Strategies for improving the monitoring of vital events in Brazil

Célia Landmann Szwarcwald

Accepted	30 May 2008
Background	In view of the limitations of survey-based demographic techniques for infant mortality estimation, the current strategy of some developing countries is to improve vital information. This article presents recent progress in the improvement of national databases in Brazil.
Methods	For the vital information analysis, the data sources are the Mortality Information System and the Live Birth Information System. The adequacy analysis is based on five indicators calculated at the municipality level per 3-year period. Adequacy criteria are established by means of the indicator percentile distributions among Brazilian municipalities. To complement the vital data analysis, in 2001, a proactive search of infant deaths was carried out in selected areas of the North and North-east with very deficient information.
Results	Temporal trends of the adequacy indicators indicate advances in both information systems. In 2003–05, 80.3% of municipalities (87.3% population) have adequate live birth data and 63.6% of municipalities (77.9% population) have a satisfactory level of mortality information. The most important problem refers to deaths with undetermined causes, mainly in the North-east. The proactive search of infant deaths showed large deficiencies of vital information in areas of extreme poverty: from 520 infant deaths found in the study, only 175 (33.7%) were reported to the Mortality Information System.
Conclusions	The monitoring of vital events is an essential step in the process of reducing infant mortality. The analysis of local irregularities not only improves the quality of vital data registration, making possible to estimate the infant mortality rate, but also identifies priority areas for intervention.
Keywords	Vital events, underreporting, monitoring indicators, infant mortality, Brazil

Introduction

Due to the close relationship between infant mortality and the socioeconomic and health conditions of a population, the infant mortality rate (IMR) has been widely used to compare health status among countries. However, in spite of the broad use of this health indicator, most developing nations are unable to produce such estimates with a satisfactory level of reliability and timeliness. Defined as the number of infant deaths per 1000 live births, the direct estimation of the IMR depends on complete registration of infant deaths and births.

The difficulty in obtaining accurate estimates of the IMR has encouraged the methodological development of demographic procedures for its estimation.[1]

Oswaldo Cruz Foundation, Av Brasil, 4365, 21045-900, Rio de Janeiro, RJ, Brazil.
E-mail: celials@cict.fiocruz.br

The indirect estimation techniques were originally proposed by Brass[2] and then adapted throughout the years.[3–6] These methods are based on the conversion of the proportions of children dead, classified by the mother's 5-year age-groups, into probabilities of dying between childbirth and different ages of childhood.[7] Since the 1970s, the inclusion of specific questions for the indirect measuring of mortality in censuses and household surveys in many Latin American countries have become standard procedure.[8,9]

More recently, survey-based methods have increasingly adopted direct estimation procedures based on complete birth histories collected from women of reproductive age. The direct estimation technique is based on a life table approach, where the probabilities of dying are estimated from mothers' reports on birth and death dates of their children and the number of children of a particular age exposed to the risk of dying during a specified period.[10] The Demographic and Health Surveys (DHS) employ a variant of this method known as the synthetic cohort life table approach and produce estimates for the periods 0–4, 5–9 and 10–14 years preceding the survey, which refer to mortality rates at interval midpoints of 2.5, 7.5 and 12.5 years before the survey, respectively. The procedure is, however, subject to recall bias and results in progressive underestimation of mortality rates with increased years before the study, since misreporting of birth and death dates are likely to occur more frequently as time goes by.[11]

Although the survey-based estimates facilitated the availability of approximate levels of the IMR in many developing countries, the quality of the statistics from this source depends heavily on the sample size, the design of the study and the way the survey is carried out. Despite the fact the estimates are provided by samples, they are often treated as population parameters without estimation of the error of point estimates.[12]

In general, because of insufficient sample size, the estimation techniques cannot be applied to small geographic areas, limiting the identification of areas with more child health problems. In addition, infant mortality estimates are not of a continuous nature as survey-based methods provide point estimates that refer to a period that is typically 2–3 years before the survey took place and the immediate evaluation of health actions and programmes is much more constrained.[13]

The variability of the indirect estimates according to the adopted system of model life tables[14] or the method of estimation[15,16] is another problem when estimating infant mortality by indirect demographic techniques. This hinders the interpretation of time trends and the knowledge of the real level of infant mortality in the population under study.[17,18]

In view of the limitations of the survey-based demographic techniques and the need to monitor IMR, some countries are investing heavily in improving their vital information systems. This article reports on recent efforts to improve national databases being adopted in Brazil, seeking to contribute to the debate on infant mortality estimation in countries with incomplete vital statistics.

