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Impact of IMCI health worker training on routinely collected child health indicators in Northeast Brazil

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The Integrated Management of Childhood Illness (IMCI) is a global strategy including improvements in case management at health facilities, strengthening health systems support and improving key family and community practices relevant to child health. In Brazil, IMCI was introduced in 1997, being largely restricted to training health workers in case management. IMCI training of doctors and nurses took place in many municipalities, but implementation of the other two components of IMCI was very limited. We analyze the impact of IMCI health worker training on infant mortality in three states in north-eastern Brazil, by comparing three groups of municipalities over the period 1999 to 2002: 23 with training coverage of 50% or greater, 216 with lower training coverage, and 204 without any IMCI training. Two sources of mortality data are used: vital registration of deaths and births, and the community health workers' (CHW) demographic surveillance system. The latter resulted in a larger number of deaths being reported and in more stable mortality rates over time than the former. Infant mortality rates (IMR) declined rapidly according to both sources of information, during the study period. After adjustment for confounding factors, there was no association between IMCI training coverage and infant mortality measured through either information system. According to the CHW data, the adjusted annual changes were of −7.2 deaths per 1000 births in the high IMCI training coverage group, −4.6 in the low IMCI training coverage and −5.0 in the no IMCI group ($p = 0.46$). According to vital statistics, the corresponding average annual changes were −5.0, −4.2 and −2.8 deaths per 1000 births ($p = 0.16$). The negative findings from the Brazil evaluation suggest that IMCI clinical training, in the absence of the other two components of IMCI, and in an area with infant mortality under 50 per 1000, is unlikely to lead to a measurable impact on mortality.

Key words: child health, indicators, health services, infant mortality, Brazil

Introduction

Over 10 million deaths of children aged under 5 years occur every year, and Brazil is among the 42 countries that account for 90% of all global deaths (Black et al. 2003). Although infant mortality is declining in Brazil (the 2002 rate was estimated at 27.8 per 1000 live births), there are wide regional differences within the country, with the highest rates being observed in the north-eastern states (IBGE 2004).

The Integrated Management of Childhood Illness (IMCI) strategy was launched in the mid-1990s by the World Health Organization and UNICEF to address the leading causes of death among young children (Gove 1997). The strategy was designed to include three components: improving health worker performance, strengthening health systems support and improving family and community practices relevant to child health (World Health Organization 2005).

In Brazil, IMCI implementation started in 1997, and the strategy was adopted by the Family Health Programme of the Ministry of Health. Each family health team includes a doctor, a registered nurse, two health auxiliaries and 4–6 community health workers (CHWs). Each Family Health Programme team covers about 600–1000 families; each CHW visits from 100 to 200 families at least once a month, collecting regular information on deaths, births and other health indicators. However, as will be shown below, most Family Health Programme workers were not trained in IMCI.

The Multi-Country Evaluation of IMCI started in 1998 (Bryce et al. 2004). Brazil was selected as one of the participating countries along with Bangladesh, Peru, Tanzania and Uganda. A survey compared the quality of care provided by health workers who were trained in IMCI with those who had not received such training. For most indicators investigated, IMCI-trained doctors and nurses performed significantly better than those who had not been trained in IMCI (Amaral et al. 2004). Similar results were observed in Bangladesh, Tanzania and Uganda (El Arifeen et al. 2004; Gouws et al. 2004).

The IMCI evaluation also investigated the impact of IMCI on mortality. In Tanzania, where IMCI was strongly implemented in two districts, under-five mortality levels after 2 years were 13% lower than in matched comparison districts (Armstrong Schellenberg et al. 2004). In Peru, on the other hand, there was no association between routine implementation of IMCI in health facilities and infant mortality levels in the 24 departments of the country (Huicho et al. 2005a).

In this paper, we report on the association between IMCI training coverage and routinely collected indicators of infant mortality and programme coverage, in three states in north-eastern Brazil, to address the question of whether or not IMCI implementation is associated with increased coverage and reduced mortality, under routine conditions.

