Original Article

Factors Associated with Morbidities Among Infants in Three Sub Centre Areas of Belgaum District of South India: A Longitudinal Study

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ABSTRACT

Background: Health status of infants is a sensitive indicator of development and factors influencing it need to be better understood. **Objectives:** This study was conducted to search for factors associated with morbidity among infants and to find out their influence on weight gain during infancy. **Materials and Methods:** This longitudinal study was undertaken in south India from November 2004 till April 2006. A birth cohort of all children born during first 6 months of the study period were assessed at enrollment and followed up monthly till they attained 1 year of age. **Results:** Incidence of morbidity among infants was found to be least among those exclusively breast fed (EBF) for 6 months and most when EBF for less than 6 months ($P = 0.045$). It was also more when infants were weaned with a combination of animal milk, formula milk, semi-solids and solid diet and least when weaned only with semi-solids and solids ($P = 0.018$). Diarrheal episodes were more in infants who were bottle-fed ($P < 0.001$). Weight gain between 6th and 12th month of infancy was found to be significantly affected by various morbidities ($P = 0.001$). Incidence of morbidities was less among preterm babies and more among partially immunized ($P < 0.001$) babies with birth order ≥ 3 ($P = 0.012$), babies of mothers with low socio-economic and educational status. Delayed milestones during infancy was seen more in babies with history of birth asphyxia ($P = 0.018$). **Conclusion:** Several factors influenced incidence of morbidities and these morbidities had a negative effect on weight gain. Hence these factors need to be addressed to promote better child health.

Keywords: Factors, infants, incidence, longitudinal study, morbidity, weight gain

Introduction

Infants (0-1 year) form a vulnerable group in any population. Health of infants is considered as a sensitive indicator of health status and level of socio-economic development of a country. Although the chances of survival of these newborns has improved by 50% in the last 20 years, the first few hours, days and months of their lives are still an obstacle race.[1] From the time of birth 30% of babies are underweight. That makes them vulnerable to infection and disease.[2] For every 10 children aged 6-9 months in India, only 5 children born to illiterate and 7 children born to literate mothers, receive solid or semi-solid foods in addition to breast milk as recommended.[2] The result is that more and more children in developing countries reach adulthood with their health already largely impaired.[1] Various studies done in India have shown that respiratory and gastrointestinal tract infections are the leading cause of morbidity in children.[3,4] These infectious diseases are affected by several factors such as birth weight, gestational age, socio-economic status, ethnicity, immunization status, nutritional status of infants, number of siblings, day care attendance and parental

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smoking.[4-7] Breastfeeding has been suggested as a modifiable influencing factor. When given exclusively, breastfeeding reduces the risk of infectious diseases in infants in developing countries.[8,9]

Although various factors have been known to influence the morbidity pattern among children, very few studies have done a comprehensive search of most factors and have actually linked the effect of incidence of various morbidities on weight gain during different periods of infancy. Hence, there is a need to explore these problems and the extent to which they have bearing on infant growth and development. This longitudinal study was thus conducted to do a search of most factors associated with morbidity among infants and to find out their influence on weight gain during infancy.

Materials and Methods

A longitudinal study was conducted on a birth cohort of 194 infants who were followed up for a period of 1 year. It was carried out in the field practice area, Kinaye of Jawaharlal Nehru Medical College in Belgaum district of Karnataka state of south India. The study was approved by the institutional ethical clearance committee of this college.

Kinaye has a primary health centre (PHC) with 5 sub-centres under it. Three of these sub-centres were randomly selected for this study, namely Santibastwad, Machhe and Peeranwadi with a population of approximately 20,000.

Study period was from November 2004 to April 2006. All children born from November 2004 to April 2005 formed the birth cohort that was followed up. During the initial phase, the investigator visited houses of mothers within 10 days of childbirth and collected baseline data on a pretested proforma. Thereafter, monthly follow-up visits were done to enquire about their morbidities followed by a detailed clinical examination. Document verification was done in case child had illness in between the visits. Anthropometric measurements like weight were also recorded during each of these visits.

