RESEARCH ARTICLE

Shigella and salmonella as a bacterial pathogen of acute bloody diarrhoea in children aged between 2 months and 12 years.

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ABSTRACT

Introduction: Diarrhoea is a leading cause of morbidity and mortality among children in developing countries. Bloody diarrhoea in young children is usually a sign of invasive enteric infection and represents about 20-30 % of all diarrhoea. It causes significant inflammatory intestinal illness and, under some circumstances, produces severe complications.

Objective: To determine the frequency of Shigella and Salmonella as a bacterial pathogen that causes acute gross bloody diarrhoea in children aged from 2 months to 12 years old and to study different demographic, clinical and laboratory factors that are associated with them.

Methods: A hospital-based prospective cross-sectional study was conducted at Child's Central Teaching Hospital for 9.5 months. We included patients presented with acute gross bloody diarrhoea admitted to Child's Central Teaching Hospital in Baghdad from 1st May 2018 to 15th February 2019. Mothers were interviewed to obtain the necessary information about water supply and feeding practices. A Clinical examination, complete blood count, general stool examination and stool culture were performed for these children.

Results: We have 108 children admitted with acute bloody diarrhoea. The mean age was 3.5±3.4 years, and the mean duration of illness was 2.2±0.7 days. A positive culture for Shigella was reported in 23 (95.8%) patients and for Salmonella in one patient only (4.2%).

Age between 6-12 years, using unsafe water or an outdoor source of food, abdominal pain, convulsion, high WBC count, high neutrophil count, and low lymphocyte count have statistically significant associations with a positive stool culture for Shigella and Salmonella, with p-values < 0.001 for all these variables.

Conclusion: Shigella is a more common cause of acute bloody diarrhoea than Salmonella. Positive stool culture results for Salmonella and Shigella have a statistically significant association with age, unsafe water or an outdoor source of food, abdominal pain, convulsions, and levels of white blood cells, neutrophils, and lymphocytes.

Key words: Shigella, Salmonella, bacterial pathogen, acute gross bloody diarrhoea in children.

INTRODUCTION

Diarrhoea is a leading cause of morbidity and mortality among children in developing countries. It is estimated that 1.3 thousand million episodes and 3.2 million deaths occur each year in those under five years of age. These children experienced an average of 3.3 episodes of diarrhoea per year, but in some areas, the average exceeds nine episodes per year.[1,2] It ranks as the third leading cause of both mortality and morbidity among infectious diseases, placing it above tuberculosis and malaria.[3] Diarrhoea is estimated to account for 12% of all deaths due to infectious diseases in the world.[3,4]

The situation is critical in developing countries due to inadequate potable water supplies, limited sanitation and poor personal

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hygiene practices.[5] Unhygienic and unsafe environments place children at risk of death; use of unsafe water for domestic purposes, inappropriate storage of food and processed food,[6] inadequate availability of water for hygiene, and lack of access to sanitation contribute to about 1·5 million child deaths and around 88% of deaths from diarrhoea.[7] Also, diarrhoeal illnesses, especially early and repeated episodes among young children, can be associated with malnutrition, micronutrient deficiencies, and significant deficits in psychomotor and cognitive development.[8]

The leading cause of death from acute diarrhoea is dehydration, which results from the loss of fluid and electrolytes in diarrhoeal stool. Other important causes of death are dysentery, malnutrition and serious infections, such as pneumonia.[9]

Dysentery, inflammation of the intestines, especially the colon, that leads to severe diarrhea containing blood and/or mucus, is a significant cause of illness and death in young children, particularly those who live in less-developed countries.[3] Infections are the most common causes of dysentery, while non-infectious causes contribute to a very small proportion. Bloody diarrhoea in young children is usually a sign of invasion of the enteric infectious pathogen into the mucosa, producing cytotoxins and enterotoxins carrying the risk of serious morbidity and death. Infectious dysentery is divided into bacillary, caused by bacteria, and amoebic, caused by amoebas.[10,11] Bacterial dysentery accounts for about 15% of episodes and occurs less often in developed than developing communities.[12] Species of shigella, campylobacter, enteritis, typhoid and non-typhoid salmonella, ***Escherichia coli***, especially Shiga toxin-producing and enteroinvasive strains, ***Yersinia enterocolitica***, and ***Clostridium difficile*** are causes of bacterial bloody diarrhoea.[1]