Methods

North-eastern Brazil is the poorest region in the country, a fact that is reflected in its health indicators. Its infant mortality rate (IMR) in 2002, estimated through indirect methods, was 41.4 per 1000, about 50% above the national rate (IBGE 2004). The present study was carried out in three of the nine states in the Northeast region: Ceará, Paraíba and Pernambuco. These were leading states in IMCI implementation in Brazil.

The units of analysis in this study were municipalities. The study was restricted to those with a year 2000 population of 5000 to 50 000 inhabitants. Larger municipalities were excluded because they were atypical (e.g. the state capitals or regional centres), and small municipalities because the number of births and deaths was often too small and there were important fluctuations in mortality rates.

The independent variable was IMCI training coverage among first-level health workers, including doctors and nurses. During visits to the State Secretariats of Health, information on the total number of health workers, and on the number who had been trained in IMCI, was collected for the period 1999–2002. If necessary, the information was confirmed by a phone call to the Municipal Secretariats of Health. Municipalities were then stratified into three groups:

(a) High IMCI training coverage: this included the 23 municipalities presenting IMCI training coverage among health workers of 50% or higher in 2000, and of 60% or higher in 2001 and 2002 (the initial definition was a coverage of 60% or greater in the 3 years, but it had to be relaxed because the number of municipalities was not sufficiently large).
(b) Low IMCI training coverage: this intermediate group included 216 municipalities with at least one IMCI-trained health worker at any time between 2000 and 2002, but did not fulfill the criteria for group A.
(c) No IMCI: including 204 municipalities with no health workers trained in IMCI.

Health worker training is one of the three components of IMCI. The 23 municipalities with high IMCI training coverage and 23 comparison municipalities without IMCI were visited by the research team in order to carry out a health facility survey (Amaral et al. 2004). Forty-eight facilities were visited in each group. This survey showed improved quality of care in IMCI facilities. In terms of health systems support, IMCI and non-IMCI facilities were compared regarding the availability of 10 vaccines, 9 injectable drugs and fluids, and 14 oral drugs. There was only one significant difference between the two groups of facilities, namely the availability of erythromycin which was greater in IMCI facilities (MCE-Brasil: [http://www.geocities.com/mcebrasil]). IMCI facilities were more likely to have all essential vaccines, drugs and equipment (56%) than facilities with no IMCI (28%). Supervision was poor in all facilities; of those in which health workers had received training in IMCI, only 19% (9/48) had received at least one supervisory visit that included observation of case management during the previous 6 months (Amaral et al. 2004). Staff turnover was also high. In 2001, 48 facilities with more than 60% of doctors and nurses trained in IMCI were selected for the survey; only 31 (65%) of these facilities still had a training coverage of 60% or greater (Amaral et al. 2004).

Regarding the community component of IMCI, there was no specific intervention at the time of the study. CHWs were present both in municipalities with and without IMCI, as shown below. Although CHWs delivered a number of child survival messages (e.g. infant feeding, immunizations, oral rehydration, growth monitoring), there was no attempt at integrating these messages with the delivery of IMCI (Cesar 2005), and only in 2003 were specific training materials developed.

Two sources of routinely collected mortality data are available in Brazil. The first is the Mortality Information System (MIS, or SIM in Portuguese) (Ministério da Saúde 2005a), based on officially reported deaths; its companion system, the Live Births Information System or SINASC (Ministério da Saúde 2005b), provides information on the denominator for the IMR. Birth reporting is greater than 80% in most municipalities, but under-reporting of deaths is a common problem, particularly in small towns and in rural areas. Data from the SIM/SINASC databases were analyzed for the period 1999–2002.

The second data source is the community health worker (CHW) information system (SIAB) (Ministério da Saúde 2005c), based on the monthly reporting of deaths, births and other health events by CHWs. The system has high coverage in most small and middle-sized municipalities, typically reaching over 80% of the population. Its coverage in large cities is not as high. Up to 1998, this system was in the implementation phase, so the time series for analysis is restricted to the period 1999–2002. The municipal level data used in the present analyses were obtained by the authors directly from the Secretariats of Health in the three states.

