (51), Harar 100% (41), Jimma 100% (39), Hawassa 93% (34). This may be due to widespread resistance strain throughout the countries. Another antibiotic resistance of *Shigella* spp was seen against tetracycline 71.4% and this was comparable with findings reported from Harar 70.6% (41), Jimma 63.6% (33) and Mekelle 77.8% (42). The result was slightly lower than the study reported from Butajira 82.4% (45), Gondar 86% (52) & 86% (49), Hawassa 90% (34). This may be due to those strains moderately susceptible for tetracycline at a certain corner of the country. Our result also indicated that 52.4% resistance was seen against co-trimoxazole and this was comparable with a study done in Hawassa 56.0% (43), Addis Ababa 45.7% (53) and Mekelle 55.6% (42). Inconstant to
our finding higher result reported from Gonder 73.4% (49). Several factors may contribute to resistance by pathogens causing gastroenteritis in developing countries like Ethiopia. These include frequent overuse, misuse and factors related to the potency and quality of antimicrobials and the distribution of resistant strains (53).

Our finding in the multivariate analysis showed that who had a habit of washing the hands of a child after toilet sometimes as compared to those practice hand washing always 235.1 times at risk of infection. Similarly, those who store cooked food in an open container for later use was 34.44 times at risk of infection as compared to those who practice closing of the container with p-value ≤ 0.05 which is in agreement with a study conducted in Southern Ethiopia Arbaminch (8, 25, 54).

Conclusion

Our study indicated that there was a high rate of *Shigellosis* among diarrheic paediatrics patients that visited Alamura Health Center during the study period and single *Salmonella was isolated*. Ampicillin, augmentin and tetracycline are with high resistance and ciprofloxacin, ceftriaxone, ceftazidime, gentamycin, chloramphenicol, cefuroxime and cotrimoxazole relatively sensitive. Those practised hands wash for their child after defecation for sometimes was 235.1-fold at risk of infection. Similarly, those store foods for later use in an open container was 36.44 times at risk of infection. Therefore, to alleviate this infection the concerned body should focus on giving health education for hand wash after defecation and storing food in a closed container later use is mandatory.

Declarations

Ethical Clearance: The study was conducted after formal permission was obtained from Southern Nation Nationality and People Regional Health Office, Hawassa city administration health office, Alamura Health centre manager and laboratory head. The patients were included in the study if their parents or caretaker sign the consent. Culture results and antimicrobial susceptibility results were communicated to the concerned bodies of in health centre within 72 hrs and treatment accordingly.

Consent for publication: Not applicable

Availability of data and material: All the data supporting the findings can be obtained from the corresponding author.

Competing of interest: The authors declare that they have no competing interests

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Authors’ contribution: MH, TA,BT.EM, ZB equally conceived the idea, develop the proposal, collected the data, perform the analysis and prepared the manuscript, TA & ZB has made a final edition of the document. All authors have read and approved the manuscript.
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References

1. Surafel k GKaAK. Prevalence of Shigella Related Diarrhea in Ambo Town and Antibiotic Susceptibility of the Isolated Strains. Greener Journal of Epidemiology Public Health. 2015;3(1):001.

2. Troeger C, Khalil IA, Reiner RC. Estimating health-loss due to enteric pathogens: importance and challenges. The Lancet Global Health. 2019;7(3):e284-e5.

3. Kotloff KL, Nataro JP, Blackwelder WC, Nasrin D, Farag TH, Panchalingam S, et al. Burden and aetiology of diarrhoeal disease in infants and young children in developing countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study. The Lancet. 2013;382(9888):209–22.

4. women UDMtsoca. Diarrhoeal disease. https://datauniceforg/topic/child-health/diarrhoeal-disease/. 2019.

5. Alemu A, Geta M, Taye S, Eshetie S, Engda T. Prevalence, associated risk factors and antimicrobial susceptibility patterns of Shigella infections among diarrheic pediatric population attending at Gondar town healthcare institutions, Northwest Ethiopia. Trop Dis Travel Med Vaccines. 2019;5:7-.