Inclusion criteria were singleton pregnancy and newborns of mothers who were permanent residents of study area. Exclusion criteria were multiple births and newborns of mothers who were temporary residents and thus not available for full year follow-up. It is a common cultural practice in India for pregnant women to come to their parental house few months before delivery and stay there till few months after. This is to obtain better care and support during these vital periods. When the baby is a few months old, they go back to their place of residence. That would make them unavailable for a full year of follow-up.

Four infants who died and 17 infants who were lost during the one year follow up period were also excluded from the data analysis.

Data analysis was done using SPSS Inc. Illinois, USA version 10.0 and presented as rates and proportions. Chi-square, *t* test, ANOVA and Spearman rank coefficient of correlation were used for testing significance. Socio-economic status was calculated using Modified B G Prasad's classification of 2004.

Results

Socio-demographic characteristics of mothers showed that 173 (89.2%) were aged between 19-29 years, 148 (76.3%) were Hindus, 174 (89.7%) were of poor socio-economic class and 102 (52.5%) were educated up to high school.

The incidence rate of all morbidities was found to be 3.28 per infant per year with reference to our previously published study.[10]

The mean number of episodes of morbidities was least among infants who were EBF for 6 months (2.16 ± 0.95 episodes per infant per year) as compared to infants who were either EBF for less than (4.1 ± 1.74 episodes per infant per year) or more than 6 months (4.03 ± 1.62 episodes per infant per year). This difference between mean number of episodes between the groups was found to be statistically significant using one-way ANOVA test (F = 2.89, P = 0.045) [Table 1].

Proportion of infants with RTI and diarrheal diseases were significantly more among infants EBF for less than 6 months and anemia was significantly more among infants EBF for more than 6 months [Table 2].

The mean number of episodes of morbidities was least among infants who were weaned with a combination of semi-solid and solid diet (2.47 ± 1.15 episodes per infant per year) followed by infants who were weaned with semi-solid, solid and animal milk (4.03 ± 1.85 episodes per infant per year) followed by infants who were weaned with semi-solid, solid and formula milk (5.0 ± 1.92 episodes per infant per year) and most when infants who were weaned with a combination of formula milk, animal milk, semi-solid and solid diet (5.27 ± 1.95 episodes per infant per year). This difference between mean number of episodes between the groups was found to be statistically significant using one-way ANOVA test (F = 3.92, P = 0.018) [Table 3].

Proportion of infants with RTI and diarrhea were significantly more among infants weaned with formula feeds, semi-solid and solid diet [Table 4].

Table 1: Incidence of different morbidities among infants according to period of exclusive breast feeding

Morbidity	EBF for 6 months (*n*=81)		EBF<6 months (*n*=77)		EBF>6 months (*n*=36)	
	No. of episodes	In /infant/yr	No. of episodes	In /infant/yr	No. of episodes	In /infant/yr
Resp. tract infections	66	0.81	143	1.86	60	1.67
Diarrhea	38	0.47	79	1.02	25	0.69
Skin diseases	18	0.22	26	0.34	14	0.39
Otitis media	4	0.05	5	0.06	1	0.03
Anemia	31	0.38	27	0.35	21	0.58
Vit A def	6	0.07	9	0.12	3	0.08
Eye infections	-	-	5	0.06	1	0.03
Others	12	0.15	22	0.28	20	0.55
Total episodes	175		316		145	
Mean episodes±SD		2.16±0.95		4.1±1.74		4.03±1.62

Fisher's test F=2.89, *P*=0.045, EBF: Exclusive breast feeding, Vit A def: Vitamin A deficiency, Resp. Tract Infections/RTI: Respiratory tract infections, In/infant/yr: Incidence per infant per year

Table 2: Morbidity pattern among infants according to different periods of exclusive breast feeding

