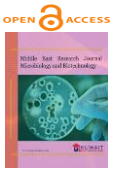

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Epidemiology and Risk Factors for Diarrheic *Escherichia coli* Carriage among Infants in Mosul, Iraq

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Abstract: ***Background*:** The term EPEC was coined a half century ago to indicate the *Escherichia. coli* O serogroups associated with diarrhea and during many years these organisms were identified in routine by their O serogroups. As after sometime there was no consensus any more about these EPEC O serogroups the World Health Organization convened a meeting in 1987 to settle the subject. ***Materials and Methods*:** This study was carried out in hospital of Children hospital and nursey of Mosul city, Iraq. 602 infants were included and they were 351 infants with diarrheic diseases and 251 infants from nursery. Demographic characters like gender, age, feeding and season of collection were recorded for all infants including in the study. Slide agglutination technique of BioMerieux were utilized for serotyping of E.coli. Blood group typing of infants was also carried out. ***Results*:** The present study revealed a strong relation between large number of pus cells and diarrhoea with enteropathogenic *Escherichia coli* (EPEC). Forty four serotypes of enteropathogenic *E. coli* were isolated from infants hospitalized in paediatric hospital and nursery with frequency of 59.1 and 40.9% respectively. It was concluded that the highest incidence of EPEC diarrhoea recorded among the infant age group 7 to 12 months from hospital. The present study revealed that the lowest incidence (3.7%) of EPEC diarrhoea was recorded among infant group of breast feeding and 8.5% of EPEC cases were seen among winter. ***Conclusions*:** Hospital isolates accounted for a greater proportion of EPEC strains than nursery isolates, indicating a possible higher transmission burden within hospital-associated environments. It was found that the total number of O blood group was 234 infants and 133 of them were males. It was found that the males of blood group B were with higher risk of infection by EPEC compared to females of infants. The highest frequency (13.9%) of EPEC diarrhoea was recorded among age group 7-12 months of nursery infants. The present study revealed that 8.5% of EPEC cases were seen among winter which was the highest rate of infection.

Keywords: Infants, EPEC, Diarrhoea, Serotyping, Blood Group, Demography.

Research Paper

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INTRODUCTION

The species *Escherichia coli* is serologically divided into serogroups and serotypes on the basis of its antigenic composition (somatic or O antigens for serogroups and flagellar or H antigens for serotypes). Many strains express a third class of antigens (capsular or K antigens) that although important in pathogenesis only occasionally are used in serotyping. The species comprise intestinal and extraintestinal pathogens. The intestinal pathogens are also known as diarrheic *E. coli* (DEC) of which six categories have been characterized: enteropathogenic *E. coli* (EPEC), enterohaemorrhagic *E. coli* (EHEC), enterotoxigenic *E. coli* (ETEC), enteroinvasive *E. coli* (EIEC), enteroaggregative *E. coli* (EAEC), and diffusely adhering *E. coli* (DAEC) [1]. The term EPEC was coined by Neter *et al*., [2], a half century ago to indicate the *E. coli* O serogroups associated with diarrhea and during many years these organisms were identified in routine by their O serogroups. As after sometime there was no consensus any more about these EPEC O serogroups the World Health Organization convened a meeting in 1987 to settle the subject. According to this meeting the following *E. coli* O serogroups should be considered EPEC O serogroups: O26, O55, O86, O111, O114, O119, O125, O126, O127, O128, O142, and O158 [3]. At this time already there

were studies showing that at least some of these serogroups possessed different diarrheic serotypes but their pathogenic diversity only latter became clear [1]. During the last 10 years it has been studied most of the EPEC O serogroups in regard to DEC categories, serotypes, clones, and genetic relationships. It is based on the study of 805 strains of serogroups O26, O55, O86, O111, O114, O119, O125, O126, O127, O128, and O142 most of which were isolated in São Paulo from children with diarrhea between 1970 and 1990. All strains were studied in regard to adhesion patterns, virulence genes implicated in the definition of the diarrheic EPEC category, and serotypes. The strains of serogroups O55, O111, and O119 were also studied and a representative number of strains of serogroups O86, O127, O128, and O142 were studied by ribotyping. Potential virulence factors were studied in a representative number of strains of the diarrheic EPEC categories detected [4-10], Diarrhea has been reported to kill about 480,000 children each year worldwide. It accounted for 8% of all deaths in children less than 5 years of age in 2017, which translates to about 1,300 daily pediatric deaths, mostly in low- and middle-income countries. African countries like Nigeria has an untenably high number of deaths in children under 5 years of age annually, and in the year 2015, 15% of this mortality was attributed to diarrhea. Global diarrhea mortality declined by 61% between 1990 and 2020 due to improvements in preventive and treatment interventions. These improvements have less impact on morbidity, including in Nigeria [4-17]. Many factors contribute to the prevalence and variance of the epidemiology of EPEC such as age, geography, and conditions based on socioeconomic status. Comparable studies have pinpointed that EPEC is prevalent with infantile diarrhea, most notably in underdeveloped countries [18, 19]. Over the years, EPEC has been the catalyst for diarrhea in infant children within the first year of their lives. This association is higher within children six months and under. Countries such as Brazil, Chile, Mexico, and South Africa report that the number of infant diarrhea cases caused by EPEC ranges from 30 to 40% [20]. Although EPEC cases have declined in developing countries, instances of EPEC infections have increased within these demographic areas. Utilizing Brazil as an example, 92% of EPEC isolates reported in 2001-2002 were of the atypical strain compared to 38% within the year spanning 1998-1999 [5-23]. Understanding diarrhea etiology can help to discern and interrupt transmission pathways, overcome pathogen-specific risk factors, and provide valuable information to support vaccine and therapeutics development. There are numerous diarrhea pathogens, including enterovirulent bacteria, such as Salmonella and diarrheagenic *E. coli* (DEC). Diarrheagenic E. coli isolates are classified based on virulence gene carriage and/or epithelial cell adherence pattern into different pathotypes, including Shigella and enteroinvasive *E. coli* (EIEC), Shiga toxin-producing E. coli (STEC), enterotoxigenic E. coli (ETEC), enterohemorrhagic *E. coli* (EHEC) [24-27].

MATERIALS AND METHODS

Patients

This study was carried out in hospital of Children hospital and nursey of Mosul city, Iraq. 602 infants were included and they were 351 infants with diarrheic diseases and 251 infants from nursery. The acceptance for participation in the present study was taken from all the participants families whose native language is Arabic. They were not mentally retarded and they were completely healthy considering hearing and speaking.

Demographic Characters

Gender, age, feeding and season of collection were recorded for all infants including in the study.

Sampling

Rectal swabs were taken from each infant. Swabs were rinsed with sterile nutrient broth as a transport media. 351 samples of paediatric hospital patients and 251 swabs were from nursery infants [28-30].

Isolation

All samples were inoculated on MacConkey agar (Oxoid). Inoculated plates were incubated at 37 ^{0}C for 24 hours [29].

Identification of Escherichia Coli

The purified isolates of suspected *E.coli* were conventionally. All plates of MacConkey agar were examined for the presence of lactose fermenting colonies. One to three suspected colonies were selected from each plate and tested for indole, acid and gas production from lactose and for ability of growth at 44 ^{0}C.These suspected *E. coli* were further identified by IMViC tests; H_2S production; fermentation of sucrose, maltose, xylose, rhamnose, sorbose , raffinose, sorbitol, dulcitol and salicin; decarboxylation of ornithine, arginine and lysine [31-33].

Serotyping

BioMerieux (BioMerieux, Laboratory Reagents and Products, France) slide agglutination technique was utilized for identification of different groups of serotypes of enteropathogenic *Escherichia coli* as mentioned by the manufacturer [9].

Blood Group Typing

Blood group typing of infants was carried out as mentioned elsewhere [10].

Statistical Analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as means, standard deviations, and frequency distributions were computed to summarize the data. A paired sample

t test correlation coefficient (R) and coefficient of determination (R2) were calculated [34-37].