6. Abebe W, Earsido A, Taye S, Assefa M, Eyasu A, Godebo G. Prevalence and antibiotic susceptibility patterns of Shigella and Salmonella among children aged below five years with Diarrhoea attending Nigist Eleni Mohammed memorial hospital, South Ethiopia. BMC Pediatrics. 2018;18(1):241.

7. Assefa A, Girma M. Prevalence and antimicrobial susceptibility patterns of Salmonella and Shigella isolates among children aged below five years with diarrhea attending Robe General Hospital and Goba Referral Hospital, South East Ethiopia. Trop Dis Travel Med Vaccines. 2019;5(1):19.

8. Ameya G, Tsalla T, Getu F, Getu E. Antimicrobial susceptibility pattern, and associated factors of Salmonella and Shigella infections among under five children in Arba Minch, South Ethiopia. Annals of Clinical Microbiology Antimicrobials. 2018;17(1):1.

9. Yildiz C, Öztürk C, Emekdas G. Research of the E. coli 0157: H7 strains cases of the Gastro-enteritis. Infeksiyon Dergisi. 2005;19:189–92.

10. Abdullahi M. Incidence and antimicrobial susceptibility pattern of Salmonella species in children attending some hospitals in kano metropolis, kano state–Nigeria. Bayero Journal of Pure and Applied Sciences. 2010;3(1).

11. Shao Y, Zhu S, Jin C, Chen F. Development of multiplex loop-mediated isothermal amplification-RFLP (mLAMP-RFLP) to detect Salmonella spp. and Shigella spp. in milk. Int J Food Microbiol. 2011;148(2):75–9.
12. Lauri A, Castiglioni B, Mariani P. Comprehensive analysis of Salmonella sequence polymorphisms and development of a LDR-UA assay for the detection and characterization of selected serotypes. Appl Microbiol Biotechnol. 2011;91(1):189–210.

13. Okeke IN, Klugman KP, Bhutta ZA, Duse AG, Jenkins P, O’Brien TF, et al. Antimicrobial resistance in developing countries. Part II: strategies for containment. The Lancet infectious diseases. 2005;5(9):568–80.

14. Pawlowski SW, Warren CA, Guerrant R. Diagnosis and treatment of acute or persistent diarrhea. Gastroenterology. 2009;136(6):1874–86.

15. Beyene G, Tasew H. Prevalence of intestinal parasite, Shigella and Salmonella species among diarrheal children in Jimma health center, Jimma southwest Ethiopia: a cross sectional study. Ann Clin Microbiol Antimicrob. 2014;13:10.

16. Pickering LK, Bartlett AV, Woodward WE. Acute infectious diarrhea among children in day care: epidemiology and control. Clin Infect Dis. 1986;8(4):539–47.

17. Girma G. Prevalence. Antibiogram and Growth Potential of Salmonella and Shigella in Ethiopia: Implications for Public Health: A Review. Research Journal of Microbiology. 2015;10(7):288.

18. Wikipedia c.. Awasa. In Wikipedia, The Free Encyclopedia. Retrieved 09:01, November 23. 2019, from. https://en.wikipedia.org/w/index.php?title=Awasa&oldid=927029817. 2019, November 19.

19. Cheesbrough M. Microbiological tests. District laboratory practice in tropical countries Part. 2000;2.

20. CLSI C. LSI. (2018). Performance Standards for Antimicrobial Susceptibility Testing Clinical and Laboratory Standards Institute.

21. Vargas M, Gascon J, Casals C, Schellenberg D, Urassa H, Kahigwa E, et al. Etiology of diarrhea in children less than five years of age in Ifakara, Tanzania. Am J Trop Med Hyg. 2004;70(5):536–9.

22. Vandepitte J, Verhaegen J, Engbaek K, Rohner P, Piot P, Heuck C, et al. Basic laboratory procedures in clinical bacteriology: World Health Organization; 2003.

23. Beyene G, Haile-Amlak A. Antimicrobial sensitivity pattern of Campylobacter species among children in Jimma University Specialized Hospital, southwest Ethiopia. Ethiopian Journal of Health Development. 2004;18(3):185–9.