Methods

Historical process

Brazil is politically and geographically divided into five distinct regions (North, North-east, South-east, South and Center-West) with varied physical, demographic and socioeconomic characteristics. The North and the North-east have the worst levels of socioeconomic development. The South-east is the most important region from the economic standpoint and retains 44% of the population, including São Paulo and Rio de Janeiro states. The South occupies the smallest territorial area, representing 14% of the total population and has the highest levels of education and development. The Center-West, where the capital (Brasilia) is located, has an intermediate level of socioeconomic development and presents an accelerated pace of progress.

The country is comprised of a federal district (the seat of the government), and 26 states that are subdivided in 5564 municipalities. The population size of each municipality varies widely: the smallest municipality has 688 inhabitants and the largest, São Paulo, has over 11 million population. Only 249 municipalities have more than 100 000 inhabitants, yet they contain 50% of the population.

The Brazilian Ministry of Health has set up two vital information systems: the Mortality Information System, created in 1976 based on death certificates, and the Live Birth Information System, created in 1994, which provides information on birth conditions and mothers' characteristics. The data are openly available at the government health data internet site disaggregated by municipality (www.datasus.gov.br).

The recognition of the importance of monitoring vital information, along with the easy access to such data, has resulted in a substantial increase of the coverage and quality of both systems over the two last decades.[19] However, due to the persistent incompleteness of vital registration systems in the less developed regions (North and North-east), it is still not possible to estimate the national IMR directly.

In the 1990s, the Ministry of Health implemented a series of programmes focused on reducing infant mortality. The Family Health Program became the national policy for primary care, giving priority to municipalities with the worst socioeconomic levels located in the North and North-east. The implementation of these programmes at the municipality level has led to the need for evaluation of their impact on local populations. Estimation of infant mortality and the monitoring of time trends became, therefore, essential in very poor areas with deficient vital information.

In 1998, by request of the Ministry of Health, IMRs were estimated by indirect demographic techniques in all Brazilian municipalities with more than 80 000 inhabitants,[20] including those with adequate vital information. In these areas, due to the methodological procedure employed, the indirect rates overestimated the true values. As local governments were developing specific actions to reduce the IMR, these high indirect estimates had a very negative impact on morale. Health professionals and researchers were opposed to using these estimates and addressed a manifest to the Ministry of Health.[21]

Presently, the strategy adopted by the Ministry of Health is to improve the vital information systems, focusing on the quantitative aspect (coverage), the regularity of data and the quality of information. As part of this process, since 2001, studies have been conducted to analyse the adequacy of the death and live birth information at the municipal level.

Analysis of vital information at the municipality level

For the analysis of vital information, the data sources are the Mortality Information System and the Live Birth Information System. The analysis of adequacy is based on the following five indicators calculated at the municipality level, per 3-year period:[22,23]

Age-standardized mortality rate
This indicator is used to identify problems in the completeness of the Mortality Information System. Low values indicate deficiency in death information. For comparative reasons, the age-standardized mortality rate per 1000 inhabitants is used, considering the total Brazilian population as the standard population.