Information was also collected on confounding factors that might affect the association between IMCI implementation and infant mortality. Data for the year 2000 were available on the following indicators, obtained from the Brazilian Institute of Geography and Statistics (IBGE 2005) unless otherwise stated:

- Population: resident population in the 2000 Demographic Census;
- Illiteracy rate: percentage of individuals aged 15 years or more who were illiterate;
- Per capita monthly income: average of household per capita monthly income (in Brazilian reais);
- Poverty rate (%): percentage of households with per capita family income under one-quarter of the minimum wage;
- Water supply (%): percentage of households with piped water inside the house;
- Urban population (%): percentage of individuals living in urban areas;
- Human development index: composite indicator including education, life expectancy and income variables (source: UNDP 2005);
- Distance from state capital (km): distance by road between the seat of the municipality and the centre of the state capital.

Two other confounding variables were also considered. These are coverage of the Family Health Programme in the municipalities (expressed as a percentage of the target of one family health team per 3450 inhabitants) and CHW coverage (expressed as a percentage of the target of one CHW per 975 inhabitants). The information was obtained directly from the Ministry of Health.

Analysis of variance (ANOVA) was used to compare mean levels of confounding factors and of mortality indicators between the three groups of municipalities stratified by strength of IMCI implementation. For the analyses of time trends in mortality rates, the average annual change was calculated for each municipality by regressing IMRs on calendar year, and regression slopes were compared using ANOVA. IMCI implementation was treated as an ordinal variable with three categories (strong, weak, none) and tests for linear trend were carried out.

Results

Information was obtained for all eligible municipalities in the three states: 156 in Ceará, 136 in Paraíba and 151 in Pernambuco. The average municipal population size was 17 777 inhabitants.

Only 23 municipalities (eight each in Paraíba and Pernambuco, and seven in Ceará) were classified as having high IMCI training coverage; 204 had no IMCI-trained staff, and 216 had low training coverage.

Table 1 shows the descriptive statistics for the variables included in the analyses, in the three sets of municipalities. The three groups were similar in terms of illiteracy and water supply. IMCI implementation was associated with population size, income, distance from the capital, human development index, urbanization and poverty rate (with p levels below 0.1). IMCI implementation was more frequent in larger and wealthier municipalities and those closer to the state capital. Such baseline differences were taken into account when examining a possible impact of IMCI.

Table 1 also shows that coverage of the population with family health teams was around 50% in the three sets of municipalities. Coverage rates with CHWs were also

Table 1. Summary statistics for the demographic, socioeconomic and environmental variables, according to strength of IMCI implementation in the 443 municipalities

	Year	High IMCI training coverage		Low IMCI training coverage		No IMCI		All municipalities		P level (ANOVA for linear trend)
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Population	2000	20 252	11 566	20 226	10 698	14 906	9572	17 777	10 558	<0.001
Illiteracy rate (%)	2000	40.2	8.0	39.4	5.6	39.7	6.5	39.6	6.2	0.93
Water supply (%)	2000	36.2	19.5	37.1	16.8	35.6	16.4	36.3	16.7	0.45
Urban population (%)	2000	49.0	22.7	52.0	16.2	48.1	17.6	50.0	17.3	0.09
Per capita monthly income	2000	82.3	23.9	84.9	27.1	76.7	15.8	81.0	22.7	0.001
Human development index[a]	2000	0.605	0.052	0.612	0.038	0.603	0.042	0.607	0.04	0.08
Distance from state capital (km)	2000	123	77	192	123	247	147	213	137	<0.001
Poverty rate (%)	2000	70.5	7.9	69.7	8.2	71.4	6.2	70.6	7.4	0.04
Family Health Programme coverage (%)	2000	53.0	55.6	53.4	42.1	49.7	44.1	51.7	43.8	0.42
Community health worker coverage (%)	2000	112.9	33.1	114.9	24.6	113.4	38.8	114.1	32.3	0.77
Number of municipalities		*23*		*216*		*204*		*443*		

Data sources: IBGE (2005), except for [a] UNDP (2005).

