Intestinal Parasitosis and Shigellosis among Diarrheal Patients in Gondar Teaching Hospital, Northwest Ethiopia

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Abstract

Background: Diarrheal diseases are the major causes of morbidity and mortality in developing world. Understanding the etiologic agents of diarrheal diseases and their association with socio-demographic characteristics of patients would help to design better preventive measures. Thus, this study was aimed to determine the prevalence of intestinal parasites and enteropathogenic bacteria in diarrheic patients.

Methods: A cross-sectional study involving 384 consecutive diarrheal patients who visited Gondar teaching hospital, Gondar, Ethiopia from October 2006 to March 2007 was conducted. Stool specimens were collected and examined for intestinal parasites and enteropathogenic bacteria following standard parasitological and microbiological procedures.

Results: Intestinal parasites were diagnosed in 36.5% of the patients. The most frequently encountered protozoan parasite was Entamoeba histolytica/dispar (7.3%) followed by Giardia lamblia (5.0%), Cryptosporidium parvum (1.8%) and Isospora belli (1.3%). The dominant helminthic parasite identified was Ascaris lumbricoides (5.5%) followed by Strongyloides stercoralis and Schistosoma mansoni (3.1% each), hookworm infection (1.8%), and Hymenolepis species (1.3%). Multiple infections of intestinal parasites were also observed in 6.3% of the patients. Among the enteropathogenic bacteria Shigella and Salmonella species were isolated from 15.6% and 1.6%, respectively, of the patients. Escherichia coli O57:H7 was not found in any of the stool samples tested. Eighty percent and 83.3% of the Shigella and Salmonella isolates were resistant to one or more commonly used antibiotics, respectively.

Intestinal parasitosis was higher in patients who live in rural area, in patients who were washing their hands after visiting toilet either irregularly with soap and without soap or not at all, in patients who used well and spring water for household consumption, and in patients who had nausea (P < 0.05). Statistically significant associations were also observed between Shigella infections and patients who were using well and spring water for household consumption, and patients who had dysentery and mucoid stool (P < 0.05).

Conclusions: The high prevalence of intestinal parasites and Shigella species in diarrheic patients calls for institution of appropriate public health intervention measures to reduce morbidity and mortality associated with these diseases. The rational use of antibiotics should also be practiced.

Keywords: Intestinal parasitosis, Shigellosis, Gondar

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Background

Diarrheal diseases are the major causes of morbidity and mortality in developing world [1]. The burden of diseases associated with intestinal parasitic infections and enteropathogenic bacteria is enormous [1-4]. Globally about two billion people are affected by intestinal parasites, of whom 300 million suffer from associated severe morbidity [2]. The high prevalence rates of the intestinal parasites are attributed largely to poor socio-economic status, poor sanitation, inadequate medical care and absence of safe and adequate water supplies [3]. Intestinal parasitic infections are among the major cause of diseases of public health problems in sub-Saharan Africa including Ethiopia [5]. Shigellosis is a highly infectious disease of world significance. Its prevalence is highest in tropical and subtropical parts of the world where living standards are very low and access to safe and adequate drinking water and proper excreta disposal systems are often limited [6]. Salmonella infections also remain as an important public health problem particularly in developing countries [7]. Like other developing nations, shigellosis and salmonellosis are among the common causes of morbidity and mortality in Ethiopia [6,8]. Moreover, emergence and spread of antibiotic resistance is posing serious problems in antimicrobial treatment worldwide [9].

*Escherichia coli* O157:H7 has emerged as an important food borne pathogen of considerable public health concern, because of the severity of infection which causes [10]. *E. coli* O157: H7 is one of the hundreds of strains of the bacterium enterohemorrhagic *E. coli* and a pathogenic serotype. It has been documented that outbreak due to *E. coli* O157: H7 occurred in refugee camps in Mozambique, Swaziland and Malawi [11]. According to studies undertaken in United Kingdom, North America and elsewhere, *E. coli* O157:H7 is recognized as the major cause of haemorrhagic colitis and hemolytic uremic syndrome [11-13]. Except a single study conducted from retail raw meat products which showed a 4.2% prevalence of *E. coli* O157:H7 among 738 meat specimens inspected [14], there has been no other report on the pathogen from human subjects in Ethiopia.

Understanding the magnitude of intestinal parasites, the prevalence and drug susceptibility pattern of enteropathogenic bacteria is important in designing public health intervention measures. Since studies addressing such issues are very scant in northwest Ethiopia; the present study was aimed to assess the prevalence of intestinal parasites, *Shigella* and *Salmonella* species, and *E. coli* O157:H7 in patients who were presenting diarrhea at Gondar teaching hospital, northwest Ethiopia.

