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Temporal trends and spatial distribution of unsafe abortion in Brazil, 1996-2012

Tendência temporal e distribuição espacial do aborto inseguro no Brasil, 1996-2012

ABSTRACT

OBJECTIVE: To analyze temporal trends and distribution patterns of unsafe abortion in Brazil.

METHODS: Ecological study based on records of hospital admissions of women due to abortion in Brazil between 1996 and 2012, obtained from the Hospital Information System of the Ministry of Health. We estimated the number of unsafe abortions stratified by place of residence, using indirect estimate techniques. The following indicators were calculated: ratio of unsafe abortions/100 live births and rate of unsafe abortion/1,000 women of childbearing age. We analyzed temporal trends through polynomial regression and spatial distribution using municipalities as the unit of analysis.

RESULTS: In the study period, a total of 4,007,327 hospital admissions due to abortions were recorded in Brazil. We estimated a total of 16,905,911 unsafe abortions in the country, with an annual mean of 994,465 abortions (mean unsafe abortion rate: 17.0 abortions/1,000 women of childbearing age; ratio of unsafe abortions: 33.2/100 live births). Unsafe abortion presented a declining trend at national level (R^2: 94.0%, $p < 0.001$), with unequal patterns between regions. There was a significant reduction of unsafe abortion in the Northeast (R^2: 93.0%, $p < 0.001$), Southeast (R^2: 92.0%, $p < 0.001$) and Central-West regions (R^2: 64.0%, $p < 0.001$), whereas the North (R^2: 39.0%, $p = 0.030$) presented an increase, and the South (R^2: 22.0%, $p = 0.340$) remained stable. Spatial analysis identified the presence of clusters of municipalities with high values for unsafe abortion, located mainly in states of the North, Northeast and Southeast Regions.

CONCLUSIONS: Unsafe abortion remains a public health problem in Brazil, with marked regional differences, mainly concentrated in the socioeconomically disadvantaged regions of the country. Qualification of attention to women's health, especially to reproductive aspects and attention to pre- and post-abortion processes, are necessary and urgent strategies to be implemented in the country.

DESCRIPTORS: Abortion, Induced, statistics & numerical data. Epidemiology. Spatio-Temporal Analysis.

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RESUMO

OBJETIVO: Analisar tendências temporais e padrões de distribuição espacial do aborto inseguro no Brasil.

MÉTODOS: Estudo ecológico realizado com base nos registros das internações hospitalares de mulheres por abortamento no Brasil, no período de 1996-2012, obtidos do Sistema de Informações Hospitalares do Ministério da Saúde. Estimou-se o número de abortos inseguros segundo local de residência, utilizando-se técnicas de estimativas indiretas. Foram calculados os indicadores: razão de aborto inseguro por 100 nascidos vivos e coeficiente de aborto inseguro por 1.000 mulheres em idade fértil. As tendências temporais foram analisadas por regressão polinomial e a distribuição espacial utilizando os municípios brasileiros como unidade de análise.

RESULTADOS: Foram registradas 4.007.327 internações hospitalares por abortamento no Brasil no período. Estimou-se um total de 16.905.911 abortos inseguros, com média anual de 994.465 abortos (coeficiente médio de aborto inseguro de 17,0 abortos/1.000 mulheres em idade fértil e razão de 33,2 abortos inseguros/100 nascidos vivos). O aborto inseguro apresentou tendência de declínio em nível nacional (R^2: 94,0%; $p < 0,001$), com padrões desiguais entre as regiões. As regiões Nordeste (R^2: 93,0%; $p < 0,001$), Sudeste (R^2: 92,0%; $p < 0,001$) e Centro-Oeste (R^2: 64,0%; $p < 0,001$) apresentaram tendência de declínio, enquanto a região Norte (R^2: 39,0%; $p = 0,030$), tendência de aumento, e a região Sul (R^2: 22,0%; $p = 0,340$), de estabilidade. A análise espacial identificou a presença de *clusters* de municípios com altos valores de abortos inseguros, localizados especialmente em estados das regiões Norte, Nordeste e Sudeste.

CONCLUSÕES: O aborto inseguro se mantém como problema de saúde pública no Brasil, com marcantes diferenças regionais e concentradas nas regiões socioeconomicamente menos favorecidas do País. A qualificação da atenção à saúde da mulher, em especial aos aspectos reprodutivos e de atenção aos processos pré e pós-abortamento, são estratégias necessárias e urgentes.

DESCRITORES: Aborto Induzido. Estatística & dados numéricos. Epidemiologia. Análise Espaço-Temporal.

