Prevalence, antimicrobial susceptibility pattern, and associated factors of Salmonella and Shigella among food handlers in Adigrat University student's cafeteria, Northern Ethiopia, 2018

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Abstract

Background: Food handlers play a significant role in the transmission of foodborne infection. Salmonella and Shigella are the most common foodborne pathogens and their infections are a major public health problem of the globe. Thus, this study was aimed to determine the prevalence, antimicrobial susceptibility patterns, and associated factors of Salmonella and Shigella among food handlers.

Methodology: A cross-sectional study was conducted from March to August 2018 at Adigrat University student cafeteria, Northern Ethiopia. Data on socio-demographic and associated factors were collected using a structured questionnaire. Fresh stool samples were collected from 301 food handlers and transported to Adigrat University Microbiology Laboratory. Bacterial isolation and antimicrobial susceptibility test were performed using standard bacteriological methods. Data analysis was performed using SPSS version 22 and $P < 0.05$ with a corresponding 95% confidence interval was considered statistically significant.

Results: A total of 301 food handlers were included in this study. The majority of study participants were females 265 (88.0 %). About 22 (7.3%) and 11 (3.7%) of food handlers were found to be positive for Salmonella and Shigella respectively. Hand washing after using a bathroom with water only, hand washing after using the bathroom, hand washing after touching dirty materials, hand washing before food handling and fingernails status were significant associated factors identified. None of the Salmonella and Shigella isolates was sensitive to ampicillin. On the other hand, low resistance was found for chloramphenicol, ceftriaxone, and ciprofloxacin.

Conclusion: The present study revealed that the prevalence of Salmonella and Shigella among food handlers found to be 22 (7.3%) and 11 (3.7%) respectively. Such colonized food handlers can contaminate food, drinks and could serve as a source of infection to consumers via the food chain. This indicates that the need for strengthened infection control measures to prevent Salmonella and Shigella transmission in the students' cafeteria.

Background

Foodborne diseases are a major public health problem in the globe. The severity is higher among developing countries due to low hygienic food handling practices, lack of environmental sanitation and poor access to safe drinking water [1]. In developing countries, approximately 70% of cases of diarrheal diseases are associated with the consumption of contaminated food [2].

Salmonella remains a major cause of foodborne infection in humans [3], which leads to approximately, 93 million infections every year [4, 5]. World Health Organization (WHO) estimates that there are around 16 million new cases and 600,000 deaths due to typhoid fever each year worldwide [6]. It causes bacterial bloodstream infections with a fatality rate of 20-25% [7]. The widespread nature of salmonellosis increases antibiotic resistance which in turn increases the treatment cost, hospitalization, morbidity, and mortality [8].

These bacteria are transmitted directly and indirectly through contaminated objects such as food, water, nails, and fingers, this indicates those microorganisms can be spread by faecal-oral human-to-human transmission [9, 10]. Bacteria are transmitted directly and indirectly through food, water, and fingernails compared to other parts of the hand, fingernails harbour the most microorganisms and difficult to clean easily.

Shigella continues to play a major role in etiology for inflammatory diarrhoea, and dysentery in food handlers [11]. The annual incidence of *Shigella* is estimated to be 164.7 million people, with 69% of all deaths attributable to shigellosis worldwide [12, 13]. The highest prevalence of shigellosis is observed in tropical and subtropical parts of the world [14].

Salmonella and *Shigella* are a significant cause of severe post diarrheal complications such as reactive arthritis, sepsis, reiter syndrome, myocarditis, inflammatory bowel diseases, irritable bowel syndrome, and peritonitis [15, 8, 16]. The emergence of

antimicrobial-resistant *Salmonella* and *Shigella* becomes a significant threat to deliver reliable therapies [17, 18].

In Ethiopia, it is difficult to estimate the severity of salmonellosis and shigellosis as well as their antibiotic resistance due to limited scope of studies, lack of coordinated epidemiological surveillance system, poor reporting system and limited availability of culture facilities [19].

