Breast feeding and lower respiratory tract illness in the first year of life

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Abstract

Objective—To assess the relation between breast feeding and subsequent experience of lower respiratory tract illness.

Design—Prospective (from well child visits) and retrospective (from maternal recall) study of breast feeding and prospective assessment by paediatricians of lower respiratory tract illness in infants during first year of life.

Setting—Health maintenance organisation.

Participants—Over 1000 infants who were healthy at birth and whose parents used the paediatricians of a local health maintenance organisation.

Main outcome measures—Duration of breast feeding and type of lower respiratory tract illness (wheezing and non-wheezing) at different age intervals during the first year of life.

Results—Breast feeding was associated with a decreased incidence of wheezing illnesses only in the first four months of life. Interactions existed between breast feeding and sharing a room, being Mexican American, and being a boy. Multivariate techniques showed that after controlling for a variety of factors children who received minimal breast milk had a greater risk of early wheezing illnesses; the risk was further increased by simultaneous exposure to sharing a room.

Conclusion—Breast feeding seems to protect against wheezing respiratory tract illnesses in the first four months of life, particularly when other risk factors are present.

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Introduction

Lower respiratory tract illnesses are main causes of childhood morbidity and in developing countries of death.[1] A quarter to a third of children are estimated to develop these illnesses in the first year of life.[2,3] Furthermore, three to five million children die annually world wide as the result of acute respiratory illness.[4] Identifying factors that may protect children from these illnesses could have important implications for public health.

Breast feeding is one of many factors that have been associated with the development of lower respiratory tract illnesses. Though breast feeding seems to protect against the occurrence of these illnesses in developing countries,[5] the evidence has been much less convincing in industrialised countries, with some studies showing a protective effect[6-8] and others no such relation.[9-12] Existing studies have been criticised recently for several potential methodological flaws, including detection bias, poor definition of both breast feeding and illness, and lack of adjustment for potential confounders.[13] After reviewing the merits of recent studies of breast feeding and lower respiratory tract illness Bauchner *et al* suggested that breast feeding has, at best, a minimal protective effect in industrialised societies.[13]

We report the relation between breast feeding and the incidence and characteristics of lower respiratory tract illnesses in a large cohort of children followed from birth. The Tucson children's respiratory study has been designed to investigate the risk factors for and long term sequelae of these illnesses.[14] It uses data collected prospectively on feeding practices and illnesses diagnosed by doctors. Illnesses are differentiated by wheezing state and by age of occurrence during the first year of life.

Subjects and methods

POPULATION

Healthy infants born to parents using the paediatric services of the largest health maintenance organisation in Tucson were eligible to participate in the study. A total of 1246 children were enrolled between May 1980 and October 1984 (78% of those eligible). Most families who use this practice have a medical insurance in the form of a prepaid health plan available through their employer; thus the population studied is employed and middle class. The participants are generally representative of the employed sector of Tucson, and their characteristics have been described elsewhere.[14]

LOWER RESPIRATORY TRACT ILLNESS

Parents were instructed to contact a paediatrician if their child developed symptoms such as a deep and "wet" cough, wheezing, hoarseness, stridor, or shortness of breath. The criteria for diagnosis of a lower respiratory tract illness included a history of acute cough or wheeze with positive physical findings that could not be explained by nasal obstruction; acute inspiratory stridor that could not be explained by anything but croup; and positive findings in a chest radiograph.[14] At the time of the acute illness doctors completed a standardised form on the presence of a list of signs and symptoms and provided a diagnosis.[2] This analysis was limited to illnesses diagnosed by the paediatricians as a lower respiratory tract illness for which data on symptoms were obtained.

Only illnesses that were observed when the child was considered to be under the care of one of the paediatricians—that is, at risk—were included in the analysis.[2] Thus analyses for the whole first year of life were limited to the 1022 children who were at risk throughout this time, whereas analyses for the first four months of life included 1144 children who were at risk during this time.

FEEDING STATE

Data on feeding patterns were derived from two sources: prospectively from well child visits and retrospectively from questionnaires completed by parents. At each well child visit the paediatrician recorded on a standardised form whether the child was currently breast fed. When their child was between 12 and 15 months of age parents completed a questionnaire that asked if the child had been breast fed and, if so, for how long. Data were completely concordant in most (90%, 636/705) cases for which information from both sources existed.

