Protective effect of breastfeeding on diarrhea among children in a rapidly growing newly developed society

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In developed communities, the effect of exclusive breastfeeding (EBF) is encouraged since it has been found to be protective against infantile diarrhea. In a newly developing Qatar, modern water supply and sanitation facilities have become available to everyone during the last two decades. The objectives of the current study were to explore the relationships between breastfeeding and diarrhea and to assess the effect of EBF on the risk reduction of diarrhea in children aged 1-5 years. This is a cross-sectional survey conducted in the Well-Baby clinics and pediatric clinics in the 11 Primary Health Care (PHC) Centers and Hamad General Hospital, Hamad Medical Corporation, Qatar. A multistage sampling design was used, and a representative sample of 1500 Qatari infants and pre-school children in the age group of 1-5 years and mothers aged between 18 to 47 years were surveyed during the period from October 2006 to September 2007; 1,278 mothers agreed to participate in this study, with a response rate of 85.2%. The sociodemographic characteristics, feeding modes and diarrhea morbidity were collected from the parents of the children during the interview. Of the 1,278 infants studied, more than half (59.3%) were EBF, followed by those partially breastfed (28.3%), and finally the formula fed (12.4%). The duration of EBF was 11.4±6.7 months (mean±SD) and the duration of partial breastfeeding with bottled milk was 9.2±4.1 months (mean±SD), and the difference was statistically significant ($p<0.0010$). When compared to the EBF infants, the risk of diarrhea was higher and statistically significant in both the partially breastfed (48.7% vs 32.5%) and in the non-EBF (37.3% vs 32.5%, $p<0.001$). Upper respiratory tract infection (URTI), short duration of breastfeeding, level of maternal education, and sterilization of bottles were considered as predictors. These results indicate that in Qatar, breastfeeding plays an important role in reducing the incidence and severity of infantile diarrhea. This observation is particularly important given the growing concern that, as an unwanted effect of 'modernization', breastfeeding is on the decline in Qatar and comparable populations elsewhere.

Key words: infant feeding, breastfeeding, diarrheal diseases, upper respiratory tract infection, risk factors, Qatar.

Human milk is considered an ideal nutrition and provides advantages regarding general health, growth and development, and psychological and social benefits[1]. Being readily available and economic, breast-milk makes breastfeeding an effective preventive measure against allergic diseases[2]. In 2003, the World Health Organization (WHO) issued a revised global recommendation that mothers should breastfeed exclusively for six months. This recommendation is likely to influence national policies on the recommended age for the first introduction of solids, so it is important that pediatricians are aware of the issues and the evidence (or lack thereof) on which the WHO recommendation is based[1]. In developing countries, breastfeeding reduces the incidence and severity of diarrhea in infants[1-9], although

this effect may be less pronounced in areas with better water supply and sanitation facilities[3-5]. An important limitation of many of these studies is that they did not use the currently recommended classification of breastfeeding, i.e., exclusive, predominant (almost exclusive), and partial, thus not permitting the protection afforded by each to be assessed. Modem water supply and sanitation facilities are also thought to at least partly explain the absence of protection by exclusive breastfeeding (EBF) against infantile diarrhea, as seen in some studies in developing countries[1-18].

There is ample evidence of a positive influence of breastfeeding, especially of EBF, on diarrhea. Yoon et al.[6] reported a higher risk of mortality due to diarrhea associated with no breastfeeding. A similar pattern has also been reported from other studies[3-10]. In a recent meta-analysis of data from six developing countries, breastfeeding provided a greater degree of protection against diarrhea attributable to acute respiratory infection in the first six months of life, whereas the level of protection was similar for infants who were 6 to 11 months of age (WHO 2000)[1,4,10].

The WHO recommends[1-18] that all infants be exclusively breastfed for six months[1]. In developing countries, EBF has a large protective effect on infant mortality and severe morbidity. However, the public health importance of breastfeeding in healthy, term infants in developed countries has rarely been quantified[4-17]. Few studies have assessed the effect of breastfeeding on hospitalization rates in such settings. These observations raise the question of whether protection by breastfeeding against infantile diarrhea in developing countries will decline with improvements in water supply and sanitation. We considered Qatar an ideal site for this study because in this rapidly growing and newly developed traditional society, modem water supply and sanitation facilities have become available to everyone during the last two decades. The objectives of the current study were to explore the relationships between breastfeeding and diarrhea and to assess the effect of EBF on the risk reduction of diarrhea.

Material and Methods

The infant and pre-school children studied were the subjects of this cross-sectional population study conducted in both urban and semi-urban areas of Qatar. Approval for the study was obtained from the Medical Research Committee of Hamad General Hospital, Hamad Medical Corporation. Mother-child pairs were enrolled only after informed verbal consent was obtained from the mother and other adult family members who were present.

