
Epidemiology and Pattern Resistance of Enterobacteriaceae Isolated from Urinary Tract Infections in Children Aged 0 to 5 Years Old in N'djamena.

Main Author:

ADOUM HISSEIN MOUSSA;

Faculty of Medicine and Pharmaceutical Sciences, Douala
N'djamena University Hospital Center for Mother and Child
Address: +23566293297/+23590737325 N'Djamena, Chad

Co-author:

Professor ADIOGO DIEUDONNE; Faculty of Medicine and Pharmaceutical Sciences, Douala.

doi: 10.51505/ijmsshr.2025.9313

URL: <http://dx.doi.org/10.51505/ijmsshr.2025.9313>

Received: Mar 30, 2025

Accepted: Jun 09, 2025

Online Published: Jun 25, 2025

Abstract

Introduction: Urinary tract infection (UTI) is defined as an abnormal colonization of the urinary tract by germs. The aim of our study is to identify Enterobacteriaceae, their resistance genes, and to monitor their resistance to antibiotics in order to enable better therapeutic management at the University Hospital for Mothers and Children of N'Djamena, Chad.

Methodology: During the period from August 1, 2024 to April 30, 2025, we conducted a prospective and analytical study on cytobacteriological examinations of urine of children aged 0 to 5 years. After examination of the urine pellet, we performed a urine culture on Cled and Eosine Méthylène Blue medium (EMB). For positive cultures, we considered only Enterobacteriaceae (Gram-negative oxidase-negative bacilli) after Gram and oxidase tests. Identification was carried out using API 20 E. The sensitivity of organisms to antibiotics is carried out by the Kirby Bauer method; the data were analyzed using SPSS software version 20.0. The chi2 test was used to compare percentages at the 0.05% threshold.

Results: One thousand two hundred and sixty (1,262) urine samples were analyzed in the laboratory, specifically in the bacteriology unit, of which 246 were positive, with a rate of 19.49%. The infection rate among male children was 18.65% compared to 20.14% among females. *Escherichia coli* were the dominant species with a percentage of 41.05%, followed by *Klebsiella pneumoniae* with a rate of 23.57%.

Conclusion: Among the enterobacteriaceae responsible for urinary tract infections, *Escherichia coli* was the most isolated; it was 97% sensitive to imipenem and 84% to fosfomycin, but only 16% sensitive to amoxicillin.

Keywords: urinary tract infection, antibiogram, urine, culture, Enterobacteriaceae, antibiotics.

Introduction

Urinary tract infection is an invasion of the urinary tract by pathogenic organisms[1]. Urinary tract infections in children constitute a real problem of hospital-acquired infections [2] and the second most common reason for consultation and prescription of antibiotics after respiratory infections [3]. It is a serious pathology because it occurs in a growing organ with a potential risk of progression to chronic renal failure and renal destruction [4]. Enterobacteriaceae are most often isolated in urinary tract infections[5]. Bacterial resistance to antibiotics is a global problem [5]. Globally, a study of 204 countries estimates that in 2019, 4.95 million deaths worldwide were attributable to antibiotic resistance [6].

In France, resistance to Enterobacteriaceae is 15.9% for ciprofloxacin, 16.4% for ofloxacin, 24.1% for cotrimoxazole and 30.9% for amoxicillin-clavulanic acid [7]. In Morocco, according to a study conducted in the city of Rabat, the rates of Enterobacteriaceae isolated from urinary tract infections were 79% [8].

In Mali, *Escherichia coli* showed 92.5% resistance to aminopenicillins, 93.48% to amoxicillin plus clavulanic acid, 76.09% to 3rd generation cephalosporins and 65.22% to ciprofloxacin [9]. In Cameroon, according to a study conducted in 2014, Enterobacteriaceae were the most common of all isolates and the resistance rates in 2012 were 51.6% for 3rd generation cephalosporins, 44% for ciprofloxacin [10].

In Chad, a study conducted in N'Djamena in 2019 revealed a prevalence of 47.72% of Enterobacteriaceae among all isolated germs [11]. Another study conducted in N'Djamena in 2014 revealed a prevalence of 20.14% of Enterobacteriaceae with a predominance of *Escherichia coli* at 54.5%. This study established the antibiotic resistance rate of 79% to nalidixic acid, 70% to ciprofloxacin, and 62% to gentamicin [12].

In view of these results, the situation appears particularly worrying, especially among children who suffer from resistance to the various antibiotics used in Chad. In the fear of being trapped in a therapeutic impasse, especially since there is no glimmer of new antibiotic molecules in the coming years, the periodic review of antibiotic activity spectra must be maintained because it constitutes the most suitable means of obtaining updated information. It is with this in mind that we undertook a prospective study in children aged 0 to 5 years consulting in the pediatric department at the Mother and Child Hospital of N'Djamena.