INTRODUCTION

Unsafe abortion represents a controversial and challenging question, which incorporates social justice aspects in low and middle income countries,[7] involving a complex network of legal, economic, social, and psychological factors.[7,17] Unsafe abortion is defined as the interruption of a pregnancy performed by persons/professionals without the necessary technical abilities and/or in environments without adequate sanitary standards.[a] On the other hand, abortion that is considered safe is that which performed in situations set forth in law, making it possible to provide women with the necessary and qualified treatment on behalf of structured health services. These services should offer psychosocial assistance at the moment of decision and guarantee the quality of health care necessary for the treatment and monitoring of the event.[17,a]

Unsafe abortions occur mainly in countries where the laws are restrictive to the procedure or in those where it is legal, but women's access to health services is hampered.[12] As a consequence, unsafe abortion is one of the main causes of maternal morbidity and mortality in these countries.[1,10,b] In 2008, it is estimated that

[a] World Health Organization. Safe abortion: technical and policy guidance for health systems. Geneva; 2003 [cited 2013 Jan 10]. Available from: http://whqlibdoc.who.int/publications/2003/9241590343.pdf

[b] Singh S, Wulf D, Hussain R, Bankole A, Sedgh G. Abortion worldwide: a decade of uneven progress. New York: Guttmacher Institute; 2009 [cited 2013 Jan 10]. Available from: http://www.guttmacher.org/pubs/Abortion-Worldwide.pdf

22 million unsafe abortions occurred around the world, 97.0% in developing countries.[22,23] Approximately 13.0% of maternal deaths in the world are related to unsafe abortion, resulting in 47,000 deaths of women each year, mainly in Latin American countries.[22,23]

In Brazil, the illegality of unsafe abortion obscures its real magnitude and repercussions. The practice of abortion is considered a crime in the country, being permitted by law in cases of sexual violence (rape) or maternal risk of life[8,c] and, more recently, in cases of pregnancies of anencephalic fetuses.[21] Against the difficulties of registering the number of abortions, the estimates are based on hospital admissions due to abortion recorded in the Brazilian Unified Health System (SUS).[17,18] It is estimated that between 729,000 and 1.25 million unsafe abortions are performed annually.[18] It is additionally estimated that by the end of reproductive life, one in five women in Brazil will have had an abortion.[10] Post abortion curettage is the second most frequent obstetrician procedure in the public health system. Around 240,000 hospital admissions are performed annually for treatment of complications arising from abortions in the SUS, generating annual costs of approximately 45 million reais.[d] Besides this, abortion-related indicators reveal strong social and regional inequalities. States in the North and Northeast regions present higher abortion rates[18] and constitute the main cause of maternal death in some capitals of these states.[d]

Knowledge of the magnitude and trends of unsafe abortion is necessary to monitor the progress in the direction of improving maternal health care and access to family planning. Furthermore, it can contribute to the development of public policies that promote the discussion, prevention, and integral and humanized care for women in abortion situations.[14,17] Due to the difficulties of obtaining data, indirect estimates have been important tools, and various methodologies have been developed and tested.[2,11,14]

The objective of this study was to analyze time trends and spatial distribution patterns of unsafe abortion in Brazil, from1996 to 2012.

METHODS

Ecological study of time-series and spatial analysis, utilizing secondary data of hospital admissions due to abortion occurring in Brazil, from 1996 to 2012. A database was compiled based on the number of hospital admissions due to abortion, the number of live births and the population of women aged 10 to 49. The data were obtained from the *Sistema de Informações Hospitalares* (SIH – Brazilian Hospital Information System) and the *Sistema de Informações sobre Nascidos Vivos* (SISNAC – Brazilian Live Birth Information System), from the *Departamento de Informática do SUS* (DATASUS – Brazilian Unified Health System Information Technology Department)[e] and the Brazilian Institute of Geography and Statistics (IBGE).[f] The population data were collected from the Brazilian Population Demographic Census (2000 and 2010), Population Counting (1996) and population estimates for inter census years (1997-1999, 2001-2009 and 2011-2012).[f] The data of live births were obtained from the live birth declarations (DN), standardized nationwide (data available until 2011).[e] The information about hospitalizations due to abortion were obtained from the *Autorização de Internação Hospitalar* (AIH – Hospital Admission Authorization) recorded from 1996 to 2012,[e] according to place of residence. Abortion and its complications correspond to the codes O00-O08 (Pregnancy with abortive outcome), of Chapter XV – Pregnancy, childbirth and puerperium, of the Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10).[g]

The number of hospitalizations due to abortion (NIH – *internações hospitalares por abortamento*) subsidized the calculation of estimates of unsafe abortions (NAI – *número de abortos inseguros*) by year and place of residence. To achieve this, the methodology of Alan Guttmacher[2] was used, based on the following formula:

$$NAI = (5)*(1.125)*(0.75)\ NIH$$

This methodology estimates the number of unsafe abortions, considering: 20.0% of hospital admissions due to abortion complications (one admission for every five abortions); parameter of 12.5% as an estimate of underreporting (admissions performed outside SUS) and a discount of 25.0% of abortions due to spontaneous causes.[17,18] The following indicators were calculated: unsafe abortion rate per 1,000 women of childbearing age (10 to 49), a measurement that describes the number of unsafe abortions in a female population in reproductive age, and the unsafe abortion ratio per 100 live births (2000-2011), that indicates the probability of a pregnancy ending in unsafe abortion instead of a live birth.[23]