Morbidity pattern	No. of infants (%)			
	EBF for 6 months (*n*=81)	EBF for <6 months (*n*=77)	EBF for >6 months (*n*=36)	Total (*n*=194)
RTI	32 (39.5)	62 (80.5)	27 (75)	121 (62.4); χ^2=40.009, *P*<0.001
Diarrhea	25 (30.9)	40 (51.9)	18 (50)	83 (42.8); χ^2=8.108, *P*=0.0173
Skin diseases	14 (17.3)	18 (23.4)	10 (27.8)	42 (21.6); χ^2=1.843, *P*=0.398
Otitis media	3 (3.7)	3 (3.9)	1 (2.8)	7 (3.6); χ^2=0.0192, *P*=0.955
Anemia	24 (29.6)	22 (28.6)	20 (55.5)	66 (34.0); χ^2=9.152, *P*=0.0103
Vit A deficiency	6 (7.4)	9 (11.7)	3 (8.3)	18 (9.3); χ^2=0.906, *P*=0.636
Eye infections	-	5 (6.5)	1 (2.8)	6 (3.1); χ^2=5.568, *P*=0.061
Others	9 (11.1)	17 (22.1)	14 (38.9)	40 (20.6); χ^2=11.916, *P*=0.003

EBF: Exclusively breastfed

Table 3: Incidence of different morbidities in relation to the type of weaning foods

Morbidity pattern	BF with SS and S (*n*=112)		BF with An.Milk, SS and S (*n*=57)		BF with FF, SS and S (*n*=10)		BF with FF, An.Milk, SS and S (*n*=15)	
	No. of episodes	In/in/yr	No. of episodes	In/in/yr	No. of episodes	In/in/yr	No. of episodes	In/in/yr
RTI	112	1.0	94	1.65	29	2.9	34	2.27
Diarrhea	51	0.45	55	0.96	13	1.3	23	1.53
Skin diseases	29	0.26	26	0.46	-	-	3	0.2
Otitis media	7	0.06	-	-	-	-	3	0.2
Anemia	43	0.38	29	0.51	3	0.3	4	0.27
Vitamin A deficiency	10	0.09	7	0.12	1	0.1	-	-
Eye infections	1	0.01	3	0.05	1	0.1	1	0.07
Others	24	0.21	16	0.28	3	0.3	11	0.73
Total episodes	277		230		50		79	
Mean episodes±SD		2.47±1.15		4.03±1.85		5.0±1.92		5.27±1.95

Fisher's test *F*=3.92, *P*=0.018, BF: Breast fed, SS: Semi-solid diet, S: Solid diet, An.Milk: Animal milk, FF: Formula feeds, SD: Standard deviation

Table 4: Morbidity pattern among infants according to the types of weaning foods

Morbidity pattern	No. of infants (%)			
	BF with SS and S (*n*=112)	BF with An.Milk, SS and S (*n*=57)	BF with FF, SS and S (*n*=10)	BF with FF, An.Milk, SS and S (*n*=15)
RTI	54 (48.2)	44 (77.2)	10 (100)	13 (86.7); χ^2=24.703, *P*<0.001
Diarrhea	35 (31.2)	31 (54.4)	7 (70)	10 (66.7); χ^2=15.741, *P*=0.0013
Skin diseases	23 (20.5)	16 (28.1)	-	3 (20); χ^2=4.254, *P*=0.235
Otitis media	5 (4.5)	-	-	2 (13.3); χ^2=6.222, *P*=0.0778
Anemia	37 (33.0)	22 (38.6)	3 (30)	4 (26.7); χ^2=1.015, *P*=0.798
Vit A deficiency	10 (8.9)	7 (12.3)	1 (10)	–; χ^2=2.167, *P*=0.538
Eye infections	1 (0.9)	3 (5.3)	1 (10)	1 (0.07); χ^2=4.935, *P*=0.177
Others	8 (7.1)	16 (28.1)	5 (50)	11 (73.3); χ^2=45.401, *P*<0.001

Bottle feeding was practiced in 7 (3.6%) cases. The incidence of diarrheal episodes in these infants was 1.57/infant/year compared to 0.7/infant/year among non-bottle fed infants and this difference was statistically significant ($P < 0.001$).

