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Infant mortality and geographic access to childbirth in Brazilian municipalities

ABSTRACT

OBJECTIVE: To analyze geographic access to hospital childbirth in Brazilian municipalities.

METHODS: Information on deaths and births were analyzed in regards to appropriateness for calculating the infant mortality rate during the period 2005 to 2007, for the 5,564 Brazilian municipalities. Indicators of supply and geographic access to health services were calculated to express hospital childbirth access. A multivariate regression model was used to test the association between geographic access to childbirth and the infant mortality rate in municipalities with adequate vital information.

RESULTS: Of the municipalities analyzed, 56% had adequate vital information, corresponding to 72% of Brazil's population. The geographic distance between the municipality of residence and municipality of hospitalization was inversely associated to population size, per capita income and the infant mortality rate, even when controlling for demographic and socioeconomic factors.

CONCLUSIONS: Although important strategies have been developed in Brazil to improve the quality of care for pregnant women, actions to guarantee equal access to childbirth services are still insufficient. Large geographic distance to childbirth facility was identified as a risk factor for infant mortality, together with unequal supply of quality health services and lack of integration with primary care.

DESCRIPTORS: Infant Mortality. Health Services Accessibility. Equity in Access. Health Inequalities. Geographic Distance.

INTRODUCTION

Changes in the health conditions of Brazil during the mid-20th century had a large impact upon infant mortality and morbidity, such as the reduction of infectious and parasitic diseases, improved quality of life and decreased fertility, together with technological advances.[4]

Despite the benefits, the implementation of health policies to reduce infant mortality occurred in an incomplete and delayed fashion in less developed countries, where the same results were not seen. In developed countries, important gains in life expectancy corresponded to large reductions in infant mortality; nonetheless, the decline in mortality during the first year of life did not occur in such a marked fashion in less developed countries.[12]

Research during the 1970s and 1980s highlighted the factors associated to inequality in the trends of decreased infant mortality between nations. Slower decreases were principally attributed to income inequality and differential

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access to health, sanitation and education resources among social strata.[7,13]

The large reduction in infant mortality from control of infectious diseases in developed countries resulted in the increased importance of perinatal causes, which became responsible for the majority of infant deaths. Since the 1970s, perinatal technologies began to be developed with the use of diagnostic methods and sophisticated therapeutic resources that led to increased costs for health systems, increasing differences in infant mortality between developed and developing countries.[22]

The development model that predominated in Brazil over many years was exclusionary and concentrated income, resources and services in specific regions and social strata, resulting in a highly unequal society. This model affected the evolution of infant mortality in Brazil as reflected by the distinct trajectories between geographic regions.[16]

The 1990s was characterized by strong expansion of primary health care through the Brazilian Unified Health Care System (*Sistema Único de Saúde,* SUS) and primary care programs: Community Health Agents (*Agentes Comunitários de Sáude,* ACS) and Family Health Program (*Programa de Saúde da Família,* PSF). These programs contribute to the reduction of infant mortality, particularly in poorer municipalities.[11]

Currently, geographic access to childbirth services, which is related to the unequal provision of quality health services, is a component of maternal and child vulnerability. If access to health services is critical for efficient care and reduction of inequities, then targeting the lack of access among certain population groups is essential for decision-making about the location and scope of services.[20]

In addition to inequality in the availability of health services and resources, the problems with geographic access to childbirth services reflect failures in integration and communication between health sectors. Although childbirth is a foreseeable emergency, maternal and infant care remain fragmented and unorganized.[5]

Geographic access to childbirth is therefore a fundamental measure of maternal and infant care services. If, on one hand, the population's health conditions are strongly associated to the pattern of social inequality, on the other hand, inequalities in access to health services are a direct reflection of the health system's characteristics, such as the availability of services, diagnostic and therapeutic equipment and human resources.[19]

Therefore, analysis of aspects related to geographic access to childbirth services can provide important contributions to reducing infant mortality in Brazil. The study objective was to analyze the geographic access to hospital childbirth in Brazilian municipalities.

METHODS

The study utilized information on deaths and births from the Mortality Information System (*Sistema de Informações sobre Mortalidade,* SIM) and the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos,* SINASC), both generated by the Ministry of Health for the resident population of municipalities during 2005-2007 and by the Survey of Medical-Sanitary Assistance (*Pesquisa de Assistência Médico-Sanitária*, AMS) from 2005. Data were retrieved from the Internet.