The WHO estimated that shigella caused 190 million cases of gastroenteritis in 2010, accounting for 27% of the global foodborne disease burden.[13] It causes 250 million cases of diarrhoea and 650,000 deaths worldwide per year.[14] Approximately 61% of all shigella-related deaths involve children younger than 5 years.[15] Infection in the first six months of life is rare for reasons that are not clear. Infection with shigella occurs most often during the warm months in temperate climates and during the rainy season in tropical climates. It spread rapidly within families, custodial institutions, and child care centres, demonstrating the ability of Shigella to be transmitted from one individual to the next and the requirement for ingestion of very few organisms to cause illness.[16]

Salmonellosis is more common in children aged 5-19 years and young adults, and it is prevalent in impoverished areas with overcrowding and inadequate access to sanitation. Salmonella causes 1-5% of gastroenteritis in most developing countries. Infection is usually transmitted by ingesting contaminated water and food, especially undercooked poultry and contact with pets (reptiles).

Grossly bloody stool occurs in about 10-20% of salmonella infections, and it results from intestinal perforation and haemorrhage due to ileocecal lymphatic hyperplasia and erosion of blood vessels of the Peyer's patches, usually in the 2nd-4th weeks of illness.[17]

The aims of this study was to determine the frequency of shigella and salmonella in stool culture of children aged 2 months to 12 years old admitted to Child's Central Teaching Hospital in Baghdad complaining of acute gross bloody diarrhoea and study demographic, clinical and laboratory factors associated with having positive stool culture for these bacterial pathogens.

METHODS

Setting and study design: We conducted a descriptive cross-sectional study on children aged 2 months to 12 years who were admitted to Child's Central Teaching Hospital in Baghdad complaining of acute bloody diarrhoea from 1st May 2018 to 15th February 2019.

Ethical considerations: A permission was obtained from the adminstration of the hospital to do this research. A consent was obtained from the mothers for an interview to obtain the necessary information about their children after explaining the aims of the study the the steps followed fo conduct it.

Case definition: ***Inclusion criteria***: The target of this study was children between 2 months and 12 years who were admitted to the hospital (emergency room and inpatient wards) complaining of gross acute bloody diarrhoea. Acute blood diarrhoea was defined as diarrhoea in less than 2 weeks. ***Exclusion criteria***: Patients who had received antibiotic therapy during their illness, had a history suggestive of inflammatory bowel disease, and patients who were found to have surgical causes such as intussusception, fissure, or haemorrhoids were excluded from this study.

Study sample: A total number of 153 patients were found to have acute gross bloody diarrhoea, and after applying exclusion criteria, only 108 patients were recruited in the study. The samples were collected conveniently.

Definition of variables:

- *Demographic features*: We recorded the age, gender and weight of each child. We grouped the children into two groups: Group 1 included those aged 2 months to 6 years, and Group 2 included those aged 6 years to 12 years. Residence was recorded as urban and rural. The mother's educational level was categorised as illiterate, primary, secondary, or higher education. The occupation of the mother was divided based on her availability at home, which included housewives and working outside the home. The household water supply was divided into safe and unsafe categories. Ordinary tap water was considered unsafe, while boiled, filtered, and purified water were considered safe.
- *Clinical history*: A detailed history of the duration and character of the diarrhoea, as well as its associated symptoms, such as abdominal pain, convulsions, vomiting, and fever, was taken. A thorough clinical systematic examination done by our team was conducted on all patients, including vital signs (heart rate, respiratory rate, temperature) and measurement of body weight and height (or length) and confirmed with growth chart (Length or Stature-for-age and Weight-for-age percentiles) to find out if the patient under; normal or overweight and signs and the degree of dehydration were also assessed. The degree of dehydration was assessed clinically.
- *Feeding history*: We divided the feeding history by age into the following categories: 2-6 months old, feed on milk only (breast, bottle, or mixed); 6-24 months old, on milk (breast or bottle feeding) and solid food; and >24 months-144 months old, depending on solid food.
- *Sterilisation* of the bottle was grouped into effective and ineffective. Sterilisation of the bottle by boiling, using chemical sterilisation such as hypochlorite, or using an electric steam steriliser, microwave steriliser, or dishwasher [18] is considered an effective sterilisation method.
- Preparing foods for eating was classified into eating outside or at home.

Procedure: The following investigations were done on all patients at our hospital laboratory:

1. A 2-ml blood sample was aspirated from all patients to estimate the complete blood count.
2. A stool sample from each patient is sent to the laboratory in our hospital within 30 minutes in a sterile container for general stool examination and stool culture.