Episodes of diarrhea showed a negative correlation with the weight gain of infants during 0-6 months, 7-12 months, and 0-12 months. With respect to episodes of respiratory tract infection, negative correlation with weight gain of infants was observed during 7-12 months and accordingly 0-12 months. Similarly, negative correlation of all morbidities with weight gain was also observed during 7-12 months and accordingly 0-12 months [Table 5].

The incidence of morbidity disorders among infants was found to decrease with increase in literacy increase in literacy ($P = 0.231$) and socio-economic status ($P = 0.305$) of their mothers. However, these results were not statistically significant [Figure 1].

The incidence of infectious morbidity disorders was found to be significantly more among partially immunized infants compared to fully immunized infants [Table 6].

The incidence of morbidity disorders was found to be 2.6 among the 10 preterm babies, 3.3 among the 183 full-term babies and 2 episodes/infant/year in one post-term baby ($P = 0.222$).

The incidence of morbidity was found to be 3.1, 3.0, 3.7, 4.3 episodes per infant per year in infants of birth order 1, 2, 3, ≥ 4 respectively. These differences in incidence were found to be statistically significant ($P = 0.012$).

Out of 3 infants with otalgia, history of oil application into the ears was positive in 2 cases. One infant who developed conjunctivitis had a positive history of oil and black carbon application into the eyes.

The incidence of diarrheal episodes among 57 infants with untrimmed fingernails (0.93/infant/year) was found to be significantly more than those infants with trimmed finger nails (0.65/infant/year) ($P = 0.028$).

Delayed milestones during infancy was seen in 61 (31.4%)

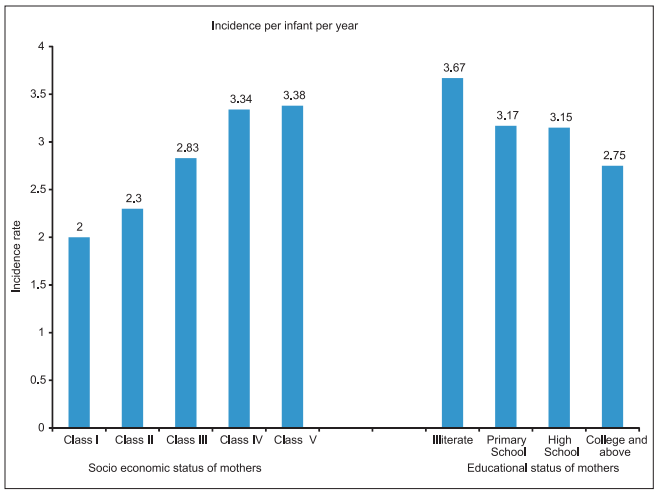

Figure 1: Association between incidence of morbidities in infants and socio economic and educational status of their mothers

Table 5: Association between types of morbidities and its influence on weight gain at various periods of infancy

Type of morbidity	Mean no. of episodes mean (SD)	Mean weight gain (kgs) mean (SD)	Spearman rank correlation coefficient	*P* value
Between 0-6 months				
RTI	0.58 (0.94)	3.64 (0.72)	r_1=0.174	*P*=0.115
Diarrhea	0.30 (0.60)	3.64 (0.72)	r_2=–0.034	*P*=0.640
All morbidities	1.50 (1.64)	3.64 (0.72)	r_3=0.032	*P*=0.654
Between 7-12 months				
RTI	0.79 (1.15)	2.07 (0.50)	r_1=–0.243	*P*=0.001
Diarrhea	0.45 (0.88)	2.07 (0.50)	r_2=–0.153	*P*=0.033
All morbidities	1.76 (1.94)	2.07 (0.50)	r_3=–0.260	*P*=0.000
Between 0-12 months				
RTI	1.38 (1.59)	5.72 (0.811)	r_1=–0.133	*P*=0.064
Diarrhea	0.74 (1.12)	5.72 (0.811)	r_2=–0.140	*P*=0.052
All morbidities	3.28 (2.85)	5.72 (0.811)	r_3=–0.227	*P*=0.001