Determining the prevalence and antimicrobial susceptibility pattern of *Salmonella* and *Shigella* is very important for the proper selection of antimicrobial agents to control the spread of infection. However, in the study area, there was a scarcity of data on the carriage of salmonellosis and shigellosis among food handlers. Therefore, the aim of this study is designed to assess the prevalence, antimicrobial susceptibility patterns, and associated factors of *Salmonella* and *Shigella* among food handlers in Adigrat University, Tigrai, Northern Ethiopia.

Materials And Methods

Study Design, Area and Period

A cross-sectional study was conducted among food handlers who were participated in food preparation, dispatch and store of Adigrat University student's cafeteria from March to July 2018. The annual rainfall ranges from 400-600mm and the minimum and maximum temperature range from 6-21.8^{0}c. Currently, the University enrolled more than 15,000 students who are getting dining services in the student cafeteria. There are six cafeterias and a total of 700 food handlers are working in the student's cafeteria (Adigrat University human resource management and registrar office).

Sample size determination and sampling technique

Sample size determination

The sample size was determined by using a single population proportion formula.

$$n = \frac{(Z\alpha/2)^2 P(1-P)}{d^2}$$

The sample size was determined based on the prevalence of *Salmonella* among university food handlers done by Mama and Alemu at Arba Minch University, South Ethiopia (6.9%) [14] Then with a margin of error (5%), (d=0.03) and 95% level of confidence (z=1.96), the sample size was calculated as follows:

$$n = \frac{(1.96)^2 * 0.069(0.931)}{(0.03)^2} = 274$$, with 10 % non response rate =301

Therefore, a total of 301 food handlers were included in the study from all cafeteria of the university. A simple random sampling technique was employed. The lottery method was used to select the study subjects after a complete list of food handlers was obtained from a roster of cafeteria office Adigrat University.

Eligibility criteria

Inclusion criteria

Food handlers working in Adigrat University student's cafeterias were included in the study.

Exclusion criteria

Food handlers who have taken antibiotics within one week, antihelminthics, and those with clinical signs of typhoid fever were excluded from the study.

Data collection and Sample processing

Socio-demographic and Specimen Collection, Handling and Transportation

A structured questionnaire was used to collect the data regarding socio-demographic and associated factors. Questionnaires were checked for accuracy and completeness. After proper instruction, about 2 g of fresh stool specimens were collected from food handlers with a labelled wide-mouthed plastic container and a clean wooden applicator stick. Specimens were immediately transported to the laboratory using icebox.

Isolation and identification

The stool specimen was collected and transported to Adigrat University Medical Microbiology laboratory within one hour of collection. Stool specimens were immediately inoculated in Selenite F enrichment broth and incubated at 37°C for 24 hours, and then subculture onto selective media of xylose-lysine desoxycholate agar (XLD) and Hektoen enteric medium agar incubate at 37°C for 18-24 hours. The isolated colonies were differentiated and identified based on gram stain, colonial morphology and pigmentation, hemolysis on blood agar, catalase test, oxidase test, carbohydrate fermentation, H_2S production, motility, indole formation and urease production, citrate utilization and incubated for 24 to 48 hours at 37°C. Then colonies producing an alkaline slant with acid butt and hydrogen sulfide production on Triple Sugar Iron Agar, positive for lysine, negative for urea hydrolysis, negative for indole test, positive for citrate utilization and motility test were considered to be *Salmonella*. Colonies which were urease negative, indol positive/negative, in Triple Sugar Iron agar produce a pink-red slope and yellow butt with no blackening, Lysine decarboxylase negative and citrate negative is identified as *Shigella* species. Finally, all of the confirmed *Salmonella* and *Shigella* isolates were examined for antimicrobial susceptibility.

