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Prevalence of Intestinal Protozoa and Bacteria Associated with Diarrhea in Infants and Children in Different Locations in Zakho City, Kurdistan Region, Iraq

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ABSTRACT

Background and Objective: Diarrheal diseases remain a significant health concern for infants and young children, particularly in developing regions like Iraq, where environmental and socioeconomic factors contribute to a high burden of enteric infections. This study aimed to investigate the prevalence of intestinal protozoa and bacteria associated with diarrhea in infants and children aged 1 month to 15 years in Zakho City, Iraq. **Methodology:** A cross-sectional study was conducted between October 2024 and April 2025 across distinct locations in Zakho City. A total of 406 stool samples have been collected and examined using specific diagnostic methods for protozoa and bacteria. **Results:** Overall, 86.94% of samples were positive for at least one enteric pathogen. Intestinal protozoa were detected in 19.45% of cases, with *Entamoeba histolytica* (86.07%) and *Giardia lamblia* (13.92%) being the most prevalent. Bacterial pathogens were identified in 85.96% of samples, predominantly *Escherichia coli* (87.96%) and *Klebsiella* spp. (10.60%). The highest protozoan infection rates were in the >1-5 years age group (29.77%), while bacterial infections peaked in the 1-month to 1-year age group (87.17%). **Conclusion:** Our findings reveal a substantial burden of intestinal protozoan and bacterial infections contributing to diarrhea in the pediatric population. The high prevalence of *E. histolytica* and *E. coli* highlights an urgent need for targeted WASH interventions, particularly in high-risk areas and among vulnerable age groups. Continuous epidemiological surveillance is crucial for effective control strategies in the Kurdistan Region of Iraq.

INTRODUCTION

Diarrhea remains a primary global health concern, especially for young children and newborns, contributing substantially to morbidity and mortality in developing countries (WHO, 2017). The etiology of diarrheal diseases is diverse, encompassing a wide range of bacterial, viral, and parasitic pathogens. Among these, intestinal protozoa and bacteria are frequently implicated, often leading to acute or persistent diarrheal episodes that can result in dehydration, malnutrition, and impaired growth (Kotloff *et al.,* 2013).

Diarrhea is the second most common cause of mortality for children worldwide, accounting for 9% of all fatalities in children under five. (UNICEF, 2019). In developing countries, diarrheal infections are thought to kill 1.8 million people annually, with children under five making up over 80% of these fatalities. (Bakir *et al.,* 2017).

The causative pathogenic agents of diarrhea may vary significantly, based on the population sampled, duration of the connection, or the geographic location (Lindsay *et al.,* 2015).According to the World Health Organization (WHO) the children who have diarrhea will experience several issues, such as decreased appetite, electrolyte imbalance, malnourishment, a higher chance of contracting other infectious diseases, and delayed mental and physical development (WHO, 2005). Three clinical forms of diarrhea exist: acute watery diarrhea, which includes cholera, lasts for a few hours or days; bloody diarrhea, also known as dysentery, lasts for 14 days or more and chronic diarrhea, which is a frequent ailment that lasts for more than 4 weeks and affects up to 3-5% of the population (Hodge *et al.,* 2016).

They are spread through direct contact between people, contaminated hands, and the consumption of tainted food or beverages. Human hands typically contain germs as part of their natural microbial flora as well as temporary microbes that they have picked up from their surroundings, particularly in rural regions (Siddiqui *et al.,* 2020). In addition, studies found that the following factors significantly influenced children's diarrhea: family size, number of children under five in the home, maternal age, distance and source of drinking water, latrine and hand washing facilities, breastfeeding, place of residence, disposal of children's stool, maternal education, lower socioeconomic status and maternal education (Nasir *et al.,* 2020).