Table 6: Association between immunization status of infants and incidence of morbidity disorders‡ during the period of infancy

Immunization status	Males			Females			Total		
	No.	I.D episodes	In./infant/year	No.	I.D episodes	In./infant/year	No.	I.D episodes	In/infant/year
Partially	15	57	3.8	15	55	3.67	30	112	3.73
Fully	75	198	2.64	89	221	2.48	164	419	2.55
Total	90	255	2.83	104	276	2.65	194	531	2.74

P<0.001, ‡Only infectious diseases (I.D) like RTI, diarrhea, skin diseases, otitis media, eye infections, urinary tract infection etc. were considered

babies. This was seen more commonly among newborns with history of birth asphyxia 4 (80%) with (χ^2 = 5.61, P = 0.018), preterm babies 4 (40%) and maternal history of pre-eclampsia or eclampsia 5 (38.5%).

Discussion

Morbidity during infancy is a sensitive indicator of the health care progress of any community. Preventive variables such as health education, prenatal care, nutrition, social support, risk identification and obstetric care can effectively reduce infant morbidity and mortality.[11]

Faulty breastfeeding and weaning practices is a major contributor to morbidities in infancy. In this study, the incidence of morbidity in infants who were EBF for less than 6 months was almost twice than incidence of morbidity in infants EBF up to 6 months. Similar observation was made in a study conducted in New York where the incidence of morbidity among limited EBF was found to be 1.6 times more compared to prolonged exclusively breastfed (for more than or equal to 4½ months) infants.[12] Individual morbidities that were more common among infants EBF for less than 6 months were RTI, diarrhea, eye infections and vitamin A deficiency. Similar observations have been made in studies done in different parts of the world for instance diarrhea was more common among partially breastfed in UAE[13] and RTI and eye infections were more common in Malawi.[14] A study in Dhaka also showed that prolonged breastfeeding was protective against vitamin A deficiency.[15]

In our study, the number of infants with RTI and diarrhea was more in those who were EBF for less than 6 months compared to those who were EBF for 6 months. This was similar to findings of Tucson and Dundee where the number of infants suffering from RTI was 33.6% and diarrhea was 48.2% in limited exclusively breastfed group (<3 months) compared to 29.8% and 22.5% in prolonged exclusively breastfed group (≥3 months).[16]

A population-based prospective cohort study done in the city of Rotterdam, Netherlands found that infants who were exclusively breastfed for 6 months or longer had lower risks of infections of upper respiratory, lower respiratory and gastro-intestinal system.[17]

Incidence of morbidities being more among infants breastfed for more than 6 months compared to infants breastfed for 6 months could be because of greater under-nourishment in the former group compare to the latter.

The incidence of morbidity disorders was found to be least among infants weaned with semi-solids and solids compared to those weaned also with animal or formula milk. Also, the incidence of RTI, diarrhea, otitis media, vitamin A deficiency and eye infections were less while incidences of anemia and skin diseases were more when infants were weaned with semisolids and solids compared to other groups. Other studies have revealed similar outcomes such as, a study by Kasla *et al*., reporting incidence of morbidity of 3.1/infant/year for breastfed babies, 8.1 for mix-fed and 9.9 for totally artificially-fed in the first 6 months.[18] A study conducted in Peru found that incidence of morbidity disorders was less when infants were weaned with semi-solids compared to artificial milk.[19] Diarrhea was found to be more common among top-fed and formula-fed babies in an North Indian and a US study, respectively, with latter also showing increased incidence of otitis media.[20,21]

In a study done in Thailand, the incidence of anemia was significantly higher in breastfed infants compared to formula-fed infants, which was similar to our findings.[22] Feeding infants with a variety of weaning foods comprising of semi-solid, solid diet, animal milk, formula milk even though protects the infant from anemia but results in greater incidence of infections.

