Kufa Journal for Nursing Sciences
Open Access Full Text Article

Publisher
University of Kufa, Faculty of Nursing

Received: 19 August, 2023
Accepted: 23 September, 2023
Published: 07 October, 2023
Vol. 13(2), 2023: 329 – 329

https://doi.org/10.36321/kjns.vi20232.13236

ORIGINAL RESEARCH

Prevalence of Diarrheagenic Escherichia coli and its Relation to Household Factors and Symptoms Distribution among Children in Babylon Governorate Hospitals, Iraq

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ABSTRACT

Background: Diarrheagenic Escherichia coli, pose a significant threat and have been associated with a range of disorders, including gastrointestinal infections that may develop into various diseases such as diarrhea, Urinary tract infection, septic shock, and meningitis.
Objectives: to determine the Prevalence of E. coli and household factors and symptom distribution associated with E. coli among children under-12 years in Babylon Governorate.
Methodology: Using a descriptive cross-sectional type of study design and a Non-random convenient sampling technique with a proposed sample of 200 children were used to evaluate the Prevalence of Escherichia coli bacteria at two hospitals in the Babylon Governorate. They were: (Babil educational hospital for Maternity and Children and Al Noor Hospital for Children) located in Al Hillah City, the center of Babylon Governorate. This study was performed from October 1st, 2022, to May 1st, 2023.
Results: The majority of participants, 63%, did not have E. coli, while 37% were found to have E. coli. which indicates a high prevalence of E. coli infection among under 12 years children. The highest reported symptom is diarrhea, accounting for 35.40%, followed by vomiting at 20.40%, fever at 16.60%, and loss of appetite at 14.70%. Approximately 33.5% of respondents confirmed that someone in their family experienced similar symptoms during the same period. Families with 4-5 members and 6-8 members were more likely (41%) to have E. coli in comparison to families with 3 members (15.4%). Families with more than 4 children were more likely to have E. coli (100%) in comparison to families with only one child (23.2%). Families with 4 and more rooms were less likely to have E. coli (25%, 0%).
Conclusion: These results indicate that diarrhea followed by vomiting and fever were the highest reported symptoms. Approximately 53% of respondents confirmed that someone in their family or neighbor experienced similar symptoms during the same period. The results also showed that Families with 4-5 members and 6-8 members, Families with more than 4 children, Families with 3 or fewer rooms, Families who raise animals (especially sheep), and family members of the same infected child were more likely to have E. coli with significant association.

Keywords: Prevalence, Escherichia coli, Association, household factors, symptoms, Babylon Governorate.

How to Cite: Hameed, A. M., Farid, W. A. A., & Al-Saad, D. S. H. (2023). Prevalence of diarrheagenic escherichia coli and its relation to household factors and symptoms distribution among children in Babylon Governorate Hospitals, Iraq. *Kufa Journal for Nursing Sciences, 13*(2), 329-339. https://doi.org/10.36321/kjns.vi20232.13236

INTRODUCTION

Escherichia coli (E. coli) is classified as a member of the Enterobacteriaceae family, characterized by its mostly motile gram-negative bacilli morphology. E. coli is detected in significant quantities in the human environment shortly after birth, establishing its place as a crucial constituent of the normal intestinal flora in the intestines of humans and animals. Both the host organism and E. coli derive mutual benefits from their symbiotic relationship (Madigan et al., 2017).

Nevertheless, specific strains, such as Diarrheagenic Escherichia coli (DEC), pose a significant threat and have been associated with a range of disorders, including gastrointestinal infections that may develop into various diseases such as diarrhea, Urinary tract infection (UTIs), septic shock, and meningitis. This condition can lead to the presence of incapable or immunosuppressed hosts, as well as weakened gastrointestinal barriers (Nataro & Kaper, 1998).

Animal-derived food products constitute an essential reservoir of pathogens responsible for foodborne illnesses, often leading to gastrointestinal disorders (Abebe et al., 2020). Milk and other dairy products possess a possible risk of containing diverse microorganisms, which have been associated with the onset of diseases impacting livestock. Insufficient sanitation, inappropriate storage methods, and inexperienced personnel contribute to the heightened risk (Farrokh et al., 2013; García-Heredia et al., 2016).