Relative mean deviation of the crude mortality rate
This indicator is used to identify temporal irregularities in death information. As only small variations are expected within a period of 3 years, high values are considered critical. This indicator is calculated as the mean deviation from the crude mortality rate (CMR) obtained in the 3-year period:

$$\text{RMDCMR} = \frac{\left[\begin{array}{c} |\text{CMR}_1 - \text{MEAN}| + |\text{CMR}_2 - \text{MEAN}| \\ + |\text{CMR}_3 - \text{MEAN}| \end{array}\right]}{3 \times \text{MEAN}}$$

where

$$\text{MEAN} = \frac{N_{\text{Deaths1}} + N_{\text{Deaths2}} + N_{\text{Deaths3}}}{\text{Pop}_1 + \text{Pop}_2 + \text{Pop}_3}$$

Ratio of informed-to-estimated live births
This indicator is used to identify problems in the completeness of the Live Birth Information System. The estimated number of live births is based on the number of children under 1-year-old resulting from population projection methods and is available for all Brazilian municipalities. Low values indicate under-reporting of live births.

Relative mean deviation of the crude birth rate
Analogously to the mortality indicator, the relative mean deviation of the crude birth rate is used to monitor temporal irregularities in the live birth data. As only small variations are expected in a period of 3 years, high values are considered critical.

Proportion of deaths with undetermined causes
This indicator is calculated as the number of deaths with undetermined causes ('Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified', ICD 10 R90-R99) divided by the total number of deaths. It is used as a tracer of death information quality.

In Brazil, eight states are judged to have adequate vital information.[24] Based on the five indicator distributions in the municipalities of these eight states, criteria for the adequacy of vital information are established for the remaining Brazilian municipalities for every 3-year period. The cut-off points for the age-standardized mortality rate and for the ratio of reported-to-estimated live births are established by the 10% percentile and for the three other indicators by the 90% percentile. Due to the larger variation of data in small municipalities, the critical limits are established by population size category (less than 50 000 population; 50 000 population and over).

Based on these criteria, all Brazilian municipalities are classified every 3 years according to their adequacy in each of the following three dimensions: (i) live births—adequate ratio of reported-to-estimated live births and relative mean deviation of the crude birth rate; (ii) mortality—adequate age-standardized mortality rate and relative mean deviation of the CMR; (iii) quality of the mortality information—adequate proportion of deaths with undetermined causes. The results are available on the internet.[25]

Proactive search of infant deaths
To complement the analysis of adequacy of vital information at the municipality level, a proactive search of infant deaths was carried out in 2001 in eight selected areas located in six states of the North and North-east where the criteria described above suggested that information was very deficient. Each selected area was composed of contiguous municipalities comprising in total a population of at least 50 000. All selected municipalities presented age-standardized mortality rate less than 4 per 1000 inhabitants and Family Health Program coverage higher than 90%. The study sought to identify infant deaths not reported to the Mortality System and failures in the processes of death certification and notification.[26]

The following sources of information were used in the survey: public notary office; official and unofficial

cemeteries; health facilities (hospital patient records); health workers employed by the Community and Family Health Programs; key informants such as traditional midwives, community leaders, healers, faith healers; funeral homes and pharmacies.

Data were collected with a standardized instrument, comprehending foetal and non-foetal infant deaths (<1-year-old) that occurred between January 1 and December 31, 2000 in the selected municipalities. Foetal deaths were included in the analysis for subsequent validation of the type of death. Infant deaths identified at the local level were made available to the Municipality Health Departments, which were then requested by the Ministry of Health to emit and process the missing death certificates.

Results

In Table 1, results of the analysis of vital information adequacy are presented by region in the last period with available data (2003–05). The analysis shows that the highest level of information adequacy has been achieved by the Live Birth Information System: 80.3% of municipalities, representing 87.3% of the Brazilian population, have adequate live birth data. Regarding mortality information, 63.6% of municipalities, representing 77.9% of the population, have satisfactory levels of information.

The analysis of mortality information adequacy shows the pronounced differences between regions: the percentage of population with satisfactory data is <60% in the North but >80% in the Center-South. Deaths ascribed to undetermined causes showed greater variability; the percentage of municipalities classified as adequate for this indicator is only 25.3% in the North-east, compared with 92.1% in the South (Table 1).