Study Design and Population

The potential subjects of this study were all children aged 1-5 years and their mothers visiting the children's immunization centers at the Primary Health Care (PHC) Centers. These children are considered as a representative sample of all Qatari children in our target age group because: (a) children in the State of Qatar visit immunization facilities according to a standard schedule; (b) in Qatar, the National Health Authority provides all children's vaccines free of charge; and (c) current coverage rates for individual vaccines in Qatar children aged <4 months range from 90-99%[7]. Of the many immunization centers for children in Qatar, we chose these hospital-based centers because they serve large numbers of children daily. Our choice of PHC Centers as the study setting is unlikely to introduce selection bias because in Qatar, parents can take their children for immunization to any of the government centers as convenient.

The sample was comprised of Qatari male and female children in the age group of 1-5 years. The study was performed at the Well-Baby Clinics in the 11 PHC Centers (PHCC) of the Hamad Medical Corporation, State of Qatar. The PHCC sample was adjusted proportional to subjects from each clinic obtained from the daily visits for immunization and Well-Baby clinics by systematic sampling technique. The sampling plan controlled the factors underlying heterogeneity among PHCC visits such as age, sex and socioeconomic level. Accordingly, the sampling plan included stratification based on these variables, together with multistage sampling. The infants and children who were sampled from each PHCC were chosen with probability proportional to the substrata sizes by a simple random sample. A multistage sampling design was used and a representative sample of 1500 infants and pre-school children with an age range of 1-5 years and mothers aged between 18 to 47 years were surveyed during the period from October 2006 to

September 2007 in Qatar. A total of 1,278 mothers (85.2%) consented to participate in this study.

Data Collection

A pre-tested structured questionnaire was used by one of the authors (AB) to obtain data from each enrolled mother during a personal interview. During the interview, collected data about the child included date of birth, gender, birth order, parental consanguinity, socioeconomic status, mother's age, mother's educational level, mother's occupation, breastfeeding mode, technique for sterilization of bottles, and incident diarrhea. Data related to diarrhea included the total number of episodes and the place of treatment for each episode.

Definition of Variables

Diarrhea was defined as the presence of three or more liquid or semi-liquid stools per day accompanied with or without mucus or fever. The total number had to exceed the usual number of daily bowel movements. Incident diarrhea in the child was defined by the mother as the onset of stools that were more frequent and/or fluid than normal. The end of a diarrheal episode in the child was defined by the mother as the point when both the frequency and fluidity of stools became normal.

Acute upper respiratory tract infection (URTI) was defined as the presence of runny nose or cough for at least two consecutive days plus one or more of the following signs independent of duration: erythematous mucosa, hoarse cry, respiratory distress, or fever. Erythematous mucosa was considered to be positive only when written in medical records.

Based on each mother's report as to the usual dietary intake of her child three months prior to the interview, we grouped the children as fully breastfed (intake of breast milk without regular supplements), partly breastfed (regular intake of both breast milk and supplements), and non-breastfed (no intake of breast milk at all) at baseline.

In the current survey, breastfeeding was defined by the question, "How was he/she fed in the first three months of life?". The parent could answer (1) breastfed only, (2) bottle-fed only or (3) breastfed and bottle-fed. Exclusively breastfed (EBF) was defined as the breastfed only group.

Data Analysis

Chi-square test was performed to test for differences in proportions of categorical variables between two or more groups. In 2x2 tables, the Fisher exact test (two-tailed) was used instead of chi-square, in particular, when the sample size was small. Multiple logistic regression analysis using the forward inclusion and backward deletion method was used to assess the relationship between dependent and independent variables and to adjust for potential confounders, and orders the importance of risk factors (determinant) for diarrhea in children. A level of $p<0.05$ was considered as the cut-off value for significance.

Results

Table I shows the sociodemographic characteristics of diarrhea morbidity in the children studied. Out of 1,278 infants, 458 (35.8%) had diarrhea episodes. The risk for presenting diarrhea were higher and statistically significant in male children (55.5%, $p=0.002$) and in infants of mothers with low educational level ($p<0.05$).

Table II describes characteristics of the surveyed children by mode of feeding. Of the studied 1,278 infants, more than half (59.3%) were EBF, followed by those partially breastfed (28.3%), and finally the formula-fed (12.4%). The duration of EBF was 11.4±6.7 months (mean±SD) and the duration of partial breastfeeding with bottled milk was 9.2±4.1 months (mean±SD), and the difference was statistically significant ($p<0.0010$). As can be seen from this Table, when compared to the EBF infants, the risk for diarrhea was higher and statistically significant in both the partially breastfed (48.7% vs 32.5%) and in the non-EBF (37.3% vs 32.5%, $p<0.001$).