RESULTS

Infant Diarrhoea and General Stool Analysis

The present study revealed a strong relation between large number of pus cells and diarrhoea with enteropathogenic Escherichia coli (EPEC) as it was demonstrated a full field of slide with these cells indicating acute infection of gastrointestinal tract with EPEC (Table 1). Large number of erythrocytes and epithelial cells were also associated with cases of infant diarrhoea with frequency of 11.2 and 4.3 % respectively. Undigested foods particularly fats and monilia were recorded in the stool of infants. *Giardia lamblia, Trichomonas hominis* and *Entamoeba histolytica* were seen in faeces with faeces of other infectious diseases rather than diarrhoea of EPEC (Figure 1).

Table 1: General stool examination of infants in paediatric hospital of Mosul city

Constituent	No. Positive stool	EPEC *E. coli* positive:	
		No.	%
Pus cells	134	6	4.5
Erythrocytes	53	6	11.3
Epithelial cells	33	1	4.3
Undigested food	17	1	5.9
Monilia	12	2	16.7
Giardia lamblia	7	0	0
Trichomonas hominis	2	1	50
Entamoeba histolytica	1	0	0
Hymenolepis nana	1	0	0
Mucous	3	0	0
Total	**166**	**17**	**10.2**

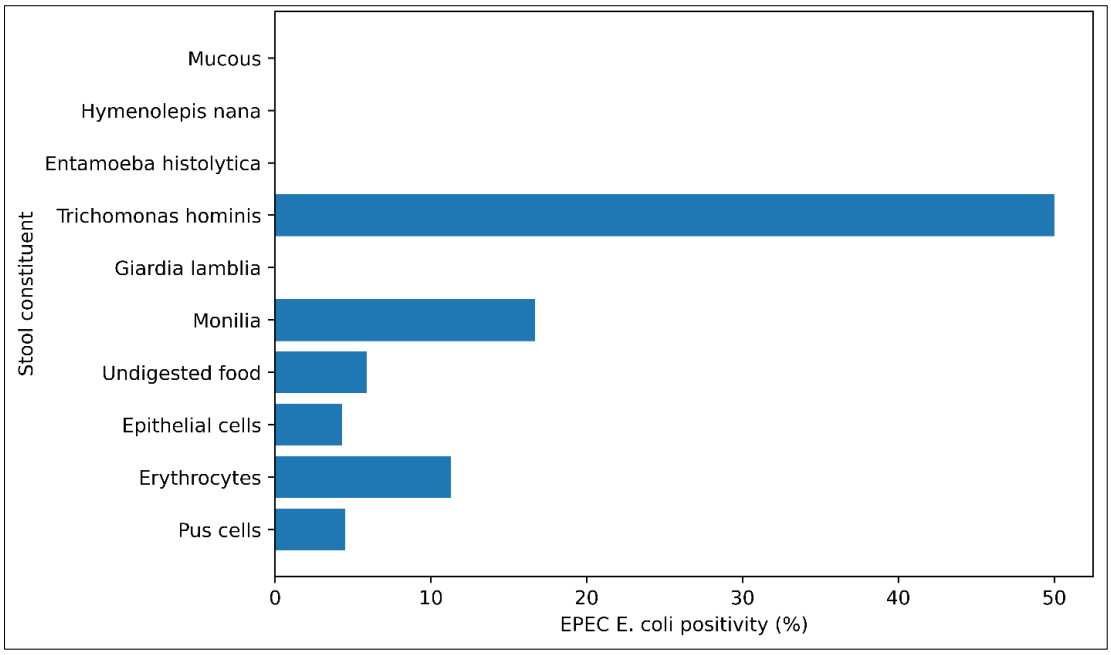

Figure 1: General stool examination of infants in paediatric hospital of Mosul city

Serotyping

Forty four serotypes of enteropathogenic *Escherichia coli* were isolated from infants hospitalized in paediatric hospital and nursery with frequency of 59.1 and 40.9% respectively (Table 2). The total samples tested of infant stools was 614. It was concluded that the most prevalent serotypes causing infant diarrhoea were 0125 and 0126 with 5 isolates each. Serotypes 0119 and 0142 were the most frequent among infants of nursery and the number of their isolation was three for each serotype. EPEC serotypes O125, O126 and O142 were the dominant circulating serotypes among pediatric diarrheal cases in Mosul. Hospital isolates accounted for a greater proportion of EPEC strains than nursery isolates, indicating a possible higher transmission burden within hospital-associated environments. Exact contingency-table analysis is recommended due to sparse counts in several serotype categories (Figure 2).

Table 2: Distribution of enteropathogenic *Escherichia coli* (EPEC) among of paediatric hospital and nursery of Mosul district

Source	Serotype	Incidence	
		No.	%
Paediatric hospital	026	1	2.3
	086	2	4.5
	0111	4	9.1
	0114	2	4.5
	0119	1	2.3
	0125	5	11.4
	0126	5	11.4
	0127	1	2.3
	0142	4	9.1
	O I+II+III	1	2.3
	Total	26	59.1
Nursery	026	1	2.3
	0 86	2	4.5
	0119	3	6.8
	0 125	2	4.5
	0 126	2	4.5
	0 127	2	4.5
	0 142	3	6.8
	0 I+II+III	2	4.5
	O I+II+III+IV	1	2.3
	Total	18	40.9
Overall		**44**	**100**

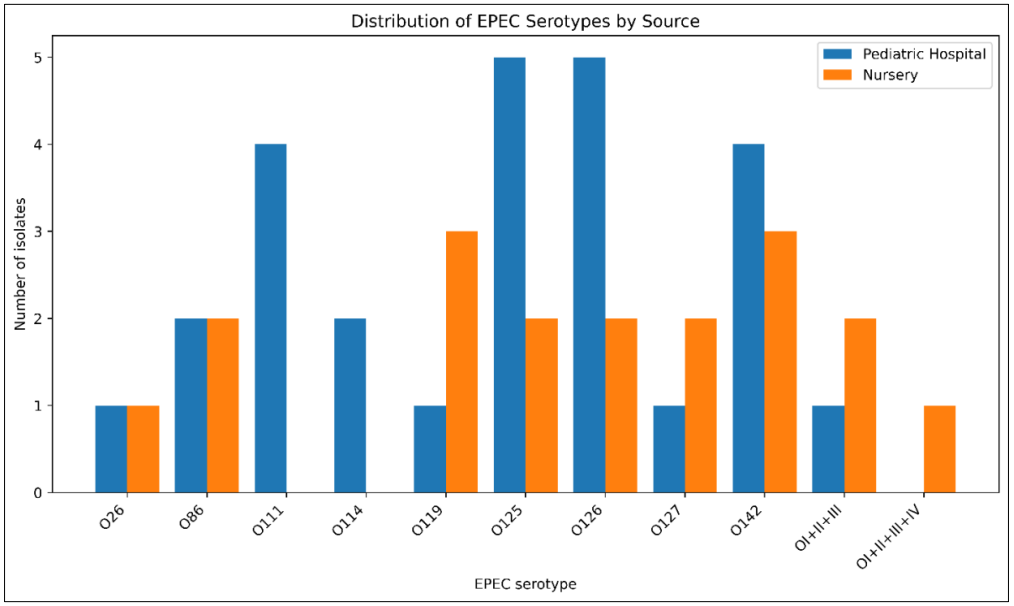

Figure 2: Distribution of Enteropathogenic *Escherichia coli* (EPEC) Serotypes Isolated from Pediatric Hospital and Nursery Sources in Mosul District

Blood Groups

It was found that the total number of O blood group was 234 infants and 133 of them were males (Table 3). It was found that the males of blood group B were with higher risk of infection by EPEC compared to females of infants. Whereas the rate of infection of males and females of group A were almost the same. Infant diarrhoea among blood group O category was the most prevalent 41.1% compared to other blood group types. Hospital-derived cases accounted for a larger proportion of infections than nursery-derived cases. Due to the small frequency observed in the AB category, Fisher–Freeman–Halton exact testing is recommended to evaluate the association between blood group and source (Figure 3).

