

Epidemiology of Diarrhea in Two Major Cities in Saudi Arabia

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ABSTRACT The epidemiological pattern of diarrheal diseases, causative agents, and risk factors of their occurrence in two referral hospitals of Saudi Arabia was investigated in this study. Stool specimens from 1726 admitted diarrheal cases were examined for parasites, yeast, entero-pathogenic bacteria and rotavirus using the ELISA test. Two-fifth of cases were due to rotavirus (RVGE) while 53.1% of cases showed no causative pathogens. Mean age of all cases was 20.2 months and RVGE cases showed a steady rise from the neonatal period onward, reaching a peak between 6-14 months. Males were of higher percentage in all diarrheal cases. Mothers of diarrhea cases were mostly house wives with low educational level. Bottle fed children showed higher proportion (53.1%) of diarrhea than other types of feeding suggesting the feco-oral route of infection and the effect of poor sanitation. A pattern of higher RVGE cases was seen in warmer months in Al-taif and in cooler months in Jeddah. Our findings demonstrated the interaction between host, pathogen and environmental factors in the epidemiology of infectious diarrhea in developing countries and the areas of possible prevention. [Paediatr Indones 1995;35:124-131]

Introduction

Infectious diarrhea has long been recognized as a leading cause of morbidity and mortality, especially in developing countries.¹⁻³ Endemic diarrheal diseases caused by agents such as rotavirus and

other diarrhea-producing enteropathogens remain largely uncontrolled and epidemic of diarrheal disease has occurred in recent years in unprecedented proportion.⁴ The epidemiological pattern of these infections and risk factors of their occurrence in most of developing countries are still to be examined.

In this study, we investigated some of the epidemiological factors and determinants which influenced diarrheal disease

in two major cities of Saudi Arabia and described the epidemiology of major causative agents in admitted cases in 2 large referral hospitals of Jeddah and Al-taif.

Methods

The study was carried on children admitted with diarrhea to the two main general children hospitals in Jeddah and Al-taif in Saudi Arabia. The main children hospital (MCH) in Jeddah city receives a yearly admission of 7500 of which 10% are diarrhea in 20 rehydration beds. Jeddah city is at the sea level with hot humid weather and limited rainfall. This puts it in contrast to Al-taif which is a high altitude city with cold weather and high amount of rainfall around the year. The main children hospital in Al-taif receives a yearly admission of 6000 of which 16% are diarrhea cases in 18 rehydration beds. These two hospital are estimated to receive more than 70% of all diarrhea admissions in both cities. Stool specimen for admitted cases are usually tested for the presence of entero-pathogens (*Salmonella*, *Shigella*, *Giardia lamblia*, and yeast) by standard laboratory techniques. No viral testing is done routinely on these cases.

In-patients up to 5 years of age admitted to Jeddah's MCH (March 1988 to Dec 1992, inclusive) and to Al-taif's MCH (April 1992 to June 1993, inclusive) with acute diarrhea and suspected clinically to be of infectious origin were studied in this prospective study. Stool specimens were examined microscopically for parasites and cultured on selective media for isolation of entero-pathogenic bacteria. All stool specimens were tested with the

enzyme-linked immunosorbent assay (ELISA) for rotavirus laboratories, North Chicago, IL). Demographic data of these cases (age, sex, nationality, number of siblings, occupation and education of the mother) were taken by questioning the mother. Presence of associated symptoms of fever and vomiting in addition to the type of feeding of the child and the number of family members and rooms in the house were also obtained.

Data were coded in a personal computer and analyzed to identify any of the investigated parameters which may influence the susceptibility for infection and to detect significant differences between the cases from the two cities using the suitable significant testing. Total of family members (FM) and rooms (R) in the house were used to produce a crowding index (CI=FM/R). Further analysis was conducted by comparing all rotavirus (RVGE) and non rotavirus gastroenteritis (non-RVGE).

Results

A total of 1726 cases of diarrhea suspected clinically to be of infectious origin were admitted to both hospitals during the study periods (359 from Al-taif and 1367 from Jeddah). Total of cases in the tables were not equal to this total as missing information in some of the variables were excluded.

Age distribution

Mean age for all diarrheal cases was 20.2 months (SD=22.8). A significant difference was noted between the mean ages of RVGE cases (17.01 months) and non

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RVGE cases (22.55) with a p value <0.0001 (t=4.5). Another significant difference was noted between the mean ages in both cities (23.0 for Al-taif & 19.2 for Jeddah, p=0.0007) and this was mainly due to the difference in the non-RVGE cases as Jeddah cases were of younger mean age.

