Burden of Illness in the First 3 Years of Life in an Indian Slum

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Summary

The morbidity and mortality in a cohort of 452 children followed up from birth up to 3 years of age, in an urban slum in India, is described. These children were recruited and followed from March 2002 to September 2006. A prospective morbidity survey was established. There were 1162 child-years of follow-up. The average morbidity rate was 11.26 episodes/child-year. Respiratory infections caused 58.3 and diarrheal disease 18.4% of the illnesses. Respiratory illnesses resulted in 48, 67.5 and 50 days of illnesses, and there were 3.6, 1.64 and 1.16 diarrheal episodes per child in the 3 years, respectively. There were five deaths in the cohort in the 3 years of follow-up. Of the 77 drop-outs 44 were contacted for mortality data. The morbidity in the area is high, comparable to other studies. The mortality is low, and is attributed to the facilitated access to care.

Key words: childhood morbidity, acute respiratory infections, India.

Introduction

India's urban population increased by 31.2% from 1991 to 2001, compared to 17% in the rural population (17.9%) over the same period [1]. Around 20–25% of urban households in India live in slums, squatter settlements and refugee colonies, and 40–50% of them are below the poverty line (urban), a per capita (INR) $\leq$547.42/month (USD11.4, at INR48/USD) [2]. In general, urban slums have poor sanitation and drainage facilities, are overcrowded, jobs are low paying and insecure [1]. The combination of air pollution and indoor air pollution due to cooking fuels increase the risk of acute respiratory infections [1, 3]. Such environments will promote high morbidity rates.

Even in areas where morbidity is high, mortality rates can be reduced by early recognition of severe illness, and appropriate referral and health care delivery practices. These are the principles embodied in the Integrated Management of Neonatal and Childhood Illnesses (IMNCI), which has been adopted in India. Recognition of morbidity patterns will facilitate appropriate allocation of resources.

We present here data on the morbidity and mortality of a cohort of babies that was followed up from birth to 3 years of age in Vellore, Tamil Nadu, a state with a high immunization coverage and good public health care delivery infrastructure [4]. The data on morbidity in infancy have been published earlier [5] and are the results of a 3-year rotavirus surveillance cohort study. This report differs from the previous article in that it presents the differences in the pattern of morbidity at 2 and 3 years of age and draws attention to the low mortality rate in an area where access to care was facilitated.

Methods

The study site, the cohort recruitment and the baseline characteristics of the households have been described earlier [5]. Briefly, a cohort of 452 children was recruited at birth between March 2002 and September 2003 for a study on rotaviral infections and followed until the age of 36 months with twice weekly home visits to document morbidity. Babies with a birth weight of $<$1500 g or gross congenital

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anomalies were excluded from the study. The study was conducted in contiguous urban slum areas with a population density of 17 000/km^2. The most common occupation of all members of the family was manual production of *beedis* (leaf-wrapped tobacco containing country cigarettes). Access to health services included government hospitals, urban health centers and numerous private practitioners and hospitals.

Fieldworkers were trained to use standard definitions to identify common morbidities and advised to refer infants to a health facility if necessary. Retraining was carried out every 3 months during the first 2 years and every 6 months in the third year. A physician-run study clinic was set up to care for the study cohort. Morbidity data at the clinic were used to validate the information gathered by the field worker. The study team also interacted closely with the government-run urban health clinic for care of patients, and obtained details of health care access by these babies from private health care providers in the area.

Field workers classified morbidity into five categories: (i) acute diarrheal disease: defined as at least three watery stools in a 24-hour period, being considered a new episode if there was a 48-hour symptom-free interval; (ii) acute respiratory illness: defined as runny nose or cough either with or without fever lasting at least 72 hours; (iii) undifferentiated fever: defined as fever not associated with other symptoms and lasting for at least 48 hours; (iv) other infections included ≥ 3 days of swelling or discharge from ears, eyes, skin or other localized infections with or without fever and (v) non-infectious morbidities included congenital diseases, malnutrition, injury and anemia. Illnesses documented as lower respiratory infections, otitis media, meningitis, seizures, congenital anomalies, anemia and malnutrition were physician-confirmed diagnoses and were diagnosed on referral to the clinic. Lower respiratory illnesses were physician-defined, and used the WHO criteria for classification of pneumonia, not accounting for wheezy episodes separately.

