PATHOGENIC MICROORGANISMS ASSOCIATED WITH DIARRHEA IN INFANTS AND CHILDREN IN DUHOK PROVINCE, KURDISTAN REGION / IRAQ"

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Abstract

This study was performed to assess the incidence of microorganisms causing diarrhea in infants and children of both sexes and different ages from 12 days to 14 years in Duhok province, during the period from October 2012 to June 2013, in which 522 diarrheal samples (278 males and 244 females) were collected from infants and children attended pediatrics Heevi teaching hospital in Duhok city coming from different regions of Duhok province. Out of 522 samples 426 (81.61%) were positive for bacteria, followed by 146(27.97%) parasites, 69(13.21%) viruses and 5 (0.96%) fungi. The most prevalent enteric pathogens were *Escherichia coli* 305(58.43%), followed by *Entamoeba histolytica* 134(25.67%), *Klebseilla* spp. 105(20.1%), and Rotavirus 57(10.91%). Mixed infections were documented in 129 (24.71%) cases, with the maximum being with bacteria and parasite in 62(11.87%). The most frequent microorganisms encountered in mixed infections were *E. coli* and *E. histolytica* at rates of 64.34 and 62.01%, respectively. Infants less than 2 years showed the highest rate (72.22%), while children aged 12-14 years were least infected (0.96%). Moreover, the rate of infection in males was greater than females, but statistically this difference was nonsignificant.

Keywords: *Microbial Diarrhea, Bacteria, Parasites,Viruses, Infants and Children*

Introduction

Gastroenteritis is the most common cause of morbidity and mortality in children worldwide (Revelas, 2012). Although diarrhea kills about 4 million people in developing countries each year, it remains a problem in developed countries as well; diarrhea is common in all age groups but is more common in infants, annually at least 1500 million episodes of diarrhea occur in children under age of 5 years (Khan *et al*., 2004).The risk of children in this age group dying from diarrheal disease is 600 times greater in developing countries than in developed countries (Vandepitte *et al*., 2003).The etiological agents of diarrhea include a wide range of viruses, bacteria and parasites (Bueris *et al*., 2007). They are transmitted by ingesting contaminated food or drink, by direct person-to person contact, or from contaminated hands. Human hands usually harbors microorganisms both as a part of person's normal microbial flora as well as transient microbes acquired from the environment (Tambekar *et al*., 2009).

This disorder is much more serious in infants than in older children, and this is mainly due to the relatively more marked disturbances in fluids, electrolytes and acid-base balance produced in infants (Brimble and Barltrop, 1984). In developing countries, summer outbreaks of diarrheal diseases are largely due to bacterial agents; this has been reported in Turkey, Saudi Arabia and Egypt (Al-Sekait, 1998 and National Guideline, 2001). While amoebiasis is primarily a tropical disease, but it is more closely related to sanitary and socioeconomic conditions than to climate (Gendrel *et al*., 2003).

Very limited information are available on diarrheal cases in children in Duhok province, therefore, the aim of this study was to perform a survey and to identify the causative agents of diarrhea in infants and children of both sexes and different ages.

Materials and Methods

Sample collection

In this study 522 diarrheic stool samples were collected from infants and children of both sexes and different ages ranged from 12 days to 14 years, who attended pediatrics Heevi teaching hospital in Duhok city coming from different regions of Duhok province from October 2012 to June, 2013. After collection, if it was not possible to deliver the sample to the laboratory within 2 hours of its collection, a small amount of the fecal specimen (together with mucus, blood and epithelial threads, if present) was

collected on 2 to 3 swabs and placed in a container with transport medium (Cary–Blair), and taken to the laboratory.

All culture media used in the study were prepared according to the procedures that recommended by the manufacturing companies.

Sample processing

In the laboratory the collected samples were processed following the standard laboratory protocol (WHO protocol) in the Public Health Research laboratories, as

1 Macroscopical examination

The color, consistency, presence of blood and mucus and any other abnormalities were observed macroscopically and documented.