Table 2. Infant mortality rate trends according to two data sources, by strength of IMCI implementation in the 443 municipalities

	Year	High IMCI training coverage		Low IMCI training coverage		No IMCI		All municipalities	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Infant mortality rate (CHW surveillance)	1999	43.8	23.1	42.3	26.1	45.1	28.9	43.7	27.3
	2000	38.8	19.8	39.1	26.9	37.6	24.5	38.4	25.4
	2001	26.3	13.6	32.7	19.8	32.9	22.5	32.5	20.8
	2002	27.9	12.3	31.9	19.5	32.8	21.4	32.1	20.1
Annual reduction per 1000[a]	1999–2002	−6.0	8.1	−3.7	9.2	−4.2	10.3	−4.1	9.7
Infant mortality rate (registered deaths and births)	1999	39.3	18.1	40.0	26.4	34.2	26.6	37.3	26.2
	2000	37.3	13.5	37.5	20.6	33.9	18.7	35.8	19.5
	2001	23.8	11.5	26.9	13.2	25.1	15.0	25.9	14.0
	2002	26.7	10.0	27.5	13.5	27.1	15.0	27.3	14.1
Annual reduction per 1000[b]	1999–2002	−5.1	5.9	−4.8	8.6	−3.0	9.6	−4.0	9.0
Number of municipalities		*23*		*216*		*204*		*443*	

[a]p level = 0.51 (ANOVA comparing the rates of reduction in the three groups).
[b]p level = 0.04 (ANOVA for linear trend in rates of reduction in the three groups).

Table 3. Infant mortality rate trends according to two data sources, by strength of IMCI implementation in the municipalities with at least 100 reported births according to each information system

	Year	High IMCI training coverage		Low IMCI training coverage		No IMCI		All municipalities	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Infant mortality rate (CHW surveillance)	1999	47.6	21.6	43.6	22.2	48.1	26.6	45.6	24.0
	2000	42.6	18.1	38.5	24.9	38.0	23.0	38.6	23.8
	2001	26.6	13.8	32.0	18.8	34.2	22.3	32.5	20.1
	2002	29.9	11.8	30.8	18.3	31.9	20.6	31.2	18.9
Annual reduction per 1000[a]	1999–2002	−6.9	8.1	−4.5	8.2	−5.2	9.6	−4.9	8.8
Number of municipalities		*20*		*191*		*137*		*348*	
Infant mortality rate (registered deaths and births)	1999	41.6	18.1	39.6	24.1	33.2	21.4	37.1	22.9
	2000	37.3	14.1	37.3	19.3	34.4	17.6	36.1	18.4
	2001	26.0	10.8	27.6	12.9	25.9	14.1	26.8	13.3
	2002	26.8	10.4	28.4	13.3	27.6	13.2	28.0	13.1
Annual reduction per 1000[b]	1999–2002	−5.6	5.9	−4.3	7.6	−2.5	7.7	−3.7	7.6
Number of municipalities		*19*		*181*		*126*		*326*	

[a]p level = 0.40 (ANOVA comparing the rates of reduction in the three groups).
[b]p level = 0.01 (ANOVA for linear trend in rates of reduction in the three groups).

similar in the three groups. Coverage was slightly greater than 100% in most municipalities because the original target of one CHW per 975 inhabitants was often exceeded. Because of the lack of association between these variables and IMCI training, it was not necessary to control for them in the adjusted analyses presented below.

Table 2 shows the evolution of mortality rates in the three groups of IMCI implementation, including all 443 municipalities. Both sources of mortality data show evidence of a decline in infant mortality over time. Mortality rates according to the two sources of data were roughly of the same magnitude. In 2002, the correlation coefficient between the two mortality rates, for the 443 municipalities included in the analyses, was equal to 0.620 ($p < 0.001$). Standard deviations tended to be larger for the IMRs based on vital statistics.