Methods

A cross sectional study was conducted in Gondar teaching hospital, Gondar, Ethiopia between October 2006 and March 2007, and 384 consecutive patients presenting with diarrhea (passage of three or more loose stools per 24 hours) [15] were included during the study period. A structured questionnaire was utilized to collect socio-demographic characteristics and relevant clinical data of the patients. Patients who did take any antibiotics in the past four weeks were excluded.

Stool specimens were collected following the standard procedure [11]. Samples were then inoculated immediately on MacConkey and Salmonella-Shigella agar plates (Oxoid). The inoculated plates were incubated at 37°C aerobically for 24 hours. The plates were then examined for the presence or absence of visible bacterial colonies. The presence of non-lactose fermenting (NLF) colonies was taken as a presumptive diagnostic tool for *Shigella* and *Salmonella* species. The NLF colonies were further tested through a series of biochemical tests to identify *Shigella* and *Salmonella* species [11]. Antibiotic resistance testing of the *Shigella* and *Salmonella* species was conducted on Muller-Hinton agar (DIFCO) against the commonly used antibiotics: tetracycline (TTC, 30 μg), ampicillin (AMP, 30 μg), cotrimoxazole (SXT, 25 μg), gentamicin (GEN, 10 μg), chloramphenicol (CAF, 30 μg) and ciprofloxacin (CIP, 5 μg) following the single disc diffusion technique [16].

All stool samples were immediately cultured on Eosin Methylene Blue (EMB) agar (Oxoid) for primary screening of *E. coli* and incubated aerobically at 37°C for 24 hours. Suspected colonies of *E. coli*, a green metallic sheen on EMB, were further subcultured on Sorbitol MacConkey Agar (Oxoid) supplemented with 0.05 mg/liter cefixime and 2.5 mg/liter potassium tellurite (Oxoid) and incubated at 37°C for 24 hours. Following the incubation period, the agar plates were inspected for the presence of non-sorbitol fermenter colonies. All non-sorbitol fermenting colonies were further serotyped for *E. coli* O157:H7 with a commercial serologic kit following the manufacturer’s instructions (Oxoid *E. coli* O157 Latex agglutination test, UK). The sensitivity and specificity of the kit is 100% and 99%, respectively. The latex beads were coated with antibodies, which bind to any O157:H7 antigens on the test organisms, forming a visible antigen-antibody precipitate [17]. Proper microbiological quality control was employed at each step of the procedure and American Type Culture Collection quality control strains of *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 were used for susceptibility testing.

Stool specimens were also processed and examined by direct microscopy for intestinal parasites. Modified acid-fast staining technique was employed to detect *Cryptosporidium parvum* and *Isospora belli* [18].

The data was entered and analyzed using SPSS version 13 packages. The relationships between proportion of intestinal parasitism and *Shigella* infections, and
independent variables were analyzed using chi-square tests. *P*-value less than 0.05 was considered as statistically significant.

The study was reviewed and approved by the Institutional Ethical Review Board of the University of Gondar, Gondar, Ethiopia and informed consent was also obtained from the study subjects and/or guardians. Patients were treated as per the existing clinical practices of the health institution.

**Results**

Three hundred eighty four diarrheal patients were included in this study. The mean ± SD age of the participants was 27.9 ± 18.3 years and 53.1% of study subjects were females. A quarter of the patients (25%) were children under 5 years. The overall prevalence of intestinal parasites in the present study was 36.5%. The predominant protozoan parasite detected was *Entamoeba histolytica/dispar* (7.3%) followed by *Giardia lamblia* (5.0%). Opportunistic protozoan parasites: *Cryptosporidium parvum* (1.8%) and *Isospora belli* (1.3%) were also detected. *Ascaris lumbricoides* was the dominant helminthic parasite identified (5.5%) followed by *Strongyloides stercoralis* (3.1%) and *Schistosoma mansoni* (3.1%) (Table 1). Multiple infections with two and three intestinal parasites was detected in 3.6% (Table 2) and 2.6% (Table 3), respectively.

The prevalence of intestinal parasite was significantly higher (*P* = 0.013) in patients who live in rural (41.9%) than urban area (29.6%), in patients who were using well and spring water (62.9%) than who were using pipe (30.7%) for household consumption (*P* < 0.0001). There was a statistically significant relationship between presence of intestinal parasites and hand washing practice after visiting toilet either irregularly with soap and without soap or not at all (69.1%) than patients who were washing their hands regularly with soap (28.7%), (*P* = 0.005). Statistically significant difference was also observed between presence of intestinal parasites and nausea (42.9%) than patients who did not have nausea (28.5%), (*P* = 0.003).