According to a survey, the majority of sausages sold in school settings were contaminated with Salmonella and E. coli. The majority of the rolled noodles, according to the same study, also contained E. coli, rendering them unsafe for human consumption (Syahrul et al., 2020).

The severity of the infection's symptoms is primarily influenced by the virulence of the E. coli strain. The symptoms could include vomiting, intense abdominal pain, hematochezia, with potential progression to Hemolytic Uremic Syndrome, as well as profuse watery diarrhea. In the majority of cases, recovery occurs within a span of ten days, during which the manifestation of fever is generally undetectable (Mahon & Manuselis, 2000; Nataro & Kaper, 1998).

Enterotoxigenic E. coli (ETEC) is one of the DEC that are known to cause diarrhea, and it is a leading cause of diarrhea in travelers of all ages and young children each year, especially in developing countries (Qadri et al., 2005a; Zhang et al., 2016).

ETEC is the most common of the pathogens that can cause diarrhea ranging from mild to severe and watery in people of all ages (Qadri et al., 2005b). Enteroaggregative E. coli (EAEC) strains have been identified as the source of various diarrheal illness outbreaks around the world and are linked to persistent diarrhea in people. EAEC is the second most common global cause of traveler's diarrhea and is typically found in the stomach of asymptomatic humans. Diarrhea is frequently linked to EAEC in HIV-positive individuals and children in developing countries (Nataro, 2005; Weintraub, 2007).

Results from a community-based cross-sectional study revealed a significant association was found between the number of children under 5 years old and the presence of E. coli. Families with more than 4 children were more likely to have E. coli (100%) in comparison to families with only one child (23.2%). Also, Close to one-half (52.6%) of the households had a family size of fewer than five.

In Jordanian young children under the age of five. In 265 stool samples collected from children who received treatment in the Rahma hospital, ETEC was detected at a frequency of 5.7% as one of the leading isolated enteropathogens (Youssef et al., 2000).

Another study carried out in Baghdad discovered that among the children with diarrhea,

Enteropathogenic E. coli (EPEC) was the most often isolated organism (13%) (Tawfeek et al., 2002).

One of the most effective approaches for minimizing the likelihood of infection is to limit exposure to potentially contaminated food and water. This can be achieved through the provision of safe water sources and the distribution of educational materials on appropriate food preparation and hygiene practices. Additional preventive measures encompass the practice of hand hygiene, consumption of pasteurized milk and beverages, as well as thorough cooking of meals, with a particular emphasis on meat products. (E. Coli Infection: Symptoms, Causes, Treatment, and Prevention, n.d.; Nataro & Kaper, 1998). There is currently no vaccine for DEC infection and the success of the control measures is in understanding the epidemiology of the disease, particularly the risk factors.

AIMS OF THE STUDY

This study aims to determine the Prevalence of E. coli and household factors and symptom distribution associated with E. coli among children under 12 years in Babylon Governorate, Iraq.

METHODOLOGY

Study Period:

This study was performed from October 1st, 2022, to May 1st, 2023.

Study Design:

An institutional-based cross-sectional study was done among under-12-year children at Babylon Governorate Hospitals.

Population source:

The study population consisted of children under the age of 12 who were admitted to the selected hospitals in Babylon province and diagnosed with E. coli during the specified study duration.

Inclusion Criteria:

This study involved children under the age of 12 who were admitted to the wards of selected hospitals suffering from diarrhea. Diarrhea was defined by the occurrence of >3 loose stools, liquid or watery, or at least 1 bloody stool in a 24 h period.

Exclusion Criteria:

Any patient to the wards selected hospitals without having diarrhea. Patients who received antibiotics before admission were excluded from the study:

Sample size and Sampling techniques:

Non-random sampling. A convenient sampling technique was used. Thompson's statistical equation was used to calculate the sample size (Thompson, 2012). was applied to determine the appropriate sample size, considering a confidence level of 95%. Z= Standard degree =1.96, P= Rate of availability of property = 0.50, d= Error ration = 0.05. Thus, a proposed sample was 200, given by the following formula:

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

The numbers of cases were calculated proportionally for each hospital, by taking the ratio of cases for a certain hospital to the cases in all previously chosen hospitals was multiplied by the sample size to determine the proportion of cases taken from each hospital.