Antimicrobial susceptibility tests

Antimicrobial susceptibility testing was performed using the modified Kirby- Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines, 2016 [20]. Using a sterile wire loop, 3-5 well-isolated colonies of the test organism was emulsified into a tube of 3-4 ml sterile physiological saline to get bacterial inoculums equivalent to 0.5 McFarland turbidity standards. Then the standardized suspension (test organisms) were uniformly swabbed within 15 minutes using a sterile cotton swab into Muller-Hinton agar and allowed to dry. After that, the antibiotic discs were placed manually on the medium and incubated at 37°C for about 18 hours and the zones of inhibition were measured using a calliper. The interpretation of the results was made based on the CLSI criteria as sensitive, intermediate and resistant [20]. The following antimicrobials are prioritized by considering local prescription; gentamicin (10 µg), ampicillin (30 µg), amoxicillin (30 µg), ciprofloxacin (5 µg), clarithromycin (30 µg), chloramphenicol (30 µg), cotrimoxazole (25 µg), amoxicillin-clavulanic acid (30 µg), and ceftriaxone (30 µg) [20].

Data Quality Assurance

Data quality was ensured at various activities of the study by following a prepared standard operating procedure (SOP). Questionnaires were prepared in a clear and precise way and translated into the local language and back-translated to English to ensure the consistency of the questionnaires. The pretest was done on 5% of food handlers and modifications were made accordingly. To ensure general safety; universal bio-safety precautions were followed. American Type Culture Collection (ATCC) strains P*. aeruginosa* (ATCC 27853), *E. coli (ATCC-25922)* were used as control strains for the culture and antimicrobial susceptibility testing.

Statistical Analysis

After collection of socio-demographic characteristics, associated factors and laboratory data using a structured questionnaire and laboratory report format, data were edited, cleaned, entered and analyzed using statistical package for social science (SPSS) version 22. Descriptive statistics, bivariate, and multivariate logistic regression were performed. Bivariate logistic regression was employed to look association between the outcome variable and each independent variable. A binary logistic regression analysis was used to calculate the odds ratios (OR); crude odds ratio (COR) and adjusted odds

ratio (AOR) to ascertain the degree of association between dependent and independent variables. In this study, multi-collinearity among independent variables was detected using the standard errors for regression coefficients. Finally, variables with p-value < 5% with a corresponding 95% confidence interval (CI) were considered as statistically significant.

Results

Socio-demographic characteristics

A total of 301 food handlers were included in the study. Out of the total respondents, 265 (88.0 %) were females. The age of study participants ranged from 19-38 years (23.51 ± 3.186 years). The majority of 241(80.1%) of the participants were between the ages of 21 and 30 years. One hundred fifty-six (51.8%) were enrolled in secondary school with an average of 3.74 years of work experience in the cafeteria. Out of the total study participants, 37(12.3%) were certified for training in food handling and 265(88.0%) had previously undergone a medical checkup stool microscopy examination **(Table 1)**.

Prevalence and associated factors of Salmonella and shigella carriers

The prevalence of *Salmonella* and *Shigella* in this study was 22 (7.3%) and 11 (3.7%) respectively. In the current study, 13 independent variables were considered during the analysis of associated factors for *Salmonella* and *Shigella* carriers **(Table 2)**. All variables with a significance value in the bivariate analysis were entered into multivariate logistic regression analysis. Accordingly in the multivariate analysis being hand washing after using the bathroom with water only (AOR=23.239,95%:2.125-254.17, P<0.01), hand washing after using the bathroom (AOR=2.25, 95%CI: 5.11-77.34, P<0.001), hands washing after touching dirty materials (AOR=37.19, 95%CI: 5.66-244.45, P<0.001), hand washing before food handling (AOR=33.1, 95%CI: 4.958-220.52, P<0.001) and fingernail status (AOR=13.97, 95%CI: 3.404-57.362, P<0.001) were significant factors associated with *Salmonella* and *Shigella* carriers **(Table 3)**.