Table 3: Distribution of enteropathogenic *Escherichia coli* among diarrheic infants according to gender and blood groups

Blood group	Gender	Diarrheic infants at:				Total	
		Hospital		Nursery			
		No.	%	No.	%	No.	%
O	Male	7	17.1	1	2.4	8	11.5
	Female	6	14.6	3	7.3	9	31.1
	Total	13	31.7	4	9.7	17	41.4
A	Male	0	0	5	12.2	5	12.2
	Female	0	0	5	12.2	5	12.2
	Total	0	0	10	24.4	10	24.4
B	Male	6	14.6	2	4.1	8	19.5
	Female	4	9.8	1	7.4	5	12.2
	Total	10	24.4	7	7.3	13	31.7
AB	Male	0	0	1	2.4	1	2.4
	Female	0	0	0	0	0	0
	Total	0	0	1	2.4	1	2.4
Overall		**23**	**56.1**	**18**	**43.9**	**41**	**100**

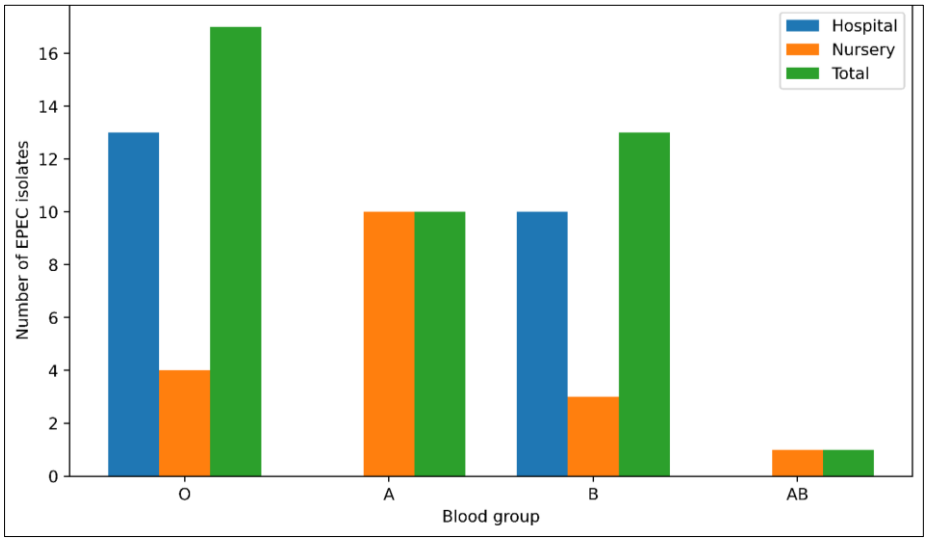

Figure 3: Distribution of Enteropathogenic Escherichia coli among Diarrheic Infants According to Blood Group and Source

Gender

It was concluded that 23 out of 351 infants resident in hospital were infected with EPEC whereas only 18 infants of 251 in nursery were carrier of this organism (Table 4). The frequency of infected females from hospital and nursery were almost the same ranged from 7.5 to 7.1%. Hospital-derived cases accounted for a larger proportion of infections than nursery-derived cases. Due to the small frequency observed in the AB category, Fisher–Freeman–Halton exact testing is recommended to evaluate the association between blood group and source (Figure 4).

Table 4: Distribution of enteropathogenic *Escherichia coli* (EPEC) among diarrheic infants in relation to gender of Mosul district

Source	Gender	Number of infants	Infants with EPEC diarrhea	
			No.	%
Hospital	Male	217	13	6
	Female	134	10	7.5
	Total	351	23	6.6
Nursery	Male	126	9	7.1
	Female	125	9	7.1
	Total	251	18	7.2
Overall		**602**	**41**	**6.8**

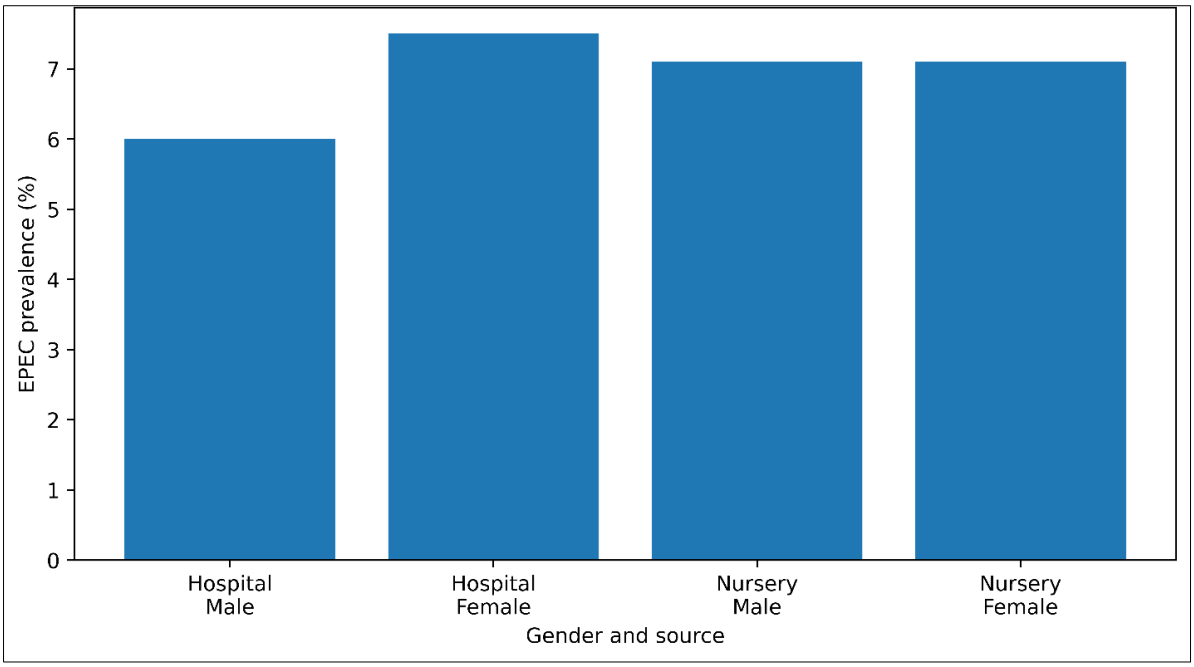

Figure 4: Prevalence of Enteropathogenic *Escherichia coli* among Diarrheic Infants According to Gender and Source in Mosul District

Age

It was concluded that the highest incidence of EPEC diarrhoea recorded among the infant age group 7 to 12 months from hospital. EPEC diarrhoea did not recorded among infants age groups 19-24, 25-30 and 31-36 months of infants hospitalized (Table 5). The highest frequency (13.9%) of EPEC diarrhoea was recorded among age group 7-12 months of nursery infants. The lowest frequency (3.2%) of EPEC dirrhoea was recorded among 19-24 months age group of nursey infants. EPEC infection was concentrated predominantly in infants younger than 12 months. Hospital cases showed a clear age-dependent decline, whereas nursery cases exhibited a peak at 7–12 months followed by lower prevalence in older age groups. These findings indicate that early infancy represents the period of greatest vulnerability to EPEC-associated diarrhea (Figure 5).