Materials and Methods:

This was a prospective and analytical study. It took place from August 1, 2024, to April 30, 2025, at the University Hospital for Mothers and Children (CHUME), in N'Djamena Chad. It is a national referral center for children aged 0 to 14 years and women. It has 221 beds and 654 employees. Samples were collected in the biomedical analysis laboratory and the pediatrics department.

The study population consisted of children aged 0 to 5 years attending or hospitalized in the pediatrics department of the CHUME, subject to inclusion and exclusion criteria.

Inclusion criteria: Any child consulting or hospitalized at the Mother and Child Hospital Center of N'djamena whose age is between 0 and 5 years and whose parents have consented to participation in the study.

Exclusion criteria: children aged 0 to 5 years who are consulting or hospitalized at the Mother and Child Hospital Center of N'Djamena and whose parents refused to participate in the study and children aged over 5 years.

The sample size was calculated using the Lorenz formula:

$$N = \frac{t^2 \times p \times (1 - p)}{m^2}$$

N= number of samples with confirmed Enterobacteriaceae infection ;

t=95% confidence level = 1.96

p= prevalence or proportion of the variable studied in the population;

m= margin of error at 5%= 0.05.

In a study conducted in N'Djamena by Ndoutamia *and al*, the prevalence of Enterobacteriaceae was 20.14% [12]. This prevalence allows us to calculate our sample size.

$$N = \frac{1.96^2 \times 0.20 \times (1 - 0.20)}{0.05^2}$$

N= 245.86 substantially equal to 246.

Data collection was carried out using a pre-test questionnaire, after obtaining ethical clearance from the National Bioethics Committee of Chad and research authorizations; this form provided sociodemographic and socioeconomic data. Questions were asked to the parents of children included in the study. Data were collected through confidential interviews. The examination was offered to each parent for obtaining informed consent. Once collected, the urine was transported to the laboratory as quickly as possible; otherwise, it must be stored at +4°C.

The data were analyzed using Excel and SPSS 20.0 software.

Results:

A total of 1,262 children participated in the study; among which 552 were male or 43.74% and 710 were female or 56.25%.

Table I: Distribution of participants by age

AGE (in months)	n(%)	Sex (%)	
		Male(%)	Female(%)
0 – 12	329(26)	135(24.45)	194(27.32)
13- 24	252(19.96)	122(22.1)	130(18.30)
25 – 36	252(19.96)	108(19.56)	144(20.28)
37 – 48	190(15)	85(15.39)	105(14.78)
49 - 60	239(18.77)	102(18.47)	137(19.29)

Legends: % = percentage; n = number of participants.

Table I shows that the 0-12 month age group is the most representative, with a percentage of 26%, followed by the 13-36 month age group with a percentage of 19.96%. The least represented age group is the 37-48 month age group, with a percentage of 15%.

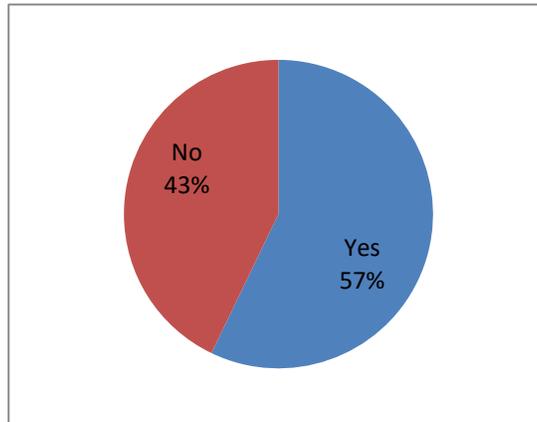
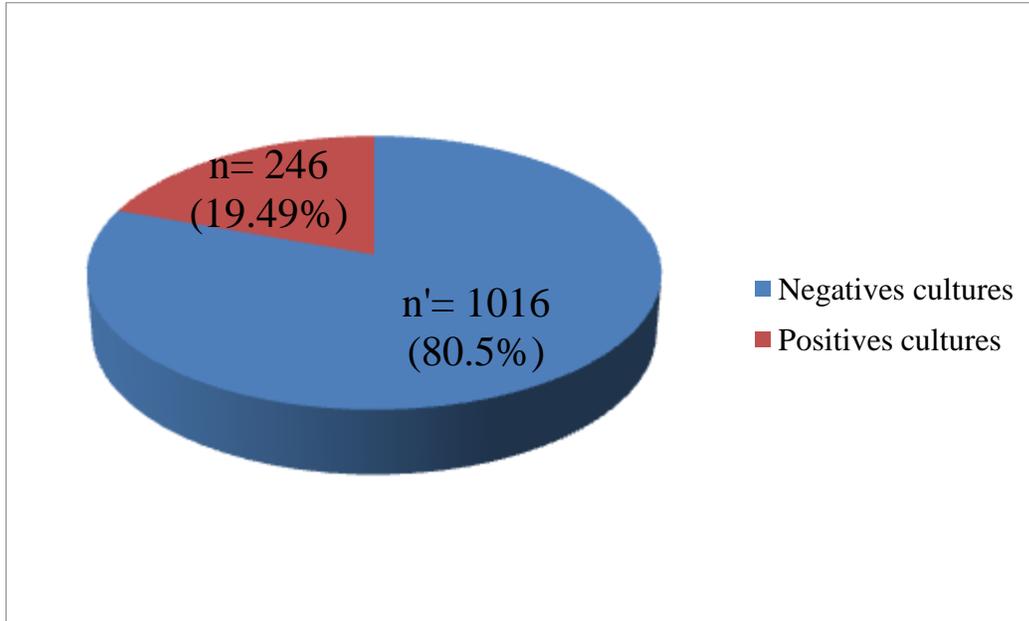