Prospective data collected at well baby visits was

given priority in analyses, with questionnaire data being used only when data from the visits were incomplete. In 74% (879/1184) of children data on feeding came from well child visits. Information provided by the parent on the questionnaire at 12-15 months was used in 26% (305/1184) of children for whom well baby data was unreliable (15 cases) or incomplete (290), because no data existed for the well check immediately preceding the one in which breast feeding was first reported as having finished. In 62 of the 1246 children (5%) no information was available from either source. In 146 children information was available on breast feeding only at 2 months; these children were excluded from analyses on the duration but not the initiation of breast feeding.

DATA ANALYSIS

For the purposes of analysis lower respiratory tract illnesses were grouped in intervals that corresponded to the schedule of well child visits (2, 4, 6, 9, and 12 months), which were then combined to assure sufficient numbers of illnesses and variability in feeding behaviours. Illnesses were also analysed by wheezing state. Thus the incidences of all illnesses, of wheezing illnesses, and of non-wheezing illnesses were assessed for the first year, and for three age groups (0 to <4 months, ≥4 to ≤6 months, and >6 to 12 months).

Duration of any breastfeeding—that is, regardless of whether other foods were given—was categorised as none or for less than a month, one to less than four months, and four or more months. Data for other risk factors, including years of maternal education, maternal smoking, self reported ethnic group, the child's sex, whether either parent reported "childhood respiratory trouble" before age 16 (including asthma, bronchiolitis, and bronchitis),[15] and whether other people slept in the same room as the child, were taken from questionnaires completed at the child's birth. In addition, data on day care were elicited at 12-15 months of age in response to the question: "Does your child spend nine or more hours a week in the company of other children?"

Relations between feeding practices and illness by age group were assessed for the whole group and stratified by potential confounders. The relative excess risk due to interaction[16] was also calculated. Significance was assessed with χ^2 tests and analysis of variance. Logistic regression was used to test the significance of relations between feeding and illness when controlling for potential confounders; odds ratios were calculated from the coefficients. Statistical analyses used the statistical package for the social sciences programs X and PC+2 (SPSS-X and SPSS/PC+2) on IBM compatible and VAX/Cyber computer systems. In addition, a Fortran program provided by the National Heart, Lung, and Blood Institute, Washington, DC, was used for logistic regression. p Values of <0·05 were considered to be significant.

The study was approved by the human subjects committee of the University of Arizona.

Results

The cumulative incidence of lower respiratory tract illness in the first year of life using a life table was 33 per 100 children.[2] Table I shows the age distribution of first illnesses, giving the number of all first illnesses observed at each interval, and the numbers associated and not associated with wheeze. The percentage of all illnesses associated with wheeze in those at risk during the whole first year of life decreased from 76% in the first half to 60% in the second half of the first year ($\chi^2=11·7$, p=0·0007).

A high percentage of infants (84%) (868/1038) in whom information on breast feeding was available received at least some breast milk, with 29% (301) having stopped being breast fed in the first four months of life, 15% (160) between 4 and 6 months, and 40% (407) thereafter.[17]

TABLE I—*Age at occurrence of first lower respiratory tract illness in population of 1022 children. Values are numbers (percentages) of children*

Age (months)	Respiratory tract illness		
	Total*	Wheezing	Non-wheezing
<4	91 (8·9)	71 (7·0)	20 (2·0)
≥4-≤6	78 (7·6)	58 (5·7)	20 (2·0)
>6-12	127 (12·4)	77 (7·5)	50 (4·9)
Total	296 (29·0)	206 (20·2)	90 (8·8)

*Excluding first illnesses in 43 children for which data on symptoms were not recorded; 12 children were aged <4 months, 10 ≥4-6 months, and 21 >6-12 months.

FEEDING PRACTICES AND LOWER RESPIRATORY TRACT ILLNESS IN THE FIRST YEAR

The relation between incidence of first illnesses and duration of breast feeding was assessed for the first year of life. Duration of breast feeding was not significantly associated with having a lower respiratory tract illness or with having either a wheezing or a non-wheezing illness when the whole first year of life was considered. Table II shows the relation between duration of breast feeding and the incidence of illness associated with and without wheeze for three age intervals in the first year.