Information on childhood diarrhea in Zakho city is quite limited, with a significant lack of data regarding pediatric diarrhea in this locality. Hence, this study aimed to conduct a survey and determine which agent cause diarrhea in infants and kids of all ages and genders., and some risk factors in Zakho city, Kurdistan Region of Iraq, focusing mainly on the connection between bacteria and parasites and comparing the data collected with age and sex, to gain a more accurate understanding of the situation in this area.

MATERIALS AND METHODS

Sample Collection:

In this study, a total of 406 stool samples were collected from patients with diarrhea between October 2024 and April 2025. Participants included infants and children of both genders, ranging in age from 1 month to 15 years. Samples were obtained from patients presenting at Zakho General Hospital and various outpatient clinics within Zakho city, as well as from the nearby refugee camp. Before sample collection, verbal informed consent was obtained from the mother or guardian of each infant or child. The study protocol received ethical approval from the General Directorate of Health in Zakho city (Reference No. UOZE41).

Data were collected from all diarrheal patients (infants and children) using a pre-designed questionnaire. This questionnaire included demographic and clinical information, including patient name, gender, age, level of education, breastfeeding status, parents' educational levels, type of drinking water, source of food consumed, and family size. Stool samples were obtained from each patient and collected in clean, sterile containers. All of the samples were processed for macroscopic and microscopic examination, and part of the sample was immediately stored in an ice box and transported daily, within two hours of collection, to the microbiology laboratory located in the Biology Department, College of Science, Zakho University, then cultured on media for detection of bacteria and subsequent identification.

Macroscopical Examination:

The macroscopic examination of fresh stool samples involved observing various physical characteristics, including: color (categorized as yellow, green, brown, black, or red), consistency (classified as soft, watery, liquid, or mucoid), presence of blood (noted as absent, few, present, or abundant), presence of mucus (recorded as not seen, moderate, present, or abundant), and the detection of any macroscopic worms (Garcia, 2015).

Microscopical Examination: Direct Saline Wet-Mount Preparation:

For microscopic examination, a small amount of the stool specimen was placed onto the center of a clean microscope slide. In the situation that the specimen was solid, one or two drops of normal saline (0.85%) were added, homogenized with an applicator stick, and prepared as a wet mount. Typically, for every specimen, two smears were made on the same slide: one unstained and another stained with two drops of Lugol's iodine solution, mixed with an applicator stick, and then cover-slipped. Slides were subsequently examined under a light microscope (AmScope, China) at 10x and 40x objectives, with 100x oil immersion used as required (Zeibig, 2014). A minimum of three slides were prepared and analyzed from different areas of each stool specimen to ensure a comprehensive assessment.

Isolation of Bacteria (cultivation):

Following delivery to the laboratory, bacteriological examination and characterization were performed. A loopful from each stool specimen was aseptically streaked onto the following selective and differential media: Nutrient Agar, MacConkey Agar, Eosin Methylene Blue (EMB) Agar, and *Salmonella-Shigella* (SS) Agar. All media were prepared strictly according to the manufacturer's instructions. Inoculated plates were then incubated at 37 ºC for 18 to 24 hours. Subsequently, isolated pure colonies were subcultured onto various media to facilitate the examination of colony morphology and microscopic assessment using Gram's stain. Final identification was achieved through several biochemical tests, including the Triple Sugar Iron (TSI) agar, the IMViC test (Indole, Methyl Red, Voges-Proskauer, and Citrate utilization tests), and the Oxidase test.

Data Analysis:

The SPSS statistical analysis software (version 25) was used to examine the epidemiological data collected, and the Chi-squared (X2) test was used to assess the probability value, with $P < 0.05$ considered significant.

RESULTS AND DISCUSSION

A total of 406 stool specimens underwent comprehensive macroscopic and microscopic examination, leading to the detection of various enteric parasites and bacteria. A notable observation was the presence of co-infections involving multiple microbial species in a subset of these positive samples.