Variables of the study:

Dependent variables:

This study used patient statuses of E. Coli infection (yes, no) as a dependent variable.

Independent variables

The independent variables are the number of family members, symptoms, The number of children (less than 5), The number of rooms in the house, and other variables.

Data Collection Method

The data was gathered utilizing a questionnaire that was created based on an extensive examination of pertinent literature. This questionnaire served as a tool for data collection and was administered by the parents of the afflicted child who were interviewed.

The duration of each interview ranged from 10 to 15 minutes.

E. coli detection:

Stool samples were collected in sterile plastic vials, transported to a microbiology laboratory and initially screened for the presence of leukocytes, red blood cells, ova, and cysts of parasites using conventional microscopy and cultured on the same day to isolate E. coli. Samples were inoculated into selective enrichment medium [Lauryl sulphate tryptose broth (LSTB)] and after overnight incubation, subcultured onto MacConkey's agar. By utilizing the lactose available in the medium, Lac+ bacteria such as Escherichia coli produce acid, which lowers the pH of the agar below 6.8 and results in the appearance of pink colonies.

Statistical Analyses

Statistical software SPSS version 26 was used for the data analysis. The sample population was first described with relevant variables using descriptive statistics, such as proportion, mean, and standard deviations. Then Pearson Chi-square test (X2-test) with the application of Yate's correction or Fisher Exact test was carried out to investigate the association between the dependent variable (Presence of E. coli) and each group of independent variables (socioeconomic and child-related factors). The prevalence was estimated as the total number of cases divided by the total number of study participants who are under the age of twelve multiplied by 100.

Statistical significance was considered whenever the P value was equal to or less than 0.05 (Daniel & Cross, 2018).

Ethical Considerations

Before commencing the study and data collection, it is imperative to obtain permission from the research ethical committee of Southern Technical University, specifically the Faculty of Graduate Studies in Basra. To gain legal access to the hospitals within Babylon Governorate, the necessary authorizations were acquired from the Babylon Health Directorate's Training and Human Development Center. The selected hospitals were approved. In addition to this, parental oral consent was obtained, indicating their voluntary agreement to participate following a comprehensive explanation of the study's objectives. Furthermore, the participants were appropriately notified that their involvement in the research endeavor was entirely voluntary.

RESULTS and DISCUSSION:

The majority of participants, 63%, did not have E. coli, while 37% were found to have E. coli. This indicates a high prevalence of E. coli infection among under 12 years children.

A cross-sectional study conducted in Ethiopia reported a prevalence of E. coli O157:H7 related diarrhea at 15.3% (95% CI: 11.8–19.5) (Getaneh et al., 2021a). The observed prevalence in this study exceeds that of the study conducted in Benin City, Nigeria, which reported a prevalence of 20% (Esumeh et al., 2011). In Egypt, a study investigating 320 diarrhea stool samples examined E. coli isolates for specific genes related to ETEC, EPEC, EAEC, Enteroinvasive E. coli (EIEC), and Enterohemorrhagic E. coli (EHEC) using PCR. The results showed that 20.6% of the children with diarrhea had DEC isolates. EAEC was the most prevalent (47%), followed by typical EPEC (28.8%) and atypical EPEC (16.6%). Co-infection by EPEC and EAEC was detected in 7.6% of the isolates. However, ETEC, EIEC, and EHEC were not detected. Phylogroup A (47%) and B2 (43.9%) were the predominant types (Khairy et al., 2020).

In Iraq, a previous study was conducted to assess the prevalence of enterohaemorrhagic Escherichia coli, specifically E. coli O157, and other enteropathogens among 200 children with bloody diarrhea and 100 age-matched controls at two hospitals in Baghdad. The study revealed that E. coli O157 was detected in 11.5% of cases, and multiple pathogens were identified in 15.5% of cases. The difference in findings between this study and the

current one may be attributed to variations in sample size, study population source, and the methodology used for sample collection (Shebib et al., 2003). As shown in Figure (1).