Table 5: Distribution of enteropathogenic *Escherichia coli* among infants of different ages

Source	Age (month)	Number of infants	Infants with EPEC diarrhea	
			No.	%
Hospital	-6	115	11	9.6
	7-12	151	11	7.3
	12-18	55	1	1.8
	19-24	23	0	0
	25-30	3	0	0
	31-36	4	0	0
	Total	351	23	6.6
Nursery	-6	11	1	9.1
	7-12	36	5	13.9
	13-18	52	3	5.8
	19-24	63	2	3.2
	25-30	50	5	10
	31-36	31	2	5.1
	Total	251	18	7.2
Overall		**602**	**41**	**6.8**

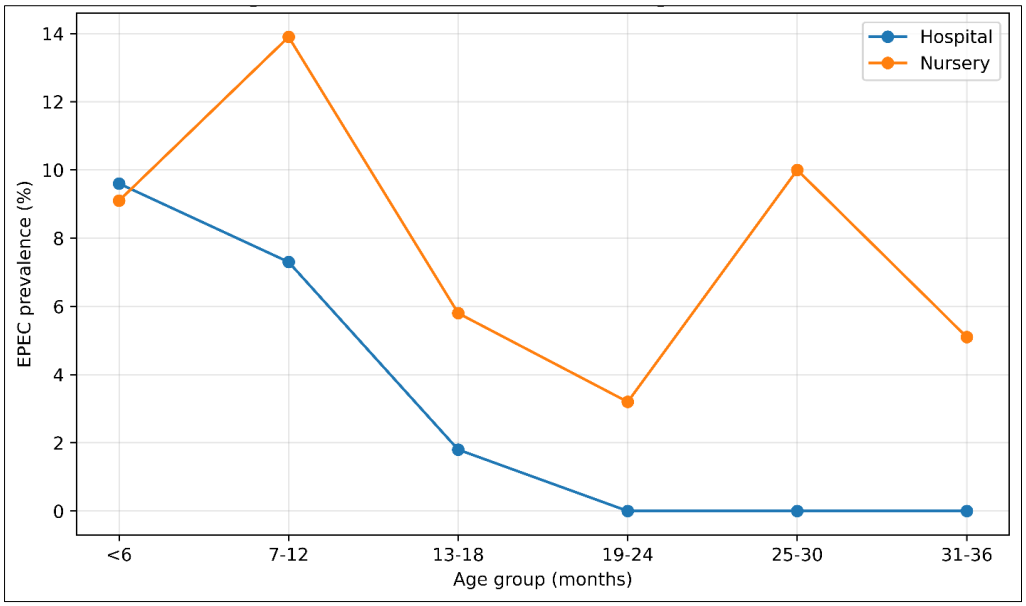

Figure 5: Age-Related Distribution of Enteropathogenic *Escherichia coli* among Diarrheic Infants from Hospital and Nursery Sources

Infant Feeding

The present study revealed that the lowest incidence (3.7%) of EPEC diarrhoea was recorded among infant group of breast feeding and the highest frequency (8.3%) of diarrhoea was seen among artificial feeding group of infant (Table 6). Breastfeeding was associated with the lowest incidence of EPEC infection, whereas artificial feeding exhibited the highest prevalence. The results suggest that exclusive breastfeeding may reduce susceptibility to EPEC-associated diarrhea during infancy and should be encouraged as a protective feeding practice (Figure 6).

Table 6: Effect of infant feeding on incidence of diarrhea caused by enteropathogenic *Escherichia coli* (EPEC).

Feeding type	Number of infants	Infants with EPEC diarrhea	
		No.	%
Breast	161	6	3.7
Artificial	277	23	8.3
Mixed	164	12	7.3
Total	**602**	**41**	**6.8**

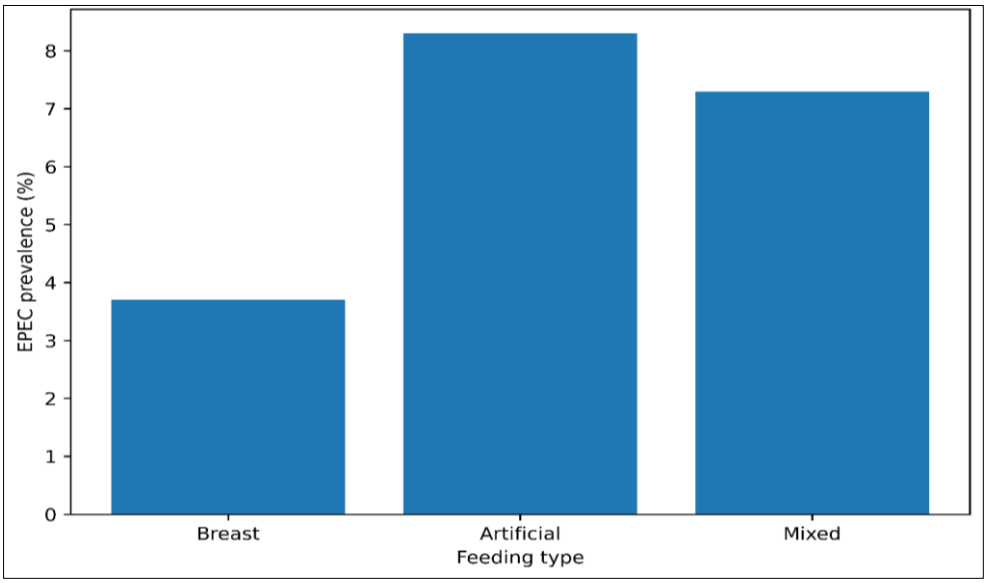

Figure 6: Association between Infant Feeding Type and Prevalence of Enteropathogenic Escherichia coli (EPEC) Diarrhea

Season

The present study revealed that 8.5% of EPEC cases were seen among winter which was the highest rate of infection. The lowest frequency (3.8%) of diarrhoea was seen during autumn (Table 7). The graph demonstrates a seasonal fluctuation in EPEC prevalence. Infection rates declined from summer to autumn, followed by a marked increase during winter. The winter peak (8.5%) and the greater diversity of serotypes detected during this season suggest that environmental conditions during colder months may facilitate EPEC transmission among infants. For formal statistical assessment, a Chi-square test for seasonal differences or a Cochran–Armitage trend analysis may be reported (Figure 7).

Table 7: Seasonal variation of infant diarrhoea caused by enteropathogenic *Escherichia coli* (EPEC)

Season	Number of isolates	serotype	Infants with EPEC diarrhea	
			No.	%
Summer	125	026	1	0.8
		086	1	0.8
		0111	2	1.6
		0119	1	0.8
		0125	3	2.4
		Total	8	6.4
Autumn	54	0111	1	1.1
		0114	1	1.1
		Total	2	3.8
Winter	184	086	1	0.5
		0111	1	0.5
		0114	1	0.5
		0125	2	1.1
		0126	5	2.7
		0127	1	0.5
		0142	4	2.2
		0 I+II+III	1	0.5
		Total	16	8.5
Overall			**26**	**7.2**

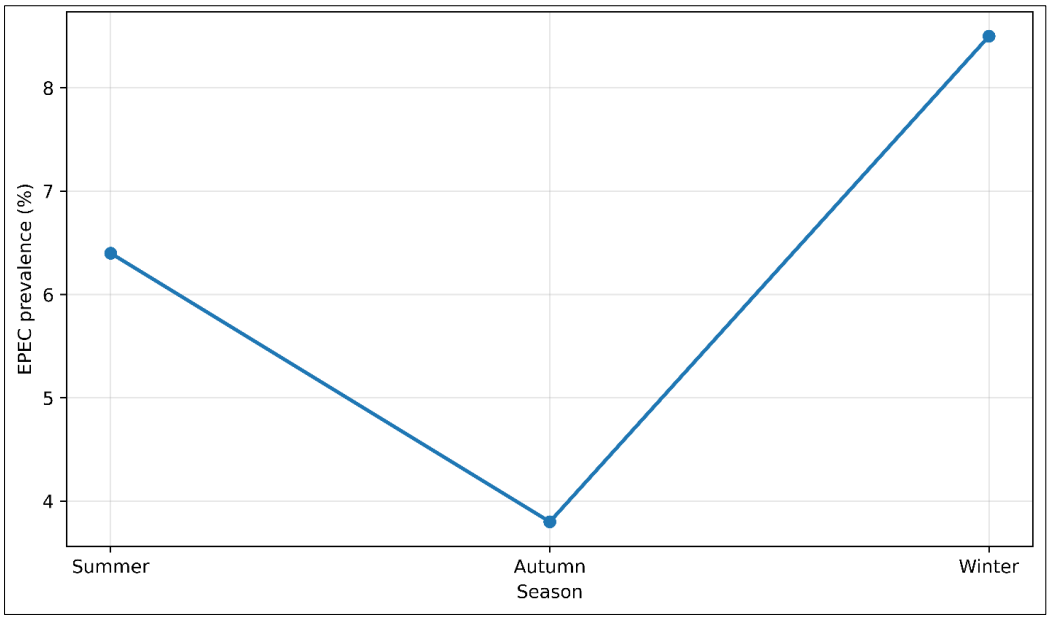

Figure 7: Seasonal Trend of Enteropathogenic *Escherichia coli* (EPEC) Infection among Infants in Mosul District