The prevalence of enteric parasites and bacteria in the examined stool with diarrhea specimens is presented in Table 1**.** As indicated, overall infection was 86.94% (353/406) of the tested stool specimens yielded positive results for the presence of these microorganisms. Bacteria exhibited the highest prevalence at 85.96%, significantly exceeding that of parasites, which accounted for 19.45% of the positive findings.

Our findings, particularly the high overall detection rate, are consistent with several studies conducted in the broader Duhok Governorate and other parts of Iraq. For instance, a study in Duhok province by Badry *et al.* (2014) also reported a high positivity.

The rate of microorganisms causing diarrhea, with 81.61% of samples positive for bacteria, parasites, or viruses. While it was higher than the other study conducted locally in Zakho City by Mero *et al.* (2015), which found that approximately 57% of diarrheal cases were associated with bacteria, parasites, and viruses. Additionally, Abdulqader *et al.* (2022) revealed an overall enteric pathogen prevalence of 64.2%, where a significant proportion of positive samples were attributed to co-infections with multiple microbial species. The general trend of high enteric pathogen detection in diarrheic samples in Zakho and surrounding areas is a consistent finding, reinforcing the need for continued surveillance and targeted interventions to improve water, sanitation, and hygiene practices in the Kurdistan Region of Iraq.

Table 1: The spreading of parasites and bacteria in the diarrheal stool samples during examination.

No. of examined specimens	No. infected	%	Types of microorganisms			
			Bacteria		Parasites	
			No. infected	%	No. infected	%
406	353	86.94	349	85.96	79	19.45

In Table 2**,** as shown, the prevalence of all specific parasites and bacteria was identified in this study. Regarding bacterial isolates, *E. coli* was the most frequently identified species, accounting for 87.96% of bacterial detections. *Klebsiella* spp. were found at a rate of 10.6%, while *Pseudomonas* and *Proteus* species were identified at lower respective rates of 0.85% and 0.57%. Among the parasitic infections, all detected parasites were exclusively protozoa. *E.histolytica* demonstrated the highest incidence among protozoa, recorded at 86.07%, followed by *Giardia lamblia* at 13.92%. In an Iraqi study by Abdulhaleem *et al.* (2017), *Entamoeba histolytica* was identified as the predominant parasitic infection, observed in 13% of the examined population, and *G. lamblia* also demonstrated significant prevalence at 7.2%. This high prevalence of both *E. histolytica* and *G. lamblia* reflects the substantial challenge of protozoan infections in post-war Iraq. Such rates are likely influenced by compromised public health infrastructure, including disrupted water and sanitation systems, which facilitate the fecal-oral transmission of these pathogens. The findings underscore an urgent need for targeted interventions to improve water safety and hygiene practices in the region.

Table 2: Indicating the types of parasites and bacteria found and their proportions in the stool samples that were analyzed (n=406).

Type of recorded microorganism		No. of infected	%
Bacteria	*E. coli*	307	87.96
	Klebsiella spp.	37	10.60
	Pseudomonas spp.	3	0.85
	Proteus spp.	2	0.57
Sub-total		349	85.96
Parasites	*E. histolytica*	68	86.07
	G. lamblia	11	13.92
Sub-total		79	19.45
Total number of recorded microorganisms Including double infections		386	95

The types of infections observed are listed in Table 3, with a specific focus on single infections. Single infections constituted 74.2% (256/345) of the total positive cases. Among these, bacterial single infections predominated, accounting for 71.01% (245/256), while parasitic single infections were considerably less frequent at 3.03% (11/256).