The adequacy of the information from SIM and SINASC during 2005-2007 for the 5,564 municipalities was analyzed according to the method by Szwarcwald et al,[17] where indicators of regularity and coverage are calculated to establish the criteria to classify municipalities according to their vital information (deaths and births). The indicators calculated included:

a) Age-standardized by Mortality Rate (MR): defined by the total number of deaths per thousand residents, for a given population and period;

b) Relative mean deviation of the MR: defined as the arithmetic mean of the deviation values of the MR, for each year, in regards to the average MR during the period;

c) Ratio of reported-to-estimated live births (LB): the estimated number of LB is calculated based on the population of under-ones, based on the cohort of LB that survived the first year;

d) Relative mean deviation of the birth rate: defined as the rate between the average deviation of the birth rate, in each year, in regards to the average birth rate during the period.

Municipalities were defined by population category and classified based on critical values of 5% and 10% for the coverage indicators (MR and ratio of reported-to-estimated LB); and the values of 90% and 95% for the indicators of information regularity (relative mean deviations of the MR and birth rate) between the municipalities of the eight Federal Units with adequate information.[1]

For classification of the adequacy of each dimension evaluated, morality and births, the municipalities with coverage indicators greater than 10% and regularity indicators less than 90% were considered satisfactory and those with coverage less than 5% and regularity greater than 95% were considered deficient. All other municipalities were considered unsatisfactory.

Based on this classification, municipalities were considered to have (I) satisfactory vital information, when both dimensions were satisfactory; (II) unsatisfactory vital

information, when at least one of the aspects was not satisfactory and none were deficient; (III) deficient vital information, when at least one of the aspects is deficient.

To characterize the geographic access to hospitalization for childbirth, the following indicators were constructed:

a) Geographic distance to hospitalization for childbirth: projected average distance between the municipality of maternal residence and the municipalities of hospital childbirth. The projections were made according to the proportion of LB in each municipality. The indicator was calculated by the following formula:

$$D(A) = \frac{\sum_{i} w_i \times d(A, A_i)}{\sum_{i} w_i}$$

Where A is the municipality of maternal residence; i is the index for variation of municipalities where the births from municipality A occurred; w_i is the proportion of LB from municipality A that occurred in municipality A_i; $d(A,A_i)$ represents the distance (km) between A and A_i. The intermunicipal distances were calculated by the distance between the center of the municipalities of residency and birth, by geoprocessing of the information. To calculate the geographic distance traveled D(A), intramunicipal distances were not considered; therefore if childbirth occurred in the municipality of residence, D(A,A) was zero. The indicator was calculated for all Brazilian municipalities, based on data from SINASC 2007;

b) Proportion of home births; ratio of the number of LB at a home and the total LB in the period, multiplied by 100. The indicator was calculated for municipalities, based on 2007 data from SINASC;

c) Obstetric beds per 1000 LB: ratio between the number of available obstetric beds in a health establishment and the total number of LB in the municipality, multiplied by 1000. The indicator was calculated for all municipalities, based 2005on data from AMS and SINASC;

d) Number of institutions that hospitalize for childbirth per 1000 LB: ratio of the number of institutions that hospitalize for childbirth in each municipality and the number of LB in the municipality, multiplied by 1000. The indicator was calculated for all municipalities, based on 2005 data from AMS and SINASC;

e) Number of institutions that hospitalize for childbirth and that have a neonatal intensive care unit (NICU) per 1000 LB: ratio of the number of institutions that hospitalize for childbirth and have a NICU in each municipality, multiplied by 1000. The indicator was calculated for all municipalities, based on 2005 data from AMS and SINASC.

To evaluate geographic social inequities, the indicator "geographic distance to hospitalization for childbirth" was analyzed in all Brazilian municipalities by the *per capita* income quintiles of municipalities, according to geographic region and municipal population (1 to 20,000; 20,001 to 50,000; 50,001 to 200,000 and 200,001 or more residents).

In the municipalities with satisfactory vital information, the infant mortality rate (IMR) was by the direct method for the period 2005-2007. The association between infant mortality, geographic access and other factors was analyzed only in these municipalities.

To correlate infant mortality with geographic access to childbirth services, the IMR was calculated by the direct method for municipalities with adequate information, as well as by the level of geographic distance (less than 5km, from 5 to 20 km, from 20 to 50 km and more than 50 km), based on the indicator's percentiles of 10, 50 and 90.