24. Mulatu G, Beyene G, Zeynudin A. Prevalence of Shigella, Salmonella and Campylobacter Species and Their Susceptibility Patterns Among Under Five Children With Diarrhea in Hawassa Town, South Ethiopia. Ethiopian Journal of Health Sciences. 2014;24(2):101.

25. Terfassa A, Jida M. Prevalence and Antibiotics Susceptibility Pattern of Salmonella and Shigella Species among Diarrheal Patients Attending Nekemte Referral Hospital, Oromia, Ethiopia. International journal of microbiology. 2018;2018.

26. Mamuye Y, Metaferia G, Birhanu A, Desta K, Fantaw S. Isolation and antibiotic susceptibility patterns of Shigella and Salmonella among under 5 children with acute diarrhoea: a cross-sectional study at selected public health facilities in Addis Ababa, Ethiopia. Clinical Microbiology: Open Access; 2015.
27. Qu M, Lv B, Zhang X, Yan H, Huang Y, Qian H, et al. Prevalence and antibiotic resistance of bacterial pathogens isolated from childhood diarrhea in Beijing, China (2010–2014). Gut pathogens. 2016;8(1):31.

28. Wilson G, Easow JM, Mukhopadhyay C, Shivananda P. Isolation & antimicrobial susceptibility of Shigella from patients with acute gastroenteritis in western Nepal. Indian J Med Res. 2006;123(2):145.

29. Lango-Yaya E, Djeintote M, Djimeli C. Contribution to the Study of Antibiotic Resistance on Salmonella and Shigella Strains Isolated in Central African Republic. J Microbiol Exp. 2017;4(1):00105.

30. Akinnibosun F, Nwafor F. Prevalence of diarrhoea and antibiotic susceptibility test in children below 5 years at University of Benin Teaching Hospital, Nigeria. International Research Journal of Public Environmental Health. 2015;2(4):49–55.

31. Hawaz H, Girma S, Tezera Y, Ahmed U, Kelel M. Prevalence and drug susceptibility pattern of Shigella and Salmonella species in under ten diarrhoeic children admitted to Tirunesh-Beijing hospital. International Journal. 2017;3(2):63.

32. Lamboro T, Ketema T, Bacha K. Prevalence and antimicrobial resistance in Salmonella and Shigella species isolated from outpatients, Jimma University Specialized Hospital, Southwest Ethiopia. Canadian Journal of Infectious Diseases and Medical Microbiology. 2016;2016.

33. Mache A. Antibiotic resistance and sero-groups of Shigella among paediatric out-patients in southern Ethiopia. East Afr Med J. 2001;78(6):296–9.

34. Roma B, Worku S, Mariam ST, Langeland N. Antimicrobial susceptibility pattern of Shigella isolates in Awassa. Ethiopian Journal of Health Development. 2000;14(2):149–54.

35. Debas G, Kibret M, Biadglegne F, Abera B. Prevalence and antimicrobial susceptibility patterns of shigella species at Felege Hiwot Referral Hospital, Northwest Ethiopia. Ethiop Med J. 2011;49(3):249–56.

36. Mekonnen H, Kebede A, Menkir S. Isolation rate and drug resistance patterns of Shigella species among diarrheal patients attending at Hiwot Fana hospital, Harar, Ethiopia. Ethiopian Journal of Science Technology. 2014;7(1):15–25.

37. Admassu M, Yemane G, Kibret M, Abera B, Nibret E, Adal M. Prevalence and antibiogram of Shigella and Salmonella spp. from under five children with acute diarrhea in Bahir Dar Town. Ethiopian Journal of Science Technology. 2015;8(1):27–35.

38. Samie A, Guerrant R, Barrett L, Bessong P, Igumbor E, Obi C. Prevalence of intestinal parasitic and bacterial pathogens in diarrhoeal and non-diarrhoeal human stools from Vhembe district, South Africa. J Health Popul Nutr. 2009;27(6):739.