Regarding single parasitic infections, *E.histolytica* was the most prevalent species, identified in 81.81% (9/11) of these cases. Conversely, *Giardia lamblia* showed the lowest incidence, recorded at 18.18% (1/39) within this category. For single bacterial infections, *Escherichia coli* was the dominant species, present in 92.65% (227/245) cases. *Pseudomonas* species exhibited the lowest rate among bacteria, at 1.14% (3/245) of single bacterial infections. Abdulqader *et al.* (2022) reported that single bacterial infections accounted for 61.68% of positive cases, and *E. coli* was predominant among the most frequently isolated bacterial species, representing 49.53%. While parasitic infections constituted only 12.15% of the single-infection cases, and oocysts of *Cryptosporidium* spp. were identified as the most frequently isolated parasite species. This disparity suggests that bacterial pathogens, particularly *E. coli*, are a more significant cause of single microbial infections in the studied population compared to parasites. The high prevalence of *E. coli* often points towards issues with fecal contamination of food or water sources, warranting targeted public health interventions.

Our analysis revealed a double infection rate of 24.51% (89 out of 345 total cases). Further characterization of these dual infections indicated that 76.40% (68 of 89) involved a concurrent presence of both parasitic and bacterial agents. Specifically, the co-detection of *E.coli* and *E. histolytica* was a prominent finding, constituting 59.55% of the identified parasite-bacteria co-infections. A study conducted by Badry *et al.* (2014) in Duhok province investigated mixed infections, reporting that the combination of *E. coli* and *E.histolytica* was the most prevalent bacteria-parasite co-infection, accounting for 36 (27.90%) of all identified mixed infections. In contrast, a study by Alrifai *et al.* (2009) in Tikrit identified bacteria-bacteria co-infections as Children's most prevalent mixed illness type, comprising 64.3% of the total mixed infection cases. While specific bacterial pairs are not detailed in this snippet, the dominance of bacterial co-infections in Tikrit suggests a different epidemiological profile or a more acute environmental challenge driving bacterial propagation.

According to double bacterial infections, comprising *E. coli* and *Klebsiella* spp., were observed in 17.97% (16 of 89) of the double infection cohort, where *E. coli* was the prevalent pathogen. Conversely, infections involving two distinct parasitic species were rare, representing only 3.37% (3 of 89) of the cases. A study by Taheri *et al.* (2011) in Kirkuk City reported a low incidence of double parasitic infections, at just 4.4%.

These co-infections were exclusively *Giardia lamblia* and *Entamoeba histolytica*. This specific pairing is expected, as both are common intestinal protozoa transmitted via contaminated water and food. The finding points to ongoing issues with water safety and sanitation in the region, which remain key drivers of these enteric protozoal infections.

Table 3: Showing the different types of infections.

Single infections of bacteria	No. of infected	%
E. coli	227	92.65
Klebsiella spp.	15	5.70
Pseudomonas spp.	3	1.14
Sub-total	**245**	**71.01**
Single infections of parasites	**No. of infected**	**%**
E. histolytica	9	81.81
G. lamblia	2	18.18
Sub-total	**11**	**3.03**
Total number of single infections	**256**	**74.20**
Double infection		
Bacteria+ Parasites	**No. of infected**	**%**
E. coli + *E. histolytica*	53	59.55
Klebsiella + *E. histolytica*	6	6.74
E. coli + *G. lamblia*	9	10.11
Sub-total	**68**	**76.40**
Bacteria+ Bacteria	**No. of infected**	**%**
E. coli + *Klebsiella* spp.	16	17.97
E. coli + *Proteus* spp.	2	2.24
Sub-total	**18**	**20.22**
Parasite+ Parasite	**No. of infected**	**%**
E. histolytica + *G. lamblia*	3	3.37
Sub-total	**3**	**3.37**
Total number of double infections	**89**	**24.51**