Statistically significant associations were also observed between infections with *Shigella* species and patients who were using well and spring water (37.6%) than pipe water (8.5%) for household consumption,(*P* = 0.004), and in patients who had dysentery and mucoid stool (66.4%) than patients who had watery stool(7.9%), (*P* <0.0001)(Table 4).

No statistically significant difference was observed between occurrence of intestinal parasites, and availability of toilet, level of education, fever and appearance of the stool. Similarly there was no significant association between *Shigella* infections and variables such as residence, methods of hand washing, level of education, availability of toilet, nausea, and fever (*P* >0.05),Table 4).

*Shigella* species were isolated from 15.6% of the stool samples. Among patients who had *Shigella* infections, 18.3% were co-infected with intestinal parasites. The dominant parasite detected in these co- infected patients was *I. belli* (20%) followed by *A. lumbricoides* (19%), *G. lamblia* (15.8%) and *E. histolytica/dispar* (14.3%). Resistance to TTC, AMP, SXT, CAF, GEN, and CIP was observed in 85, 80, 76.7, 48.3, 10, and 8.3%, of the *Shigella* isolates, respectively. Forty, 33.3, 3.3 and 3.3% of the *Shigella* isolates were found to be resistant to 3, 4, 5 and 6 commonly used antibiotics, respectively (Table 5).

*Salmonella* species were isolated from six diarrheic (1.6%) patients. Of the *Salmonella* isolates, 83.3% (5/6) were resistant for AMP and TTC. Sixty seven, 50, and 16.7% of the isolates were resistant to SXT, CAF and GEN, respectively. The majority *Salmonella* isolates were resistance for 3 or 4 commonly used antibiotics (Table 5). All of the *Salmonella* isolates were sensitive to CIP. No *E. coli O157: H7* was detected from stool samples of all (0%) the diarrheic patients.

**Table 1** Intestinal parasites in diarrheal patients at Gondar teaching hospital, Gondar, Ethiopia, October 2006 to March 2007

| Intestinal parasites                  | Male (n = 180) No. (%) | Female(n = 204) No. (%) | Total (n = 384) No. (%) | *P* value |
|--------------------------------------|------------------------|-------------------------|-------------------------|-----------|
| *Entamoeba histolytica/dispar*       | 8(4.4)                 | 20(9.8)                 | 28(7.3)                 | 0.044     |
| *Giardia lamblia*                    | 5 (2.8)                | 14(6.9)                 | 19(5.0)                 | 0.066     |
| *Ascaris lumbricoides*               | 10(5.6)                | 11 (5.4)                | 21(5.5)                 | 1.00      |
| *Strongyloides stercoralis*          | 6 (3.3)                | 6 (2.9)                 | 12(3.1)                 | 0.82      |
| *Schistosoma mansoni*                | 6 (3.3)                | 6(2.9)                  | 12(3.1)                 | 0.82      |
| Hookworm infection                   | 3 (1.7)                | 4(2.0)                  | 7(1.8)                  | 1.00*     |
| *Hymenolepis* species                | 3 (1.7)                | 2 (1.0)                 | 5(1.3)                  | 0.67*     |
| *Cryptosporidium parvum*             | 4 (2.2)                | 3(1.5)                  | 7(1.8)                  | 0.71*     |
| *Isospora belli*                     | 0 (0)                  | 5(2.5)                  | 5(1.3)                  | 0.063*    |
| Multiple infections                  | 12 (6.7)               | 12 (5.9)                | 24 (6.3)                | 0.751     |
| Overall prevalence                   | 57 (31.7)              | 83(40.8)                | 140 (36.5)              | 0.066     |

*P* value from Fisher’s exact test
Discussion

In this cross-sectional study among diarrheal patients in Gondar teaching hospital, northwest Ethiopia, the overall prevalence of intestinal parasites in stool samples was found to be 36.5%. This finding was consistent with previous study conducted in southwest Ethiopia [19] and with a report from Yemen [20]. However, our finding was lower compared to the studies undertaken in central Ethiopia and South Africa [21,22]. These could be due to the differences in hygiene practices of the populations, environmental and host factors. The methods used for detection of the parasites could also attribute to the observed difference.