2 Microscopical examinations

This was performed by 2 methods:

2.1. Direct wet mount method

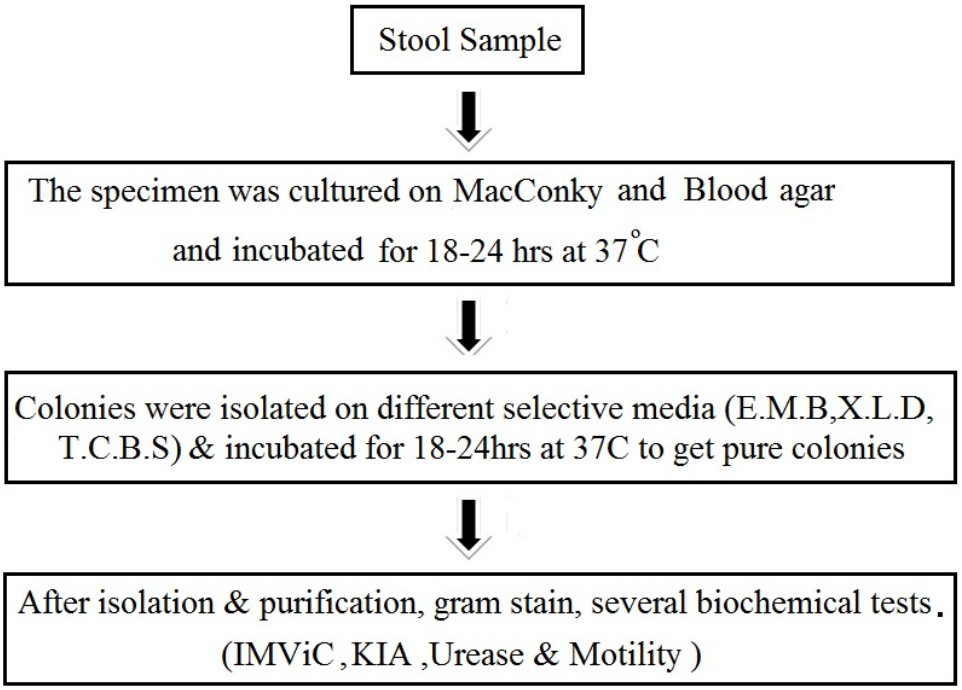
A small fleck of the specimen was placed in a drop of diluted lugal's iodine with normal saline on the center of a clean slide mixed thoroughly by a wooden stick, then covered with a cover slide and examined by microscope, firstly with 10x then 40x. To look for parasites, pus, leukocytes etc. From each sample 3 slides from different parts of the sample were examined, detected microorganisms were recorded.

2.2 Concentration technique (Zinc sulphate floatation) (Faust *et al*., 1938)

This method was used to detect protozoan cysts, helminthes ova and larva, in which about 2gm from each stool sample was mixed with 10-12ml of normal saline. The mixture was strained through two layers of wet surgical gauze, and centrifuged for two minutes at 1500-2000 rpm. The supernatant fluid was decanted and the sediment was resuspended in normal saline and centrifuged again, this process was repeated for three times. A centrifuge tube was filled with zinc sulfate close to the rim and covered with a cover slide and centrifuged again at 2500 r.p.m for one minute. The cover slide was transferred to a slide containing one drop of lugal's iodine, then was examined under 10x,40x and 100x. The detected organisms were recorded.

Bacteriological isolation (cultivation)

After delivering stool samples to the laboratory for bacteriological examination and characterization, the following steps as indicated in the flow chart were followed:



Identification of viruses

Viruses were identified using cer test Rotavirus- Adenovirus Card test, approximately 100 mg of stool specimen was transferred by a stick into the stool collection tube with diluent samples, and then the tube was shacked in order to assure good sample dispersion. After that 4 drops of solution provided with the kit were added into the circular window marked with an arrow, finally the results were read at 10 minutes by observing the coloring bands:

Negative: Only one green band appeared across the central window in the site marked with letter C (control line).

Rotavirus positive: In addition to the green control band, a red band (Rotavirus test line) also was appeared in the site marked with the letter T.

Adenovirus positive: in addition to the green control band, a blue band (Adenovirus test line) was appeared in the site marked with the letter T.

Rotavirus-Adenovirus positive: all the lines were appeared in the result region.

Isolation and identification of fungi:

After gram staining, the yeast isolates were subcultured on candida chrome agar for the identification of candida species, and incubated at 35 ◦C for 24-48 hours, to permit the development of colored colonies. The presumptive identification was made by color and morphology of the colonies; the isolates were further identified microscopically and morphologically.