For general stool examination, two stool samples were mixed with a few drops of normal saline fluid and another with iodine. The 1st one was used to recognise RBCs, pus cells and motile trophozoites containing RBC, and the 2nd one was used to recognise cysts of ***Entamoeba histolytica***.

The stool sample is cultured on shigella-salmonella (SS) agar exclusively (selective and differential medium for both clinical and

Table 1 | Sociodemographic features of the sample

Variable	Category	No.	%
Age Group	2m-6y	87	80.6
	>6-12y	21	19.4
Gender	Male	42	38.9
	Female	66	61.1
Weight status	Underweight	31	28.7
	Normal weight	77	71.3
	Overweight/obese	0	0.0
Residence	Urban	93	86.1
	Rural	15	13.9
Maternal Education	Illiterate	26	24.1
	Primary	37	34.3
	Secondary	34	31.5
	Higher	11	10.2
Maternal Occupation	Employed	7	6.5
	Housewife	101	93.5
Total		108	100

non-clinical specimens such as from faeces, urine and suspected food items, fresh and canned foods) and tetrathionate broth (used with iodine for recovery of salmonella spp.), incubated for 24 hours at 37 c°. Growth from tetrathionate broth was cultured again on SS agar for an additional 24 hours at 37°C to enhance bacterial growth and yield better results.

Statistical analysis: Statistical package for social sciences version 24 (SPSS v24) used to analyse data. Continuous variables are presented as means with standard deviation, and discrete variables are presented as numbers and percentages. The chi-square of independence and Fisher's exact test was used as appropriate to test the significance of the association between discrete variables. A level of a P-value less than 0.05 was considered significant.

Table 2 | Feeding practices in age groups of children with acute bloody diarrhoea.

Variable	Category		No.	%
2 months-6 years	Safe water supply	Safe	17/87	19.5
		Unsafe	70/87	80.5
	Feeding type*	Breastfeeding	1/87	1.2
		Bottle feeding	29/87	33.3
		Mixed	1/87	1.2
	Sterilisation*	Effective	7/87	8.1
		Ineffective	24/87	27.6
	Sources of food†	Outdoor	17/87	19.5
		Indoor	39/87	44.8
>6 - 12 years	Safe water supply	Safe	6/21	28.6
		Unsafe	15/21	71.4
	Sources of food	Outdoor	16/21	76.2
		Indoor	5/21	23.8

*For those who are young and using milk (31 children).
† For those who were eating foods (56 children)

Table 3 | Clinical and laboratory indices of studied children with acute bloody diarrhoea on presentation.

Feature	Status	No.	%
Abdominal Pain	Yes	56	51.9
	No	52	48.1
Convulsion	Yes	3	2.8
	No	105	97.2
Vomiting	Yes	93	86.1
	No	15	13.9
Fever	Yes	99	91.7
	No	9	8.3
Dehydration	Mild	35	32.4
	Moderate	54	50
	Severe	19	17.6
WBC level	Normal	33	30.6
	Elevated	75	69.4
	Decreased	0	0.0
Neurtophils %	Normal	26	24.1
	Elevated	26	24.1
	Decreased	56	51.9
Lymphocytes %	Normal	27	25.0
	Elevated	55	50.9
	Decreased	26	24.1
PCV %	Normal	56	51.9
	Elevated	1	0.9
	Decreased	51	47.2
E. histolytica on GSE	Yes	54	50.0
	No	54	50.0
Culture Positive	Yes	24	22.2
	No	84	77.8
Culture +ve Shigella	Yes	23/24	95.8
Culture +ve Salmonella	Yes	1/24	4.2
Total		108	100

RESULTS

In this study, 153 patients were admitted to the Child`s Central Teaching Hospital

Table 4 | Association between positive stool culture and demosocial features of the children with acute bloody diarrhea.