*E. histolytica/dispar* was the predominant protozoan parasite (7.3%) isolated from stool of the diarrheic subjects. This report was comparable to the study conducted by Al-Mohammed et al [23]. The occurrences of *A. lumbricoides* (5.5%), *G. lamblia* (5%) and *S. stercoralis* (3.1%) detected in the current study were in agreement with a study conducted in southwest Ethiopia [19]. The rate of protozoan opportunistic infections: *C. parvum* (1.8%) and *I. belli* (1.3%) in the present study were low compared with previous study done in central Ethiopia [21]. This discrepancy could be due to the methods used to detect the parasites and/or low rate of those parasites in the study area. However, similar rate of *C. parvum* was reported in a study done by Lee et al [24].

The rate of *S. mansoni* (3.1%) and hookworm infection (1.8%) observed in the study are in line with reports done elsewhere [25,26]. Similarly, the 1.6% of *Hymenolepis* species diagnosed in the study was also in accordance with a study conducted in Yemen [20]. Multiple infections with intestinal parasites occurred in 6.3% of patients and this rate was comparable with a report from Nigeria [27].

Our result revealed that significantly higher parasitic infections were observed in patients who live in rural than those who live in urban area. This difference may occur due to lack of awareness towards general hygiene practices in rural compared to patients who live in

| Table 2 Patients harboring double infections and types of parasite combinations in diarrheal patients at Gondar teaching hospital, October 2006 to March 2007 |
|-----------------------------------------------|
| Parasite combinations | Male (n = 180) | Female (n = 204) | Total (n = 384) |
|-----------------------------------------------|
| No. (%) | No. (%) | No. (%) | No. (%) |
| Al, Sst | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Sm | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Eh | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Ib | 1 (0.55) | 0 (0) | 1 (0.26) |
| Al, Gl | 1 (0.55) | 1 (0.49) | 2 (0.52) |
| Eh, Gl | 1 (0.55) | 0 (0) | 1 (0.26) |
| Eh, Sm | 2 (1.1) | 0 (0) | 2 (0.52) |
| Eh, Sst | 0 (0) | 2 (0.99) | 2 (0.52) |
| Sm, Gl | 1 (0.55) | 1 (0.49) | 2 (0.52) |
| Gl, Ib | 1 (0.55) | 0 (0) | 1 (0.26) |
| Total | 7 (3.9) | 7 (3.4) | 14 (3.6) |

Keys: Al- *Ascaris lumbricoides*, Sst- *Strongyloides stercoralis*, Hy spp.-*Hymenolepis* species, Sm- *Schistosoma mansoni*, Eh- *Entamoeba histolytica*, Gl- *Giardia lamblia*, Cp- *Cryptosporidium parvum*, Ib- *Isospora belli*, Hw- Hookworm.

| Table 3 Frequency of triple infections and types of parasite combinations among diarrheal patients at Gondar teaching hospital, Gondar, Ethiopia, October 2006 to March 2007 |
|-----------------------------------------------|
| Parasite combinations | Male (n = 180) | Female (n = 204) | Total (n = 384) |
|-----------------------------------------------|
| No. (%) | No. (%) | No. (%) | No. (%) |
| Al, Sst, Gl | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Eh, Sm | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Sst, Hw | 1 (0.56) | 0 (0) | 1 (0.26) |
| Al, Eh, Hw | 1 (0.56) | 0 (0) | 1 (0.26) |
| Al, Gl, Cp | 0 (0) | 1 (0.49) | 1 (0.26) |
| Al, Hy spp., Cp | 1 (0.56) | 0 (0) | 1 (0.26) |
| Sst, Gl, Hw | 2 (1.1) | 0 (0) | 2 (0.52) |
| Eh, Gl, Hw | 0 (0) | 2 (0.98) | 2 (0.52) |
| Total | 5 (2.8) | 5 (2.5) | 10 (2.6) |

Keys: As indicated in table 2
Table 4 Socio-demographic and clinical characteristics of diarrheal patients at Gondar teaching hospital, Gondar, Ethiopia, October 2006 to March 2007