TABLE II—*Incidences (numbers of cases) of first lower respiratory tract illness by age* and duration of breast feeding in 949 children†*

	Duration of breast feeding (months)			
	<1 or not at all (n=207)	≥1 to <4 (n=221)	≥4 (n=521)	p Value for χ^2 test‡
Wheezing illnesses				
Age (months):				
<4	12·3 (24)	8·1 (17)	5·2 (25)	0·005
≥4 to ≤6	6·9 (11)	4·7 (9)	7·4 (34)	NS
>6-12	6·3 (10)	13·1 (24)	7·0 (30)	NS
Non-wheezing illnesses				
Age (months):				
<4	2·0 (3)	3·8 (6)	2·5 (10)	NS
≥4 to ≤6	2·7 (4)	2·0 (3)	2·1 (8)	NS
>6-12	7·0 (10)	7·3 (11)	2·9 (11)	NS

*Children experiencing any illness before age interval under consideration were not included in denominator.
†Information on breast feeding missing in 73 children.
‡χ^2 Tests were performed for each type of illness in each interval—that is, wheezing illness in the first four months *v* all other categories.

A significant trend was evident only for one type of illness in one interval: longer breast feeding was associated with decreased incidence of wheezing illnesses in the first four months of life ($\chi^2=7·8$, p<0·006). Non-wheezing illnesses seemed to be unrelated to duration of breast feeding in all intervals.

STRATIFIED ANALYSES

Table III shows the rate of wheezing illnesses in the first four months of life by exposure to minimal breast feeding and to potential risk factors for illness, either singly or in combination. A strong interaction is evident between minimal breast feeding and sharing a room: children who share a room and receive minimal breast milk have almost five times the risk of a wheezing illness as those who are exposed to only one of these risk factors. Strong interactions also exist between breast feeding and ethnic group, sex, low maternal education, and use of day care for the rate of wheezing illnesses. The relative excess risk due to interaction, however, was no higher or only marginally higher than the risk due to either of the individual factors for the last three variables. As day care attendance interacted with breast feeding only marginally to

TABLE III—*Rates (odd ratios,† 95% confidence intervals) of early wheezing illnesses by exposure to minimal breast feeding and other risk factors*

Risk factor‡	Group A (breast fed ≥1 month and not exposed to risk factor)	Group B (breast fed <1 month and not exposed to risk factor)	Group C (breast fed ≥1 month and exposed to risk factor)	Group D (breast fed <1 month and exposed to risk factor)	Relative excess risk due to interaction§
Sharing room	4·5	3·6 (0·8)	6·4 (1·5)	18·0 (4·7, 2·5 to 8·9)****	3·4
Ethnic group	5·3	8·0 (1·6)	6·6 (1·3)	18·6 (4·1, 2·0 to 8·6)***	2·2
Parental childhood respiratory trouble	4·1	10·9 (2·9, 1·6 to 5·4)***	12·3 (3·4, 1·8 to 6·4)***	11·1 (3·0, 1·0 to 9·1)	
Sex	6·2	7·6 (1·2)	4·7 (0·8)	14·6 (2·6, 1·3 to 5·1)**	1·6
Maternal education	4·9	8·8 (1·9)	7·3 (1·5)	13·0 (2·9, 1·5 to 5·7)**	0·6
Day care	5·9	9·4 (1·6)	5·1 (0·9)	12·1 (2·2, 1·1 to 4·4)*	0·7
Maternal smoking	4·3	12·4 (3·2, 1·7 to 5·7)***	11·8 (3·0, 1·5 to 5·7)***	7·0 (1·7)	

†Ratio of exposure odds among those who developed illness to exposure odds among those who did not, calculated by using formula ad/bc.
‡Risk factors were considered in dichotomous categories (from non-exposed to exposed): sharing a room (not shared *v* shared); ethnic group (non-Mexican American white *v* all other groups); parental childhood respiratory trouble (in neither parent *v* in either one); sex (girls *v* boys); maternal education (>12 years *v* ≤12 years); day care (not used *v* used); maternal smoking (none *v* currently smoking). Duration of breast feeding was also considered in two categories: ≥1 month *v* none or <1 month.
§Calculated by subtracting the risk of each single exposure from the risk of both exposures and adding 1.
*p<0·05, **p<0·01, ***p<0·001, ****p<0·0001. Differences were tested between rate for group A and for groups B, C, and D separately. Confidence intervals were calculated by the Mantel-Haenszel test.[11]

TABLE IV—*Odds ratios (confidence intervals) for wheezing illnesses in first four months of life in whole group and by sex and ethnic group analysed by logistic regression*