Statistical analysis

Statistical analysis was carried out using Graph Pad Prism 5 program. The chi-square test was used and $P < 0.05$ was considered to be statistically significant (Sokal and Rohlf, 2009).

Results and Discussion

1. The prevalence of microorganisms in the diarrheic samples

The distribution of enteric microorganisms in the examined diarrheal samples is shown in tables (1 and 2). As it is obvious from the tables that all of the examined samples (522) were infected with various types of microorganisms, some with more than one species of microorganisms, the highest percentage (81.61%) of infection was with bacteria, followed by parasites (27.97%), viruses (13.22%) and the lowest was with fungi (0.96%).

The isolated bacteria included, *E. coli* (at highest rate, 58.43%), followed by *K. spp.*(20.1%), *Shigella* and *Pseudomonas spp*.(2.3 and 0.77%), the recorded parasites were *E. histolytica* at highest rate(25.67%), *G. lamblia*(2.11%) and only one case of *H.nana*, the viruses included Rotavirus at highest rate(10.92%) and Adenovirus(2.3%), regarding fungi only 5(0.96%) cases of candida spp. were recorded. Furthermore, it is worthwhile to mention that 24.71% of the examined samples showed mixed infection as indicated in table (3).

A comparable prevalence of bacteria (87%) among children was recorded by Kilic *et al* (2007) in Gaziantep (Turkey). While, Al-Khateeb (2008), recorded a higher bacterial prevalence (95%) in Kut city.

However; a lower prevalence rates of bacterial infection ranged between 33 to 44.84% were recorded among children and infants in various parts of Iraq, such as AI-Qadisiya, Baghdad, Tikret and Karkuk Governorate a rate of 46.52% was recorded by Esmaeel *et al*. (2009); Ali *et al*. (2009); Mahmoud, (2010), and Ibrahim (2012**)**. The rate of parasites in this study was comparable to that found among children in Baghdad (25.56%) (Ibrahim, 2012). On the other hand, a lower rate (11.6%) than that reported in the present study was detected among children in Kerbala (Hasan, 2010). While, Mahmud (2009) and Hadi (2011) recorded much higher rates (34.6 % and 43.1%) with parasite infection among children in Al-Sowera city and Thi-Qar, respectively. The viral figures in the present study was very close to that found among children (14.42%) in Shiraz (Iran), while in other Iranian cities Tabriz, Mashhad and Tehran lower rates of viral infection were recorded, which were, 7.56, 7.76 and 8.97%, respectively (Jadali *et al*., 2012). On the other hand, Hussan (2012) in Baghdad reported a much higher incidence of viral infection (42.4%) among children. Regarding fungi only 5 cases were detected.

Diarrhea is caused by a wide variety of microorganisms including bacteria, parasites, viruses, and fungi. But in the present study it appeared that the main causative agents were bacteria and parasites as they were encountered in the highest rates among the studied samples this may be due to poor hygienic condition of the children and the atmosphere that they live in, as

most cases of diarrhea are transmitted via the fecal-oral route through a variety of agents, including contaminated food and drink, person to person, hand to mouth contact, contact with contaminated objects and possibly flies (Nguyen *et al*.,2006, and *Ali et al*., 2009)

Table (1): The distribution of various microorganisms in the examined Diarrheic stool samples (n=522)

Types of Microorganisms							
Bacteria		Parasites		Viruses		Fungi	
No. infected	%	No. infected	%	No. infected	%	No. infected	%
426	81.61	146	27.97	69	13.21	5	0.96

Table (2):; Types of microorganisms recorded in diarrheic samples.

Microrganismis	Number infected	% of infection
1. Bacteria		
E. coli	305	58.43
Klebsiella spp.	105	20.12
Shigella spp.	12	2.30
Pseudomonas spp.	4	0.77
Total	426	81.6
2. Parasites		
E. histolytica	134	25.67
G. lamblia	11	2.11
H.nana	1	0.20
Total	164	31.42
3.Viruses		
Rotavirus	57	10.92
Adenovirus	12	2.30
Total	69	13.22
4. Fungi		
Candida albicans	5	0.96
Total	5	0.96