The relationship between parasites and some variables is shown in Table 4. Out of 406 examined individuals, parasitic infections were detected more frequently in females than males (20.71% and 18.56%, respectively. The observed differences in prevalence between sexes for parasitic infections appear minimal. Statistical analysis revealed no significant association between gender and the rate of infection with parasites ($p < 0.59$). This disagrees with earlier research conducted in the Kurdistan Region and other parts of Iraq, such as Kirkuk city (Taher *et al*., 2022). In Erbil (Chalabi, 2024), both studies found that males had greater infection rates than females, which were 18.4% (vs. 13.3%) and 65.73% (vs. 34.27%), respectively. Both studies suggest that males' higher infection rates may be linked to their increased outdoor activities, leading to greater exposure to environmental conditions and direct contact with infection sources (Jameel and Eassa, 2021). Conversely, Ali & Najy (2021) in Wasit, investigating intestinal parasitic infections in children, reported that females constituted a larger proportion of infected cases (53.5%) than males (46.5%). Variations in infection rates and the influence of factors like gender across different areas are due to a complex interplay of environmental conditions, sanitation, socioeconomic disparities, the accessibility and quality of healthcare, population dynamics, and the specific characteristics of the pathogens themselves. With age, most parasite infection rates were observed in the >1 to 5-year group, accounting for 29.77%. The lowest infection rate was found in the 1-month to 1-year age group, which was 9.40%. This lower rate in early infancy may be related to factors such as reduced environmental exposure or the presence of protective maternal antibodies. Statistical analysis revealed significant differences ($P < 0.01$) across age groups, particularly in children. This finding aligns with previous regional investigations, including a study by Chalabi (2024) in Erbil, which reported a comparable overall parasitic infection rate of 28.5% among children under six years old, with peak prevalence observed in the 2–5-year age group. Such consistency underscores a recurrent epidemiological pattern of increased parasitic burden in early childhood within the Kurdistan Region. The highest infection rate among this age group may be due to their immature immune systems; babies and young children are more susceptible to protozoal infections. Behavioral factors such as hand-to-mouth contact, playing in contaminated environments, and less developed hygiene habits are also emerging as significant contributors. While some sources suggest a lower prevalence of certain parasites in very young children due to maternal care, other findings emphasize the role of behaviors like nail-biting and scratching in autoinfection.

Regarding residency, most parasitic infections among diarrheal cases were found among residents of camp areas (23.68%), followed by rural areas (22.34%), compared to those living in urban areas (15.65%). Hence, there was no statistically significant correlation ($p < 0.16$) between the prevalence of parasitic illnesses and residence. Similarly, other studies reported that camp areas have the most significant prevalence of parasitic infections, as in Duhok. Badry *et al*. (2014) stated that the rate of parasitic infection among children residing in camp areas (32.9%) was higher than in villages, the center, and districts, which were 25.88%, 28.5% and 23.9%, respectively. Furthermore, in a recent study in the Kurdistan Region, such as those by Hussein and Meerkhan (2019) in Duhok province and Majeed & Khoshnaw (2024) in Zakho city, have demonstrated higher prevalence of parasitic infection rates in rural areas (25.26%, 18.01%, and 20%), respectively. A study conducted in Tikrit city by Al-Azzawi and Al-Azawi (2020) demonstrated that living in rural areas was associated with a higher parasitic infection (35.71%) compared to urban areas. This elevated prevalence in rural settings is often attributed to limited access to safe water and adequate sanitation facilities, reduced availability of healthcare services and health education initiatives, suboptimal housing conditions, and increased human-animal contact, all of which facilitate the transmission of parasitic agents. However, the current findings run counter to prior research in Zakho city, Mero *et al*. (2015) found that urban primary schools had greater rates of parasite infection (32.56%) compared to rural schools (10.2%). This might indicate an evolving epidemiological situation, a unique local context, or specific characteristics of the pathogens studied that do not exhibit a strong correlation with residency. Further research could explore the specific risk factors that are significantly associated with infection in your study population, as this might reveal more nuanced drivers of disease transmission in the region.

According to the size of family members, the highest infection rate of parasites was found in medium-sized (5-10 members) and very large (more than 10 members) sized families (20.9% and 20%), and the lowest.