Figure 1: Antibiotic use during the 15 days preceding the study

Figure 1 shows participants' antibiotic use during the 15 days prior to urine sample collection. Of all participants, 719 used antibiotics, representing 57% of the total number of participants.



Legends: n = number of positive Enterobacteriaceae cultures; n' = number of negative cultures; (%) = percentage.

Figure 2: Distribution of participants according to culture results.

According to the results obtained, 19.49% of the seeded urine samples tested positive for Enterobacteriaceae and 80.5% were negative.

Table II: Distribution of isolated species

Germes isolated	n	(%)
<i>E. coli</i>	101	(41.05)
<i>Klebsiella pneumoniae</i>	58	(23.57)
<i>Proteus mirabilis</i>	54	(21.95)
<i>Enterobacter spp</i>	33	(13.41)
Total	246	(100)

Legends: n = number of isolated germes; (%) = percentage

According to the results of the current survey, *Escherichia coli* was the most represented with a percentage of 41.05%, followed by *Klebsiella pneumoniae* at 23.57%, and *Enterobacter spp.* was the least represented with a percentage of 13.41%.

Table III: Distribution of infections by sex

SEX	n	(%)
Male	103	(18.65)
Female	143	(20.14)
Total	246	(19.49)

Legends: n = number of infected patients; (%) = percentage.

According to Table III, girls are more infected than boys, 20.14% versus 18.65%.

Table IV: Distribution of infection by age

AGE (in months)	n	(%)
0-12	62	(25.2)
13-24	51	(20.73)
25-36	49	(19.91)
37-48	46	(18.69)
49-60	38	(15.44)
Total	246	(19.49)

Legends: n = number of infected patients% = percentage

This study shows that the 0-12 month age group is the most infected, with a percentage of 25.2%.

Table V: Resistance profile of the species *Escherichia coli*

Escherichia coli	(n= 101)		
Antibiotics		R	%
Fosfomycin (FOS)		16	15.84
Amoxicillin (AM)		85	84.15
Nitrofurantoin(NFE)		56	55.44
Gentamicin (GN)		16	15.84
Ceftriaxone (CRO)		25	76.23
Amoxicillin plus clavulanicAcid (AUG)		53	52.47
Ciprofloxacin (CIP)		90	89.10
Ampicillin (AMP)		55	54.45
Imipenem (IMP)		03	2.97

Legends: n = number of germs isolated; (%) = percentage; R = resistance.

Table VI: Resistance profile of the species *Klebsiella pneumoniae*

<i>Klebsiella pneumoniae</i>	(n= 58)		
Antibiotics		R	%
Fosfomycin (FOS)		08	14.54
Amoxicillin (AM)		50	90.9
Nitrofurantoin(NFE)		09	16.36
Gentamicin (GN)		09	16.36
Ceftriaxone (CRO)		38	69
Amoxicilline (AUG) plus clavulaniqueacid		40	72.72
Ciprofloxacin (CIP)		38	66.66
Ampicillin (AMP)		05	9
Imipenem (IMP)		02	3.63

Legends: n = number of germs isolated; (%) = percentage; R = resistance.

Table VII: Resistance profile of the species *Proteus mirabilis*

<i>Proteus mirabilis</i>	(n= 54)		
Antibiotics		R	%
Fosfomycin (FOS)		14	25.92
Amoxicillin (AM)		34	62.96
Nitrofurantoin(NFE)		16	29.62
Gentamicin (GN)		18	33.33
Ceftriaxone (CRO)		15	26.31
Amoxicillin (AUG) plus Clavulanic Acid		30	46.29
Ciprofloxacin (CIP)		36	66.66
Ampicillin (AMP)		16	29.62
Imipenem (IMP)		00	00

Legends: n = number of germs isolated; (%) = percentage; R = resistance.