2. Mixed infections

Table (3) shows the frequency of mixed infections encountered in diarrheal samples. The mixed infections with two or more microorganisms was documented in 129 (24.71%) of the examined samples. The correlation between bacteria and parasites was the most common, and found in 62 (48.06%) of total mixed cases. However a lower rates (15.5%) of mixed infections ranged from 11 to 15.5% were recorded among children in Northern Jordan, Saudia Arabia, Turkey, and Burkina Faso (Youssef *et al*., 2000; El-Sheikh and El-Assouli, 2001; Turhanoglu *et al*.,2012, and Bonkoungou *et al*., 2013). *E. coli* and *E. histolytica* were the most frequent pathogens, occurring at rates of 64.34 and 62.01%, respectively in mixed infection cases. The high occurrence of *E. histolytica* might be attributed to the fact that the cysts of *E. histolytica*, are resistant to chlorination, they are killed by heating only and also the unsanitary practice associated with child living environment (e.g playing in contaminated dirt and water, sucking dirty fingers and other objects, etc.) (Nguyen*et al*., 2006; Raddam and Hasson, 2008).

Among the bacteria-parasite mixed infection *E. coli*+ *E. histolytica* was the leading agents appeared in 36(27.90%) of total mixed infections. While in Tikrit the most common type of mixed infection among children was found to be bacteria-bacteria which were identified in 64.3% of the total mixed infection

cases (Alrifai *et al*., 2009). Moreover, *E. coli* was also appeared to be an important pathogen in bacteria-virus infection. *E. coli*+ rotavirus recorded in 16(12.40%) cases. However, a lower incidence of mixed infection *E. coli*+ rotavirus (1.15%) was recorded among children in Kirkuk (Zaman *et al*., 2012), while *Klebsiella* spp.+*rotavirus* recorded in 6(4.65%) cases. A lower rate of mixed infection *E. histolytica* +rotavirus (2.4%) was obtained from children in Kirkuk (Zaman *et al*., 2012).

Table (3): The frequency of mixed infections among 522 cases of diarrhea

Microorganisms recorded in mixed infections		
1. Bacteria + Parasite	Frequency	%
E.coli + Entamoeba histolytica	36	27.90
Klebsiella spp. + Entamoeba histolytica	15	11.62
Shiglla spp. + Entamoeba histolytica	7	5.42
E.coli + Giardia lamblia	3	2.32
E.coli + Klibsiella spp.+ Entamoeba histolytica	1	0.77
Total	62	48.06
2. Bacteria + Virus	Frequency	%
E. coli + Rotavirus	16	12.40
E. coli + Adenovirus	5	3.87
Klebsiella spp. + Rotavirus	6	4.65
Total	27	20.93
3. Bacteria + Bactria	Frequency	%
E. coli + Klebsiella spp.	17	13.17
E.coli + Pseudomonas spp.	1	0.77
Total	18	13.95
4. Parasite + Virus	Frequency	%
Entamoeba histolytica + Rotavirus	12	9.30
Entamoeba histolytica + Adenovirus	1	0.77
Total	13	10.07
5. Parasite + Parasite	Frequency	%
Entamoeba histolytica + Giardia lamblia	2	1.55
Entamoeba histolytica + Hymenolepsis nana	1	0.77
Total	3	2.32
6. Bacteria + Parasite + Virus	Frequency	%
E. *coli*+ *Entamoeba histolytica* + Rotavirus	2	1.55
E. coli+ *Entamoeba histolytica* + Adenovirus	1	0.77
Total	3	2.32
7. Parasite + Fungus	Frequency	%
Entamoeba histolytica + Candida albicans	2	1.55
8 Bacteria + Fungi	Frequency	%
E. coli + Candida albicans	1	0.77
Total number of cases	129	24.71

3. The distribution of microorganisms according to the age

The distribution of enteric microorganisms in different age groups is shown in table (4). The highest percentage of infection was in the age group from 12 days to 2 years which was 66.28% (346) with bacteria, 13.79 %(72) parasites and 10.53 %(55) viruses. This outcome could be due to exogenous factors such as reduction of breastfeeding along with increase in food supplementation in the second year of life. The supplementary food can become contaminated in the preparation process under poor hygienic conditions, therefore, continuing breastfeeding of children and maintaining personal hygiene by those who prepare food for children can also play an important role in reducing the incidence of diarrhea (Arif and Naheed, 2012). Similarly Rabatti and Rasheed (2008) in Erbil reported the highest rate of infection with different microorganism in this age group, in Baghdad, Ibrahim (2012) also recorded the highest prevalence of bacteria, parasites, viruses and fungi in children less than 2 years (61.88% for 1 day to 1year and 21.52% for 1.1 to 2 years) than other age groups. While