The highest reported symptom is diarrhea, accounting for 35.40%, followed by vomiting at 20.40%, fever at 16.60%, and loss of appetite at 14.70%. Furthermore, a significant percentage of respondents mentioned experiencing abdominal pain (10.30%) or diarrhea with blood (2.70%). As shown in Figure (2)

In terms of the presence of symptoms within the family, approximately 33.5% of respondents confirmed that someone in their family experienced similar symptoms during the same period. Similarly, about 19.5% of respondents reported their neighbors having similar symptoms. When considering the child's classmates, 25% of respondents indicated that their child's classmates did not experience the same symptoms, while the majority mentioned that it was not applicable (75%). As shown in Table (1).

A significant association was observed between the number of family members and E. coli, with a p-value greater than 0.049. Families with 4-5 members and 6-8 members were more likely (41%) to have E. coli in comparison to families with 3 members (15.4%). This finding suggests that family size can play a role in the occurrence of E. coli, which could be influenced by various factors such as household hygiene, sanitation practices, and overcrowding.

The study conducted in Ethiopia used a community-based matched case-control study to evaluate the relationship between the microbial quality of drinking water, sanitation conditions, hygiene practices, and the occurrence of childhood diarrhea, carried out by Soboksa et al. reported that a family size of more than five (AOR 1.22, 95% CI: 0.82-1.83) had a positive association with acute diarrhea, but the association was not statistically significant (Soboksa et al., 2020). Results from a community-based cross-sectional study conducted by Bizuneh et al. also revealed a significant association between family size and diarrhea due to E. coli (Bizuneh et al., 2017).

In this study, a significant association was found between the number of children under 5 years old and the presence of E. coli, with a p-value of 0.000. Families with more than 4 children were more likely to have E. coli (100%) in comparison to families with only one child (23.2%). This suggests that families with a larger number of children may face more challenges in maintaining proper hygiene practices. Issues related to handwashing, sanitation, and food handling can contribute to the transmission of E. coli in such households.

Similar findings were reported in a cross-sectional study by Getaneh et al. where they revealed a positive association between the prevalence of E. coli O157:H7 infection and the number of children under 5 years old in a household (AOR: 7.16, 95% CI: 2.90-17.70) (Getaneh et al., 2021a). These findings are further supported by a study conducted by Adane et al. (Adane et al., 2017).

On the other hand, there was no significant association found between the number of adult children and E. coli, with a p-value less than 0.05. E. coli infections are often associated with fecal-oral transmission, particularly through contaminated food or water. The number of adult children in a family may not directly impact the transmission of E. coli, as it is more closely related to individual hygiene practices and exposure to contaminated environments.

In this study, a significant association was found between the number of rooms in the house and the E. coli presence, with a p-value of 0.000. Families with 4 and more than 4 rooms were less likely to have E. coli (25%, 0%) compared to families with 3 and 2 or fewer rooms (83.3%, 31.3%). The findings suggest that families living in smaller houses with fewer rooms may experience overcrowding, with multiple family members sharing limited living space. Overcrowding can create challenges in maintaining proper hygiene practices, thereby increasing the risk of E. coli transmission.

These results differ from the findings of a cross-sectional study conducted by Getaneh et al. which reported no significant association between the number of rooms and E. coli (Getaneh et al., 2021b). It is important to consider that various factors, such as cultural practices, socio-economic conditions, and specific household characteristics, can influence the relationship between the number of rooms and the presence of E. coli. Further research is needed to explore these discrepancies and better understand the role of housing conditions in E. coli transmission.

In this study, a significant association was found between the type of house in which the family lives and the presence of E. coli, with a p-value of 0.000. Families living in owned houses were more likely to have E. coli (58.8%) compared to families living in rented houses (25.4%) and other groups. These findings are in contrast to the results of a community-based matched case-control study conducted by Adane et al. which showed a significant association between house ownership and acute diarrhea presence among children. The study reported that those with rented housing had higher odds of diarrhea compared to those with their own houses (Adane et al., 2017). The discrepancy in findings could be attributed to various factors, including differences in the study populations, geographical locations, cultural practices, and hygiene behaviors specific to the respective settings. Housing conditions can influence the presence and transmission of E. coli, as they are closely linked to sanitation practices, access to clean water, and overall hygiene standards. Further research is warranted to explore the complex relationship between house type and the risk of E. coli infection, taking into account contextual factors and local variations in housing conditions.