Table III presents multivariate stepwise logistic regression analysis for possible risk factors associated with the incidence of diarrhea episodes. The result revealed that acute URTI, duration of breastfeeding, formula-feeding, partial breastfeeding, maternal educational level, and technique for sterilization of bottles were considered as diarrhea predictors after adjusting for the child's age, gender and other independent variables.

Discussion

Despite the universal access to modem water supply and sanitation facilities in Qatar, we have detected a substantial positive association

Table I. Sociodemographic Characteristics and Prevalence of Diarrheal Episodes in the Children Surveyed (N = 1278)

Characteristics	Diarrheal Episodes: Yes n (%)	Diarrheal Episodes: No n (%)	p-value
Number	458 (35.8)	820 (64.2)	
Child's age			
1-2 years	137 (16.8)	100 (21.6)	0.024
3-4 years	500 (61.47)	286 (61.8)	
Above 5 years	177 (21.7)	77 (16.6)	
Child's gender			0.002
Male	254 (55.5)	378 (46.1)	
Female	204 (44.5)	442 (53.9)	
Child's birth order			
1-2	215 (46.9)	393 (47.9)	NS
3-4	168 (36.7)	311 (37.9)	
5-8	75 (16.4)	116 (14.1)	
Parental consanguinity			NS
Yes	171 (37.3)	278 (33.9)	
No	287 (62.7)	541 (66.1)	
Maternal age group (Years)			
<25	104 (22.7)	225 (27.4)	NS
25-34	282 (61.6)	469 (57.2)	
≥35	72 (15.7)	126 (15.4)	
Maternal educational level			
University	91 (19.9)	150 (18.3)	
High School	204 (44.5)	313 (38.2)	0.05
Secondary School	55 (12.0)	140 (17.1)	
Primary School	45 (9.8)	94 (11.5)	
Illiterate	63 (13.8)	123 (15.0)	
Maternal occupation			
Housewife	324 (70.7)	600 (73.2)	NS
Professional	96 (21.0)	151 (18.4)	
School teacher	32 (7.0)	57 (7.0)	
Police / Security officer	6 (1.3)	12 (1.4)	
Family income			
Low (<US$2,750 /month)	103 (22.5)	198 (24.1)	NS
Medium (2,750-4,130 US$/month)	221 (48.3)	422 (51.5)	
High (>US$4,130/month)	134 (29.3)	200 (24.4)	
Accommodation type			
Villa-semi villa	213 (46.5)	399 (48.7)	NS
Traditional house	77 (16.8)	123 (15.0)	
Apartment flat	168 (36.7)	298 (36.3)	

NS = Not significant.

Table II. Associations Between Feeding Modes and Diarrhea Morbidity in the Children Surveyed (N = 1278)

Variables	Baseline feeding modes			p-value
	EBF	PBF	NEBF-Formula	
Number of subjects	n=758	n=362	n=158	
Mean duration of breastfeeding (Mean±SD)	11.4±6.7	9.2±4.1	–	<0.001
Diarrhea				<0.008
Yes	246 (32.5)	135 (37.3)	77 (48.7)	
No	512 (67.5)	227 (62.7)	81 (51.3)	
Child's age				
1-2 years	205 (27.0)	91 (25.1)	34 (21.5)	NS
3-4 years	292 (38.5)	135 (37.3)	58 (36.7)	
Above 5 years	261 (34.4)	136 (37.6)	66 (41.8)	
Diarrheal episode				
Never	512 (67.5)	227 (62.7)	81 (51.3)	
Once per week	34 (4.5)	22 (6.1)	11 (7.0)	<0.001
Once per month	42 (5.5)	27 (7.5)	24 (15.2)	
Every 3 months	67 (8.8)	32 (8.8)	24 (15.2)	
Every 6 months	76 (10.0)	36 (9.9)	12 (7.6)	
Once in >6 months	27 (3.6)	18 (5.0)	6 (3.8)	
Treatment of diarrhea				
None	512 (67.5)	227 (62.7)	81 (51.3)	<0.01
At home	87 (11.5)	47 (13.0)	21 (13.3)	
PHCC visit	122 (16.1)	66 (18.2)	42 (26.6)	
Hospital visit	37 (4.9)	22 (6.1)	14 (8.9)	
Sterilization of bottles				
Chemical	60 (7.9)	33 (9.1)	16 (10.1)	NS
Boiling water	96 (12.7)	48 (13.3)	14 (8.9)	
Steam	82 (10.8)	52 (14.4)	27 (17.1)	
Washing with plain water	249 (32.8)	102 (28.2)	56 (35.4)	
Combination	271 (35.8)	127 (35.1)	45 (28.5)	
URTI				
Yes	256 (33.8)	115 (31.8)	52 (32.9)	NS
No	502 (66.2)	247 (68.2)	106 (67.1)	

EBF: Exclusive breastfeeding. PBF: Partially breastfed. NEBF: Non-EBF. NS: Not significant. PHCC: Primary health care center. URTI: Upper respiratory tract infection.

