Environmental Aspects of Rotavirus Diarrhea Infections in Arid and Semi-Arid Zones: Benghazi City As Study Case

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ABSTRACT

Rotavirus is a common worldwide infection in infants and children under five years old. Because of lack of enough information about rotavirus diarrhea in arid and semi-arid zones, the aim of this work was to increase the understanding of relationship between seasonality of rotavirus diarrhea and associations with environmental characteristics in such these regions. The coastal city of Libya (Benghazi) has been chosen for this work. This study carried out for seven months with different climatic conditions. 200 Stool samples from hospitalized infants and children under three years old were collected under aseptic conditions. Enzyme-linked immunosorbent assay (ELISA)method was used to detect the rotavirus infections in the samples. The results showed that 42% of the samples were infected with rotavirus. The study revealed that more than 70% of Rota infections were in male samples. Clearly, Breastfeeding helped to decrease infections in comparison to artificial lactation. Where they were 7.1% and 54.8%, respectively. The number of infections increased slightly by increasing rainfalls and temperature was limiting factor for rotavirus diarrhea in Benghazi city. The infections were highly seasonal; they peaked during the late winter and early spring and lowered in autumn. These findings are agreed with different results from temperate zones, while they differed with others from the tropics.

Keywords: *Rotavirus; Diarrhea; Arid zones; Climatic factors; Libya.*

1. Introduction

One third of the earth's surface land is arid and semi-arid area. ICRISAT (1998) estimates that semi-arid areas cover most parts of the developing countries in the world. In Africa, arid and semi-arid zones are bordered Morocco, Algeria, Libya, and Egypt in the north, and the dominant climate type by land area is the arid B (57.2%)((Peel et al 2007). The semi-arid regions are defined as areas where precipitation is less than potential evaporation, characterized by high temperatures in the hottest months. They have been classified according to amount of rainfall received. These zones are characterized by low and restricted precipitation of up to 700mm per year. According to Köppen climate classification, one of major types of climate when describing the arid and semi-arid zone is the Mediterranean climate (Kottek et al. 2006). In the Mediterranean climate, the rainy season is during autumn

and winter. Summers are hot with no rains; winter temperatures are mild. Figure (1) illustrates the Mediterranean climate in Libya, with a wet season starting in October and ending in April or May, followed by around 6 months of drought period. While, the warm summer months are almost devoid of rainfall. Rotaviruses are a major cause of gastroenteritis in infants and young children under 5 years old worldwide. Over 600000 deaths caused by rotavirus and the great majority occurring in developing countries (Parashar et al. 2006). In temperate zones, rotavirus infections are highly seasonal and peak in the winter and early spring (Cook et al. 1990). And by contrast, these infections are more common during the dry season in the tropics(Cunliffe et al. 1998). A number of human rotavirus disease studies reported that increasing the risk of rotavirus infections is associated with lower climatic factors such as rainfall, lower temperature and lower relative humidity((Brandt et al. 1982; Paul &Erinle 1982; Ram et al. 1990; Gomwalk 1993;Armah et al. 1994; Hashizume et al. 2007; D'Souza et al. 2008). Benghazi city is located in the coastal north eastern part of Libya(North Africa), with inhabitants of around one million. From our ecological point of view, the Mediterranean climate is one of the characteristics of this city as arid zone(mean precipitations are 270.6 ml per year). Thus, it has been chosen to be study case. Until recently, there was no direct evidence of the effect of environmental factors especially rainfall and temperature on distribution and abundance of rotavirus infections in Libya. This work is a trial to evaluate and find out the relationship between the climatic factors and rotavirus infections. In addition, the results might have benefits and can be generalized on other arid and semi-arid zones.

2. Materials and Methods

2.1. Sample collection: 200 Stool samples from hospitalized infants and children under three three years old were collected under aseptic conditions at Benghazi hospital of children. The samples were collected for seven months starting from October 2009 to the end of April 2010. The collected samples were kept in refrigerator for 7 days under 2-8 C and/or -20 C for more than 8 days.

2.2. Competitive ELISA: *Enzyme-linked immunosorbent assay* (ELISA)method was used to detect the rotavirus infections in the samples. Briefly; 1 ml sample deluent were added to *cuvettes contain* one gram of each sample and left for 10 minutes. After that, 100µI of the treated sample were transferred in micro wells and subsequently, 100µI of conjugate solution added to the microwells and incubated in incubator(Binder, Germany) at 20-30 °C for 60 minutes. The samples were washed, the plate wells is measured to determine the presence and quantity of antigen, and the data were printed out using (Biotek, USA) washer and reader.