Data were double entered using Epi Info6.4 Software (CDC, Atlanta, GA, USA). Quality checks were done at the time of entry and also by programs running logical checks before validation, and data analysis using STATA version 8.0 (State Corp, College Station, Texas, USA). Incidence rates were calculated as the number of episodes divided by the child-years of follow-up. The total person-time at risk was calculated as total days under surveillance minus days of missing surveillance data (if ≥ 1 week), till the end of follow-up. To account for the multiple failures within a child, frailty Poisson survival models were fitted to obtain the variance-corrected incidence rates and rate ratios.

Results

The morbidity in the first year has been published earlier, and a few results referred to here are for comparison purposes only.

The study completed 3 years of follow-up for 373 of the 452 children originally enrolled. Total 44 of 77 dropouts were due to migration from the study area. These drop-outs were contacted to check on child survival, except for 33 who could not be contacted.

The number of illness episodes in the second and third year was 11.27 and 10.52, respectively. The incidence of acute respiratory infections was 7.12 in the second and 6.58 in the third year. Lower respiratory infections more than halved compared with year one, to 0.11 in the second and 0.18 in the third year. Incidence of diarrheal illness declined from 3.6/child-year in the first year to 1.16 in the third year, and undifferentiated fever decreased from 0.5/child-year in the first year to 0.26/child-year in the third year. The rate of other infections remained static, from 1.7/child-year in the first year to 1.64/child-year in the third year (Table 1). Non-infectious morbidity steadily increased from an incidence of 0.5/child-year in the first year to 0.88/child-year by the third year. In particular, injuries increased from 0.12/child-year in the first year to 0.37/child-year in the third year.

A seasonal pattern of gastrointestinal and respiratory illnesses was seen, with gastrointestinal illnesses more often in the hot/dry season from March to June, and respiratory illnesses in the wet/cold season, from October to January. There were a total of 8830 hospital visits made for 6648 episodes of illnesses. The most common diagnoses were: acute respiratory infections (55%), diarrhea (19%), ear infections (7%), skin-related problems (4%) and lower respiratory infections (4%). Hospitalizations were required for 1.7% of the total illnesses, including 2% of the gastrointestinal illnesses and 1.4% of the respiratory illnesses. There were a total of 176 hospitalizations, a rate of 15 (13–19) per 100 child-years.

Parents sought health care for about half (50.7%) of their children's illness episodes experienced. This information was collated from the weekly morbidity surveys, which also included questions on health care access during illness episodes. There was no significant difference in treatment seeking for boys (3671 episodes) than for girls (2977 episodes), (Wald statistic, $P = 0.12$). Not surprisingly hospitalizations were less in years 2 and 3, with 0.97 and 0.68% of total morbidities hospitalized in the second and third year, respectively. The rate of hospitalization reported earlier was 0.28/child-year in the first year, decreasing to 0.11/child-year in the second year and 0.07/child-year in the third year (Table 2).

There were five deaths, with three children dying of diarrhea and dehydration at home during infancy as previously reported [5]. Two children died in

TABLE 1
Burden of illness during the first three years of life in an urban slum birth cohort in southern India