Variable	Category	No.	Culture positive		Culture negative		P- value
			No.	%	No.	%	
Age Group	2m-6y	87	9	10.3	78	89.7	**P < 0.001**
	>6-12y	21	15	71.4	6	28.6	
Gender	Male	42	6	14.3	36	85.7	**P = 0.114**
	Female	66	18	27.3	48	72.7	
Weight status	Underweight	31	7	22.6	24	77.4	**P=0.955**
	Normal weight	77	17	22.1	60	77.9	
	Overweight/obese	0	0	0.0	0	0.0	
Residence	Urban	93	20	21.5	73	78.5	**P=0.655**
	Rural	15	4	26.7	11	73.3	
Maternal Education	Illiterate	26	5	19.2	21	80.8	**P=0.953**
	Primary	37	8	21.6	29	78.4	
	Secondary	34	8	23.5	26	76.5	
Maternal Occupation	Higher	11	3	27.3	8	72.7	**P=0.601**
	Employed	7	1	14.3	6	85.7	
	Housewife	101	23	22.8	78	77.2	
Total		108	24	100	84	100	

complaining of gross bloody diarrhoea. After applying the exclusion criteria, 108 patients were eligible for analysis. The ages of the studied children varied from 2 months to 12 years, with a mean age of 3.5 ± 3.4 years. The duration of diarrhoea on presentation varied from one to four days, with a mean duration of 2.2 ± 0.7 days. We found that 66 (61.1%) of the children are females, and 31 (28.7%) are underweight. For other sociodemographic features of the sample, see **Table 1**.

We analysed feeding practices according to age. Therefore, breastfeeding, bottle feeding, mixed feeding, and sterilisation were applied to only 31 children, and the food source applied to 56 children. We found that 70 out of 87 (80.5%) participants, aged 2 months to 6 years, and 15 out of 21 (71.4%) participants aged > 6-12 years were using unsafe water supplies. For other factors related to feeding, such as the food source and the effectiveness of sterilisation, see **Table 2**.

Fever followed by vomiting were the most common presenting symptoms, at 99 (91.7%)

Table 5 | Association between positive stool culture and feeding practices of the children with acute bloody diarrhea.

Feeding practices	Category	No.	Culture positive		Culture negative		P- value
			No.	%	No.	%	
Safe water supply	**Safe**	23	2	8.7%	21	91.3%	P <0.001
	Unsafe	85	22	25.9%	63	74.1%	
Sources of food	**Outdoor**	33	17	51.5%	16	48.5%	P < 0.001
	Indoor	44	7	15.9%	37	84.1%	
Feeding type	**Breastfeeding**	1	0	0.0%	1	100.0%	P = 0.870
	Bottle feeding	29	1	3.5%	28	96.5%	
	Mixed	1	0	0.0%	1	100.0%	
Sterilisation	**Effective**	7	0	0.0%	7	100.0%	P = 0.853
	Ineffective	24	1	4.2%	23	95.8%	
Total		108	24	100	84	100	

Table 6 | Association between positive stool culture and clincial and laboratory features of the children with acute bloody diarrhea.

Feeding practices	Category	No.	Culture positive		Culture negative		P- value
			No.	%	No.	%	
Abdominal Pain	Yes	56	21	37.5	35	62.5	P < 0.001
	No	52	3	5.8	49	94.2	
Convulsion	Yes	3	3	100.0	0	0.0	P < 0.001
	No	105	21	20.0	84	80.0	
Vomiting	Yes	93	17	18.3	76	81.7	P = 0.014
	No	15	7	46.7	8	53.3	
Fever	Yes	99	24	24.2	75	75.8	P = 0.094
	No	9	0	0.0	9	100.0	
Dehydration	Mild	35	11	31.4	24	68.6	P = 0.189
	Moderate	54	11	20.4	43	79.6	
	Severe	19	2	10.5	17	89.5	
WBC level	Normal	33	0	0.0	33	100.0	P < 0.001
	Elevated	75	24	32.0	51	68.0	
	Decreased	0	0	0.0	0	0.0	
Neurtophils%	Normal	26	6	23.1	20	76.9	P < 0.001
	Elevated	26	15	57.7	11	42.3	
	Decreased	56	3	5.4	53	94.6	
Lymphocytes%	Normal	27	6	22.2	21	77.8	P < 0.001
	Elevated	55	3	5.5	52	94.5	
	Decreased	26	15	57.7	11	42.3	
PCV%	Normal	56	11	19.6	45	80.4	P = 0.665
	Elevated	1	0	0.0	1	100.0	
	Decreased	51	13	25.5	38	74.5	
Total		108	24	100	84	100	

and 93 (86.1%), respectively. Moderated dehydration was reported in 54 (50%) children and elevated WBC count in 75 (69.4%). ***Entameba histolytica*** were detected in general stool examination in 54 (50%) children. Stool culture was positive in 24 (22.2%) cases, with 23 (95.8%) positive for shigella and only 1 (4.2%) positive for salmonella. See Table 3.