2.3. Data collection and analysis: Health and clinical information about individual patients were obtained from patient record file. The climatological data of temperature, rainfall, relative humidity,sunshine hours and dusty storms of Benghazi city, and for last thirty years, were obtained from Benina meteorological station. the data analyzed according to contribution of climatic factors to increasing and decreasing rotavirus infections.

3. Results

The number of hospitalized patients for treatment at Benghazi Hospital for Children during the study period in which stools were tested for rotavirus was 200. 84 cases were found infected with rotavirus (42%). The ages of patients with acute diarrhea ranged from 9 days to 36 months. The infection found to be decreased by increasing the age(Table1). While the high value was recorded in children under one year old. The infections with rotavirus were higher in males than females and they were 70.2% and 29.8%, respectively (Table 1). The number of infections was varied among the feeding method. In the natural lactation method, the level was decreased to the percentage of 7.1%, while it increased to 54.8% when glasses were used (Table 1). Of a total of 84 patients evaluated for rotavirus during the study period, 91% of the patients had rotavirus infections with watery diarrhea, for more than nine times per day. In addition, the cases with vomiting were 96.42% of the total number of infections. There were slight increases in the occurrence of rotavirus infections during the winter months of December through February (Figure 2). A major peak was recorded in April (spring), coinciding with increasing temperature. The occurrence of rotavirus infections in stool sample, however, declined in autumn, whereas the number of infections was only 6 cases in October (Figure 2).

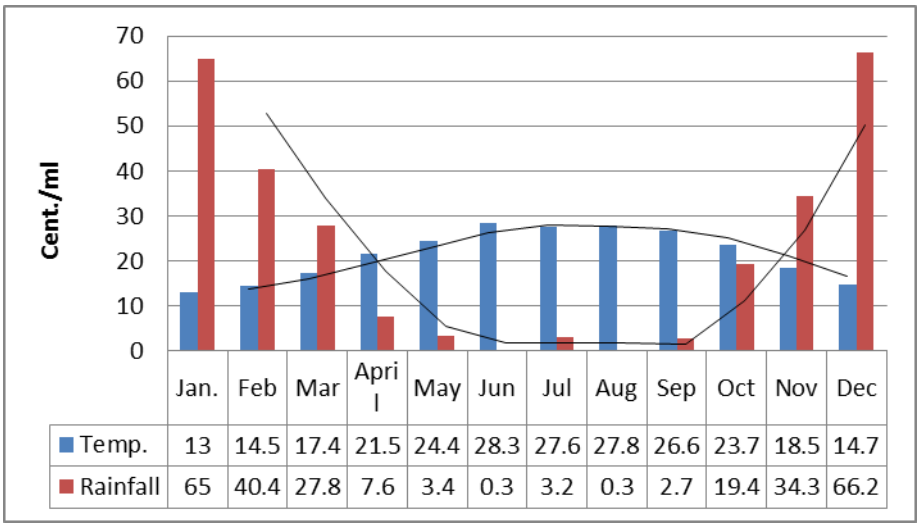
Table 1. Distribution of hospitalized children with rotavirus diarrhea according to their age, sex and feeding type**.**

Age(months)		%	No. of infections
	0-12	79.8	67
	13-24	16.7	14
	25-36	3.6	3
Sex			
	Male	70.2	59
	Female	29.8	25
feeding type			
	Natural	7.1	6
	Artificial	54.8	46
	Mixed	38.1	32