	Total group (n=1006)	White boys (n=415)	White girls (n=430)	Mexican American boys (n=81)*
Breast fed <1 month and did not share room	0·73	1·29	0·43	§
Breast fed ≥1 month and shared room	1·25	0·70	1·65	2·11
Breast fed <1 month and shared room	3·29 (1·8 to 6·0)‡‡	1·23	3·36 (1·2 to 8·0)**	11·23 (1·7 to 72·5)**
Maternal education	1·28	2·01 (0·9 to 4·7)‖	0·67	3·62 (1·0 to 12·6)¶
Paternal childhood respiratory trouble	2·25 (1·4 to 3·5)‡‡	1·74	2·40 (1·2 to 4·7)**	5·96 (1·7 to 21·4)††
Ethnic group (Hispanic)	1·94 (1·1 to 3·3)††			
Sex (Male)	1·09			
Maternal smoking	1·64 (1·0 to 2·7)‖	2·53 (1·1 to 5·8)‖	1·60	
No of cases†	65	20	27	14
No (%) of cases in top fifth of risk distribution‡	34 (52)	7 (35)	14 (52)	9 (64)
p Value for χ^2 goodness of fit	0·228	0·84	0·23	0·21

*Small number of cases of illness (n=4) among Mexican American girls precluded use of logistic regression in this group.
†Number of cases considered is less than the number of wheezing illnesses in the first four months because risk factor data were not available for all children.
‡Subjects were ranked into 10ths of distribution of risk according to risk probability of having a wheezing illness in first 4 months, and numbers of cases of wheezing illnesses in each tenth were identified. Twenty per cent of cases would fall in top fifth if no risks of wheezing associated with independent variable had been identified. Because risks of wheezing for independent variables in this model were high more than 20% of cases fell into top fifth. p Values associated with χ^2 goodness of fit indicate that models fit well.
§No cases fell into this category so coefficients were calculated without this variable.
‖p<0·10, ¶p<0·05, **p<0·025, ††p<0·01, ‡‡p<0·005, one tailed test of significance. Confidence intervals were calculated by the Mantel-Haenszel test.[11]

produce wheezing illnesses and as the question asked did not apply directly to the first four months of life, it was eliminated from later multivariate analyses. Minimal breast feeding does not seem to increase the risk of illnesses if the mother smokes. (Paternal smoking was not considered in stratified analyses because it was not a significant risk factor for early wheezing illnesses.)

MULTIVARIATE ANALYSES

Logistic regression was used to assign adjusted odds ratios to variables related to early wheezing illnesses and to test two models of the relation of breast feeding to early wheezing illnesses after considering sharing a room, maternal education, maternal smoking, parental childhood respiratory trouble, ethnic group, and sex. In the first model variables were entered one at a time. When considered alone lack of breast feeding was a significant risk factor (odds ratio=2·3; p<0·013) for early wheezing illnesses. When all other variables were entered into the model little breast feeding still significantly increased the risk of early wheezing illnesses (odds ratio=1·7; p<0·05). In the second model breast feeding was entered as an interaction term with sharing by creating three dummy variables: minimal breast feeding and non-sharing, sharing and having been breast fed, and finally minimal breast feeding and sharing. (The reference group, group A, was exposed to neither risk factor—that is, they did not share and were breast fed for one or more months.)

Table IV shows the odds ratios for early wheezing illnesses in the second model for the group as a whole and by sex and ethnic group. When exposed to both minimal breast feeding and sharing a room the risk of an early wheezing illness rose to three times the risk in other children after controlling for all other factors. In this model neither little breast feeding alone nor sharing alone were significant risk factors when other factors were taken into account. Having at least one parent with a history of childhood respiratory trouble or being Mexican American significantly increased the risk of having an early wheezing illness for the group as a whole; maternal smoking was a borderline risk.

Different relations existed for non-Mexican American white boys. The combination of minimal breast feeding with sharing or parental respiratory trouble did not significantly increase the risk of early wheezing illnesses. Low maternal education and maternal smoking, however, emerged as significant risk factors in this group. In non-Mexican American white girls the combination of minimal breast feeding with sharing and a parental history of childhood respiratory trouble significantly increased the risk. In Mexican American boys exposure to both sharing and minimal breast feeding increased the risk to 11 times that of other children. (The effect of minimal breast feeding among those who did not share a room could not be tested in this group because no children with wheezing illnesses fell into this category.) Low maternal education and a parental history of illness also increased the risk of an early wheezing illness. The model could not be tested for Mexican American girls because of an insufficient number (four) of wheezing illnesses in this group.