Tables 4, 5, and 6 present the association between positive culture for Salmonella and Shigella and sociodemographic features, feeding practices, and clinical presentation, respectively. We found that 15 out of 21 (71.4%) children aged >6-12 years have positive stool culture for salmonella and shigella compared to 9 out of 87 (10.3%) for those aged 2 months to 6 years, with a p-value < 0.001. Other sociodemographic features were statistically non-significant. Using an unsafe water supply and eating outdoors have shown statistical significance in increasing the probability of being culture-positive for Salmonella and Shigella, with a p-value of < 0.001. Abdominal pain, convulsion, elevated WBCs, high neutrophil, and decreased lymphocyte count were statistically significant associations with positive stool culture for Salmonella and Shigella, with a p-value of < 0.001 for all.

DISCUSSION

Bloody diarrhoea is defined as diarrhoea with visible or microscopic blood in the stool. [3] Infectious causes of bloody diarrhoea may be bacterial or parasitic. Bacterial infections of bloody diarrhoea account for about 15% of episodes and occur less often in developed than developing communities.[12]

In this study, we investigated 108 children who presented with acute gross bloody diarrhoea and had been admitted to the hospital. The included samples were within the age group of 2 months to 12 years, with a mean age of 3.5±3.4 years, which is near to that reported by Mota in his study.[1]

Regarding gender, the current study shows that females (66, 61.1%) are affected more than males (42, 38.9%). This result contradicts that of Al-Kubaisy,[3] Abu-Elyazeed [19] and Al-Awadi,[6] where they showed a male predominance. This contradiction can be attributed to variations in sample size and differences in the characteristics of the general population.

Concerning the age group, our study shows that children younger than 6 years (87, 80.6%) are at a higher risk of developing bloody diarrhoea, similar to the results found by Abu-Elyazeed.[19] However, it contradicts what was obtained by Al-Kubaisy,[3] which showed a higher prevalence among the older age group. This may be explained by several factors, including decreased maternal immunity, the introduction of complementary food (which can be contaminated by enteropathogens), and the child's increased activity, which leads to contact with contaminated materials and the potential ingestion of contaminated food.

This study shows that the number of children with bloody diarrhoea who live in urban areas was 93 (86.1%) more common than those in rural areas. Al-Kubaisy[3] found similar results; however, Al-Awadi[6] and Abu-Elyazeed[19] found bloody diarrhoea more common in urban areas than in rural.

We found that children with bloody diarrhoea are more likely if the mothers are housewives and of low education (primary school level). In their studies, al-Kubaisy[3] and Abu-Elyazeed[19] have supported this result. The possible reasons include a lack of appropriate knowledge and attitude towards food and personal hygiene, handling a child with diarrhoea, seeking medical consultation, and improper utilisation of primary healthcare services.

In our study, most children younger than 24 months had ineffective sterilisation, which may be due to low maternal education and inappropriate knowledge about effective sterilisation. Nevertheless, this result was statistically non-significant.

Most children with bloody diarrhoea in our study use unsafe water supply; this result is similar to Phillips-Howard Pa[20] and Al-Kubaisy. [3] Using tap water, which may be used by many families in Iraq, is considered unsafe, leading to more risk of childhood diarrhoea. The annual report of the Iraqi Ministry of Health stated that childhood diarrhoea has increased during the last decade.

In our study, most children with bloody diarrhoea presented with fever and vomiting, at 99 (91.7%) and 93 (86.1%), respectively; however, there was no statistically significant association with positive stool culture. Similarly, Abu-Elyazeed[19] reported the same. These results mean that the absence of fever or vomiting does not exclude bacterial causes of bloody diarrhoea.

Our study did not show any significant association between the degree of dehydration and positive stool culture, but this result differs from Abu-Elyazeed's.[19] The insignificant association between the degree of dehydration and positive stool culture for Salmonella and Shigella may be explained by the fact that our study was conducted in an urban area where families can consult physicians early and avoid severe dehydration.

Regarding laboratory data, PCV% was not significantly associated with positive stool cultures in this study. While an elevated WBC count, elevated neutrophils, and decreased lymphocyte count are significantly associated with a positive stool culture, the result differs from Talan's.[21] Total WBCs and neutrophils are expected to be high in invasive bacterial infections due to inflammation. Low lymphocytes may occur relatively secondary to neutrophilia.