	First year	Second year	Third year
Number of children at the start of follow-up	452	390	380
Child-years of follow-up	403.67	381.68	376.24
Total morbidity			
Number	4837	4300	3958
Rate (95% CI) per child-year	12.0 (11.3–12.6)	11.27 (10.7–11.87)	10.52 (9.95–11.13)
Gastro-intestinal infections			
Number	1345	625	438
Rate (95% CI) per child-year	3.6 (3.3–3.9)	1.64 (1.47–1.83)	1.16 (1.02–1.33)
Respiratory infections			
Number	2442	2716	2476
Rate (95% CI) per child-year	7.4 (6.9–7.9)	7.12 (6.75–7.51)	6.58 (6.25–6.95)
Other infections			
Number	634	573	616
Rate (95% CI) per child-year	1.7 (1.5–1.9)	1.50 (1.33–1.70)	1.64 (1.45–1.86)
Undifferentiated fever			
Number	210	120	97
Rate (95% CI) per child-year	0.5 (0.5–0.6)	0.31 (0.26–0.38)	0.26 (0.21–0.32)
Non-infectious morbidity			
Number	207	266	331
Rate (95% CI) per child-year	0.5 (0.4–0.6)	0.70 (0.60–0.81)	0.88 (0.76–1.02)
Lower respiratory tract infections			
Number	110	40	67
Rate (95% CI) per child-year	0.4 (0.3–0.7)	0.11 (0.08–0.15)	0.18 (0.14–0.24)
Injury			
Number	45	101	139
Rate (95% CI) per child-year	0.12 (0.07–0.19)	0.27 (0.21–0.33)	0.37 (0.31–0.45)
Hospitalization			
Number	106	42	27
Rate (95% CI) per child-year	0.28 (0.22–0.35)	0.11 (0.08–0.16)	0.07 (0.05–0.11)
Median (IQR) number of days ill per child			
Gastro-intestinal infections	8 (3–18)	3 (0–7)	1 (0–4)
Respiratory infections	48 (16.5–87.5)	67.5 (32–118)	50 (23–94)
Other infections	2.5 (0–11)	6 (0–18)	7 (0–22)
Undifferentiated fever	0 (0–2)	0 (0–2)	0 (0–0)
Non-infectious morbidity	0 (0–2)	0 (0–6)	0 (0–7)
Median number of days ill per episode			
Any morbidity	4 (3–9)	5.5 (4–7)	5 (4–7)
Gastro-intestinal infections	3 (2–5)	2 (0–3)	1 (0–2)
Respiratory infections	6 (4–12)	7 (4.5–10)	6 (4–8.75)
Other infections	5 (3–10)	4 (0–7.5)	4 (0–8.5)
Undifferentiated fever	3 (2–4)	0 (0–2)	0 (0–0)
Non-infectious morbidity	4 (3–7)	0 (0–4)	0 (0–4)

CI: confidence interval.

TABLE 2
Distribution of morbidity in an urban slum birth cohort followed for 3 years

Category	First year (%)[a]	Second year (%)[a]	Third year (%)[a]	For all 3 years total (%)[a]
Gastrointestinal infections	27.8	14.5	11.06	18.4
Respiratory infections	50.5	63.16	62.5	58.3
Other infections	13.1	13.3	15.5	13.9
Undifferentiated fever	4.3	2.8	2.4	3.2
Non-infectious morbidity	4.3	6.2	8.3	6.3
Lower respiratory tract infections	2.3	0.9	1.7	1.6
Injury	0.9	2.3	3.5	2.2
Hospitalization	2.2	0.97	0.68	1.3

[a]Percent (%) implies percentage of total morbidities

TABLE 3
Comparison of the measures of morbidity reported in this study with other morbidity studies from developing countries

Type	Place	Year	Follow-up in months	Age group (years)	Frequency of surveillance	No. of children	Measures of morbidity		References
							Type of illness	Rate of prevalence (%)	
Cross-sectional	Karachi, Pakistan	1990	–	0–5	2-week recall	698	Diarrhea Respiratory infn	14.4 15	[23]
	Pune, India	1992–95	–	0–2	1-week recall	797	Diarrhea plus Fever Respiratory infn Total morbidity	26.8 29.4 46.5	[16]
	Lucknow, India	1996	–	3–5	1-month recall	396	Respiratory infn Diarrhea	17.2 6.3	[17]
	Sembabule, Uganda	2001	–	0–2	-	323	Upper respiratory infn Diarrhea	37.4 40.3	[18]
	Urban slum Delhi, India	2004	–	0–4	2-week recall	1307	Acute respiratory Infn Acute diarrheal diseases	14.6 7.7	[10]
Longitudinal	Vellore, India	1965–67	24	0–1	Twice weekly	110	Respiratory infn Diarrhea Total morbidity	Incidence/child-year 7.3 5.6 17.1	[19]
	Rural Bangladesh	1978–79	12	0–4	Once in 2 days	197	Upper respiratory infn Diarrhea	Prevalence/100 child-days 60% Prevalence/100 child-days 17%	[20]
	Haryana, India	1980s	20	0–5	Once in 10 days	1467	Diarrhea	Incidence/child-year 0.7	[21]
	Lucknow, India	1995–96	NA	1.5–3.5	6 months	1061	Respiratory infn Diarrhea	1.67 0.8	[22]