The percentage of infants suffering from anemia, vitamin A deficiency, skin diseases were more while RTI, diarrhea, otitis media were less in the group weaned with semi-solid and solid diet compared to group weaned also with animal and formula milk. Similar percentage of infants with morbidities were noted in Aligarh study where RTI was seen in 48.5%, diarrhea in 33.3%, otitis media in 6.1%, anemia in 6.1% and vitamin A deficiency in 10% cases among those weaned with semi-solids and solids. Here infants weaned with mixed feeds of semi-solids, solids, animal milk and formula milk showed greater percentage of morbidities i.e., RTI in 58.6%, diarrhea in 41.4%, otitis media in 6.9%, anemia in 10.4%, and vitamin A deficiency 10.4% cases.[23]

In a study done in USA, the infants who received formula feeds had an 80% increase in their risk of developing diarrhea and 70% increase in developing ear infections compared to others who did not.[24] In Serbian study, the incidence density of GI diseases was 49% lower and respiratory diseases was 38% lower in breast-fed infants than in infant formula or cow milk-fed infants.[25] These observations again support our findings.

We observed that the incidence of diarrheal episodes was significantly more among bottle-fed infants compared to breastfed infants. This was similar to the findings of a Canadian study where the incidence density ratio of gastrointestinal illness was 47% lower in breastfed infants than in bottle-fed infants.[26] Greater number of diarrheal episodes associated with bottle feeding could be because

feeding bottle is often not sterilized or washed properly. This practice hence needs to be widely discouraged.

In the second 6 months and throughout the period of infancy, weight gain was found to be significantly hampered by various morbidities unlike the first 6 months of infancy. This observation supports the fact that repeated infections result in poor body growth, which would later on affect the immune status of the body, making the infant more prone to develop further infections leading to a vicious cycle.

The incidence of morbidities in infants was found to decrease with increasing educational and socio-economic status of their mothers which was similar to the findings of a study done in Delhi.[27] As educated mothers are better aware of healthy infant feeding and rearing practices, the episodes of morbidity in their infants would be obviously lesser. Socio-economic status assessed based upon income is directly related to purchasing power of the family. It is a determinant of housing conditions, environmental sanitation, acquisition of education and knowledge regarding infant care. Income also determines the better availability of good quality medical services.

The incidence of morbidity among preterm infants being less than that of full-term infants could probably be because they are usually given more care by their parents.

The incidence of morbidity disorders was similar in infants of first and second birth order. Subsequently, it was found to increase significantly with birth order. Similar results were seen in a study done in a semi-urban area of Delhi where the incidence of morbidity was found to increase proportionately with birth order 1 to 4 and above.[28] The influence of birth order on morbidity could be due to the fact that the quality of infant rearing is better if the mother has fewer children.

Few cases of infants with otalgia and conjunctivitis had a positive history of oil application into the ears and eyes respectively. Hence such rearing practices needs to be widely discouraged. Incidence of diarrheal episodes was significantly more among infants of mothers who did not trim their fingernails regularly. This again stresses the importance of personal hygiene in combating infections.

Based on our observations, we conclude that morbidity pattern is influenced by several factors such as faulty feeding practices, birth order, immunization status, level of personal hygiene among infants and also educational and socio-economic status of their mothers. Thus appropriate health education targeting these aspects and schemes for poverty alleviation will help in preventing morbidities in infants. As also observed, the episodes of various morbidities significantly interfering with the weight gain of infants, morbidity containment will also improve the nutritional status of infants.

Limitations

This being a prospective study was influenced by loss due to follow-up. If the mother and child were not available during the monthly follow-up visit, data pertaining to the present month was obtained during the next visit. Therefore, accuracy of data obtained could have been influenced by recall bias. Moreover, the information on factors influencing morbidity cannot be generalized to the entire country due to the influence of local cultural practices on infant morbidities.

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