In Table 2, time trends of the adequacy indicators are presented. The analysis of the 5 and 10% percentiles of the age-standardized mortality rate and of the ratio of informed-to-estimated live births indicates an improvement in the coverage level of both information systems. In the first period studied

(1996–98), 10% of the Brazilian municipalities presented mortality rates lower than 1.96/1000 and proportions of reported live births less than 0.29. In 2003–05, the 10% percentiles increased to 4.13 and 0.63, respectively. As for data regularity, the analysis of the 90 and 95% percentiles of the relative mean deviations for deaths and live births also shows important changes for the better. Regarding the quality of mortality data, represented by the percentage of deaths with undetermined cause, the time series also show decreasing trends, although at a much slower pace than the other indicators.

In Table 3, the results of the proactive infant death search are presented. From the 520 infant deaths found by the study in the sample of municipalities with very deficient information, only 175 (33.7%) were reported to the Mortality Information System. For the municipalities located in the North-east, Community and Family Health Program reports were the best information source, in which 52% of infant deaths were identified. Health facilities came next, accounting for 28.2% of all deaths reported. In the North, hospital records provided the best information source, followed by official and unofficial cemeteries. It is worth noting that, of all deaths located within the health system (Family Health Program or hospital records), only 22% in the North and 33% in the North-east were reported to the Mortality Information System.

Discussion

In Brazil, vital information systems have shown clear advances in the expansion of coverage as well as improvements in disseminating information and facilitating access to data. The possibility of examining death and live birth information at the municipality level has created new opportunities for monitoring vital events and identifying local irregularities. In this process, criteria were established not only to detect flaws in the sources of information, but also to identify areas with satisfactory notification of vital

Table 1 Percentage of municipalities and percentage of population with adequate information by dimension and macro-geographic region (Brazil, 2003–05)

Region	Dimension					
	Live births		**Mortality**		**Undetermined causes**	
	Municipalities (%)	Population (%)	Municipalities (%)	Population (%)	Municipalities (%)	Population (%)
North	69.3	71.9	32.4	54.6	52.0	43.3
North-east	84.7	86.2	48.7	62.6	25.3	40.3
South-east	80.9	90.9	75.5	88.7	73.7	89.4
South	77.9	86.5	78.7	83.1	92.1	93.1
Center-West	78.4	88.6	69.8	87.2	91.2	95.9
Brazil	80.3	87.3	63.6	77.9	61.7	73.1

Table 2 Progress of the adequacy indicators over period of time (Brazil, 1996–98 to 2003–05)

Percentiles	Period of time 1996–98	1997–99	1998–2000	1999–2001	2000–02	2001–03	2002–04	2003–05
Age standardized mortality rate								
5%	1.10	1.17	1.63	2.05	2.40	2.66	2.88	3.02
10%	1.96	1.99	2.40	2.71	2.95	3.16	3.36	3.50
Ratio of reported-to-estimated live births								
5%	0.19	0.25	0.38	0.47	0.52	0.55	0.56	0.56
10%	0.29	0.37	0.49	0.58	0.62	0.62	0.63	0.63
Relative mean deviation of the CMR								
90%	39.22	45.30	42.05	34.10	29.04	25.97	23.89	22.69
95%	55.39	64.95	56.61	45.38	37.18	33.02	29.73	27.99
Relative mean deviation of the crude birth rate								
90%	70.19	58.68	33.49	26.45	19.98	17.16	15.18	14.61
95%	111.22	66.18	48.81	36.51	26.64	22.23	19.31	18.39
Proportion of deaths with undetermined causes								
90%	63.38	63.64	62.05	59.09	55.93	53.49	50.94	44.02
95%	72.19	73.13	70.27	66.38	63.89	61.54	59.57	51.78

Table 3 Number of infant deaths found in the proactive search by information source and percentage of informed deaths to the Mortality Information System