Bonkoungou *et al* (2013) found that the bacterial and viral infection were most common (76%) among children less than 2 years in Burkina Faso. Moreover, the majority of the bacterial infections were found in children less than 2 years in a study conducted by Cajetan *et al.* (2010) in Abuja (Nigeria). On the other hand, Hasan (2012) recorded lower prevalence of parasites in Kerbala among children less than 2 years (7.14%) than children from 2-4 years (38.5%).

A dramatical decrease of all microorganisms occurred at the age <2-4 years, the rate of bacteria dropped to 7.08% (37), parasites 5.36% (28), viruses 0.76% (4) and fungi 0.38(2). At the age above 4 to 6 years the decrease of the rates of microorganisms continued significantly, in this age group the rate of bacteria became 2.29%(12) parasites 2.49%(13), viruses 0.38%(2) and fungi 0.9% (1). At the age of 6-8 a slightly higher rate (2.87) of bacteria was recorded, while the rates of parasites, viruses and fungi declined to become 2.29%, 0.19% and 0%, respectively. From the ages 8-10 years to 12-14, the microorganism figures fall but more steadily to record the lowest rates of infection with different microorganisms in the age group 12-14 years as the rates of bacteria and parasites were 0.57 % for each of them, 0.38% for viruses, and fungi were not detected in this group. Statistical analysis of the results showed the presence of significant relation between the age and the rate of infection for bacteria and parasites ($p<0.05$), while the relation was non-significant relating to viral and fungal infections ($p>0.05$).This could be due to the differences in hygiene practices of the populations, environmental and host factors (Huruy *et al*., 2011).

The present results partly agree with those of Hasan (2010) as he found a similar relationship between parasite infection and child age in Kerbala. Sule *et al.* (2011) also confirmed a similar correlation for bacteria and age distribution in Kaduna (Nigeria). Moreover, Forbes *et al.* (2001), in a study carried out in Western Australia, also found that the fungus (Candida) is not associated with child age (Forbes *et al*., 2001). While Motamedifar *et al.* (2013), found a significant relation between viral infection and age among children in Shiraz, Iran.

Table (4): The distribution of enteric microorganisms in different age groups (No=522)

Age groups (years)	Types of pathogens							
	Bacteria + ve		Parasites + ve		Viruses + ve		Fungi +ve	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Less than 2	346	66.29	72	13.80	55	10.54	2	0.39
<2-4	37	7.09	28	5.37	4	0.77	2	0.39
<4-6	12	2.30	13	2.49	2	0.39	1	0.20
<6-8	15	2.87	12	2.29	1	0.19	0	0
<8-10	8	1.54	10	1.92	2	0.39	0	0
<10-12	5	0.95	8	1.53	3	0.57	0	0
<12-14	3	0.58	3	0.58	2	0.39	0	0
Total	426	81.61	146	27.97	69	13.22	5	0.96
	P-Value<0.05		<0.05		>0.05		>0.0	

4. Relationship between gender and age for diarrhea

The relationship between different age groups, gender and rate of diarrhea is shown in table (5). The overall rate of diarrhea showed that more males were having diarrhea as compared to females. Among the total enrolled cases 278 (53.26) males and 244(46.74%) females were diarrheic over the all age groups as shown in table (5). but this difference between both sexes was statistically non-significant (p> o.o5). This agrees with other studies conducted by Kolahi *et al*., (2008) in Tehran (Iran), Johargy *et al*.(2010) in Makkah (Saudi Arabia),Yilgwan and Okolo (2012) in Nigeria. This may be due to the fact that both sexes have the same chance of exposures to the environmental conditions and contaminated sources of infection such as food and water. While some other studies reported higher rate of diarrhea in male children (Nguyen *et al*., 2006, Ansari *et al*., 2012 and Arif and Naheed, 2012) in Hanoi (Vietnam), Kathmandu (Nepal) and rural area (Pakistan), respectively.