| Variables                              | Parasite positive No (%) | Parasite negative No. (%) | P-value | Shigella spp. positive No (%) | Shigella spp. negative No. (%) | P-value |
|----------------------------------------|---------------------------|---------------------------|---------|-------------------------------|-------------------------------|---------|
| Residence                              |                           |                           |         |                               |                               |         |
| Urban                                  | 50 (29.6)                 | 119 (70.4)                | 0.013   | 25 (14.8)                     | 144 (85.2)                    | 0.70    |
| Rural                                  | 90 (41.9)                 | 125 (58.1)                |         | 35 (16.3)                     | 180 (83.7)                    |         |
| Source of water                        |                           |                           |         |                               |                               |         |
| Pipe                                   | 47 (30.7)                 | 106 (69.3)                | <0.0001 | 13 (8.5)                      | 140 (91.5)                    | 0.004   |
| Well                                   | 85 (48.9)                 | 89 (51.1)                 | 38 (21.8)| 136 (78.2)                    |                               |         |
| Spring                                 | 8 (14.0)                  | 49 (86.0)                 | 9 (15.8) | 48 (84.2)                     |                               |         |
| Availability of toilet                 |                           |                           |         |                               |                               |         |
| Yes                                    | 66 (32.8)                 | 135 (67.2)                | 0.122   | 33 (16.4)                     | 168 (83.6)                    | 0.70    |
| No                                     | 74 (40.4)                 | 109 (59.6)                | 27 (14.8)| 156 (85.2)                    |                               |         |
| Hand washing after latrine             |                           |                           |         |                               |                               |         |
| Regularly with soap                   | 43 (28.7)                 | 107 (71.3)                | 0.005   | 24 (16.0)                     | 126 (84.0)                    | 0.90    |
| Irregularly with soap                  | 89 (44.1)                 | 113 (55.9)                | 32 (15.8)| 170 (84.2)                    |                               |         |
| Without soap/not at all               | 8 (25.0)                  | 24 (75.0)                 | 4 (12.5) | 28 (87.5)                     |                               |         |
| Level of education                     |                           |                           |         |                               |                               |         |
| Illiterate                             | 52 (32.9)                 | 106 (67.1)                | 0.70    | 24 (15.2)                     | 134 (84.8)                    | 0.51    |
| Primary school                         | 54 (38.8)                 | 85 (61.2)                 | 20 (14.4)| 119 (85.6)                    |                               |         |
| Secondary school                       | 32 (39.5)                 | 49 (60.5)                 | 16 (19.8)| 65 (80.2)                     |                               |         |
| Others                                 | 2 (33.3)                  | 4 (66.7)                  | 0 (0)    | 6 (100)                       |                               |         |
| Appearance of stool                    |                           |                           |         |                               |                               |         |
| Watery                                 | 105 (37.5)                | 175 (62.5)                | 0.70    | 22 (7.9)                      | 258 (92.1)                    | < 0.0001|
| Dysentery                              | 24 (34.8)                 | 45 (65.2)                 | 30 (43.5)| 39 (56.5)                     |                               |         |
| Mucoid                                 | 11 (31.4)                 | 24 (68.6)                 | 8 (22.9) | 27 (77.1)                     |                               |         |
| Nausea                                 |                           |                           |         |                               |                               |         |
| Yes                                    | 91 (42.9)                 | 121 (57.1)                | 0.003   | 28 (13.2)                     | 184 (86.8)                    | 0.20    |
| No                                     | 49 (28.5)                 | 123 (71.5)                | 32 (18.6)| 140 (81.4)                    |                               |         |
| Fever                                  |                           |                           |         |                               |                               |         |
| Yes                                    | 28 (39.4)                 | 43 (60.6)                 | 0.60    | 15 (21.1)                     | 56 (78.9)                     | 0.20    |
| No                                     | 112 (35.8)                | 201 (64.2)                |         | 45 (14.4)                     | 268 (85.6)                    |         |
Antimicrobial resistance to one or more antibiotics was very high among the *Shigella* species isolated in the study (88%). Multiple resistances (resistance for two up to six commonly used antibiotics) were observed in 80% of the *Shigella* species isolated. This finding was in line with a study conducted in southern Ethiopia where 82% isolates were found to be multi drug resistant [31]. Other studies from Ethiopia also showed increased antibiotic resistance among *Shigella* isolates [32,34,35]. In the current study, *Shigella* isolates were resistant to TTC (85%), AMP (80%), SXT (76.7%) and CAF (48.3%) and these findings were comparable with previous studies conducted in Ethiopia [31,34,35] and other African countries [36,37]. Ten percent of the *Shigella* isolates were resistant to GEN and this result was in agreement with a study conducted in Nigeria [36]. Comparatively high rate of resistance to CIP (8.3%) was observed in the present study as compared to previous report in which 3.1% of *Shigella* isolates were resistant to CIP [38]. This high resistance rate might reflect the indiscriminate and widespread uses of the antibiotics in public health practices since the society in the setting have easy access to different antibiotics and could buy the antibiotics without prescription [39]. However, 16% and 28.3% of *Shigella* isolates resistance to CIP were reported in South Africa and Nepal, respectively [22,40]. The patterns of resistance for the isolated *Salmonella* species in this study were consistent with previous studies conducted in South Africa, Ethiopia and Mexico [22,34,41]. The absence of *Salmonella* isolates resistance for CIP in the present study suggests that CIP could be used as a drug of choose for treating *Salmonella* infections in the absence of drug susceptibility test.