Searched areas	Source	Number of infant deaths[a]	Reported deaths (%)
North	Household	28	17.9
	Notary office	18	22.2
	Cemetery	59	20.3
	Community/Family Health Program	39	5.1
	Health establishments	69	31.9
	Other	3	0.0
	Total	166	24.7
North-east	Household	33	33.3
	Notary office	19	78.9
	Cemetery	14	4.0
	Community/Family Health Program	184	16.3
	Health establishments	100	70.0
	Other	10	40.0
	Total	354	37.9
North & North-east	Total	520	33.7

Selected Areas of the North and North-east, Brazil, 2000.
[a]The sum of the number of infant deaths does not equal the total because some deaths were found in multiple sources.

statistics, which allowed us also to reveal inconsistencies in indirect estimates.[22]

In the most recent period with available information (2003–05), the analysis indicated that almost 80% of the Brazilian population lives in areas with satisfactory levels of death information. In terms of coverage, however, we point out that the proposed indicators perform well in identifying municipalities with deficient vital information but cannot estimate the completeness of death registration. The establishment of uniform national criteria is another limitation of the method, in view of the diversity of demographic

patterns that can be found in Brazil. Further, since the indicators depend on population projections, the adequacy results are affected by the age-group population estimates, which are still based on the last available census information (in the present case, the year 2000). This is more of a problem for the estimated number of live births as the fertility rate is decreasing very quickly in Brazil.

To address these limitations, the criteria are being refined as the adequacy of information progresses. An example of refinement was the establishment of different cut-off points by municipality population size.[23] Currently, we are in the process of comparing indirect and direct estimates in municipalities with large populations. Special investigations will be conducted in municipalities with important discrepancies.

The results of the monitoring process show the marked health inequalities in the Brazilian population, observed not only in the different levels of the IMR throughout the country,[27] but also by the adequacy of vital information. The problems of IMR estimation are more intense precisely in the areas with the worst health conditions, which have larger deficiencies of information and deserve special care. The proactive search of infant deaths showed, in fact, important deficiencies of vital information and revealed pictures of extreme poverty, such as children buried in household backyards and unofficial cemeteries. The main flaws found in the process of issuing death certificates and reporting infant deaths were: occurrence of deaths without the completion of standardized forms; absence of strategies for certification in cases of household deaths in rural regions; incorrect classification of foetal and neonatal deaths; completion of death certificates by non-doctors; problems with the flow and transfer of local data to the national database and lack of perception of the importance of death registration by the local community, including community health workers.[26]

Corroborating the Brazilian results, lack of recognition of the importance of documentation is one of the main reasons of vital event underreporting in many other developing countries. In the case of infant deaths, illegal burials without completion of death certificates are even more frequent. Studies conducted in rural communities of South Africa and Mexico showed limited maternal knowledge about the importance of reporting infant deaths, as well as the lack of clarity regarding the registration procedures. Long distances from public notary offices and small population size were other factors related to a higher percentage of underreporting.[28,29]

Another interesting finding in the proactive search was the high percentage of infant deaths found in sources within the health system, such as hospital records and Family Health Program reports, but not reported to the Mortality Information System. This result indicates the need for strengthening the relationship between health care and health information systems.

The better quality of information in municipalities covered by the Family Health Program[30] confirms the importance of integrating different health information systems to improve the quality of data. Further, the improvement of the vital information systems among small municipalities in the less developed regions of the country made possible the evaluation of the impact of child health programmes implemented in the 1990s.[31–33]

Additional evidence of advances in infant death notification is provided by Frias and collaborators.[26] Their study compared the mean number of infant deaths reported to the Mortality Information System in the 4 years before and after the process of proactive search. Three of the areas showed an increase of more than 100%, another four showed some, but less marked improvement and only one showed a reduction.

Currently, in municipalities with deficient mortality data, the proactive search of infant deaths in health facilities is officially included as one component of the Mortality Information System. Especially in rural zones, collecting deaths from the civil public notary office has been shown to be insufficient.[34–36]

Although the coverage of the Mortality Information System has increased, deaths due to undetermined causes are still a problem in Brazil. Methods have been proposed to improve the quality of mortality data by the linkage of the Mortality Information System with the Hospitalization Information System, which provides data on the cause of hospitalizations. This would allow collection of information on deaths that occurred in public hospitals. Currently, proposals for analysing verbal autopsy data[37] are being discussed by the Brazilian government.