Our study shows that age is significantly associated with positive stool culture for

Salmonella and Shigella. This result is supported by the Al-Kubaisy study[3] but contradicts that of Al-Awadi[6] and Abu-Elyazeed.[19] Usually, children's activity increases with age, exposing them to unhygienic foods, such as picking up food from the ground and eating outdoors.

Our study showed that the safety of the water supply was significantly associated with positive stool culture for Salmonella and Shigella. These results aligned with that of Al-Kubaisy's study.[3] Using contaminated water for bathing, washing clothes, and drinking may expose the children to acute diarrheal infection. Interestingly, we found that even tap water increases this risk, raising concerns about the potential seepage between the main sewage pipes and the public water pipes.

This study found a significant association between the source of food and positive stool culture in children with bloody diarrhoea. Children eating food from outdoor sources were found to be more likely to present with positive culture compared to those eating indoors; this is similar to Al-Kubaisy's study,[3] The risk of contamination of outdoor foods is high; in addition, fruits and vegetables outdoors may be either not washed or washed with contaminated water.

The current study shows that the main pathogenic organism of acute gross bloody diarrhoea was ***E. histolytica*** 54 (50.0%), followed by bacterial pathogens (Shigella and Salmonella exclusively) 24(22.2%) and others(other pathogens not investigated 30(22.8%); those results are similar to studies done by Waqar Al-Kubaisy.[3] and Haitham Mohammed Al-Awadi.[6] Those results are because the amoebic cysts are resistant to low doses of chlorine or iodine.

This study showed that the most common bacterial pathogen causing acute bloody diarrhoea was Shigella 13 (95.8%), followed by Salmonella 1 (4.2%), which is similar to studies conducted by Al-Awadi,[6] Abu-Elyazeed,[19] and Phillips-Howard Pa et al.[20] However, it differs from the results of a study conducted by Waqar Al-Kubaisy.[3] Those results are due to geographical variation, sample size, and the age of patients included in this study.

Limitations of the study: A small study sample may not reflect the actual population, stool sample might not actually transfered to the lab within 30 minutes; these delays could be responsible for the low culture yield. Laboratory obstacles like lack of some types of agers or protocols to culture some bacteria prevented the authors from culturing all other types of bacteria that may cause acute bloody diarrhea in children.

CONCLUSION

Shigella is the most common bacterial pathogen that causes acute bloody diarrhoea in children compared to Salmonella, especially those over the age of 6 years.

Factors that have a statistically significant association with positive stool cultures for Shigella and Salmonella include age over 6 years, drinking unsafe water, eating food prepared outdoors, experiencing abdominal pain or convulsions, increased white blood cell or neutrophil counts, and decreased lymphocyte counts.

REFERENCES

1. Mota MI, Gadea MP, González S, González G, Pardo L, Sirok A, et al. Bacterial pathogens associated with bloody diarrhea in Uruguayan children. *Rev Argent Microbiol*. 2010;42(2):114–7.
2. Zaidan AA, Al Jiboory RK. Occurrence of amoebic versus bacillary dysentery among children under five years of age in Baghdad city. *Al-Kindy Coll Med J*. 2013;9(2):35–9.
3. Al-kubaisy W, Badre A Al. Epidemiological study of bloody diarrhoea among children in baghdad in Iraq. *Int Arch Med* [Internet]. 2015;1–9. Available from: http://www.imed.pub/ojs/index.php/iam/article/view/940.
4. hs JW, Tao W, Löfgren J, and Forsberg B.C. Diarrheal Diseases in Low- and Middle-Income Countries: Incidence, Prevention and Management. *The Open Infectious Diseases Journal*, 2020; 4:113-124.
5. https://doi.org/10.2174/1874279301004010113Feleke H, Medhin G, Abebe A, Beyene B, Kloos H, Asrat D. Enteric pathogens and associated risk factors among under-five children with and without diarrhea in Wegera District, Northwestern Ethiopia. *Pan Afr Med J*. 2018 Jan 24;29:72. doi: 10.11604/pamj.2018.29.72.13973. PMID: 29875953; PMCID: PMC5987073.
6. Al-awadi HM, Youssef TG. Epidemiology of bloody diarrhea in al-manathera city / najaf alshraf province . Iraq. *Plant Archives* 2018;18(2):1443–6.
7. Black RE, Morris SS, Bryce J. Where and why are 10 million

children dying every year? (Child survival series 1). *Lancet*. 2003;361:2226–34.