The age distribution for RVGE children compared with the non-RVGE in both cities are shown in Table 1. Rotavirus diarrheal cases showed a steady rise from the neonatal period onward, reaching a peak in the 12-14 months age group in Jeddah while it showed a peak in the 6-8 months age group in Al-taif. In Jeddah, 69.3% of RVGE cases were below 18 months of age while higher percentage (78.8%) were under this age in Al-taif.

Sex and nationality

Male cases in both cities were of higher percentage than females although the difference was significant in RVGE cases only (Table 2). Males formed 58.3% of all cases of diarrhea and the male to female ratio was 1.5:1 in RVGE cases and 1.4:1 in non RVGE cases.

Saudis formed 52.9% of all Jeddah cases followed by Yemenis (22.6%) and other Middle Eastern nationals (14.6%) while Saudis formed most (93%) of Al-taif cases (p<0.0001). This difference was noted in RVGE and non-RVGE cases.

Seasonality of infection

Proportion of RVGE cases in each month for the 92-93 year is presented in Fig 1 with mean temperatures in these months. The distribution of these cases showed a pattern of higher cases in

warmer months in Al-taif and higher in cooler months in Jeddah. No specific pattern was seen in non-RVGE cases.

Maternal factors

Mothers of diarrhea cases were mostly house wives in both cities (98.1 %) while maternal education showed a pattern of low level in both cities as only 6.4% and 14.4% of mothers reached secondary school education in Al-taif and Jeddah respectively (p<0.00001).

Feeding pattern & crowding index

Bottle fed children showed a significantly higher proportion (53.1%) of diarrhea than other types of feeding in both cities. Breast feeding pattern was compared between all RVGE and non-RVGE cases and showed no significant difference (X=0.44, P=0.51). Jeddah diarrheal cases, on the other hand, had a higher proportion of breast feeders compared to Al-taif cases which showed higher proportion of diet fed children (Table 3).

Crowding index was 2.2 person/room (SD 1.5) for all cases. A significant difference was noted in the mean of crowding indexes in the two cities as Jeddah showed a higher crowding index than Al-taif for all variety of cases (1.8 for Al-taif and 2.3 for Jeddah, P<0.0001).

Causative pathogens & associated symptoms

Diarrhea was caused by variety of known and unknown agents. Table 4 describes the causative pathogens; a considerable proportion of cases (52.3%) were not ascribed to agents under investigation.

Table 1. Frequency of rotavirus & non-rotavirus causes of diarrhea among different age groups in Al-Taif & Jeddah

Age group	Rotavirus		Non-rotavirus	
	Taif	Jeddah	Taif	Jeddah
< 3 mo	8 (5.3%)	17 (3.9%)	7 3.4%	39 6.5%
3-5 mo	24 15.9%	43 9.8%	19 9.2%	79 13.2%
6-8 mo	32 21.2%	65 14.9%	30 14.5%	104 17.4%
9-11 mo	25 16.5%	69 15.8%	18 8.7%	73 12.2%
12-14 mo	21 13.9%	74 16.9%	18 8.7%	52 8.7%
15-17 mo	9 6.0%	35 8.0%	5 2.4%	27 4.5%
18-20 mo	6 4.0%	29 6.6%	14 6.8%	48 8.1%
21-23 mo	1 0.7%	8 1.8%	6 2.9%	4 0.7%
24-26 mo	5 3.3%	25 5.7%	17 8.2%	30 5.0%
27-29 mo	2 1.3%	5 1.2%	10 4.8%	2 0.3%
30-32 mo	4 1.3%	12 2.4%	5 4.8%	26 4.3%
33-35 mo	0	0	0	2 0.3%
3yr & more	14 9.3%	55 12.6%	85 28.0%	112 18.7%
Total	151	437	207	598

$$X^2 = 12.86 \quad p = .3029$$

Total cases = 1726

$$X^2 = 47.35 \quad P < .0001$$

Missing observations = 333

Positive ELISA test for rota virus was nearly equal in both cities with a prevalence ratio of 41.3%. Giardiasis was diagnosed in 8.7% of Al-taif cases compared with 1.1% in Jeddah (p<0.0001) and *Shigella* and *Salmonella* were seen in 16.1% in Al-taif and in 1% Jeddah (p<0.0001). Hence; mixed infection of Rotavirus and bacteria or parasite was seen

more in Al-taif.