Apart from the discussions on the limitations of survey-based demographic techniques, this work makes it clear that the monitoring of vital events constitutes an essential step in the process of reducing infant mortality. The analysis of local irregularities not only improves the quality of vital information, making it possible to monitor infant mortality over time, but also identifies priority geographic areas for intervention[38] and supports the development of public policies and local strategies focused specifically on infant mortality reduction.

References

[1] Brass W. Demographic data analysis in less developed countries: 1946–1996. *Popul Stud* 1996;**50:**451–67.

[2] Brass W. *Methods of Demographic Estimation from Incomplete Data*. Chapel Hill: Laboratories for Population Statistics, University of North Carolina at Chapel Hill, 1975.

[3] Sullivan JM. Models for the estimation of the probability of dying between birth and exact ages of early childhood. *Popul Stud* 1972;**26:**79–97.

[4] Trusell TJ. A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. *Popul Stud* 1975;**29:**97–108.

5 Palloni A, Heligman L. Re-estimation of structural parameters to obtain estimates of mortality in developing countries. *Popul Bull UN* 1985;**18:**10–33.

6 United Nations. Step-by-step guide to the estimation of child mortality. *Popul Stud* 1990;**89:**83.

7 United Nations. Manual X: indirect techniques for demographic estimation. *Popul Stud* 1983;**81:**74–96.

8 Latin American, and Caribbean Demographic Center (CELADE/ECLAC). Estimaciones y Proyecciones de Población en los países de América Latina 1950–2050. *Demogr Bull* 1996;**29:**55.

9 Pujol JM. Nuevas metodologías para evaluar y ajustar datos demográficos. *Notas Poblacion* 1985;**13:**57–73.

10 Hill AG, David PH. Monitoring changes in child mortality: new methods for use in developing countries. *Health Policy Plan* 1988;**3:**214–26.

11 Boerma JT, Sommerfelt AE. Demographic and health surveys (DHS): contributions and limitations. *World Health Stat Q* 1993;**46:**222–26.

12 Murray CJ, Laakso T, Shibuya K, Hill K, Lopez AD. Can we achieve Millennium Development Goal 4? New analysis of country trends and forecasts of under-5 mortality to 2015. *Lancet* 2007;**370:**1040–54.

13 Korenromp EL, Arnold F, Williams BG, Nahlen BL, Snow RW. Monitoring trends in under-5 mortality rates through national birth history surveys. *Int J Epidemiol* 2004;**33:**1–9.

14 Guzman JM. Some problems concerning the selection of the most appropriate mortality model for the indirect estimation of infant mortality. *Notas Poblacion* 1985;**13:**75–103.

15 Garenne M. Problems in applying the Brass method in tropical Africa: a case study in rural Senegal. *Genus* 1982;**28:**119–34.

16 Adetunji JA. Infant mortality levels in Africa: does method of estimation matter? *Genus* 1996;**52:**89–106.

17 Szwarcwald CL, Leal MC, Castilho EA. Infant mortality in Brazil: Belíndia ou Bulgária? *Cad Saúde Pública* 1997;**13:**503–16.

18 Burkhalter BR, Miller RI, Silva L, Burleigh E. Variations in estimates of Guatemalan infant mortality, vaccination coverage, and ORS use reported by different sources. *Rev Panam Salud Publica* 1995;**29:**1–24.

19 Jorge MH, Laurenti R, Gotlieb SL. Quality analysis of Brazilian vital statistics: the experience of implementing the SIM and SINASC systems. *Cien Saude Colet* 2007;**12:**643–54.

20 Simões CC. *Estimativas da Mortalidade Infantil por Microrregiões e Municípios*. Brasília: Ministério da Saúde, Secretaria Executiva, Secretaria de Políticas da Saúde, 1999.