Multivariate regression was used to estimate the association between intermunicipal travel for childbirth hospitalization and infant mortality adjusting for the independent variables of municipal *per capita* income, geographic region, population size, number of NICU beds, proportion of home births and geographic distance to childbirth services.

RESULTS

The analysis of the adequacy of vital information found that approximately 56% (3,112) of municipalities can be categorized as having satisfactory information on LB and deaths. Of the 1,616 municipalities with deficient vital information, 614 are in the Northeast region. Also, almost half of the population in the North region lives in municipalities with deficient information. The Southeast and South regions have the largest proportion of municipalities with satisfactory information (Table 1).

Table 2 reveals the large regional inequity in the number of obstetric beds per 1000 LB, with larger values in the South and Southeast regions. The Central-west region presented greater number of institutions with hospitalization for childbirth, although few had NICU; the same situation occurs in the Northeast region.

Regions with greater magnitudes of travel were from the North and Central-west and smallest in the South region. Slightly more than 70% of Brazilian municipalities have less than 1% of births performed at home; in the North Region, though, the percentage was 40.1% and in the South 90.0% (Table 2).

Almost 10% of municipalities had a travel distance less than 5 km, another 10% had distances greater than 50 km. The median was 21.1 km, less than the mean (26.2 km) due to the long distances traveled.

Table 1. Percentage of municipalities and population per performance level for vital information, according to region. Brazil, 2005-2007.

Region	Performance	No. of municipalities	% of municipalities	% of the population
North	Satisfactory	127	28.3	44.2
	Unsatisfactory	57	12.7	8.2
	Deficient	265	59.0	47.6
	Total	449	100.0	100.0
Northeast	Satisfactory	871	48.6	61.9
	Unsatisfactory	308	17.2	12.0
	Deficient	614	34.2	26.1
	Total	1,793	100.0	100.0
Southeast	Satisfactory	1,092	65.5	81.5
	Unsatisfactory	231	13.8	7.7
	Deficient	345	20.7	10.8
	Total	1,668	100.0	100.0
South	Satisfactory	778	65.5	74.6
	Unsatisfactory	175	14.7	10.2
	Deficient	235	19.8	15.1
	Total	1,188	100.0	100.0
Central-west	Satisfactory	244	52.4	77.0
	Unsatisfactory	65	13.9	7.9
	Deficient	157	33.7	15.1
	Total	466	100.0	100.0
Brazil	Satisfactory	3,112	55.9	71.8
	Unsatisfactory	836	15.0	9.3
	Deficient	1,616	29.0	18.9
	Total	5,564	100.0	100.0

Table 2. Indicators of geographic access, supply of childbirth services and intensive care of newborns according to region. Brazil, 2005 and 2007.

Region	No. of municipalities	Median intermunicipal distance for childbirth, in km (2007)	Proportion (%) of municipalities with at least 1% home childbirth (2007)	Obstetric beds per 1000 LB (2005)	Institutions that hospitalize for childbirth per 1000 LB (2005)	Institutions with ICU that hospitalize for childbirth per 1000 LB (2005)
North	449	33.8	40.1	0.71	1.93	0.10
Northeast	1,793	24.6	61.1	0.67	2.01	0.09
Southeast	1,668	18.0	73.8	1.81	1.44	0.24
South	1,188	16.0	90.9	1.73	2.66	0.23
Central-west	466	27.1	83.2	0.81	2.81	0.15
Brazil	5,564	21.1	71.4	1.26	1.93	0.17

ICU: Intensive care unit; LB: Live births.

Geographic distance was inversely proportion to population size, or in other words, the larger the municipality, the shorter the distance to the municipality of birth. The trend of decreased distance with increased population size occurred in all regions. Small municipalities (less than 20,000 residents) in the North region, presented a median distance greater than 50 km.

Geographic distance to childbirth decreased with increases to *per capita* income. The greatest disparity in distance between the extreme quintiles (lowest and highest income) was encountered in the Northeast region. In Brazil, the median distance for the 1st income quintile is three times greater than for the last quintile (Table 3).

The IMR varied from 15 per 1000 LB, in municipalities with a distance less than 5 km, to 22 per 1000 LB, in municipalities with distance greater than 50 km. In the analysis by region, the pattern held: infant mortality levels increased with intermunicipal distances traveled.