Antimicrobial Susceptibility Patterns of *Salmonella* and *Shigella* isolates

Antimicrobial susceptibility patterns were performed for isolates against 9 antimicrobial agents. Of the isolates 22 (100%) *Salmonella* and 11(100%) *Shigella* were resistance to ampicillin 22(100%) and 11(100%) followed by gentamicin 22(100%) and 10(90.9%), amoxicillin 21(95.5%) and 11(100%) clarithromycin 9(40.9%) and 5(45.5%) respectively. However, all isolates were susceptible to ciprofloxacin. Resistance was observed for ceftriaxone 0(0.00%) and 1(9.1%), chloramphenicol 0(0.00%) and 2(18.2%) and cotrimoxazole 2(9.1%) and 1(9.1%) for *Salmonella* and *Shigella* respectively. None of the isolates showed intermediate resistance **(Table 4)**. Multidrug resistance in this study is defined as resistance to at least three classes of antimicrobial agents and out of the thirty-three isolates 12 (54.54%) *Salmonella* and 10(90.9%) *Shigella* species were multi-drug resistant isolates **(Table 5)**.

Discussion

In this study, the prevalence of *Salmonella* among food handlers was 22 (7.3%). This was similar to studies carried out in Southern Ethiopia, Arba Minch University (6.9%) [14] and Nigeria, Abeokuta (5.5%) [21]. However, it was higher than the studies reported from Ethiopia, Addis Ababa (3.5%) [22], Bahir Dar (1.6%) [23] and Gondar (3.1%) [24]. On the other hand, our result was lower than the studies reported from Ethiopia, Addis Ababa (10.5%) [25] and Nigeria (42.3%) [26]. The variation might be attributed to poor personal and environmental hygiene differences among the study areas.

The rate of *Shigella* (3.7%) in our study is consistent with studies done in Southern Ethiopia, Arba Minch University (3%) [14], Ethiopia, Addis Ababa (4.5%) [25], and Gondar (3.1%) [26]. However, our finding was lower than a study conducted in Nigeria (15.5%) [27]. These might be due to the differences in hygiene practices of the food handlers.

In the present study, the practice of handwashing after using the bathroom among food handlers was significantly associated with *Salmonella* and *Shigella* carriers. Food handlers who hadn't washed their hands after using the bathroom

were more likely to be colonized with *Salmonella* and *Shigella* compared to those who were washed with water and soap after using the bathroom. This finding was similar to a study conducted in Ethiopia, Mekelle [28], Gondar [29] and Bahir Dar [30]. The acquisition of *Salmonella* and *Shigella* is due to poor sanitary conditions, poor toilet facilities and availability of facilities used for handwashing practice.

Our finding also revealed that there is a statistically significant difference in handwashing after touching dirty materials among food handlers with *Salmonella* and *Shigella* carriers. Food handlers not washing their hands after touching dirty materials are twenty-eight fold more likely to be colonized with *Salmonella* and *Shigella* than those who washing with water and soap after touching dirty materials. This finding is consistent with a study conducted in Ethiopia, Bahir Dar [23]. This might be due to the absence of handwashing facilities within proximity of the food handler's workplace.

Our study showed that food handlers who were washed their hand with soap and water before touching food were less likely to be colonized with *Salmonella* and *Shigella* than food handlers who were not washing their hand with soap and water before food preparation. This is in line with the finding of a similar study reported from Ethiopia, Yebu Town [31]. In the majority of food handlers, hand washing before handling food was practiced. However, a very large proportion (42.8%) were washed their hands only by water. There are food handlers who apply some hygiene practice, though many of them do not use soap nor do they appreciate or understand the need handwashing [32].

Furthermore, in the current study, untrimmed fingernail was significantly associated with *Salmonella* and *Shigella* colonization among food handlers. This study is similar to studies conducted in Ethiopia, Yebu Town [31] and Arba Minch [14]. This result might due to the lifestyle of food handlers. Examination of fingernail contents of food handlers for *Salmonella* or *Shigella* is one way of indicating the possible contamination of food [31]. However, the current study did not assess the *Salmonella* and *Shigella* carriage of fingernail contents.

Antimicrobial susceptibility pattern data showed that ciprofloxacin, ceftriaxone, gentamicin, chloramphenicol and cotrimoxazole were effective against the *Shigella* isolates. Our finding was comparable with studies reported from Ethiopia, Haramaya University ceftriaxone(16.7%) [33], Jimma, gentamicin(1.3%) [34] , and Harar (3.6%) [35]. Whereas our result showed lower resistance pattern compared to the studies conducted in Ethiopia, Addis Ababa gentamicin(75.6%) [36], and Gondar, ciprofloxacin (8.9%) and cotrimoxazole(73.4%) [37,38]. This increase of resistance from those reports indicated that difference in the geographical area, study period and study design. Increased resistance was observed in our finding which is in line with a study reported from Harar, ampicillin (100%) [35], Arba Minch, amoxicillin (100%) [14].