21 ABRASCO (Associação Brasileira de Pós-Graduação em Saúde Coletiva). Fórum debate: O uso de fontes de dados para informações sobre mortalidade infantil. *Boletim da ABRASCO* 2000;**79:**1–2.

22 Szwarcwald CL, Leal MC, Andrade CLT, Souza PR Jr. Infant mortality estimation in Brazil: what do Ministry of Health data on deaths and live births say? *Cad Saúde Pública* 2002;**18:**1725–36.

23 Andrade CLT, Szwacwald CL. Socio-spatial inequalities in the adequacy of Ministry of Health data on births and deaths at the municipal level in Brazil, 2000–2002. *Cad Saúde Pública* 2007;**23:**1207–16.

24 Rede Interagencial de Informações para a Saúde (RIPSA). *Indicadores básicos de saúde no Brasil: conceitos e aplicações*. Brasília: Organização Pan-Americana de Saúde, 2002.

25 MONITORIMI – Sistema de Monitoramento de Indicadores Municipais relacionados à Mortalidade Infantil. Fundação Oswaldo Cruz. Available at: http://www.monitorimi.cict.fiocruz.br (Accessed May 5, 2008).

26 Frias PG, Pereira PMH, Andrade CLT, Szwarcwald CL. Mortality Data System: case-study in municipalities with high underreporting data. *Cad Saúde Pública* 2008, in press.

27 Victora CG, Barros FC. Infant mortality due to perinatal causes in Brazil: trends, regional patterns and possible interventions. *Sao Paulo Med J* 2001;**119:**33–42.

28 Tomé P, Reyes H, Piña C, Rodríguez L, Gutiérrez G. Characteristics associated with under-registration of children's deaths in the state of Guerrero, Mexico. *Salud Publica Mex* 1997;**39:**523–29.

29 Jewkes R, Wood K. Competing discourses of vital registration and personhood: perspectives from rural South Africa. *Soc Sci Med* 1998;**46:**1043–56.

30 Barreto IC, Kerr Pontes L, Correa L. Surveillance of infant deaths in local health systems: assessment of verbal autopsy reports and of information gathered from health agents. *Rev Panam Salud Publica* 2000;**7:**303–12.

31 Emond A, Pollock J, Costa N, Maranhão T, Macedo A. The effectiveness of community-based interventions to improve maternal and infant health in North-east of Brazil. *Rev Panam Salud Publica* 2002;**12:**101–10.

32 Terra de Souza AC, Peterson KE, Andrade FM, Gardner J. Ascherio A. Circumstances of post-neonatal deaths in Ceara, Northeast Brazil: mothers' health care-seeking behaviors during their infants' fatal illness. *Soc Sci Med* 2000;**51:**1675–93.

33 Macinko J, Macinko J, Marinho de Souza MdeF, Guanais FC, da Silva Simões CC. Going to scale with community-based primary care: an analysis of the family health program and infant mortality in Brazil, 1999–2004. *Soc Sci Med* 2007;**65:**2070–80.

34 Frias PG, Vidal SA, Pereira PMH, Lira PIC, Vanderlei LC. Evaluation of child mortality notifications to the Information System for Infant Deaths: a case study. *Rev Bras Saúde Matern Infant* 2005;**5(Suppl 1):**S43–51.

35 Mello Jorge MHP. Analysis of mortality data. *Rev Saúde Pública* 1997;**31(4 Suppl):**5–25.

36 Almeida MF, Alencar GP, Novaes HMD, Ortiz LP. Information systems and perinatal mortality: concepts and conditions for the utilization of data in epidemiological studies. *Rev Bras Epidemiol* 2006;**9:**56–68.

37 Reeves BC, Quigley M. A review of data–derived methods for assigning causes of death from verbal autopsy data. *Int J Epidemiol* 1997;**26:**1080–89.

38 Neumann NA, Victora CG, Halpern R, Guimarães PRV, Cesar JA. Assessment of the performance of Pastoral da Criança, a health support group, in promoting child survival and health education in Criciúma, a city in southern Brazil. *Rev Panam Salud Publica* 1999;**5:**400–10.