4. Discussion

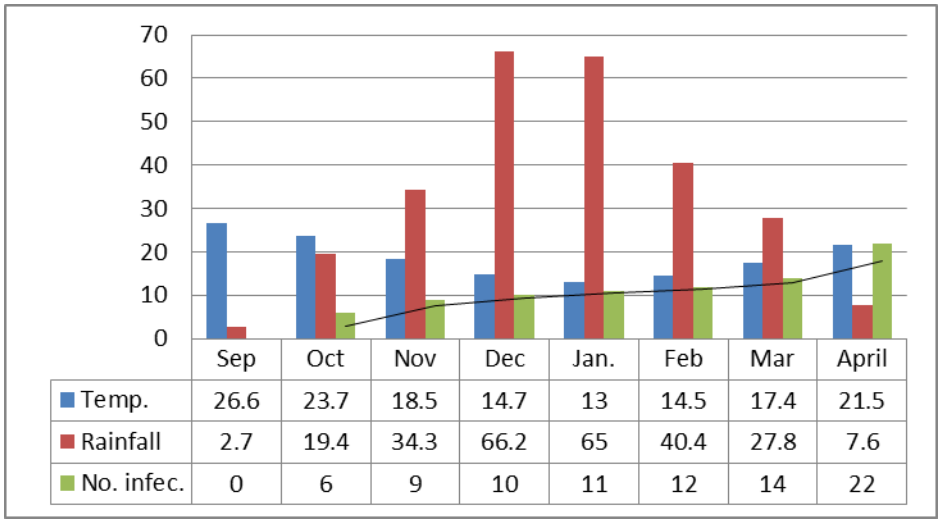
Clearly, from the results, the peak season occurred in the late winter and extended into the spring and the seasonality was more distinct. The mean temperature during the relatively colder months was 13.7 °C, compared with 22.8 °C for the relatively warmer set, a difference of only 9.1 °C. This difference caused increasing of infections from factor 10 to 22 (Figure 2). Low temperature might in some way encourage the rotavirus disease (Brandt et al 1982). But in contrast, our results showed increasing of infection by increasing temperature, even though the infections appeared at low temperatures (January; 13 °C). The high amounts of precipitations were recorded in December and January and they were 66.2 and 65 ml, respectively. Interestingly, during April, when the number of infections increased, the mean

of precipitations decreased and became very low (only 7.6 ml), while the mean temperature increased and it was 21.5 °C (Figure 1 and 2). The relatively wet weather in preceding months tended to be associated with increased rotavirus diarrhea infections (Figure 2). A lot of infections exhibit seasonal variations, thus, seasonality is an important but in rotavirus diarrhea is poorly understood (Cook et al 1990). According to our findings and in comparison to others, this fact can be touched. In temperate zones, rotavirus infections tend to be absent in summer and very common in winter (Brandt et al 1979; Hieber et al 1978; Kapikian et al 1979; Konno et al 1978). In tropics, rotavirus infections are seem to be increased during periods of low rainfall, decreased during periods of high rainfall(Hieber et al 1978; and Paul &Erinle 1982). This suggests to what extant climatic factors play role in transmission of the virus (Atchison et al 2010). And subsequently, increasing number of infections. Here, our results were agreed with this hypothesis, but it was not clear enough and the question which addressed is: does every climatic factor (e.g. temperature) has its own effect? From our results, we suggested that an interference between all climatic factors is the core of seasonality, and the factors might affect each other in causing rotavirus diarrhea infection. Rotavirus infection was prevalent with males more susceptible than females. This finding agreed with Hussein and Hassan (2000) and Junaid et al (2011). The percentage of the infection of male to female children was 70.2% to 29.8% and in ratio of 2.3: 1(Table 1). This difference needs further investigation (Junaid et al 2011), because it is not clear whether this difference is due to sex susceptibility or by chance (Junaid et al 2011).



	Jan.	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp.	13	14.5	17.4	21.5	24.4	28.3	27.6	27.8	26.6	23.7	18.5	14.7
Rainfall	65	40.4	27.8	7.6	3.4	0.3	3.2	0.3	2.7	19.4	34.3	66.2

Fig. 1: The climatic diagram of Benghazi city. The figure shows the mean of rainfall and temperature degrees recorded for last thirty years. The diagram reflects the long drought period which started from May until October. The highest temperatures are in June (28.3 C). While, the lower is in January (13 C). The amounts of precipitations are recorded in January and December.



	Sep	Oct	Nov	Dec	Jan.	Feb	Mar	April
Temp.	26.6	23.7	18.5	14.7	13	14.5	17.4	21.5
Rainfall	2.7	19.4	34.3	66.2	65	40.4	27.8	7.6
No. infec.	0	6	9	10	11	12	14	22

Fig 2: The relationship between rainfall and temperature and their effects on increasing rotavirus infections in Benghazi city. The infection jumped from factor 6 in October to factor 22 in April. While the temperature decreased and increased again to 21.5 C. the rainfall was also increased and the high amounts were recorded in December and January. But the infections increased from 11 to 22, when the precipitations decreased slightly during the rainy season.

5. Conclusions

The number of infections increased slightly by increasing rainfalls and temperature was limiting factor for rotavirus diarrhea in Benghazi city. The infections were highly seasonal; they peaked during the late winter and early spring and lowered in autumn. These findings are agreed with different results from temperate zones, while they differed with others from the tropics. We suggested that an interference between all climatic factors is the core of seasonality, and the factors might affect each other in causing rotavirus diarrhea infection in arid and semi-arid zones.

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