The absence of *E. coli* O157:H7 in our study subjects was comparable with study conducted in Uganda [42]. This absence might be due to the feeding habit of the study population. *E. coli* O157:H7 strains were first detected following the ingestion of hamburgers in the United States in 1982 [43] and out breaks occurred in United States relating in acidic foods such as mayonnaise and apple cider have underscored the unusual acid tolerance of this organism [44,45]. It is worthy to note that, many of the outbreaks that had occurred around the world were more or less related with fast foods like hamburger and acid foods such as apple-cider and mayonnaise, which are not commonly consumed by our study population and inaccessible of these foods to the study subjects. Absence of *E. coli* O157:H7 also reported from studies conducted in Spain and Italy [46,47]. On the contrary a single case and 5.4% of *E. coli* O157:H7 identified from reports done in South Africa and Nigeria, respectively [48,49].

**Conclusions**

Diarrheal patients included in this study had high prevalence of intestinal parasites and *Shigella* species, low
prevalence of *Salmonella* species and no *E. coli* O157:H7. The *Shigella* and *Salmonella* species showed very high level of antimicrobial resistance. Interventions including health education on personal hygiene, provision of safe and adequate water supply to the community and in depth studies of possible epidemiologic associations among diarrhoea, intestinal parasitosis and bacterial infections in the region are imperative and the rational use of antibiotics should also be practiced. The absence of *E. coli* O157:H7 might show limited circulation or absence of this strain in the area and may imply screening of diarrheic stools for pathogenic *E. coli* O157:H7 in routine clinical practice in the area might not be necessary. However, in-depth multi-centric studies are required to substantiate the present finding.

Nevertheless, the study has the following limitations: we did not speciate *Shigella* and *Salmonella* isolates. The speciation of the isolates would have been more valuable if the biotyping of *Shigella* and *Salmonella* was done, however, still the finding is important in the setting. Second the status of each patient was not known for HIV infection, this would be useful to correlate the results to HIV infected and non-infected subjects. Moreover, based on our objectives we only intended to investigate intestinal parasites, *Shigella* and *Salmonella* species and *E.coli*O157: H7 as causative agents for diarrhoea as results all causes of diarrhea among the patients were not studied.

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Authors’ contributions

KN, Principal investigator of the study, study design, data collection, laboratory work, and data analysis; AK, Study design and data analysis; AM and FM, study design and laboratory work; FB, NW, TF, data collection and laboratory work; SG, YB, AG, BA, SY, YW, MT, data collection, laboratory work and supervision of the work; DR, AB, AMU, supervision of the work; all authors contributed to the write up. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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References