Regarding the age, the highest rate of diarrhea was among the ages from few months to less than 2 years (table.5).The greater risk of

diarrhea in the first 2 years of life is due to combined effects of declining levels of maternally acquired antibodies, the lack of active immunity in the infant, the introduction of food that may be contaminated with fecal bacteria and direct contact with human or animals feces when the infant start to grow. Most enteric pathogens stimulate at least partial immunity against repeated infection or illness, which helps to explain the declining incidence of disease in older children (Sule *et al*., 2011). A rapid decrease in the rates of diarrhea occurred in both males and females at the age group 4-6 years, the rate of diarrhea in males became 3.64% and in female 3.07%. This rapid decline in the rates of diarrhea continued to the age 6-8 years to become 1.53% for males and 2.30% for females. On the other hand, the lowest rate of diarrhea was among the age group 12-14 years, since only 0.96% of the children found with diarrhea. These results disagree with some studies which stated that there is no significant difference in the occurrence of diarrheal illness in the general population and school children in Nepal (Rai *et al*, 1986; 1995; 2001; 2002; Ishiyama *et al*, 2001). Similarly Adhikari *et al*.(1986) and Ono *et al*.(2001) also did not observe any significant difference in the prevalence of enteric parasites in children and adults as they indicated that both children and adults, irrespective of sex, were equally exposed to enteric parasites, particularly diarrheagenic protozoa, and attributed it to unplanned urbanization, which results in poor sanitary and hygienic conditions, and contamination of drinking water with fecal matter.

Table (5): Relationship between gender and age groups for diarrhea

Age groups (years)	Gender				Total	
	Male		Female			
	Number	%	Number	%	Number	%
Less than 2	201	38.50	176	33.72	377	72.22
2-4	34	6.51	25	4.79	59	11.30
4-6	19	3.64	16	3.07	35	6.70
6-8	8	1.53	12	2.30	20	3.83
8-10	7	1.34	6	1.15	13	2.49
10-12	5	0.96	8	1.53	13	2.49
12-14	4	0.77	1	0.19	5	0.96
Total	278	53.26	244	46.74	522	100

P>0.05

From this study we can conclude that most cases of diarrhea were found to be associated with bacteria (81.61%), with the highest incidence of *E. coli* (58.43%), followed by *Klebsiella spp.*(20.12%), *Shiglla spp.* (2.3%) and *Pseudomonas spp.*(0.77%). Parasites were the second leading pathogens, they contributed to 31.42% of the total cases, with the highest rate being for *E. histolytica* (25.67), followed by *G. lamblia* (2.11%) and only one case of *H. nana* (0.76%). Viruses were recorded at a rate of 13.22%., the highest rate was with rotavirus (10.92%) and 2.30% with adenovirus. With respect to fungi, only 5(.96%) cases of *Candida albicans* were recorded. Mixed infections with 2 or more microorganisms were documented in 129 cases, with the maximum being with bacteria and parasites. The rate of infection with different types of microorganisms was found to be age dependent and gender independent.

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پوختە:

ئەڤ ڤەکولینە هاتە کرن بو دیفچون لسەر بەلاڤبونا مایکروئورگانیزمێن دبنە ئەگەرێ زک چونێ لناڤ ساڤایان و زاروکان ئەوین تەمەنێن وان ١٢ روژ – ١٤ سالا ژ هەر دووّ رەگەزا ل پارێزگەها دهوکی ل هەیڤا چریا ئێکی ٢٠١٢ – خزیرانێ ٢٠١٣ . ٥٢٢ سامپلێن بەرمایکێن زک چونێ هاتنە کومکرن کو ژوان ٢٧٨ نەخوش نێر بون و ٢٤٤ مێ بون ژ ساڤایان و زاروکان ئەوێن ژ دەڤەرێن جودا قەستا نەخوشخانا هیڤی باژیرێ دهوکێ کربو ن . هەمی سامپل هاتن شیتەل کرن ل تاقیگەها ناڤەندیا پارێزگەها دهوکێ بو دیارکرنا ریژەیا بەکتێریا،پاراسایتا و ڤایروسان ل ئەگەرێن زک چونێ .