39. Beyene G, Tasew H. Prevalence of intestinal parasite, Shigella and Salmonella species among diarrheal children in Jimma health center, Jimma southwest Ethiopia: a cross sectional study. Ann Clin Microbiol Antimicrob. 2014;13(1):10.
40. Saeed A, Abd H, Sandstrom G. Microbial aetiology of acute diarrhoea in children under five years of age in Khartoum, Sudan. Journal of medical microbiology. 2015;64(Pt 4):432.
41. Reda AA, Seyoum B, Yimam J, Andualem G, Fiseha S, Vandeweerd J-M. Antibiotic susceptibility patterns of Salmonella and Shigella isolates in Harar, Eastern Ethiopia. J Infect Dis Immun. 2011;3(8):134–9.
42. Gebrekidan A, Dejene TA, Kahsay G, Wasihun AG. Prevalence and antimicrobial susceptibility patterns of Shigella among acute diarrheal outpatients in Mekelle hospital, Northern Ethiopia. BMC Res Notes. 2015;8(1):611.
43. Demissie A, Wubie T, Yehuala FM, Fetene M, Gudeta A. Prevalence and antimicrobial susceptibility patterns of Shigella and Salmonella species among patients with diarrhea attending Gondar Town Health Institutions, Northwest Ethiopia. Sci J Pub Health. 2014;2(5):469–75.
44. Ansari S, Shercand J, Parajuli K, Mishra S, Dahal R, Shrestha S, et al. Bacterial etiology of acute diarrhea in children under five years of age. Journal of Nepal Health Research Council. 2013.
45. Mengistu G, Mulugeta G, Lema T, Aseffa A. Prevalence and antimicrobial susceptibility patterns of Salmonella serovars and Shigella species. J Microb Biochem Technol S. 2014;2:006.
46. Shah M, Kathiiko C, Wada A, Odoyo E, Bundi M, Miringu G, et al. Prevalence, seasonal variation, and antibiotic resistance pattern of enteric bacterial pathogens among hospitalized diarrheic children in suburban regions of central Kenya. Tropical medicine health. 2016;44(1):39.
47. Kara TT, Özdemir H, Kurt F, Güriz H, Çiftçi E, Aysev AD, et al. Prevalence of Salmonella and Shigella spp. and Antibiotic Resistance Status in Acute Childhood Gastroenteritis/Akut Çocukluk Çağı Gastroenteritlerindeki Salmonella-Shigella Sikligi ve Antibiyotik Direnç Durumlari. Cocuk Enfeksiyon Dergisi. 2015;9(3):102.
48. Huruy K, Kassu A, Mulu A, Worku N, Fetene T, Gebretsadik S, et al. Intestinal parasitosis and shigellosis among diarrheal patients in Gondar teaching hospital, northwest Ethiopia. BMC Res Notes. 2011;4(1):472.
49. Yismaw O, Negeri C, Kassu A. A five-year antimicrobial resistance pattern observed in Shigella species isolated from stool samples in Gondar University Hospital, northwest Ethiopia. Ethiopian Journal of Health Development. 2006;20(3).
50. Gebreegiabher G, Asrat D, Hagos T. Isolation and antimicrobial susceptibility profile of Shigella and Salmonella species from children with acute diarrhoea in Mekelle Hospital and Semen Health Center, Ethiopia. Ethiopian journal of health sciences. 2018;28(2):197–206.
51. Efuntoye MO, Adenuga A. Shigella Serotypes among nursery and primary school children with diarrhea in Ago-Iwoye and Ijebu-Igbo, Southwestern Nigeria. JPCS. 2011;2:29–32.
52. Tiruneh M. Serodiversity and antimicrobial resistance pattern of Shigella isolates at Gondar University teaching hospital, Northwest Ethiopia. Jpn J Infect Dis. 2009;62(2):93–7.
53. Asrat D. Shigella and Salmonella serogroups and their antibiotic susceptibility patterns in Ethiopia. 2008.
54. Mama M, Alemu G. Prevalence, antimicrobial susceptibility patterns and associated risk factors of Shigella and Salmonella among food handlers in Arba Minch University, South Ethiopia. BMC Infect Dis. 2016;16(1):686.

**Figures**

![Graph showing number (percent) of Shigella/Salmonella isolates](image)

**Figure 1**

Magnitude of Shigella Spp, Shigella dysentery and Salmonella typhi in diarrheic paediatrics patients from Alamura Health Center, southern Ethiopia, 2019.