In the current study, isolates of *Salmonella* species were sensitive to gentamicin, ciprofloxacin, chloramphenicol, ceftriaxone, cotrimoxazole and clarithromycin. This is consistent with reports from Gondar University, Ethiopia[24, 25, 38]. Increased resistance was observed in our findings for amoxicillin-clavulanic, amoxicillin and ampicillin which were supported by studies reported from Ethiopia, Arba Minch, Jimma and Bahir Dar [14,12,23,35]. This might be due to misuse or inappropriate use of these antibiotics for other infections in addition to the replacement of sensitive strains by resistant strains.

In the present study, the prevalence of multidrug resistance towards *Salmonella* and *Shigella* were observed. Of the total (54.54%) *Salmonella* and (90.9%) *Shigella* species of all the isolates were resistant at least to three antimicrobials. One isolate of *Shigella* was resistant to six classes of antimicrobial agents. This study is supported by a study conducted in Ethiopia Butajira [25], Addis Ababa [22], Haramaya University [33] and Gondar [24]. This increased multidrug resistance might be due to genetic variation by mutation, irrational use of antimicrobials and less hygienic practice of the food handlers.

Conclusion

The overall prevalence of *Salmonella* and *Shigella* in the study area found to be 7.3% and 3.7% respectively. The *Salmonella* and *Shigella* carriage was significantly associated with washing hand after touching dirty, washing hands after using the bathroom, fingernails status. chloramphenicol, ceftriaxone and ciprofloxacin were sensitive antimicrobials. The majority of *Salmonella* and *Shigella* were multidrug-resistant. Regular medical checkup, improve personal hygiene and environmental

sanitation and consistent training about food preparation and handling for the food handlers of Adigrat University is very important to prevent the risk of infection for the University community having close contact with those carriers.

Limitation

Fingernail content examination could not be identified, this may support to know the contamination due to poor fingernail hygiene and food handling practices.

Despite this limitation, the methods used to isolate and characterize the antimicrobial susceptibility pattern of *Salmonella* and *Shigella* spp. are comprehensive

Abbreviation

ATCC: American Type Culture Collection; **CI:** confidence interval; **CLSI:** Clinical and Laboratory Standards Institute**; MDR:** Multi-drug resistant Multi-Drug Resistant; **SOPs**: Standard Operating Procedures **USA:** United States of America; **WHO:** World health organization**;**

Declarations

Ethics approval and consent to participate

The study was approved by the College of medicine and health sciences Research ethical review committee of Adigrat University, Ethiopia (Consent Ref Number AGU/CMHS/044/2018 approval dated 07/04/2018 Official letter was obtained from Adigrat University (Consent Ref Number AGU/CMHS/RCSH/19/2018 approval dated 25/04/2018. Written informed consent was sought from each study participant before sample collection and maintained throughout the study. All participants were given code numbers to keep their identity confidential.

Consent for publication

Not applicable

Availability of data and materials

All data collected and analyzed during this study were included in the manuscript. But if the full paper is needed, it will be shared upon request by the editor from the corresponding author.

Competing interests

The authors' declared that there were no competing interests

Funding

Not applicable

Authors' contributions

HL designed the study, collection, analysis, and interpretation of data, and drafted the manuscript. TK, AG, BB, and BF designed the study, supervised data collection both on-field and in the laboratory, and prepared the manuscript. ST, GG, HN, and GA read and approved the final manuscript.