According to the CHW system (Table 2), the average annual reductions in the IMR between 1999 and 2002 were of 6.0 deaths per 1000 in the high IMCI training coverage group, 3.7 in the low IMCI training coverage group, and 4.2 in municipalities without IMCI (ANOVA $p = 0.51$). On the other hand, IMR changes based on vital registration were, respectively, 5.1, 4.8 and 3.0, showing a significant trend ($p = 0.04$, ANOVA for linear trend) towards greater reductions with IMCI.

Because all municipalities had at least 5000 inhabitants, the expected number of live births in any given year is likely to be greater than 100. Therefore, the analyses shown in Table 2 were repeated after excluding municipalities with fewer than 100 births in any of the study years. According to the CHW system, 95 municipalities were excluded, and according to vital registration there were 67 exclusions. Table 3 shows that the results did not change markedly after such exclusions. The corresponding

ANOVA p levels were 0.4 for the CHW system and 0.01 (test for linear trend) for vital statistics.

After excluding municipalities with fewer than 100 births, multiple linear regression was used to adjust for the potential confounding effects of population size, per capita income, poverty rate, distance from the capital, urbanization and human development index. According to the CHW data, the adjusted annual changes were of −7.2 deaths (95% CI −11.1 to −3.3) per 1000 births in the high IMCI training coverage, −4.6 (−5.9 to −3.4) in the low IMCI training coverage and −5.0 (−6.5 to −3.5) in the no IMCI group ($p = 0.46$). When the outcome was the IMR reduction according to vital statistics, the corresponding average annual changes were −5.0 (−8.3 to −1.7), −4.2 (−5.3 to −3.2) and −2.8 (−4.0 to −1.5) deaths per 1000 births ($p = 0.16$).

Discussion

Both sources of infant mortality data showed important declines in the IMR over time. Indirect mortality estimates based on demographic censuses and surveys confirm these declining trends for the country as a whole, and especially for the Northeast (IBGE 2004). Unfortunately, the latter data cannot be reliably broken down at municipal level and are only produced at wide time intervals, and as a consequence could not be used for the purpose of this paper. In 2002, the indirect IMR for the Northeast was estimated at 41.4 per 1000. Assuming that this would be the true value, the rate of 32.1 per 1000 (Table 2) according to the CHW system would underestimate the IMR by 22%, and the rate of 27.3 according to vital statistics would lead to an underestimate of 34%. Nevertheless, if under-reporting remains stable over time, and if it does not differ systematically between IMCI and non-IMCI municipalities, these sources may still be useful for detecting a possible impact of IMCI.

Analyses of the IMRs resulting from the two data sources suggest that the CHW system produces more reliable information than vital registration. The former resulted in higher IMRs with lower coefficients of variation (Table 2). A comparison of both systems, carried out in 2002 in Ceará State, showed that outside the state capital, the CHW system detected 10–20% more deaths than vital registration (Penteado 2003). Because CHW coverage was similar in municipalities with and without IMCI, and because the links between facility-based IMCI and CHW activities were weak (Cesar 2005), it is unlikely that using data collected by CHWs could bias the present results.

After adjustment for possible confounders, neither of the sources of data showed a significant association between IMCI and mortality decline, although these seemed to be slightly higher in the municipalities with high IMCI training coverage. Two other large interventions were also active in the study area: the Family Health Programme and the CHW programme. However, their coverage was similar in municipalities with and without IMCI, and therefore these programmes cannot have confounded the present results.

In addition to limitations regarding sources of mortality data, our findings were affected by the fact that the intervention was only partially implemented, particularly in terms of the health systems and community components of IMCI. These limitations are discussed below.

A separate paper in this special issue (Victora et al. 2005) highlights the importance of taking contextual factors into account when interpreting observational studies on the impact of health interventions delivered under routine conditions. Two main types of factors are important. Implementation-related contextual factors reflect the characteristics and the intensity of the programme, as delivered in each setting. Impact-related contextual factors reflect the scope for impact in each setting, which will vary according to burden of disease, epidemiological profile, and baseline coverage of key interventions. The next paragraphs discuss how these factors might affect the interpretation of the present results.