There was no significant association found between the school attended by the child and the presence of E. coli, as well as the number of students in the class (p-value < 0.05). These findings suggest that the school environment alone may not be a significant factor in the transmission of E. coli unless there are specific instances of contamination or poor hygiene practices. Other factors, such as personal hygiene behaviors, food handling practices, and community-level sanitation, may play a more prominent role in the occurrence of E. coli infections.

In the present study, a significant association was observed between raising animals and the presence of E. coli, with a p-value of 0.036. Families who raise animals are more likely to have E. coli, 47.5%, compared to families who do not raise animals, 36.2%. These findings align with a longitudinal study conducted in Ecuador by Kurowski et al. which reported a significant association between animal ownership and E. coli (adjusted odds ratio 1.64, 95% CI: 0.960–2.79) (Kurowski et al., 2021). Raising animals, particularly in the absence of proper hygiene measures, can increase the risk of fecal contamination within the household environment. Animal feces may contain E. coli bacteria, which can contaminate various surfaces, water sources, and food, thereby increasing the likelihood of E. coli presence in households where animals are present.

In the current study, a significant association was found between the type of animals raised by families and the presence of E. coli, with a p-value of 0.000. Families who raised sheep were more likely to have E. coli, 100%, compared to families who did not raise animals, 36.2%. It is important to note that animals such as cows, goats, sheep, and deer can carry E. coli in their stomachs and shed the bacteria in their feces. Even if these animals appear healthy and clean, they can still spread the bacteria. The germs can reside on their skin, and fur, and in the areas where they live and roam (CDC, 2022). As shown in Table (2).

There was a significant association between abdominal pain, diarrhea accompanied by m, blood, fever, and whether anyone in the family experienced the same symptoms as the child in the same period (p value = 0.037, 0.000, 0.000, and 0.002,

respectively). However, there was no significant association between a loss of appetite, and vomiting, whether any neighbors experienced the same symptoms as the child in the same period, and whether any of his classmates experienced the same symptoms as the child in the same period (p value < 0.05). A previous study conducted by Khairy et al. reported that diarrhea, vomiting, blood, and mucus were significantly associated with E. coli infection (Khairy et al., 2020). As shown in Table (3).

CONCLUSIONS:

Based on the results, it can be concluded that E. coli infection is a significant health problem among children, with a high percentage suffering from this condition. The results also indicate that diarrhea followed by vomiting and fever were the highest reported symptoms. Approximately 53% of respondents confirmed that someone in their family or neighbor experienced similar symptoms during the same period. The results also showed that Families with 4-5 members and 6-8 members, Families with more than 4 children, Families with 3 or fewer rooms, Families who raise animals (especially sheep), and family members of the same infected child were more likely to have E. coli with significant association.

RECOMMENDATIONS:

We recommend initiating public health education campaigns targeted at parents, caregivers, and community members, emphasizing proper hygiene practices, such as hand washing with soap and water before eating and after using the toilet. Increased awareness of these basic hygiene measures can help prevent E. coli transmission among children. We recommend that parents seek medical attention immediately when their kid shows symptoms of diarrhea and vomiting.

ACKNOWLEDGEMENTS:

We express our gratitude to all the study participants and staff members in the hospitals of Babylon governorate who demonstrated complete cooperation throughout the duration of the study.

FUNDING: None.

Conflict of interest statement: No conflict of interest is declared.

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TABLES & FIGURES:

Table (1): Distribution of Symptom Related Questions

Characteristics	Response category	Frequency	%
Did anyone in the family experience the same symptoms as the child in the same period	No	133	66.5
	Yes	67	33.5
Did any neighbors experience the same symptoms as the child in the same period	No	161	80.5
	Yes	39	19.5
Did any of his classmates experience the same symptoms as the child in the same period?	No	50	25
	Not applicable	150	75