ئەنجامێن ڤێ دیفچونێ دریارکر کو کوژما سامپلێن پوزەتیڤ ژ ٥٢٢ سامپلا ٤٢٦ (٨١,٦١٪) بو بەکتێریا و ١٤٦(٢٧,٩٧٪) بو پاراسایتا و ٦٩(١٣,٢١٪) بو ڤایروسا و ٥(٠,٩٦٪) بو فەنگەسا . دناڤ هەمی مایکروئورگانیزما دا ریژا بەکتریا *ئی کولای* ٣٠٥(٥٨,٤٣٪) ژ هەمیان پتر بو ل دیڤدا *ئینتامیبا هیستولاتیکا* ١٣٤(٢٥,٦٧٪) ، *کلێبسێلا* ١٠٥(٢٠,١٪) روتاڤایروس ٥٧(١٠,٩١٪).

هاتە دیارکرن ١٢٩(٢٤,٧١٪) توشبونێن ژ ئەگەر ێن تێکل، و توشبون ب (بەکتێریا – پاراسایت) زوّر بەلاڤتر بو و ریژا ٦٢(١١,٨٧٪) توشبون هاتە تومارکرن و بەهرا پتر ژ ئەگەر ێن تێکل بێن زگ جونێ بکتریا *ئی کولای* و *ئینتامیبا هیستولاتیکا* بون و هاتە دیتن ب ریژا ٦٤,٤٣٪ و ٦٢,٠١٪، لدیف ئیك.

بەرزترین ریژا توشبونێ(72.22%) هاتە تومارکرن لناف زاروکێن تەمەنێن وان کێمتر ژ دووّ سالا وکێمترین ریژا توشبونێ (0.96%) لناف زاروکێن تەمەنێن وان ژ ١٢ – ١٤ سالا و ریژا توشبونێ لناف زاروکێن نێر پتر بون ژ ریژا لناف زاروکێن مێ بەلێ ئەڤ پتربونە نە بێ ئەگەرێن بهایێن ستاتستیك یێن گرنگ.

الخلاصة :

أجريت هذه الدراسة للكشف عن إنتشار الأحياء الدقيقة المصاحبة للإسهال بين الرضع والأطفال من الأعمار بين ١٢ يوم إلى ١٤ سنة من كلا الجنسين في محافظة دهوك خلال الفترة بين شهر تشرين الأول ٢٠١٢ إلى حزيران ٢٠١٣ حيث تم جمع ٥٢٢عينة براز (٢٧٨ من الذكور و٢٤٤ من الإناث) من الرضع والأطفال المصابين بالإسهال الوافدين إلى مستشفى هيفى فى مدينة دهوك وفدوا اليها من مختلف مناطق المحافظة .

خضعت جميع العينات للعديد من الفحوصات والإختبارات للكشف عن نسبة الإصابة بالبكتيريا والطفيليات و الفايروسات والفطريات.

أظهرت النتائج أن العينات الموجبة من بين ٥٢٢عينة كانت ٤٢٦ (٨١,٦١٪) للبكتيريا و١٤٦(٢٧,٩٧٪) للطفيليات و٦٩ (١٣,٢١٪) للفايروسات و ٥(٠,٩٦٪) للفطريات.

سجلت بكتيريا *Escherichia coli* في ٣٠٥(٥٨,٤٣ ٪) بأعلى نسبة للإصابة من بين جميع المسببات الأخرى تلاها طفيلي *Entamoeba histolytica* ١٣٤(٢٥,٦٧٪) وبكتريا *Klebseilla* spp. ١٠٥(٢٠,١ ٪) وفايروس Rotavirus ٥٧(١٠,٩١٪)

تم الكشف عن ١٢٩(٢٤,٧١٪) من حالات الإصابة المختلطة وأن الإصابة المزدوجة (بكتيريا – طفيليات) كانت الأكثر شيوعا حيث وجدت فى ٦٢(١١,٨٧٪) حالة وكانت كل من *Escherichia coli* *Entamoeba histolytica* من أكثر المسببات المصاحبة لحالات الإصابة المختلطه.حيث وجدت بمعدلات بلغت ٦٤,٤٣و ٦٢,٠١٪، على التوالي.

سجلت أعلى نسبة إصابة (72.22%) بين الأطفال الذين أعمارهم أقل من سنتين، بينما أقل نسبة إصابة (96%) وجدت بين الأطفال الذين تراوحت أعمارهم بين ١٢ – ١٤ سنة ، علاوة على ذلك وجد أن نسبة الإصابة بين الذكور أعلى منه عند الإناث ولكن هذه الزياده لم تكون ذات قيمه معنويه احصائيا.