DISCUSSION

The present study revealed a strong relation between large number of pus cells and diarrhoea with enteropathogenic *Escherichia coli* (EPEC) as it was demonstrated a full field of slide with these cells indicating acute infection of gastrointestinal tract with EPEC. Large number of erythrocytes and epithelial cells were also associated with cases of infant diarrhoea with frequency of 11.2 and 4.3 % respectively. Undigested

foods particularly fats and monilia were recorded in the stool of infants. *Giardia lamblia, Trichomonas hominis* and *Entamoeba histolytica* were seen in faeces with faeces of other infectious diseases rather than diarrhoea of EPEC. Furthermore, It has beed demonstrated that several gastrointestinal disorders are associated with changes in stool characteristics, causing them to be monitored by parents and in clinical practice [38]. Odds for having hard stools were higher for infants on IF D compared to IF B and IF C, although differences in dry matter content were not found. This could relate to the limited sample size in the current study, since dry matter content (as determined by lyophilization) was different among the consistency categories, as similarly demonstrated previously in adults [39]. Breastfed infants generally have softer stools compared to formula-fed infants, with formula composition affecting factors such as fecal soap formation, that may explain variations among formula-fed infants [40-42]. Also fecal color from healthy infants varies, ranging from yellow to green, where breastfed infants more often have a yellow color compared to formula-fed infants [43-46]. The current study showed that infants consuming IF A had higher odds of having a yellow stool color compared to the other IFs. The physiological relevance of color variations within the healthy range is unknown, and clinically less relevant than discriminating category 5 and/or 6 from others. However, the current study thus suggests that fecal color may differ per the consumed formula type, similar as stool consistency [47-50]. However, the present stusy indicated that it was concluded that 23 out of 351 infants resident in hospital were infected with EPEC whereas only 18 infants of 251 in nursery were carrier of this organism. The frequency of infected females from hospital and nursery were almost the same ranged from 7.5 to 7.1%. Hospital-derived cases accounted for a larger proportion of infections than nursery-derived cases. Due to the small frequency observed in the AB category, Fisher–Freeman–Halton exact testing is recommended to evaluate the association between blood group and source. However, a study was conducted by Maasakkers *et al*., [51], in a reference service and had the general objective of studying the epidemiological, clinical and therapeutic aspects of acute diarrhea in children aged 0 to 15 years in the pediatric service of the Boffa prefectural hospital. During this study, 128 cases of acute diarrhea in children aged 0 to 15 years out of a total of 1257 were studied, representing a hospital frequency of 10.18%. This considered acute diarrhea fourth among the most frequently encountered conditions in Togo. Moreover, the present study concluded that the highest incidence of EPEC diarrhoea recorded among the infant age group 7 to 12 months from hospital. EPEC diarrhoea did not recorded among infants age groups 19-24, 25-30 and 31-36 months of infants hospitalized. The highest frequency (13.9%) of EPEC diarrhoea was recorded among age group 7-12 months of nursery infants. The lowest frequency (3.2%) of EPEC dirrhoea was recorded among 19-24 months age group of nursey infants. EPEC infection was concentrated predominantly in infants younger than 12 months. Hospital cases showed a clear age-dependent decline, whereas nursery cases exhibited a peak at 7–12 months followed by lower prevalence in older age groups. These findings indicate that early infancy represents the period of greatest vulnerability to EPEC-associated diarrhea. In Mali revealed a frequency of 31% of acute diarrhea [51-54], while Seck N, *et al*., in Senegal reported a hospital frequency of 12.9% [55-58]. Raising awareness among the local population by community relays present in all rural communes of the prefecture about the risk factors of diarrhea, as well as the improvement of certain basic hygiene measures such as hand washing since the advent of epidemic episodes in the country would explain this result in our study. Children under 12 months were the most affected, with a frequency of 51.6%, an average age of 43.18 months, and extremes from 3 to 145 months. This predominance of children under 12 months had also been reported in other studies [59-63]. This high frequency in children under 12 months could be explained by the development of the child's own immunity while maternal antibodies decline, making them more susceptible to infections. It is also at this time that the child's diet begins to be diversified, and if this process is poorly managed, diarrhea and then malnutrition can occur. However, the present study revealed that the lowest incidence (3.7%) of EPEC diarrhoea was recorded among infant group of breast feeding and the highest frequency (8.3%) of diarrhoea was seen among artificial feeding group of infant. Breastfeeding was associated with the lowest incidence of EPEC infection, whereas artificial feeding exhibited the highest prevalence. This period also corresponds to the time when children begin to explore their environment and are therefore exposed to contamination by pathogens. Males were dominant with a sex ratio of 1.5. This male predominance is reported by several authors [64,65,66]. On the other hand, Ondima *et al*., [67], and Sangaji, *et al*., [68], had respectively reported 57.14% and 52.3% female predominance. This is why we say that sex has no influence on the occurrence of diarrhea, because both sexes become infected in the same way and under the same conditions due to their behavior in unsanitary places and the consumption of contaminated food. The majority of children came from the urban community with a frequency of 66.41%. Kabore *et al*., in Burkina Faso [69], and Maiga in Mali [70], had found respectively 87.7% and 90% of children coming from urban communities. This result could be explained by the fact that the prefectural hospital is a reference hospital. It was found by Maasakkers *et al*., that 71.9% of mothers were housewives, comparable to several findings in the literature [71-74]. This is due to the fact that mothers, likely uneducated, are not well-informed about hygiene measures related to diarrhea prevention. Illiteracy would constitute a hindrance to the dissemination of messages aimed at changing behavior regarding diarrhea. The present study revealed that 8.5% of EPEC cases were seen among winter which was the highest rate of infection. The lowest frequency (3.8%) of

diarrhoea was seen during. The graph demonstrates a seasonal fluctuation in EPEC prevalence. Infection rates declined from summer to autumn, followed by a marked increase during winter. The winter peak (8.5%) and the greater diversity of serotypes detected during this season suggest that environmental conditions during colder months may facilitate EPEC transmission among infants. Furthermore, The study also reveals distinct seasonal patterns varied among detected pathogens, with viral pathogens most prevalent during colder months, particularly peaking in January through March, while bacterial pathogens were more frequent in warmer months (spring and summer), and parasitic pathogens observed throughout the year with peaks in June, July and January. These patterns are generally consistent with previously documented seasonality,1 27 though some studies report high Rotavirus incidence in dry and hot seasons.1 33 Environmental factors such as temperature, precipitation and humidity likely contributed to these patterns by impacting exposure, host immunity and pathogenicity as reported elsewhere.34 Public health strategies should therefore incorporate environmental and climate-related data to anticipate seasonal outbreaks and implement timely interventions. By leveraging this information, health systems can enhance outbreak preparedness and response efforts, ultimately reducing the burden of diarrhoeal diseases in the population. However [75], concluded that distinct seasonal patterns varied among detected pathogens, with viral pathogens most prevalent during colder months, particularly peaking in January through March, while bacterial pathogens were more frequent in warmer months (spring and summer), and parasitic pathogens observed throughout the year with peaks in June, July and January. These patterns are generally consistent with previously documented seasonality,1 27 though some studies report high Rotavirus incidence in dry and hot seasons. Environmental factors such as temperature, precipitation and humidity likely contributed to these patterns by impacting exposure, host immunity and pathogenicity as reported elsewhere.34 Public health strategies should therefore incorporate environmental and climate-related data to anticipate seasonal outbreaks and implement timely interventions. By leveraging this information, health systems can enhance outbreak preparedness and response efforts, ultimately reducing the burden of diarrhoeal diseases like EPEC type in the population. Moreover, Forty four serotypes of enteropathogenic Escherichia coli were isolated from infants hospitalized in paediatric hospital and nursery with frequency of 59.1 and 40.9% respectively. The total samples tested of infant stools was 614. It was concluded that the most prevalent serotypes causing infant diarrhoea were 0125 and 0126 with 5 isolates each., Al-Jebouri and Al-Rahaley concluded a unique pattern of negative haemagglutination for all blood group types with 16 frequency among 44 serotypes of EPEC *E.coli* whereas the second was seen with blood group A only with 17 frequency [9]. Furthermore, the cross- reactions were postulated by Orskov and Orskov [76-78], who noticed a strong cross-reaction occurred between serotype 086 of EPEC *E.coli* and blood group B which almost to the present findings. It was suggested by Evans *et al*., [79-83], that haemagglutination should be carried out at the same time with EPEC serotyping to identify the most distributed variant causing diarrhoea for children [84-88]. However, the purpose of the present utilization of CFA/I and CFA/II was to assess of application of these patterns for preparation of vaccines specific for *E.coli* strains causing gastrointestinal infections.