8. Kronman MP, Smith S, Karen J. Marcdante M, Robert M. Kliegman M. Textbook, ACUTE GASTROENTERITIS. In: Nelson Essentials of Pediatrics. 7th ed. United Stoates of America; 2015. p. 368.
9. Northrup RS, Bratt D, Cutting WAM, Gothefors L, Habte D, Khan M. Student manual. World Heal Organ Geneva World Heal Organ [Internet]. 1992;10. Available from: http://apps.who.int/iris/bitstream/10665/40343/1/9241544449.pdf
10. Bhutia TK, Lotha G, Rogers K, Tikkanen A. Dysentry. 2018; Available from: *https://www.britannica.com/science/dysentery*.
11. Leila Richards, Bennish M, M.A.Salam. The management of bloody diarrhoea in young children. 1994. p. 4,5.
12. Elliott EJ, Dalby-Payne J. 2. Acute infectious diarrhoea and dehydration in children. *Med J Aust*. 2004;181(10):565–70.
13. Quinn E, Najjar Z, Huhtinen E, Jegasothy E, Gupta L. Culture-positive shigellosis cases are epidemiologically different to culture-negative/PCR-positive cases. *Aust ZJ Public Health* [Internet]. 2018;1–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/30516310
14. Buccigrossi V, Spagnuolo MI. Textbook of Pediatric Gastroenterology, Hepatology and Nutrition A Comprehensive Guide to Practice. Guandalini S, Branski D, Dhawan A, Spagnuolo VB and MI, editors. New York Dordrecht London; 2016. 174 p.
15. Kotloff KL, Winickoff JP, Ivanoff B, Clemens JD, Swerdlow DL, Sansonetti PJ, et al. Global burden of Shigella infections: Implications for vaccine development and implementation of control strategies. *Bull World Health Organ*. 1999;77(8):651–66.
16. Richard E. Behrman M,Robert M. Kliegman M, Bonita F. Stanton M, Joseph W. St Geme III M, Nina F. Schor, MD P, Cleary TJO and TG. Shigella. In: Nelson Textbook of Pediatrics. 20th ed. Canada; 2016. p. 1393.
17. Ahmad Hatib NA, Chong CY, Thoon KC, Tee NWS, Krishnamoorthy SS, Tan NWH. Enteric fever in a tertiary paediatric hospital: A retrospective six-year review. *Ann Acad Med Singapore*. 2016;45(7):297–302.
18. Renfrew MJ, McLoughlin M, McFadden A. Cleaning and sterilisation of infant feeding equipment: a systematic review. *Public Health Nutr*. 2008 Nov;11(11):1188-99. doi: 10.1017/S1368980008001791. Epub 2008 Feb 26. PMID: 18298883.
19. Abu-Elyazeed RR, Wierzba TF, Frenck RW, Putnam SD, Rao MR, Savarino SJ, Kamal KA, PERUSKI LF, Abd-El Messih IA, El-Alkamy SA, Naficy AB. Epidemiology of Shigella-associated diarrhea in rural Egyptian children. *The American journal of tropical medicine and hygiene*. 2004 Sep 1;71(3):367-72. Available from: http://www.ajtmh.org/content/journals/10.4269/ajtmh.2004.71.367
20. Phillips-Howard PA, Brooks JT, Shapiro RI, Mintz E, Hoekstra RM, Slutsker L, et al. Epidemiology of Sporadic Bloody Diarrhea in Rural Western Kenya. *Am J Trop Med Hyg* [Internet]. 2003;68(6):671–7. Available from: http://www.ajtmh.org/content/journals/10.4269/ajtmh.2003.68.671
21. Talan DA, Moran GJ, Newdow M, Ong S, Mower WR, Nakase JY, et al. Etiology of Bloody Diarrhea among Patients Presenting to United States Emergency Departments: Prevalence of Escherichia coli O157:H7 and Other Enteropathogens. *Clin Infect Dis* [Internet]. 2001;32(4):573–80. Available from: https://academic.oup.com/cid/article-lookup/doi/10.1086/318718.

Abbreviations list: General Stool examination (GSE),Packed cell volume (PCV), Red Blood Cells (RBC), shigella-salmonella (SS), Statistical Package for Social Sciences (SPSS), White Blood Cells (WBC), World Health Organization (WHO).

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