Table VIII: Resistance profile of the species Enterobacter spp

Enterobacter spp	(n= 33)		
Antibiotics		R	%
Fosfomycin (FOS)		07	21.21
Amoxicillin (AM)		28	84.84
Nitrofurantoin (NFE)		11	33.33
Gentamicin (GN)		05	15.15
Ceftriaxone (CRO)		07	21.21
Amoxicillin plus clavulanicAcid (AUG)		04	12.12
Ciprofloxacin (CIP)		20	60.60
Ampicillin (AMP)		19	57.57
Imipenem (IMP)		0	00

Legends: n = number of germs isolated; (%) = percentage; R = resistance.

Table IX: Relationship between isolated germs and age groups

AGE (in months)	<i>E. coli</i> n (%)	<i>K. pneumoniae</i> n (%)	<i>P.mirabilis</i> n (%)	<i>Enterobacter spp</i> n (%)
0-12	35 (34.65)	15(26.31)	7(12.96)	12(36.36)
13-24	22 (21.78)	11(19.29)	11(20.37)	07(21.21)
25-36	17 (16.83)	09(15.78)	14(25.92)	05(15.15)
37-48	15 (14.85)	10(17.54)	10(18.51)	07(21.21)
49-60	12 (11.88)	12(21.05)	12(22.22)	02(6.06)
Total	101(41.05)	57(23.17)	54(21.95)	33(13.41)

Legends: (%) = percentage; n = number of germs isolated.

Based on the relationship between *E. coli*, *Klebsiella pneumoniae*, *Enterobacterspp* and age groups, the study shows that the 0-12 month's age group has a high infection rate, with percentages of 34.65, 26.31 and 36.36% respectively.

Tableau X: Relationship between isolated germs and sex

	<i>E.coli</i>	<i>K.pneumoniae</i>	<i>P.mirabilis</i>	<i>Enterobacter spp</i>
Sex	n (%)	n (%)	n (%)	n(%)
Male	42 (40,77)	21(20.38)	22(21.35)	18(17.47)
Female	59 (41,25)	37(25.87)	32(22.37)	15(10.48)
Total	101(41,05)	58(23.57)	54(21.95)	33(13.41)

Legends: (%) = percentage; n = number of germs isolated

Based on the relationship between *E. coli*, *Proteus mirabilis*, and sex, we note that there is no difference in the infection rate of strains isolated between the sexes. There is a small difference between the two sexes for the species *Klebsiella pneumoniae*. Based on the relationship between isolated *Enterobacter spp* species and sex, we find that there is a significant difference in infection rates between the sexes. The species is much more isolated in males.

Discussion:

This study, conducted from August 1, 2024, to April 30, 2025, at the N'Djamena Mother and Child Hospital (CHU-ME), involved a 1,262 urine sample from children aged 0 to 5 years. Females represented 56.25% of the sample. The main objective of this study is to investigate the epidemiomolecular profile of Enterobacteriaceae resistance in children.

Of the 1,262 samples analyzed, 246, or 19.49%, were positive for Enterobacteriaceae. This result is lower than that obtained by Ouchar *and al.*, 2019 in N'Djamena [11], who obtained a rate of 47.72%; On the other hand, our results are similar to those of Guelembaye *and al.*, 2015 in N'Djamena [12] who found a rate of 20.14%. The difference in results observed could be explained by the difference in sampling and the duration of the study.

The study showed that 18.65% of boys are infected compared to 20.14% of girls (Table III), although our results are different from those of Nadmi *and al.*, 2010 in Morocco [1] who obtained an infection rate of 85% in favor of the female sex; but our results converge with theirs, because the infection rate is higher in the female sex.

Of all the isolated germs, *Esherichia coli* was the most dominant species with a percentage of 41.05% followed by *Klebsiella pneumoniae* 23.57%; these results corroborate those of Ebongué *et al.*, 2015 in Cameroon [10] who obtained 48.5% for *Esherichia coli* and 32.8% for *Klebsiella pneumoniae*.

All isolated strains showed strong resistance to amoxicillin and ciprofloxacin; this resistance decreased considerably with the combination of Amoxicillin plus Clavulanic Acid. Fosfomycin and Gentamycin stood out from the other molecules with low resistance of all isolated strains. The most active molecule of all the antibiotics tested was imipenem.

Conclusion:

This study shows that Enterobacteriaceae are the leading cause of urinary tract infections in children, with 19.49% of the study population infected. Females were most at risk for infections. The study also showed that *Escherichia coli* was the most dominant species, with a percentage of 41.05%, followed by *Klebsiella pneumoniae*, with a percentage of 23.57%. Antibiograms performed established that all isolated organisms had very low resistance to imipenem and aminoglycosides but high resistance to β -lactams.

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