IMCI implementation varies from country to country. Findings from one country will not necessarily be relevant to another country, where the strength and scope of implementation may have been different. In Brazil, efforts were concentrated in the health worker training component of IMCI, whereas the two other components – improving family behaviours and strengthening health systems – were not as strongly implemented. This does not mean that no investments were made in reaching families with general health messages through community health workers. A massive CHW programme was in place which included the promotion of appropriate careseeking for childhood diseases, but its links with IMCI were not particularly strong at the time of the evaluation (Cesar 2005).

As mentioned, IMCI was implemented at the same time as the Family Health Programme, which included incentives to improve staff motivation through higher salaries and the definition of catchment areas for which health teams are responsible. Drug supply was reasonably adequate both in IMCI and in other facilities, but there were important shortcomings regarding supervision (Amaral et al. 2004).

Another relevant factor was that IMCI training was restricted to doctors and nurses (who had 4 years of university education). Quality of care, particularly regarding correct treatment of childhood illnesses, was reasonably adequate in the non-IMCI group, which differs from what was observed in other countries included in the evaluation (Tanzania, Bangladesh and Uganda) where IMCI was delivered by less skilled providers (El Arifeen et al. 2004; Gouws et al. 2004).

IMCI implementation was considerably slower than was foreseen at the time the impact study was designed. High rates of staff turnover (Amaral et al. 2004) meant that it was difficult to identify municipalities with a high coverage of IMCI-trained doctors and nurses during the 3-year study period.

Regarding impact-related contextual factors, the study was carried out in an area where IMRs were around 50 per 1000 when IMCI started to be implemented, and where approximately one-third of all infant deaths are due to conditions addressed by IMCI, including diarrhoea, acute respiratory infections and other infectious diseases (Victora 2001). There is no malaria in north-eastern Brazil. These indicators suggest that the potential impact of IMCI would be considerably smaller than in Tanzania or Bangladesh, where deaths due to conditions addressed by IMCI are much more frequent. At the time of the study, the IMCI algorithm in Brazil did not include children aged less than 7 days, who account for a high proportion of childhood deaths in the country (Victora 2001).

Results from three other IMCI impact evaluation sites have been published so far. In Tanzania, IMCI training was strongly implemented in two districts in a high-mortality area (under-five mortality rates around 150 per 1000 and a high malaria burden), in parallel with district management strengthening activities. This led to reduced mortality and improved nutrition in comparison with two neighbouring districts (Armstrong Schellenberg et al. 2004). In Bangladesh, an efficacy study in which the three components of IMCI are being optimally delivered, and baseline under-five mortality was 90 per 1000, is showing important progress in utilization and careseeking (El Arifeen et al. 2004). Impact data will be available in 2007. Both studies refer to strongly implemented IMCI in high mortality settings.

On the other hand, results from Peru presented in this issue show no impact of IMCI implementation, measured by the coverage of clinical training, on mortality rates (Huicho et al. 2005b). In Peru, clinical IMCI training was not accompanied by health systems strengthening, and community IMCI activities were poorly coordinated with clinical training. As in Brazil, supervision was inadequate and staff turnover rates were high (Huicho et al. 2005a).

One might question the value of attempting to measure impact when an intervention was only partially implemented. We argue that such evaluations are valuable, for two reasons. First, perfect implementation is rare – except in efficacy studies – and as a consequence effectiveness studies are badly needed to guide policy. Secondly, such evaluations can help offset publication bias resulting from the fact that positive impact results, even from imperfectly implemented programmes, may be more likely to be published by enthusiastic advocates of the programme.

Conclusions

The negative findings from the Brazilian evaluation suggest that IMCI clinical training, in the absence of the other two components of IMCI and in an area with no malaria and with infant mortality below 50 per 1000, did not lead to a measurable impact on mortality.

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Biographies

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