Discussion

Our study shows that with bivariate analysis the duration of any breast feeding is associated with a decreased incidence of wheezing illnesses during the first four months of life. Non-wheezing illnesses were not related to feeding patterns at any time in the first

year of life. Feeding patterns interacted with other risk factors, producing raised incidences of wheezing illnesses in those who received no or minimal breast milk and who shared a room, were boys, Mexican American, and whose mother had a high school education or less. After controlling for a variety of risk factors the risk of an early wheezing illness in the whole group was significantly increased for children who were breast fed for less than one month. The risk was even higher if they also shared a room. These findings were particularly apparent for Mexican American boys, who had 11 times the risk of a wheezing illness in the first four months of life if they received minimal breast milk and shared a room.

Although other studies have considered respiratory illnesses to be an undifferentiated group, we focused on respiratory illnesses associated with wheeze. In our population wheezing illnesses have a different age distribution than do non-wheezing illnesses in the first year of life, which suggests that risk factors for wheezing with an illness differ from those for infection itself. Furthermore, the hypothesised relation between early lower respiratory tract illness and lung function later in life may only pertain to wheezing illnesses. Voter *et al* found that boys with two or more preschool wheezing periods had lower lung function in adolescence than boys without this history, even when the boys with no history of preschool wheezing had non-wheezing lower respiratory tract illnesses.[18] Thus the lack of a relation between breast feeding and the incidence of illness in other studies may be attributable to combining the two types of illness in the analysis.

We found that breast feeding seemed to protect against wheezing illnesses in the first four months of life but not later in the first year, suggesting that any protective effect endures only minimally beyond the end of breast feeding. Another study that looked at illnesses by age did not find this relation, but the authors excluded bronchiolitis,[8] which is the most common diagnosis of lower respiratory tract illness in the first year[2] and is particularly likely to be associated with wheeze.

The results of other studies have been mixed on the potential protective effect of breast feeding. Our study shows that minimal breast feeding interacts with other risk factors for illness or infection, particularly sharing a room, suggesting that increased exposure to infecting organisms increases the protective effect of breast feeding. Although little information is available elsewhere on interactions between breast feeding and sharing, many studies show the deleterious effect of crowding on rates of respiratory illness.[19,20] In other studies the use of day care increased the rate of illness; the lack of a stronger association in our study may reflect the failure to elicit more precise information on the use of day care early in infancy. Our study also suggests that the ethnic make up of the population, independent of socioeconomic state (as reflected in education), may be relevant to the outcome. Most studies do not describe the ethnic group of subjects[2,8,10,12] or have not analysed results by ethnic group.[11] Those conducted among white subjects[9] may be less likely to find a relation between breast feeding and illness than those conducted with larger non-white, particularly Hispanic, populations.

Considerable attention has been given to the concerns raised in previous studies.[13] We evaluated the role of potential confounders with multivariate techniques and stratification. Detection bias was minimised because enrolled children were seen on average every two months. Furthermore, the use of health care, measured by the frequency of well child visits, was not related to the duration of breast feeding. The definition of the outcome event was agreed on before the start of the study and was used consistently; definitions of feeding state are defined in the methods. As wheezing state was not explicitly hypothesised as being an important factor until after the data had been collected the feeding state of the child probably did not unconsciously motivate the doctors' diagnosis of illness.

Our results suggest a means of reconciling discrepant results of studies conducted in industrialised as opposed to developing countries. These data suggest that breast feeding protects in certain circumstances: when children share a room (which implicates both exposure to other children and lower socioeconomic state) and in Mexican Americans. Conditions of crowding and poverty are endemic to many developing countries. Studies conducted among non-white people regardless of social class may also find a greater effect of breast feeding, although the mechanism is unclear.

In conclusion, our results suggest that decreased breast feeding is associated with a higher incidence of wheezing illnesses in the first four months of life, particularly in combination with other risk factors, such as sharing a room, being male, or being Mexican American. This effect is apparent even after controlling for potential confounders. Results of studies in industrialised countries may be reconciled with findings for developing nations by analysing relations between respiratory illness and breast feeding in those exposed to comparable risks.

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