Table 3. Median intermunicipal distance traveled for childbirth per quintiles of municipal income according to region. Brazil, 2005-2007.

Region	Income quintiles	No. of municipalities	Median
North	1	112	30.2
	2	152	36.9
	3	132	38.3
	4	35	20.4
	5	18	8.4
	Total	449	33.8
Northeast	1	907	29.6
	2	729	22.8
	3	127	9.9
	4	16	5.1
	5	14	1.3
	Total	1,793	24.6
Southeast	1	47	40.1
	2	179	31.2
	3	371	22.3
	4	511	19.8
	5	560	8.2
	Total	1,668	18.0
South	1	29	22.6
	2	27	25.1
	3	323	21.1
	4	378	15.6
	5	431	10.6
	Total	1,188	16.0
Central-west	1	19	82.6
	2	25	55.6
	3	168	33.2
	4	160	23.5
	5	94	16.6
	Total	466	27.1
Brazil	1	1,114	30.0
	2	1,112	25.0
	3	1,121	22.3
	4	1,100	18.7
	5	1,117	9.8
	Total	5,564	21.1

The greatest range of variation in the IMR by level of distance was found in the Northeast (Table 4).

The results of multivariate regression model are presented in Table 5. The analysis shows that the association between infant mortality and the intermunicipal geographic distance for hospitalization in childbirth was significant, when controlling for the effects of *per capita* income, geographic region, population size and factors related to the supply and access of health services.

Table 4. Infant mortality rate according to intermunicipal distance traveled by region. Brazil, 2005-2007.

Region	Distance (km)	No. of satisfactory municipalities	CMI[a]
North	< 5 km	16	18.4
	≥ 5 km and < 20 km	37	20.6
	≥ 20 km and < 50 km	35	22.2
	≥ 50 km	39	24.7
	Total	127	19.5
Northeast	< 5 km	52	18.8
	≥ 5 km and < 20 km	293	19.7
	≥ 20 km and < 50 km	463	21.8
	≥ 50 km	63	25.5
	Total	871	19.9
Southeast	< 5 km	207	13.6
	≥ 5 km and < 20 km	481	15.1
	≥ 20 km and < 50 km	355	16.0
	≥ 50 km	49	17.0
	Total	1,092	14.3
South	< 5 km	154	13.0
	≥ 5 km and < 20 km	365	13.8
	≥ 20 km and < 50 km	232	15.1
	≥ 50 km	27	17.3
	Total	778	13.5
Central-west	< 5 km	17	13.6
	≥ 5 km and < 20 km	108	17.7
	≥ 20 km and < 50 km	91	17.2
	≥ 50 km	28	18.7
	Total	244	15.4
Brazil	< 5 km	446	15.0
	≥ 5 km and < 20 km	1,284	16.6
	≥ 20 km and < 50 km	1,176	19.6
	≥ 50 km	206	21.9
	Total	3,112	16.1

[a] IMR: Infant mortality rate calculated directly for the 3,122 municipalities with satisfactory vital information.

DISCUSSION

The health information systems show advances in the expansion of coverage and the promotion and ease of access to data in Brazil. Despite marked regional differences in the adequacy of vital statistics between the North and Northeast and the Central-west regions, studies demonstrate notable progress in the indicators for coverage and regularity of SIM and SINASC.[6,18]

The improvement of information on deaths and LB allows for estimation of infant mortality in more than half of Brazilian municipalities and to correlate it to

Table 5. Multiple regression with infant mortality rate as the outcome variable. Brazil, 2005-2007.

Variable	β	95%CI	p
Region			
North	0.260	0.175;0.346	p < 0.001
Northeast	0.292	0.251;0.332	p < 0.001
Southeast	-		-
South	-0.079	-0.121;-0.036	p < 0.001
Central-west	0.083	0.021;0.146	0.009
Population category (residents)			
1 to 20,000	0.055	-0.041;0.151	0.260
20,001 to 50,000	0.060	-0.037;0.157	0.223
50,001 to 200,000	0.037	-0.070;0.143	0.500
200,001 or more	-		-
Per capita income	0.000	0.000;0.000	0.226
Neonatal ICU beds per 1000 LB	0.008	-0.008;0.023	0.339
Proportion of home childbirth	0.003	0.000;0.007	0.087
Travel to childbirth	0.001	0.000;0.002	0.004
Constant (β_0)	2.607	2.514;2.700	p < 0.001

ICU: Intensive care unit; LB: live births

the indicators for access to childbirth services. The greater the geographic distance for hospitalization in childbirth, the greater the IMR, even when controlling for the effects of region, population size, municipal income and access.