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Tables

Table 1 Socio-demographic characteristics of food handlers in Adigrat University student cafeteria, Tigrai, North Ethiopia March to August 2018 (N=301)

Demographic characteristics	Characteristics	Frequency	Percent
Sex	Male	37	12.3
	Female	264	87.7
Age	≤ 20	54	17.9
	21-40	247	80.1
Marital status	Single	127	42.2
	Married	174	57.8
Educational level	Secondary school	187	62.12
	Higher than secondary school	114	37.9
Years of service	≤1	36	12.0
	1-2	42	14.0
	>2	223	74.1
Certified in food preparation and handling	No	264	87.7
	Yes	37	12.3
Medical check-up	No	36	12.0
	Yes	265	88.0

Table 2 Bivariate logistic regression analysis of factors associated with *Salmonella* and *Shigella* infections among food handler's working at Adigrat University Students' Cafeteria, Tigrai, Northern Ethiopia, March to August 2018 (N=301)

Variables		Growth of *Salmonella* and *Shigella*		COR (95% CI)	P-value
		Positive N (%)	Negative N (%)		
Sex	Male	1(2.7)	36(97.3)	0.22(0.03-1.58	0.20
	Female	32(12.1)	232(87.9)	1	
Age	≤ 20	2(3.7)	52(96.3)	0.3(0.07-1.2)	0.081
	21-40	31(12.55)	216(87.45)	1	
Marital status	Single	16(12.6)	111(87.4)	1.29(.68-2.45)	0.341
	Married	17(9.78)	157(90.23)	1	
Educational status	Lower than Secondary school	16(8.56)	171(91.44)		0.507
	Higher than secondary school	17(14.9)	97(85.1)	1.74(0.92-3.31)	0.862
Hand washing after using the bathroom	Yes with water and soap	1(0.9)	112(99.1)	1	
	Yes only with water	17(13.6)	108(86.4)	17.630(2.306-134.7)	0.006
	No	15(23.8)	48(76.2)	35.000(4.495-272.49)	0.001
Hand washing After touching dirty materials	Yes with water and soap	5(3.4)	141(96.6)	1	
	Yes only with water	14(11.0)	113(89.0)	3.494(1.222-9.991)	0.020
	No	14(50.0)	14(50.0)	28.200(8.845-89.906)	0.001
Hand washing before food handling	Yes with water and soap	2(1.8)	112(98.2)	1	
	Yes only with water	13(9.2)	129(90.8)	5.643(1.247-25.548)	0.025
	No	18(40.0)	27(60.0)	37.333(8.164-170.714)	0.001
Finger nail status	Trimmed	4(2.2)	174(97.8)	1	
	untrimmed	29(23.6)	94(76.4)	13.420(4.580-39.324)	0.001
After blowing nose	Yes with water and soap	7(8.0)	81(92.0)	1	
	Yes only with water	11(11.7)	83(88.3)	0.919(.401-2.107)	0.842
	No	15(12.6)	104(87.4)	0.599(0.233-1.538)	0.287
Touch food with bare hands	No	16(14.0)	98(86.0)	1	
	Yes	17(9.1)	170(90.9)	1.597(.772-3.302)	0.207
Years of service	≤1	9(25.0)	27(75.0)	3.72(1.76-785)	0.001
	1-2	9(21.4)	33(78.6)	0.818(.285-2.349)	0.709
	>2	15(6.7)	208(93.3)	1	
Certified in food preparation and handling	No	29(11.5)	224(88.5)	1	
	Yes	4(8.3)	44(91.7)	0.702(0.235-2.097)	0.527
Medical check-up	No	10(18.5)	44(81.5)	1	

Yes	23(9.3)	224(90.7)	1.99(1.01-3.93)	0.04

Key: [a](COR=Crude odds ratio); [b](CI=Confidence interval);1(referent).