Associated symptoms of vomiting and fever were recorded highly positive in both cities with Al-taif showing significantly higher fever and vomiting rate for all cases (Table 5). RVGE cases in both cities, on the other hand, were significantly related more with vomiting than non-RVGE cases ($x^2=6.16$, p=0.013).

Table 2. Frequency of rotavirus & non-rotavirus causes of diarrhea by sex and nationality groups in Al-Taif & Jeddah

Sex	Rota		Non rota	
	Taif	Jeddah	Taif	Jeddah
Male	78 51.7%	273 61.9%	120 58.0%	350 57.4%
Female	73 48.3%	168 38.1%	87 42.0%	260 42.6%
Total	151	441	207	610
	$X^2 = 4.47997$ $p = .0343$		$X^2 = .00463$ $p = .9458$	

Total cases = 1726 Missing Observations = 317

Nationality	Taif		Jeddah	
	Taif	Jeddah	Taif	Jeddah
Saudi	139 92.7	235 69.1	193 93.2	311 52.4
Others	11 7.3	205 30.9	14 6.8	282 47.6
Total	150	440	207	593
	$X^2 = 72.6$ $p < 0.0001$		$X^2 = 107.8$ $p < 0.0001$	

Total cases = 1762 Missing observations = 336

Table 3. Feeding pattern in all diarrhea cases

City	Taif	Jeddah	Total
Bottle feeding	187 52.4	538 53.4	725 53.1
Breast feeding	62 17.3	281 27.8	343 25.1
Diet	108 30.3	189 18.8	297 21.8
Total	357	1008	1365

$X^2 = 27.7$ $P < 0.0001$

Total cases = 1726 Missing observations = 361

Table 4. Causative agents for diarrhea cases

City	Taif	Jeddah	Total
Rota only	117 33.1%	430 41.7%	547 39.5%
Rota & others (Mixed)	32 9.0%	9 0.9%	41 3.0%
Bact. & Parasite (No Rota)	56 15.8%	17 1.6%	73 5.3%
Non recognized cause	149 42.1%	575 55.8%	724 52.3%
Total	354 100.0%	1031 100.0%	1385 100.0%

$X^2 = 174.2$; $P < 0.0001$

Total case = 1726 Missing observations = 341

Table 5. Frequency of associated symptoms with rotavirus & non-rotavirus causes of diarrhea

Symptom	Rota n (%)	Non rota n (%)	Total n (%)
Fever:			
Present	398 (43.1)	525 (56.9)	923 (72.1)
Absent	158 (44.1)	200 (55.9)	358 (27.9)
$X^2 = 0.071$ $P = 0.79$	Missing observations = 445		
Vomiting:			
Present	463 (45.2)	562 (54.8)	1025 (79.7)
Absent	95 (36.4)	166 (63.6)	261 (20.3)
$X^2 = 6.16$ $P = 0.013$	Missing observations = 440		

Discussion

It is estimated that 4-5 million persons die each year from diarrheal disease, the bulk of which occur in young children in developing countries.¹³ In comparison to

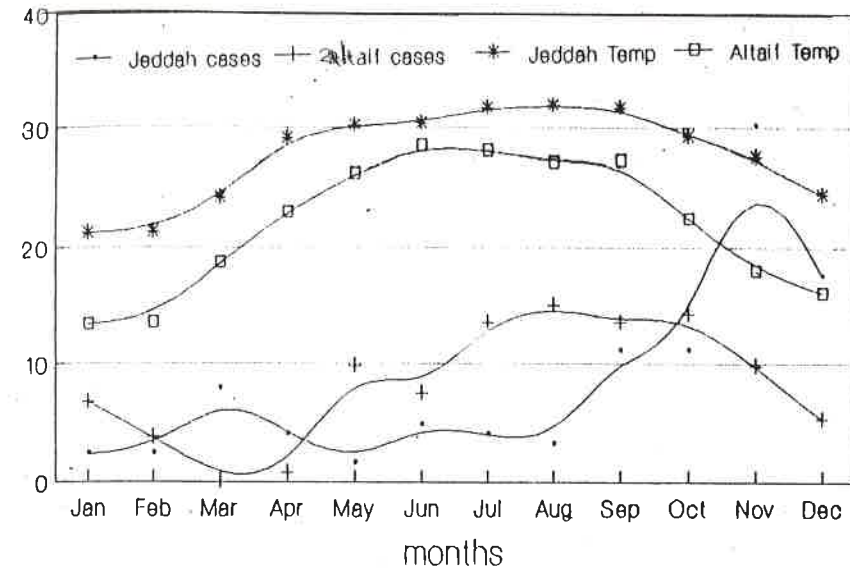


Fig 1. Rotavirus cases in 1992-1993 with temperature changes.