CONCLUSIONS

The present study revealed a strong relation between large number of pus cells and diarrhoea with enteropathogenic *Escherichia coli* (EPEC) as it was demonstrated a full field of slide with these cells indicating acute infection of gastrointestinal tract with EPEC. Hospital isolates accounted for a greater proportion of EPEC strains than nursery isolates, indicating a possible higher transmission burden within hospital-associated environments. Exact contingency-table analysis is recommended due to sparse counts in several serotype categories. It was found that the total number of O blood group was 234 infants and 133 of them were males. It was found that the males of blood group B were with higher risk of infection by EPEC compared to females of infants. Due to the small frequency observed in the AB category, Fisher–Freeman–Halton exact testing is recommended to evaluate the association between blood group and source. The highest frequency (13.9%) of EPEC diarrhoea was recorded among age group 7-12 months of nursery infants. The lowest frequency (3.2%) of EPEC dirrhoea was recorded among 19-24 months age group of nursey infants. The results suggest that exclusive breastfeeding may reduce susceptibility to EPEC-associated diarrhea during infancy and should be encouraged as a protective feeding practice. The present study revealed that 8.5% of EPEC cases were seen among winter which was the highest rate of infection.

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Statement of Ethics

All the procedures involving human participation were conducted in strict accordance with ethical standards of Institutional Research Committee, Department of Scientific Research, Mosul University as well as the 1964 Helsinki Declaration and its subsequent amendments or equivalent ethical norms.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest Statement

The author declares that he has no conflicts of interest, financial or otherwise.

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REFERENCES

1. Nataro JP, Kaper JB. Diarrheagenic *Escherichia coli*. Clinical Microbiology Review. 1998; 11(1):142-201. doi: 10.1128/CMR.11.1.142.
2. Al-Jebouri MM, Mahmood BY. Prevalence of different types of microorganisms and levels of complement C5a in patients with acute-phase wound infections. Open Journal of Pathology.2019;02-19.
3. World Health Organization. Weekly Epidemiological Record.Weekly Epidemiological Record.1987; *62*(50), 377 - 384. https://iris.who.int/handle/10665/226540
4. Akinlabi OC, Nwoko EQ, Dada RA, Ekpo S, Omotuyi A, Nwimo CC, Adepoju A, Popoola O, Dougan G, Thomson NR, Okeke IN. Epidemiology and Risk Factors for Diarrheagenic *Escherichia coli* Carriage among Children in Northern Ibadan, Nigeria. American Journal of Tropical Medicine and Hygiene. 2023 ; 30;109(6):1223-1232. doi: 10.4269/ajtmh.22-0618.
5. Al-Jebouri MM, Al-Shakarjy. The effect of low-power laser combined with providine-iodine photosensitizer on elastase production of *Pseudomonas aeruginosa* isolated from wounds. Journal of Applied Medical Sciences.2013;2(2):63-6 http://dx.doi.org/10.4236/oju.2012.23021
6. Smith H, Scotland S, Cheasty T, Willshaw G, Rowe B. Enteropathogenic *Escherichia coli* infections in the United Kingdom. Review of Microbiology.1996; 27: 45-49.
7. Toledo MR, Alvariza MCB, Murahovschi J, Ramos SRTS, Trabulsi LR. Enteropathogenic *Escherichia coli* serotypes and endemic diarrhea in infants. Infection and Immunity.1983; 39: 586-589.
8. Trabulsi LR, Campos LC, Whittam TS, Gomes TAT, Rodrigues J, Gonçalves AG. Traditional and non-traditional enteropathogenic *Escherichia coli* serogroups. Review of Microbiology.1996;27: 1-6.
9. Al-Jebouri MM, Al-Rahaley IM. An assessment of antibiotic resistance and resistotyping of Escherichia coli from stools of infants. Journal of Chemotherapy. 1991;3:119-121.
10. Al-Jebouri MM, Trollope DR. indicator bacteria in freshwater and marine molluscs. Hydrobiologia. 1984;111(2):
11. Mulatya DM, Ochieng C. Disease burden and risk factors of diarrhea in children under five years: evidence from Kenya's demographic health survey 2014. International Journal of Infectious Diseases.2014; 93: 359–366.
12. Agbonlahor DE, Odugbemi TO. Enteropathogenic, enterotoxigenic and enteroinvasive Escherichia coli isolated from acute gastroenteritis patients in Lagos, Nigeria. Transactions of Royal Society of Tropical Medicine and Hygiene.1982; 76: 265–267.
13. Al-Jebouri MM. Impact of sublethal disinfectant exposure on antibiotic resistance patterns of *Pseudomonas aeruginosa*. Medical Principles and Practice. 2024;13:1-9. https://doi: 10.1159/000542322
14. Al-Jebouri MM, Anton BG. *Escherichia Coli* Type-I Isolated From Mid-Fingers As Indicator A New Of Potential Microbial Health Hazards Associated With Food Handler Employees. World Journal of Pharmacy and Pharmaceutical Sciences.2026; 15(2), 1147–1164.
15. Al-Jebouri MM. Antibiotic-resistant *Escherichia coli* in raw sewage and in polluted water from River Tigris. Microbios letter.1985;33(131):149-152.
16. Al-Jebouri MM. A study on caused of skin rashes in Iraqi patients. 2013;68:441.
17. Al-Jebouri MM. A possible modelling of parameters interaction of environment impact and health. World Journal of Pharmaceutical Research.2015;4:412-420.
18. Al-Jebouri MM, Mahmood BYR. Estimation of cytokines involved in acute-phase wound infection with reference to residence time of patients in hospitals. Modern Research of Inflammation. 2019;8(1):1-10. DOI**:** 10.4236/mri.2019.81001
19. Hu J, Torres AG: Enteropathogenic *Escherichia coli*: foe or innocent bystander?. Clinical Microbiology and Infection. 2015, 21:729-34.DOI: 10.1016/j.cmi.2015.01.015
20. Al-Jebouri MM, Atalah N. A study on the interrelationship between renal caculi, hormonal abnormalities and urinary tract infections in Iraqi patients. Open Journal of Urology. 2012;2:6-10.
21. Ahmad O M, Rukh S, Dos Santos Pereira S, et al. A Comprehensive Review of the Role of Virulence Factors in Enteropathogenic *Escherichia coli*-Induced Intestinal Injury. Cureus.2025; 17(5): e83475. doi:10.7759/cureus.83475
22. Al-Jebouri MM, Al-Bayati HS. Incidence of surgical site infection following caesarean section and its associated factors in a Tikrit Teaching Hospital, Iraq. Journal of Current Medical Research Opinion.2025; 08(8): 4426- 4437.
23. Al-Jebouri MM, Al-Samarrai AH, Abdeljabar RA. Estimation of resistance to heavy metals of bacterial pathogens causing respiratory infections among workers of Al-Baiji Oil Refinery in Iraq. World Journal of Pharmaceutical Research.2014;3(3):3537-3551.
24. Al-Jebouri MM. Modellings of infectious diseases and cancers and pollution impacts in Iraq with reference to a novel mathematical model and