Infection was in 12.9% of smaller families (1-4 members), suggesting a trend of higher parasitic prevalence in larger households. A statistically significant correlation ($p < 0.01$) has been found between the size of the family and the occurrence of parasitic infections. Similarly, Research by Al-Khlefawi (2006) in Baghdad indicates a clear association between larger household sizes and increased prevalence of parasitic diarrhea, specifically, households with 11 or more members exhibited a 24.52% prevalence of parasitic diarrhea. This finding aligns with the understanding that larger family units can contribute to higher rates of parasitic infections. Additionally, Hasan *et al*. (2023) in Duhok indicate that households with more than 8 members demonstrated the highest rate of amoebiasis (40.39%). This means a larger family faces a higher risk of direct parasite transmission, especially for parasites with a direct life cycle, mainly because of increased sharing of personal items compared to smaller households. In addition to personal hygiene, which significantly affects parasite infection, living in an overcrowded environment can lead to intrafamilial transmission, as family members are often in close proximity to one another. (Maia *et al*., 2009).

Table 4: Prevalence of parasite among the population concerning some variables (n=406).

Variables	Parasites			
	Total No.	Infected No.	% Infected	P value Chi-square
Gender				
Male	237	44	18.56	χ^2:0.29 *P=0.59*
Female	169	35	20.71	
Age group				
1 month to 1 year	117	11	9.40	χ^2:17.7 *P=0.01*
1 year to 5 years	131	39	29.77	
5 years to 10 years	96	15	15.62	
10 years to 15 years	62	14	22.58	
Residency				
Urban	198	31	15.65	χ^2:3.62 *P=0.16*
Rural	94	21	22.34	
Camp	114	27	23.68	
No. of family members				
1 -4	70	9	12.85	χ^2:13.75 *P=0.01*
5 - 10	311	65	20.90	
More than 10	25	5	20	
Total	406	79	19.45	

Table 5 shows the associations observed between bacterial infection prevalence and a set of selected variables. Among the 406 diarrheal cases analyzed, bacterial infections demonstrated a notable sex-based difference in prevalence, with males exhibiting a higher rate (87.76%) than females (83.43%). Statistical analysis revealed no significant association between gender and the rate of bacterial infection (*p* <0.21). Similarly, Al Sorchee *et al.* (2013) in Erbil city revealed that males had a greater infection rate than females (64.2% vs 35.8%). In Thi-Qar, Harb *et al.* (2017) confirmed that the high prevalence of bacterial infection was higher in males (56.3%) compared to females (43.7%). Another study by Abdulqader *et al.* (2022) in Zakho city also found a higher rate of infection in males than females, observed at 59.19% and 40.81%, respectively. Children who are female are more likely to eat food prepared at home and are less likely to play outside. Additionally, the higher prevalence rate of microorganisms is influenced by the father's educational attainment, the mother's level of education and employment status, as well as the mother's nutritional understanding. (Alaa *et al.,* 2014).

The distribution of bacterial infections by age groups is also indicated in Table 5. Among all the samples, the highest infection rate was observed in the 1-month to 1-year age group (87.17%). The results indicate no statistically significant difference in the prevalence of bacterial infection among diarrheal cases across the various pediatric age groups examined (*p*

<0.95). Our results align with a study conducted by Yasir (2017) in Babylon, which reported a high incidence of diarrheal infections (40%), predominantly in infants aged 1 month to 1 year. Additionally, a study by Abdulqader *et al*. (2022) in Zakho city revealed that the age range of 6 months to 2 years had the highest rate (62.16%) of bacterial infection. This study indicated that infants, particularly those under 6 months of age, were most susceptible, attributing this to their developing immune systems and the natural decline of passively acquired maternal antibodies (IgG) after approximately 6 months of age.

Based on the patients' residence, the table shows the frequency of bacterial infections in cases of diarrhea. Bacterial infections were highly prevalent in all areas, with rates of 88.38% in urban areas, 82.97% in rural areas, and 84.21% among camp residents. The highest percentage was observed in urban areas. Statistical analysis revealed no significant association between the prevalence of bacterial infections (*p* >0.37). A study by Al-Awadi and Youssef (2018) reported a numerically higher prevalence of bacterial infection in individuals residing in rural areas 65% than in urban areas 35%. In Karbala, a study by Tuky and Semender (2019) reported that the majority of patients (62.4%) originated from rural areas compared to 37.6% from urban settings.