Temperature in degrees Celcius. Rotavirus cases as %.

populations living in developing countries, residents of Saudi Arabia are generally benefiting from higher expenditure per capita on health care.⁵ Nevertheless, young children are at higher risk of diarrheal diseases because of impaired host defense and are exposed to suboptimal hygienic conditions. Al-Mazrou⁶ in a national survey reported a prevalence of 14.5% in children between 6-18 months. This age preference for diarrhea is certainly true in this hospital study which can be reasonably considered representative of the acute diarrhea cases in Saudi Arabia as the mean age for admitted cases was below 2 years.

Human rotavirus have been implicated as the common cause of diarrheal disease worldwide. Studies conducted in

several countries indicated that between 30 to 60% of all pediatric admissions for diarrhea were attributed to rotaviruses,⁷⁻⁹ and in Saudi Arabia rotavirus infection is estimated to account for 46% of all diarrheal cases in early childhood.^{10,11} The present study is emphasizing the importance of rotavirus as a major causative pathogen of infectious diarrhea in both cities and accounted for 41.3% of all diarrheal cases admitted.

The highest number of RVGE cases (48%) occurred between 6-14 months of age and no difference was observed in the mean ages in both cities. The virus was associated with higher incidence of vomiting compared to other pathogens. This underlines the fact that rotavirus diarrhea is primarily a disease of young childhood and the clinical course is gen-

erally associated with more severe dehydration than with other pathogens.

A significant difference was observed in the mean age at which the non-RVGE was detected between the two cities. Non-RVGE cases can be looked at as a collection of parasitic, bacterial and mixed infections as well as non infectious causes of diarrhea. This group is expected to show different pattern in these two demographically and socially different cities as Al-taif had a more homogenous group of Saudis, a lower crowding index and a higher rate of mixed infections.

Cases with non recognized pathogens formed a large portion of the sample. These can be caused by other bacterial and viral pathogens such as enterotoxigenic *Escherichia coli* (ETEC), enteropathogenic *Escherichia coli*,¹¹ Norwalk viruses and Norwalk-like agents¹² or by alteration of bowel flora. Investigation, however, does not always reveal classical pathogens and some cases might be due to non-infectious causes such as food allergy, and feeding problems such as excessive feeding, wrong timing, rejection of new food or emotional upset.¹³ This group will need further search to determine its underlying nature.

Bottle-fed babies formed a major proportion of all diarrheal cases (including RVGE cases) in this study. Environmental factors in diarrhea are known to play a major part in causing diarrhea in bottle-fed and diet or mixed fed children. It is presumed that the primary mode of rotavirus transmission is feco-oral, although prolonged survival of the virus in the environment offers the potential for respiratory transmission. In some stud-

ies, rotavirus infection has been associated with respiratory symptoms of food sanitation, water source and personal hygiene. However, the finding of high rates of bacterial and mixed infection and their association to bottle feeding and solid feeding in this study is suggestive of their effect on diarrhea and confirms the feco-oral route of transmission of infectious diarrhea.¹⁶

Seasonal variations of rotavirus case have been investigated in these two geographically different areas in Saudi Arabia. In temperate countries rotavirus exhibits seasonal variation with peaks of infection in cooler months.^{17,18} This does not conform with findings in countries with tropical and subtropical climates where the virus is present throughout the year with winter and summer peaks.^{19,20} This study shows both patterns as cases in the cold city of Al-taif were higher in warmer months and Jeddah cases were more in cooler months (Fig 1). The graph is also characterized by the presence of cases in all months, suggesting an endemicity of the virus.

Finally, this study shows the interplay between host, pathogen and environmental factors played an important role in the temporal distribution of infectious diarrhea. Their clinical presentation and associated risk factors indicates the need for further search in its epidemiology.

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