The data presented by this study reveals differences in the supply of childbirth services between regions and states, with a spatial distribution that alternates between patterns of scarcity in some areas and excess in others. The disparities are even greater when considering more complex care.

Health services in Brazil are concentrated in urban areas, capitals and central zones, in detriment to rural areas, poorer areas and the periphery. The result is great disparity in supply and more difficulty in access to health services, as well as socioeconomic and cultural factors.[3,21]

The Amazon had large gaps in the supply of childbirth services, probably due to the large territorial expanse of the region together with low population density. The Northeast region, although it has a large quantity of health institutions that performed births in 2005, has the lowest number of institutions with a NICU per each 1000 LB.

In addition to regional disparities, the inverse relationship between municipal population size and distance to childbirth services became clear: the smaller the population size, the farther the women traveled, probably due to the concentration of institutions with obstetric beds in the large cities. Despite its universal characteristic, the SUS requires effective mechanisms that guarantee accessibility for the population of smaller size municipalities with worse socioeconomic level.[10]

The increase of primary care in Brazil permitted greater access to basic health services, which is important for women during and after pregnancy and for the child after hospital discharge.[2] Nonetheless, improved integration of the actions developed by the FHP and the model of care by the municipal health system remains a challenge for the reduction of infant mortality in Brazil.

The relationship between primary care and hospital activities should reflect continuity and be complementary.[8] Nonetheless, in public institutions it is difficult to establish a relationship between the pregnant women and the health system, which causes unawareness about the history of the pregnancy and a lack of planning for hospitalization for childbirth. Due to the excess burden of care in these institutions, it is common that the pregnant women cannot obtain a space in the first institution she visits to perform the childbirth.[3]

Despite this, maternal and infant care programs already exist, such as the *Curitibana* Mother Program, which seeks to humanize care, improve the quality of prenatal care and rationally order the referral and counter-referral system between services, in order to better organize care for pregnant women and connecting them to maternity wards for childbirth during prenatal care.[9]

The regionalization of health care in Brazil followed a logic of integrated planning, including the notion of ownership in the identification of priorities for intervention at all levels of care. Among the strategies adopted, the Regionalization Plan was developed, which generates a process to regionalize health care in each federal entity and establishes mechanisms and workflows for intermunicipal referrals and counter-referrals.[15]

The Ministry of Health instituted the Prenatal and Birth Humanization Program (*Programa de Humanização no Pré-natal e Nascimento*, PHPN) in 2000, in which reproductive rights and humanization appear as elements structured on the model of maternal and infant care. The PHPN established priority actions, such as increasing access to prenatal care and the promotion of connections between ambulatory care and moment of birth.[14]

Although they were developed within the last decade, important strategies to improve the quality and access to care for pregnant women appear to be insufficient to guarantee equal access to child birth services. Longer intermunicipal distance was a risk factor for infant mortality and is connected to disparities in the supply

of quality services and the lack of communication between ambulatory care and assistance for childbirth.

In a country of such large expanse and regional differences, with nearly unpopulated areas and super populated urban centers, viable and creative adaptations are necessary, which bring positive impacts for maternal and infant health. This study shows that strategies to reduce difficulties to access childbirth services can substantially reduce the persistent inequities of infant mortality.

The use of secondary information to construct the indicators for geographic access and infant mortality can be considered limitations of the study. For the measure of geographic distance, the distances between municipalities were calculated, excluding trips within the same municipality and the search for a vacancy to be admitted for childbirth, which are factors recognized to influence perinatal mortality. In addition, the study only included municipalities with adequate information for the direct calculation of infant mortality. The included municipalities have better socioeconomic levels, larger population size and better living conditions.[1] If other dimensions of access to hospitalization for childbirth were addressed and if all Brazilian municipalities were included instead of only those with adequate vital records, the study results of an association between IMR and geographic distance to childbirth would certainly be more pronounced.

In conclusion, there was evidence of large differences in geographic distance for hospitalization for childbirth, which was associated with socioeconomic level, population size and the location of the municipality of residence, with significant effects upon the levels of infant mortality. In the context of regionalization of health care and the logic of integrated planning, the results suggest that disparities of geographic access to hospital childbirth remain a challenge to be overcome in the structure of regional health systems.

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