Table 3: Multivariate logistic regression analysis of factors associated with *Salmonella* and *Shigella* isolates among food handler's working at Adigrat University Students' Cafeteria, Tigrai, Northern Ethiopia, March to August 2018 (N=301)

Variables	Growth of *Salmonella* and *Shigella*		COR[a] (95% CI[b])	P-value	AOR[c] (95%CI)	P-value
	Negative N (%)	Positive N (%)				
Hand washing using after using the bathroom						
Yes with water and soap	112(99.1)	1(0.9)	1		1	
Yes only with water	108(86.4)	17(13.6)	17.630(2.306,134.7)	0.006	23.239(2.125-254.17)	0.010*
No	48(76.2)	15(23.8)	35.000(4.495,272.49)	0.001	62.917(5.11-77.34)	0.001*
Hand washing after touching dirty materials						
Yes with water and soap	141(96.6)	5(3.4)	1		1	
Yes only with water	113(89.0)	14(11.0)	3.494(1.222, 9.991)	0.020	1.089(0.187-6.345)	0.924
No	14(50.0)	14(50.0)	28.200(8.845, 89.906)	0.000	37.189(5.658-244.45)	0.000*
Hand washing before food handling						
Yes with water and soap	112(98.2)	2(1.8)	1		1	
Yes only with water	129(90.8)	13(9.2)	5.643(1.247, 25.548)	0.025	5.972(.899-39.677)	0.064
No	27(60.0)	18(40.0)	37.333(8.164, 170.714)	0.000	33.065(4.958-220.52)	0.000*
Finger nail status						
Trimmed	174(97.8)	4(2.2)	1		1	
untrimmed	94(76.4)	29(23.6)	13.420(4.580, 39.324)	0.000	13.973(3.404-57.362)	0.000*

Key: [a](COR=Crude odds ratio); [b](CI=Confidence interval); [c](AOR=Adjusted odds ratio); 1(referent).

Table 4 Antimicrobial susceptibility patterns of *Salmonella* and *Shigella* isolated from food handlers Of Adigrat University Students' Cafeteria, Tigrai, Northern Ethiopia, March to August 2018 (N=33)

n)	Sensitivity pattern n(%)	Antimicrobial agents N (%)								
		GM	AML	AMP	CIP	CLR	TS	AMC	CHL	CRO
lla	S	22(100)	1(4.5)	0(0.00)	22(100)	18(81.8)	20(90.9)	13(59.1)	22(100)	22(100)
	R	0(0.00)	21(95.5)	22(100)	(0.00)	4(18.2)	2(9.1)	9(40.9)	0(0.00)	0(0.00)
n	S	10(90.9)	0(0.00)	0(0.00)	11(100)	2(18.2)	10(90.9)	6(54.5)	9(81.2)	10(90.9)
	R	1(9.1)	11(100)	11(100)	0(0.00)	9(81.2)	1(9.1)	5(45.5)	2(18.2)	1(9.1)

Key: S = Sensitive R = Resistant, GM Gentamicin, AML Amoxicillin, AMP Ampicillin, CIP=Ciprofloxacin, CLR Clarithromycin, TS Cotrimoxazole, AMC Amoxicillin-clavulanic acid CHL Chloramphenicol, CRO Ceftriaxone

Table 5 Multidrug-resistant of *Salmonella* and *Shigella* isolated from food handler's working at Adigrat University Students' Cafeteria, Tigrai, Northern Ethiopia, March to August 2018 N=33

		Resistant isolates no. (%)	
	Antimicrobials	*Salmonella*	*Shigella*
For three	AML,AMP,CLR	2(16.67)	4(40)
	AML,AMP,CHL	-	1(10)
	AML,CLR,AMC	7(58.34)	-
	AMP,CLR,AMC	1(8.33)	-
	AML,AMP,TS	1(8.33)	-
FOR FOUR	AML,AMP,CLR,AMC	1(8.33)	3(30)
FOR FIVE	AML,AMP,CLR,AMC,CHL	-	1(10)
FOR SIX	GM,AML,AMP,CLR,TS,AMC	-	1(10)
		12(100)	10(100)

Key: GM Gentamicin, AML Amoxicillin, AMP Ampicillin, CIP=Ciprofloxacin, CLR Clarithromycin, TS Cotrimoxazole, AMC Amoxicillin-clavulanic acid CHL Chloramphenicol, CRO, Ceftriaxone

MDR multidrug resistant; MDR definition for *Salmonella* and *Shigella* percent is computed from total number of *Salmonella* and *Shigella*