1. Ashgar U, us Saba N, Samad A, Qazilbash AA: Identification, Characterization and Antibiotic susceptibility of *Salmonella* and *Shigella* Species Isolated from Blood and Stool samples of Patients N.I.H, Islamabad. J Med Sci 2002, 2:85-88.
2. WHO: Fifty-Fourth World Health Assembly. Assembly documents. Provisional agenda item 13.3. Communicable diseases. Control of schistosomiasis and soil-transmitted helminth infections. Report by the secretariat. Geneva 2001.
3. World Health Organization: Statistic quarterly reported disease prevention and Control. Geneva. 1986.
4. World Health Organization: Persistent diarrhea in children in developing countries: memorandum from a WHO meeting. Bull World Health Organ 1988, 66:709-717.
5. Belete H, Kloos H: Intestinal parasitism. In Epidemiology and ecology of health and disease in Ethiopia. Edited by: Berhanie Y, Hallemariam D, and Kloos H. Shama Books, Addis Ababa, Ethiopia; 2005:518-538.
6. Abera G: Shigellosis in Ethiopia: review of studies conducted since 1974. Ethiop J Biol Sci 2004, 3:191-235.
7. Huang DB, DuPont HL: Problem pathogens: extra-intestinal complications of *Salmonella enterica* serotype Typhi infection. Lancet infect Dis 2005, 5:341-348.
8. Beyene G, Asrat D, Mengisty U, Aseffa A, Wain J: Typhoid fever in Ethiopia. J Infect Dev Ctries 2008, 2:448-453.
9. Murray PR, Rosenthal KS, Pfaller MA: Medical microbiology. St. Louis: Mosby, Fourth 2002, 275-279.
10. Coia JE: Clinical, microbiological and epidemiological aspects of *Escherichia coli* O157 infection. FEMS Immunol Med Microbiol 1998, 20:1-9.
11. Cheesbrough M: District Laboratory Practice in Tropical Countries. *Escherichia coli*. Part II. 2 edition. UK: Cambridge University Press, 2004, 178-179.
12. Armstrong CL, Hollingsworth J, Morris JG Jr: Emerging Food borne Pathogens: *Escherichia coli* O157:H7 as a model of entry of a new Pathogen in to the food supply of the Developed World. *Epidemic Rev* 1996, 18:29-51.
13. Bell BP, Goldoft M, Griffin PM, Davis MA, Gordon DC, Tarr PI, Bateson CA, Lewis JH, Barrett TJ, Wells JG, Baron R, Kobayashi J: A multistate outbreak of *Escherichia coli* O157:H7-associated bloody diarrhea and hemolytic uremic syndrome from hamburgers. The Washington experience. *JAMA* 1994, 272:1349-1353.
14. Hiko A, Asrat D, Zewed G: Occurrence of *Escherichia coli* O157:H7 in retail raw meat products in Ethiopia. *J Infect Dev Ctries* 2008, 2:389-393.
15. World health organization: Management of severe dehydration. 1999.
16. Bayer AW, Kiby WM, Sherris JC, Turck M: Antibiotic susceptibility testing by a standardized single disc method. *Am J Clin Pathol* 1966, 45:493-496.
17. De Boer E, Heuvelink AE: Methods for the detection and isolation of *Shiga toxin*- producing *E. coli*. *Symp Ser Soc Appl Microbiol* 2000, 29:1335-143.
18. Cheesbrough M: District laboratory practice in tropical countries. parasitological tests. Part I. 2 edition. UK: Cambridge University Press, 2005, 200-208.
19. Awode M, Gebere-Selassie S, Kassa T, Kibru G: prevalence of intestinal parasites in HIV- Infected adult patients in Southwestern Ethiopia. *Epidemiol Rev* 2003, 25:77-88.
20. Alyousefi NA, Mahdy MA, Mahmud R, Lim YA: Factors Associated with High Prevalence of intestinal Protozoan Infections among Patients in Sana’a City, Yemen. *PLoS One* 2011, 6:e2204.
21. Endeshaw T, Mohammed H, Woldemichael T: *Cryptosporidium parvum* and other intestinal parasites among diarrhoeal patients referred to ENHR in Ethiopia. *Ethiop Med J* 2004, 42:195-198.
22. Same A, Guerrant RL, Barrett L, Bessong PO, Obi CL: Prevalence of intestinal parasitic and bacterial pathogens in diarrhoeal and non-diarrhoeal human stools from Vhembe district, South Africa. *J Health Popul Nutr* 2009, 27:739-745.
23. Al-Mohammed HI, Amin TT, Aboulmagd E, Hablus HR, Zaza BO: Prevalence of intestinal parasitic infections and its relationship with socio-demographics and hygienic habits among male primary schoolchildren in Al-Ahsa, Saudi Arabia. *Asian Pac J Trop Med* 2010, 3:906-912.
24. Lee JK, Song HJ, Yu JR: Prevalence of diarrhea caused by *Cryptosporidium parvum* in non-HIV patients in Jeollanam-do, Korea. *Korean J Parasitol* 2005, 43:111-114.
25. Tadesse G: The prevalence of intestinal helminthic infections and associated risk factors among school children in Babile town, eastern Ethiopia. Ethiop. J Health Dev. 2005, 19:140-147.

26. Garg PK, Perry SM, Donn M, Hardcastle L, Parsannet J: Risk of intestinal helminth and protozoan infection in a refugee population. Am J Trop Med Hyg. 2005, 73:386-391.

27. Ozumba UC, Ozumba N: Patterns of helminth infection in the human gut at the University of Nigeria Teaching Hospital, Enugu, Nigeria. J Health Sci. 2002, 48:263-268.

28. Dumba R, Kaddu JB, Mangen FW: Intestinal helminths in Luweero district, Uganda. Afr Health Sci. 2008, 8:90-96.

29. Brooks JT, Ochieng JB, Kumar L, Okoth G, Shapiro RL, Wells JG, Bird M, Bopp C, Chege W, Beaty ME, Chiller T, Vulule JM, Mintz E, Slutsker L: Surveillance for Bacterial Diarrhea and Antimicrobial Resistance in Rural Western Kenya, 1997-2003. Clin Infect Dis. 2006, 43:393-401.