literature review. Open Journal of Pathology.2023; 13(3):126-139.
25. Al-Jebouri MM, Al-Jumaily S. A study on typhoid and paratyphoid fever among children of Al-Sharkat district in Iraq. The Medical Journal of Tikrit University.2008;14(2):347-349.
26. Al-Jebouri MM, Yehia MM. The prevalence of three nosocomial pathogens in chemical disinfectants. Iraqi Medical Journal.1986;34:43-46.
27. Al-Jebouri MM, Muhsen Hamad Edham MH. Quality Assessment Of Raw And Drinking Waters Of Tigris and Lower Al-Zab Rivers In A Selected Sector Of Kirkuk And Salahaldeen Provinces Of Iraq. World Journal of Pharmacy and Pharmaceutical Sciences.2025; 14(12): 1480–1488.
28. Desvaux M., Dalmasso, G., Beyrouthy, R., Barnich, N., Delmas, J., Bonnet, R., et al. Pathogenicity factors of genomic islands in intestinal and extraintestinal *Escherichia coli*. Frontier of Microbiology. 2020;11:. 2065. doi: 10.3389/fmicb.2020.02065
29. Al-Jebouri MM, Mdish SA. Tracing of antibiotic-resistant bacteria isolated from semen of Iraqi males with primary infertility. Open Journal of Urology.2019;9(1):19-29
30. Al-Jebouri MM, Shareef AY, Abdula BA. Mercury and antibiotic-resistant *Escherichia coli* from infant stool, Nineva. Iraqi Medical Journal. 1988;38:51-56.
31. Al-Jebouri MM, Al-Bayati HS. A Study on the Possible Sources of Hospital-Acquired Pathogens Leading To Caesarean Wound Infection in Tikrit Teaching Hospital, Iraq. World Journal of Pharmacy and Pharmaceutical Sciences.2025; 14(12), 1460–1479.
32. 32. Al-Jebouri MM, Dheyaa DS. A assessment of immunological parameters associated with typhoid fever among displaced Iraqi patients. World Journal of Pharmacy and Pharmaceutical Sciences.2025; 14(11), 487–501.https://doi.org/10.4236/ojpathology. 2025.154015
33. Cowan and Steel's manual for identification of medical bacteria -3rd ed. / edited and rev. by G.I. Barrow and R.K.A. Feltham. Cambridge University Press,1993
34. Al-Jebouri MM, Al-Shkarji By. Photostimulation of wound healing and hair growth of Swiss albino mice utilizing low power laser. 2015;4(7):1855-1868.
35. Al-Jebouri MM, Al-Shakarji By. Synergistic effect of of temperature and laser irradiation on survival of *Pseudomonas aeruginosa* isolated from irradiated infected wounds of animal pathogenicity model. World Journal of Pharmacy and Pharmaceutical Sciences.2014;3(7): 210-216.
36. Al-Jebouri MM. A regional study on the infertility of Iraqi males under war impact from 1980 to 2013. World Journal of Pharmaceutical Research. 2015; 4(5): 497-503.
37. Al-Jebouri MM, Al-Jebouri OAH. Antibiotic Resistance Patterns of Bacteria Isolated from Patients with Urolithiasis in Tikrit City, Iraq. World Journal of Pharmacy and Pharmaceutical Sciences.2026; 15(5): 296-312.
38. Al-Jebouri MM, Al-Janabi M, Ismail H. The prevalence of toxoplasmosis among female patients in Al-Hawija and Al-Baiji districts in Iraq. Open Journal of Epidemiology.2013;3(2):1-4.
39. Mandomando IM, Macete EV, Ruiz J, Sanz S, Abacassamo F, Vallès X, et al.. Etiology of diarrhea in children younger than 5 years of age admitted in a rural hospital of southern Mozambique. American Journal of Tropical Medicine and Hygiene.2007; 76: 522–527.
40. Al-Jebouri MM, Edham MH. An assessment of biological pollution in certain sector of lower Al-Zab and River Tigris waters using bacterial indicators and related factors in Iraq. Journal of Water Resource and Protection.2012; 4:32-38. DOI:10.4236/jwarp.2012.41005
41. Al-Jebouri MM, Trollope DR. The *Escherichia coli* content of *Mytilus edulis* from analysis of whole tissue or digestive tract. Journal of Applied Bacteriology.1991;51(1):135-142.
42. Al-Jebouri MM, Al-Obaidy HS. Providine-iodine as a new lethal photosensitizer for killing of disinfectant-resistant *Staphylococcus aureus* of wounds by light from a helium/neon laser. Proceedings of First Scientific Conference / college of Science 1997; 1,239-250
43. Liang Y, Dong T, Chen M, He L, Wang T, Liu Xet al. Systematic Analysis of Impact of Sampling Regions and Storage Methods on Fecal Gut Microbiome and Metabolome Profiles. mSphere. 2020;5(1):e00763-19. doi: 10.1128/mSphere.00763-19.
44. Jones J, Reinke S N , Ali A, Palmer DJ, Christophersen CT. Fecal sample collection methods and time of day impact microbiome composition and short chain fatty acid concentrations. Science Report.2021; 11, 13964 . https://doi.org/10.1038/s41598-021-93031-z
45. Al-Jebouri MM, Al-Meshhadani NS. A note on antibiotic-resistant *Escherichia coli* in adult man, raw sewage and sewage-polluted River Tigris, Nineva. Journal of Applied Bacteriology.1985;59:513-518.
46. Al-Jebouri MM, Yehia MM. Contamination of hospital disinfectants with antibiotic-resistant bacteria. Iraqi Medical Journal.1988;37(2): 128-132.
47. Maasakkers C M, Hageman J H, Balcazar M O, *et al.* A cross-sectional study on stool- and gastrointestinal-related outcomes of Mexican infants consuming different formulae. *BMC Pediatrics.2023;* 23: 634. https://doi.org/10.1186/s12887-023-04426-y
48. Al-Jebouri MM, Kaki MM. Mathematical Considerations for the Infectious Infertility of Male