Although bacterial infections show a high prevalence across all groups, with a notably high rate of 92.0% in families with more than 10 members. In the current study, no statistically significant relationship was found between family size and bacterial infections (*p* >0.61). This aligns strongly with recent regional research, such as that by Al-Jebouri and Al-Hamdani (2024) in Diyala, who observed bacterial diarrheal disease in children from more crowded households (e.g., 30% prevalence in households with over 3 persons per room compared to 1.4% in less dense settings). This direct correlation highlights that increased household density significantly facilitates the person-to-person transmission of fecal-oral pathogens, including Enterobacteriaceae. In crowded living conditions, the risk of pathogen spread through direct contact, contaminated surfaces, and inadequate sanitation becomes substantially elevated, making children within such family environments particularly vulnerable to acquiring and transmitting bacterial infections (Clasen *et al.,* 2007). This emphasizes the immediate household environment as a crucial nexus for public health interventions aimed at controlling diarrheal diseases. This result indicates that other factors might be more influential than household crowding. This could be due to the diverse transmission routes of bacteria, effective general hygiene practices in the community (Schmidt & Cairncross, 2009), or the specific epidemiology of the dominant bacterial species in your study area, which might be more influenced by broader environmental or community-level factors rather than solely household density (Kotloff *et al.,* 2013).

Table 5: Prevalence of bacteria among the population concerning some variables (n=406).
among the population concerning some variables (n=406).

Variables	Bacteria			
	Total No.	Infected No.	% Infected	P value Chi-square
Gender				
Male	237	208	87.76	χ^2:1.53 *P=0.21*
Female	169	141	83.43	
Age group				
1 month to 1 year	117	102	87.17	χ^2:0.33 *P=0.95*
1 year to 5 years	131	111	84.73	
5 years to 10 years	96	83	86.45	
10 years to 15 years	62	53	85.48	
Residency				
Urban	198	175	88.38	χ^2: 1.94 *P=0.37*
Rural	94	78	82.97	
Camp	114	96	84.21	
No. of Family members				
1-4	70	61	87.14	χ2:0.98 P=0.61
5-10	311	265	85.20	
More than 10	25	23	92	
Total	406	349	85.96	

Conclusion:

Our current research indicates that enteric bacteria and protozoa are major contributors to the high incidence of diarrhea among infants and children. These rates are comparable to those observed in previous surveys, both locally and nationally. A history of not utilizing antidiarrheal drugs, living in large families, eating unwashed fresh fruits and vegetables, dining outside the home, age, gender, economic stratification, education level, family size, and water source all have a substantial impact on prevalence. The high prevalence of parasitic and bacterial diarrheal infections among children in Zakho City demands immediate and focused attention. Addressing this critical public health issue requires a multi-pronged approach: strengthening infection control processes, implementing widespread screening programs for young children, and establishing robust health education initiatives within the community. By prioritizing these evidence-based interventions, health authorities can significantly reduce the burden of diarrheal diseases, protect children's health and development, and foster a healthier future for Zakho.

Declarations:

Ethical Approval: The study was approved by the General Directorate of Health in Zakho city (Reference No. UOZE41).

Conflict of interest: There is no conflict of interest in this study.

Availability of Data and Materials: The data used in this study are available on request from the corresponding author.

Authors Contributions: Both authors made substantial contributions to this article. H.H. Ahmed and A.R. Issa conceived and designed the work. H.H. Ahmed collected the samples and data, performed the analysis, and wrote the first draft of the manuscript. A.R. Issa revised the analyzed data and reviewed the manuscript. Both authors have read and agreed to the published version of this manuscript.

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