Table (2): Household Demographic Factors Associated with E. coli

Household demographic information	Response Category	E. coli				χ^2	p value
		No		Yes			
		N	%	N	%		
The number of family members	3	22	84.6%	4	15.4%	6.049	**.049**
	4-5	62	59.0%	43	41.0%		
	6-8	42	60.9%	27	39.1%		
The number of children (less than 5)	1	63	76.8%	19	23.2%	37.276	**.000**
	2-4	56	58.3%	40	41.7%		
	More than 4	0	0.0%	15	100.0%		
	None	7	100.0%	0	0.0%		
The number of adult children	1	7	100.0%	0	0.0%	5.211	.074
	2-4	11	73.3%	4	26.7%		
	More than 4	0	0.0%	0	0.0%		
	None	108	60.7%	70	39.3%		
The number of rooms in the house	2 Rooms or less	110	68.8%	50	31.3%	25.361	**.000**
	3 Rooms	4	16.7%	**20**	**83.3%**		
	4 rooms	12	75.0%	4	25.0%		
	More than 4 Rooms	0	0.0%	0	0.0%		
The house in which the family lives	Owned	33	41.3%	47	58.8%	28.129	**.000**
	Rent	44	74.6%	15	25.4%		
	With family	24	85.7%	4	14.3%		
	Owned + with family	25	75.8%	8	24.2%		
The school where the child is studied	Governmental	42	68.9%	19	31.1%	1.290	.256
	Private	0	0.0%	0	0.0%		

	Not applicable	0	0.0%	0	0.0%		
	kindergartens	84	60.4%	55	39.6%		
The number of students in the class	less than 30 students	0	0.0%	0	0.0%	1.290	.256
	More than 30 students	42	68.9%	19	31.1%		
	Not applicable	84	60.4%	55	39.6%		
Household demographic information	**Response Category**	**E. coli**				**χ^2**	**p value**
		No		**Yes**			
		N	**%**	**N**	**%**		
Animals are raised	No Animals	97	63.8%	55	36.2%	6.634	**.036**
	Family	21	52.5%	19	47.5%		
	Neighbors	8	100.0%	0	0.0%		
	In the neighborhood	0	0.0%	0	0.0%		
Animal type	Not Applicable	97	63.8%	55	36.2%	36.080	**.000**
	Sheep	0	0.0%	15	100.0%		
	Poultry	14	77.8%	4	22.2%		
	Cats	8	100.0%	0	0.0%		
	Pigeons	7	100.0%	0	0.0%		

Table (3): Symptoms-related factors associated with E. coli

Characteristics	**response category**	**E. coli**				**χ^2**	**p value**
		No		**Yes**			
		N	**%**	**N**	**%**		
Abdominal pain	No	83	58.5%	59	41.5%	4.347	**.037**
	Yes	43	74.1%	15	25.9%		
Diarrhea accompanied by blood	No	126	68.1%	59	31.9%	27.611	**.000***
	Yes	0	0.0%	15	100.0%		
Fever	No	81	76.4%	25	23.6%	17.412	**.000**
	Yes	45	47.9%	49	52.1%		
Loss of appetite	No	75	64.1%	42	35.9%	0.147	0.704
	Yes	51	61.4%	32	38.6%		
Vomiting	No	56	65.9%	29	34.1%	0.527	0.468
	Yes	70	60.9%	45	39.1%		
Did anyone in the family experience the same symptoms as the child in the same period	No	94	70.7%	39	29.3%	10.037	**.002**
	Yes	32	47.8%	35	52.2%		
Did any neighbors experience the same symptoms as the child in the same period	No	106	65.8%	55	34.2%	2.854	0.091
	Yes	20	51.3%	19	48.7%		
Did any of his classmates experience the same symptoms as the child in the same period?	Yes	0	0.0%	0	0.0%	0.029	.866
	No	31	62.0%	19	38.0%		
	Not applicable	95	63.3%	55	36.7%		