Infn = infection.

hospital, a girl because of a congenital cardiopulmonary disorder at 6 months and a boy's death at 2.5 years being preceded by seizures. Of the drop-outs, one of the 44 who could be contacted had died. The mortality in the remaining 33 is not known and is an acknowledged limitation of the study.

Discussion

This study reports high morbidity with an average of 11 illnesses each year during the first 3 years of life, the two most common causes of illnesses being respiratory and gastrointestinal infections.

Morbidity statistics are most often collected as cross-sectional surveys with a 2- or 4-week recall [6], leading to the possibility of missing milder episodes of illness. This prospective study differs from the others in that it was a longitudinal study with data collected prospectively. The clinic that was established for the purpose of the study helped cross-reference and thereby validate the morbidity data that were collected by the field workers.

There was a high morbidity rate/child-year of 11.26 in < 3-year-olds. There was a marked decrease in gastrointestinal infections from first to second and third year. This is not seen with the milder forms of respiratory infections and may possibly be explained by a wider range of respiratory pathogens or the contributory effects of indoor air pollution promoting susceptibility.

Injuries are increasingly being recognized as contributing to morbidity and mortality. This article presents rates of injuries (Table 1). The number of injuries was higher in years 2 and 3, which is in keeping with the greater physical mobility of the toddler as compared with an infant.

Hospitalization was required for 1.3% of total illness including 2% of gastrointestinal and 1.4% of respiratory infections. There were a total of 176 hospitalizations over 3 years, a rate of 15/100 child-years, with the decrease in hospitalization with an increase in age.

Direct comparison of findings between studies is difficult because of differences in study design, study populations, timing and differences in the measures of disease burden (Table 3). Given these differences, our estimates were closely in range with the morbidity estimates of 2.5 episodes of diarrhea and 4.9 episodes of respiratory infections per child-year in a Bangladesh slum population (0–2-year-olds) with alternate day surveillance as part of a clinical trial [7]. A longitudinal study on children aged < 5 years from a North Indian urban slum [8] and a cross-sectional study on 0–3-year-olds in rural South India [9] estimated that a child experiences six episodes of respiratory infection per year. Another longitudinal study in a Delhi urban slum calculated 1.7 and 2.7 episodes of diarrhea/child-year among children aged < 5 years and infants, respectively [10]. A morbidity study from a poor urban neighborhood in Kerala [11] shows that children < 3 years of age experienced very high rates of morbidity, i.e. 5.4–8.5 episodes of diarrhea per year and 12–38 episodes of respiratory infections per year but the sample size was very small ($n = 18$). Our estimates were comparable to all these previous Indian studies. Incidence rate estimates of 4.2 and 4.8 episodes of diarrhea and acute respiratory infections among infants in a neighboring rural district [12] may reflect the different morbidity pattern of an urban slum vs. a rural community.

Despite a high morbidity rate the mortality rate was low in the urban area. Access to health care, additionally facilitated by the clinic that was set up for the study could be a contributing factor. Studies have shown that if community health workers are adequately trained they are able to pick up signs of illness and encourage people in the community to seek treatment [13, 14]. In India, health workers are being recruited to mediate between the community and the health system and to provide primary care [15], an intervention that is expected to decrease mortality. Our report of low mortality where morbidity is high, suggests that increasing access to health care either by facilitation by health workers, or good road access and public transport systems (as is seen in Tamil Nadu) and integration of the existing health system between government, non-governmental organizations and private health services, as was seen in this cohort, could decrease mortality.

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