in Iraq. World Journal of Public Health. 2025; 10(4): 449-458. https://doi.org/10.11648/j.wjph.20251004.12
49. Al-Jebouri MM. Clinical Immunology and Allergy. 1st 2dn. Peramerd Publishing Company, Sulaymania, Iraq, 2024,514 p., ISBN:978-9922-9227-7-5, (in Arabic).
50. Tawfiq SK, Rezaig, Al-Jebouri MM. Determination of time of toxoplasmosis among pregnant women by using IgG avidity to various Toxoplasma gondii antigens. Kirkuk University Journal of Science studies.2019;14(1):1-12.
51. Al-Jebouri MM, Jasim HH. The relationship between periodontal disease and predisposing factors. Tikrit Journal of Dental Sciences.2016;4(1):68-80.
52. Al-Jebouri MM, Al-Dobony HM. Incidence of antibiotic-resistant bacteria in urine from healthy secondary school girls in Mosul. Iraqi Medical Journal.1985;33:97-107.
53. Al-Jebouri MM, Al-Jebouri OAH. Prevalence, Incidence, and Associated Risk Factors of Urolithiasis Among Population of Salah-Aldeen Province In Iraq World Journal of Pharmaceutical Research.2026; 15(5), 817–832. .
54. Al-Jebouri MM, Al-Jebouri OAH. Urinary Metabolic Profile and Stone Composition, Location and Recurrence in Kidney Stone Formers of the Salah-Aldeen Province, Iraq. Middle East Research Journal of Microbiology and Biotechnology. 2026 ; 6(1): 1-9.
55. Seck N , Basse I , Keïta Y , Boiro D , Thiam L , Ndongo A A , et al. La bronchiolite aiguë du nourrisson en milieu tropical. Journal de Pédiatrie et de Puériculture, 2018;31, 241-246. https://doi.org/10.1016/j.jpp.2018.09.007
56. Al-Jebouri MM, Mohamed AA. A study on infertility of males infected with *Mycoplasma hominis* with reference to sperm morphology. Open Journal of Pathology. 2020;11(1):7-21.
57. Al-Jebouri MM, Hasen AH. Vitamin D3 variation between children and adults with reference to renal stone, environment and urinary tract infections. Open Journal of Urology. 2012; 2(3):119-126.
58. Al-Jebouri MM, Al-Jebouri OAH. Co-Occurrence of Antibiotic Resistance in Extensively Drug-Resistant *Staphylococcus aureus* Isolated from Wounds in Tikrit Teaching Hospital" Middle East Research Journal of Microbiology and Biotechnology.2026;6(2):67-75.
59. Kaper J, Nataro J, Mobley H. Pathogenic Escherichia coli. Natural Review of Microbiology.2004; 2: 123–140 . https://doi.org/10.1038/nrmicro818
60. Ahmad O M, Rukh S, Dos Santos Pereira S, et al. A Comprehensive Review of the Role of Virulence Factors in Enteropathogenic *Escherichia coli*-Induced Intestinal Injury. Cureus.2025; 17(5): e83475. DOI 10.7759/cureus.8347
61. Foster M A, Iqbal J, Zhang C, McHenry R, Cleveland B E, Romero-Herazo Y, et al. Enteropathogenic and enteroaggregative *E. coli* in stools of children with acute gastroenteritis in Davidson County, Tennessee. Diagnostic Microbiology and Infectious diseases.2015; 83: 319–324. doi: 10.1016/j.diagmicrobio.2015.07.016
62. Al-Jebouri MM, Madish SA. The role of sex hormones in the formation of renal stones with reference to urinary tract infections of Iraqi patients. World Journal of Pharmacy and Pharmaceutical Sciences. 2014;3(4):352-365.
63. Al-Jebouri MM. Medical Bacteriology. 1st edn. Mosul University Press(in Arabic).
64. Jangid H , Kumar D , Kumar G , Kumar R, Mamidi N. An Emerging Foodborne Pathogen Spotlight: A Bibliometric Analysis and Scholarly Review of *Escherichia coli* O157 Research. Antibiotics (Basel). 2024;13(1), 60. doi: 10.3390/ antibiotics13010060
65. Sultan HI, Al-Jebouri MM. Pulmonary tuberculosis in Al-Zab district. Tikrit Medical Journal. 2010;16(1):37-41.
66. Desvaux M, Dalmasso G, Beyrouthy R, Barnich N, Delmas J, Bonnet R, et al. Pathogenicity factors of genomic islands in intestinal and extraintestinal Escherichia coli. Frontier of Microbiology. 2020;11:. 2065. doi: 10.3389/fmicb.2020.02065. https://doi.org/10.11604/pamj.2015.21.113.5737
67. Al-Jebouri MM, Al-Ani IA. Phage Typing of *Staphylococcus aureus* Isolated from Cancer and Noncancer Patients in Iraq. Middle East Research Journal Microbiology and Biotechnology. 2026; 6(2): 118-127.
68. Al-Jebouri MM, Al-Bayati HS. A Study on the Possible Sources Of Hospital-Acquired Pathogens Leading To Caesarean Wound Infection In Tikrit Teaching Hospital, Iraq. World Journal of Pharmacy and Pharmaceutical Sciences.2025; 14(12), 1460–1479.
69. Kaboré, A., et al. (2019) Malnutrition aigüe sévère chez les enfants de moins de 6 mois: Prévalence intrahospitalière. Revue Africaine et Malgache pour la Recherche Scientifique, 1, 28-35.
70. Al-Jebouri M M, Al-Faham Y M N. Synergistic effect of laser irradiation and photosensitizers on Pseudomonas aeruginosa isolated from the wound. World Journal of Pharmacy and Pharmaceutical Sciences.2025;14(11): 502-517.
71. Al-Jebouri MM, Dheyaa DS. A assessment of immunological parameters associated with typhoid fever among displaced Iraqi patients. World Journal of Pharmacy and Pharmaceutical Sciences.2025; 14(11), 487–501. https://doi.org/10.4236/ojpathology. 2025.154015
72. Kaper J, Nataro J, Mobley H. Pathogenic *Escherichia coli*. Natural Review of Microbiology.2004; 2: 123–140. https://doi.org/10.1038/nrmicro818

73. Al-Jebouri MM, Al-Ani IA. Matrices of Degree of Association of Paired Antibiotic Resistance of *Staphylococcus aureus* Harvested From Cancer And Noncancer Patients. World Journal of Pharmaceutical Research.2026; 15(13), 1577-1597
74. Rozen D E, Lenski R E. Long-Term Experimental Evolution in Escherichia coli. VIII. Dynamics of a Balanced Polymorphism". The American Naturalist.2000; 155 (1): 24–35. Bibcode:2000ANat..155...24R. doi:10.1086/303299.
75. Al-Jebouri MM, Kaki MNM. Application of Matrices Modelling for Infectious Diseases of Humans. Open Journal of Applied Sciences; 2025;15: 2733-2758. https://doi.org/10.4236/ojapps.2025.159184
76. Al-Jebouri MM. The outcome of Minibiobank under adverse conditions in Iraq International Conference and Exhibition on Tissue Preservation & Bio-banking. Journal of Tissue Science and Engineering.2021; 1-2. DOI: 10.13140/RG.2.2.19802.06082
77. Al-Jebouri MM, Al-Dobony HM. Incidence of antibiotic-resistant bacteria in urine from healthy secondary school girls in Mosul. Iraqi Medical Journal.1985;33:97-107.
78. Fleckenstein JM, Roy K. Purification of recombinant high molecular weight two-partner secretion proteins from Escherichia coli. Nature Protocols.2009;4(7):1083–1092.
79. Al-Jebouri MM, Al-Bayati HS. Incidence of surgical site infection following caesarean section and its associated factors in a Tikrit Teaching Hospital, Iraq. Journal of Current Medical Research Opinion.2025; 08(8): 4426- 4437.
80. Al-Jebouri M M, Al-Faham Y M N. Synergistic effect of laser irradiation and photosensitizers on *Pseudomonas aeruginosa* isolated from the wound. World Journal of Pharmacy and Pharmaceutical Sciences.2025;14(11): 502-517.
81. Al-Jebouri MM, Al-Alwani HR. Angiotensin I-converting enzyme gene polymorphism in patients with chronic renal failure. World Journal of Pharmaceutical Research. 2014;4(1):1-11.
82. Al-Jebouri MM, Al-Ani IA, Al-Jumaily S. The effect of the war of the American and the affiliated forces against Iraq on the distribution and elevation of cancer diseases in Mosul. Consequences of Depleted Uranium used by U.S. and British forces in the 1991 Gulf War Hotel Al-Rashid, Baghdad, Iraq, December 2-3, 1998.
83. Al-Jebouri,M M ,Sharif,A Y and Abdulla, B A.The prevalence of antibiotic resistance among three nosocomial pathogens isolated from the maternity hospital in Ninveh. Iraqi Medical Journal.1988;37:97-101.
84. Al-Jebouri MM, Mdish SA. Tracing of Sortoli-cell-only syndrome and other histopathological abnormalities in Iraqi males with primary infertility of azoospermia. Open Journal of Pathology. 2019;9(1):10-17.
85. Al-Jebouri MM, Al-Jebouri OAH. Prevalence, Incidence, and Associated Risk Factors of Urolithiasis Among Population of Salah-Aldeen Province In Iraq World Journal of Pharmaceutical Research.2026; 15(5): 817–832.
86. Al-Jebouri MM, Wahid NM.An Evaluation of QuantiFERON-TB Gold in-Tube and Immunological Tests for TB Diagnosis in Iraqi Patients. Current Trends in Medicine and Medical Research . 2019; 1: 75-82.
87. Al-Jebouri MM, Al-Jebouri OAH. Urinary Metabolic Profile and Stone Composition, Location and Recurrence in Kidney Stone Formers of the Salah-Aldeen Province, Iraq. Middle East Research Journal of Microbiology and Biotechnology. 2026 ; 6(1): 1-9.
88. Al-Jebouri MM, Kaki MM, Mutlek T. Quantitative assessment of wound healing of mice treated with combinations of laser irradiations and antibiotics via experimental mathematical modelling. 2026; 15(2): 1165-1177. https://doi.org/10.11648/j.wjph.20251004.12