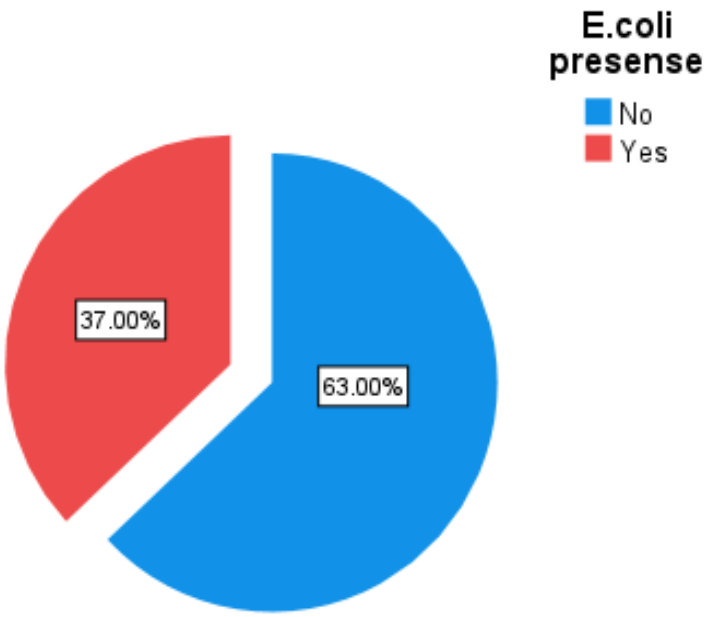

Figure (1): Presents the E. coli prevalence among children under twelve years

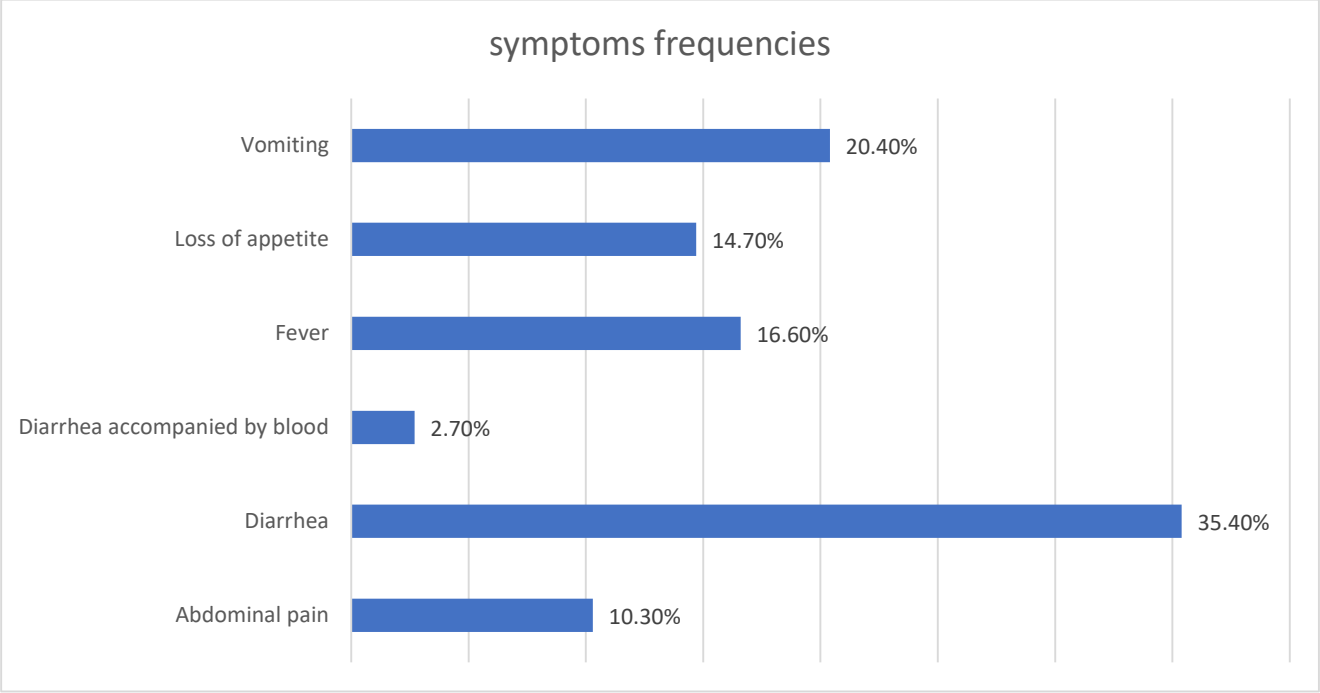

Figure (2): Presents the frequency of symptoms among study participants