30. Temu MM, Kaatano GM, Miyaye ND, Buhala SH, Shushu ML, Kishamawe C, Changalucha JM: Antimicrobial susceptibility of Shigella flexneri and S. dysenteriae isolated from stool specimens of patients with bloody diarrhoea in Mwanza, Tanzania. Tanzan J Health Res Bull. 2007, 9:186-189.

31. Roma B, Worku S, T/Mariam S, Langeland N: Patterns of helminth infection in the human gut and other enteropathogens in a Spanish Hospital. Eur J Epidemiol. 2000, 16:303-304.

32. Aseffa A, Gedlu E, Asmelash T: Antibiotic resistance of prevalent Salmonella and Shigella strains in northwest Ethiopia. East Afr Med J. 1997, 74:708-713.

33. Desenclos JC, Zergabachew A, Desmoulins B, Chouteau L, Dese G, Admassu M: Clinical, microbiological and antibiotic susceptibility patterns of diarrhoea in Korem, Ethiopia. J Trop Med Hyg. 1988, 91:296-301.

34. Asrat D: Shigella and Salmonella serogroups and their antibiotic susceptibility patterns in Ethiopia. East Mediterr Health J. 2008, 14:760-767.

35. Mache A, Mengstu Y, Cowley S: Shigella serogroups identified from adult diarrhoeal out-patients in Addis Ababa, Ethiopia: antibiotic resistance and plasmid profile analysis. East Afr Med J. 1997, 74:179-182.

36. Iwalokun BA, Gbenga GO, Smith SI, Ogundiran A, Aminide B, Omorogbehin EA: Epidemiology of Shigellosis in Lagos, Nigeria: Trends in Antimicrobial Resistance. J Health Popul Nutr. 2001, 19:183-190.

37. Mandomando I, Jaintilal D, Pons MJ, Vallès X, Espasa M, Mensa L, Sigauque B, Sanz S, Sacaral J, Maceite E, Abacassamo F, Alonso PL, Ruiz J: Antimicrobial susceptibility and mechanisms of resistance in Shigella and Salmonella isolates from children under five years of age with diarrhea in rural Mozambique. Antimicrob Agents Chemother. 2009, 53:2450-2454.

38. MoezArzandal K, Zali MR, Dallal MM, Hemami MR, Salmanzadeh-Ahrabi S: Prevalence and pattern of antimicrobial resistance of Shigella species among patients with acute diarrhoea in Karaj, Tehran, Iran. J Health Popul Nutr. 2003, 21:96-102.

39. Abula T, Worku A, Thomas K: Assessment of the dispensing practices of drug retail outlets in selected towns, northwest Ethiopia. Ethiop J Health Dev. 2005, 19:145-150.

40. Bhattacharya S, Khanal B, Bhattachar J, Das ML: Prevalence of Shigella species and their antimicrobial resistance patterns in Eastern Nepal. J Health Popul Nutr. 2005, 23:339-342.

41. Amsáile-Cuevas C: Antibiotic resistance in Mexico: a brief overview of the current status and its causes. J Infect Dev Ctries. 2010, 29:126-131.

42. Kaddu-Mulindw DH, Asu T, Gleier K, Zimmermann S, Beutin L: Occurrence of Shiga toxin-producing Escherichia coli in fecal samples from children with diarrhea and from healthy zebu cattle in Uganda. Int J Food Microbiol. 2001, 66:95-101.

43. Riley LW, Remis RS, Helgerson SD, McGee HB, Wells JG, Davis BR, Hebert RJ, Ollott ES, Johnson LW, Hargrett NT, Blake PA, Cohen ML: Hemorrhagic colitis associated with a rare Escherichia coli serotype. N Engl J Med. 1983, 308:681-685.

44. Besser RE, Lett SM, Weber JT, Doyle MP, Barrett TJ, Wells JG, Griffin PM: An outbreak of diarrhea and hemorrhagic uremic syndrome from Escherichia coli O157:H7 in fresh-pressed apple cider. JAMA. 1993, 269:2217-2220.

45. Keene WE, McNulty JM, Williams LP, Hovdey FC, Helberg K, Fleming DW: A two restaurant outbreak of Escherichia coli O157:H7 enteritis associated with consumption of foods containing mayonnasse. Presented at the Interscience Conference on Antimicrobial Agents and Chemotherapy, New Orleans, LA, USA, 1993.