Table III. Multivariate Logistic Regression Analysis for Possible Predictors and Risk Factors Associated with Incidence of Diarrhea

Independent variables	Relative risk	95% confidence interval	P value significance
URTI	4.31	3.38-5.50	0.001
Formula-fed	2.68	1.52-4.38	0.001
Short duration of breastfeeding	2.18	1.51-3.08	0.001
Maternal educational level	1.93	1.19-3.15	<0.008
Partially breastfed	1.60	1.09-2.34	0.015
Sterilization of bottles	1.52	1.06-2.18	0.024

URTI: Upper respiratory tract infection.

between breastfeeding and diarrhea in the study children aged 0-5 years. During the three months of follow-up of the study children, episodes of diarrhea were commonest among the non-breastfed infants followed by the partially breastfed infants, and least in the EBF infants. These results confirm a protective effect of EBF against infectious diseases-related morbidity in infancy. The observed protection remained even after adjustment for a number of confounders, including demographic (age and gender of child) and socioeconomic variables. The results showed that children aged 0-3 month(s) who are exclusively breastfed were less likely to have suffered from diarrhea or an acute respiratory infection than non-EBF infants. The results are consistent with those of other studies on the association between mode of feeding and diarrhea morbidity in children[3-9].

The effect of potentially confounding variables is a major concern in studies of the association between feeding modes and diarrhea in children.[1,11] To address this issue, we adjusted for several potentially confounding variables during analyses by using bivariate and multivariate methods. Demographic, health and social factors can affect the prevalence of EBF. In our study, mothers who were less educated were less likely to breastfeed their children exclusively for the six months. The authors suggest that education is a proxy for socioeconomic status, which could be related to exposure to advertisements and the capability of buying infant formula.

Studies in developing countries have found variability in the effect of breastfeeding on the development of diarrhea. In diarrheal disease studies reported in Nigeria[5], the Philippines[6], Peru[8], Sri Lanka[10], Malaysia[18], and India[19], there was a stronger protective effect of breastfeeding on diarrheal diseases. Similarly, in Bangladesh, it was shown that breastfeeding practices against diarrhea can be achieved through community-based and health education campaigns[3,9,12]. A study in Malaysia[18] found that formula feeding had a much stronger effect on mortality in infants living in households without piped water or a toilet than in households with toilets.

In a more recent study by Quigley et al.[17], it was reported that breastfeeding, particularly when exclusive and prolonged, protects against severe morbidity in the contemporary United Kingdom. A population-level increase in exclusive, prolonged breastfeeding would be of considerable potential benefit for public health. Our findings are consistent with previous observations of a negative relation between breastfeeding and diarrheal morbidity in children in areas with modem water supply and sanitation facilities[12-14]. Finally, the mechanisms through which breastfeeding may protect children against diarrhea are well recognized[4].

There is a large body of data describing how the immunologic properties of breast milk are likely to protect against infection in the infant[17,20,21]. In addition, infection may be attributable to contamination of bottles, teats, milk, and food in non-EBF infants. In our developed country setting, where rates of infection and poor hygiene are relatively low, the immune properties of "current" breast milk do not seem to persist after breastfeeding cessation. Alternatively, the immune properties may not persist at sufficient levels to protect against contamination.

Promotion of EBF in the first four to six months of life and reduction in the current practices of giving potentially contaminated drinks or foods are likely to be beneficial for infant survival in this population, with reductions expected in both diarrhea and URTI deaths, as well as in all deaths. This is consistent with earlier estimates of potential reductions in diarrhea mortality after increased breastfeeding[15-19]. Thus, estimates indicate that infant mortality could be reduced by almost one-third if the prevalence of EBF in the first four months of life could be raised to nearly 80%, with smaller gains with intermediate improvements in breastfeeding practices. In Egypt, early initiation of breastfeeding was associated with a marked reduction in the rate of diarrhea throughout the first six months of life[22]. Recent studies in Bangladesh showed that such improvements in breastfeeding practices can be achieved through community-based interventions[9,12,15]. Furthermore, a study conducted in Brazil[23] showed that the chance for presenting diarrhea was 64% higher in children younger than six months who were not breastfed compared to breastfed children, and when compared to the EBF children, the chance for presenting diarrhea increased

to 82% in children who were not breastfed. Breastfeeding and EBF were protective factors against diarrhea in the first six months of life. This latter study confirms our index survey in the State of Qatar.

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