[c] Decreto-lei no 2.848, de 7 de dezembro de 1940. Código penal. *Diario Oficial Uniao*. 31 dez 1940:2391.
[d] Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas Estratégicas. Área Técnica de Saúde da Mulher. Atenção humanizada ao abortamento: norma técnica. Brasília (DF); 2005.
[e] Ministério da Saúde, Departamento de Informática do SUS. DATASUS. Brasília (DF): 2013 [cited 2013 Oct 13]. Available from: http://www2.datasus.gov.br/DATASUS/index.php?area=02
[f] Instituto Brasileiro de Geografia e Estatística. População Residente. 2013 [cited 2013 Dec 15]. Available from: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?ibge/cnv/popuf.def
[g] Word Health Organization. Statistical Classification of Diseases and Related Health Problems (ICD): 10th rev. Geneva; 2007 [cited 2013 Jan 10]. Available from: http://apps.who.int/classifications/apps/icd/icd10online/

Data analysis was performed in two stages. In the first, the time trends of unsafe abortion indicators were analyzed using the five geographic regions (North, Northeast, Central-West, South and Southeast) and the 27 states as units of analysis. Time trends analysis was performed using the polynomial regression method,[15] with the objective of identifying the curve that best adjusted to the data, in order to describe the relationship between the dependent variable Y (unsafe abortion indicator) and the independent variable (year of study). To avoid the autocorrelation between the terms of the regression equation, an artifice of centralizing the year variable was used, transforming it to calendar year minus the mid-point of the historic series. The following models were tested: first order (simple linear) ($Y = \beta_0 + \beta_1 X$), second order ($Y = \beta_0 + \beta_1 X + \beta_2 X^2$), third order ($Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 X^3$), where β_0 is the period average rate and β_1, β_2 and β_3 represents the average annual increment. The choice of the best model was based on the best function according to scatterplot, best adjustment by the analysis of residuals, greatest statistical significance and greatest determination coefficient (R^2). In the case of similar statistical models, the simpler one was chosen. The trends were considered statistically significant when the models presented a p-value < 0.05.

In the second stage, the spatial distribution patterns of unsafe abortion in Brazil were analyzed using the municipalities of residence (5,565; territorial division of 2010) as unit of analysis. Methods of spatial analysis and GIS techniques were used to evaluate the geographic distribution and spatial dependence of unsafe abortion indicators in Brazil.

Two strategies were used as the basis for the construction of thematic maps. To correct the random fluctuations and provide greater stability of unsafe abortion rates, especially in municipalities with small populations, the average rates were estimated in three sub-periods (1996-2000, 2001-2006 and 2007-2012) and total period (1996-2012). The unsafe abortion rates were again estimated (smoothed rates) through the Local Empirical Bayesian method.[5]

The presence of global spatial dependence was analyzed using the Global Moran's I index on crude rates.[6] The local autocorrelation (LISA – Local Index of Spatial Association) was assessed by the Local Moran's index.[3] To identify critical or transition areas, we used the Moran scatterplot based on the Local Moran's index.[3] For spatial representation of the Moran scatterplot, we used the Moran Map that considers only the mapping of municipalities with statistically significant differences (p < 0.05).

We used SPSS software version 15.0 in the preparation of polynomial regression and scatterplots. ArcGIS software version 9.3 (Environmental Systems Research Institute, ESRI, Redlands, CA, USA) and TerraView version 4.2 (INPE – *Instituto Nacional de Pesquisas Espaciais, Sao José dos Campos,* SP, Brazil) were used for processing, analysis and presentation of cartographic data, calculation of autocorrelation spatial indicators and construction of thematic maps.

Since this is an ecological study using secondary data available to the public without identifying individuals, there was a waiver of the submission to the Ethics Research Committee.

RESULTS

Between 1996 and 2012, 4,007,327 hospital admissions due to abortion were recorded in SIH/SUS, with an average annual of 235,725 hospital admissions. We estimated 16,905,911 unsafe abortions in Brazil, with an average annual of 994,465 (95%CI 961,767; 1,027,163).

Hospital admissions due to abortion, estimates of unsafe abortion and unsafe abortion indicators by regions and states are shown in Table 1. The average annual unsafe abortion rate was 17.0 abortions/1,000 women of childbearing age, while the unsafe abortion ratio was 33.2 abortions/100 live births. The highest proportion of cases of hospital admissions and unsafe abortions was recorded in the Southeast region (39.2%), especially in the state of Sao Paulo (19.0%). The Northeast region presented the highest values of unsafe abortion indicators (rate: 21.6 abortions/1,000 women of childbearing age; ratio: 39.7 abortions/100 live births). Most states in the North (6/7) and Northeast (6/9) regions, and the states of Federal District and Rio de Janeiro, had higher unsafe abortion rates than the national average, while most states in the Northeast (6/9) and Southeast (3/4) regions, as well as the states of Amapá, Acre and the Federal District, presented unsafe abortion ratio values higher than the national level (Table 1). The state of Amapá had the highest unsafe abortion rate (35.9 abortions/1,000 women of childbearing age) and the state of Bahia, the highest unsafe abortion ratio per live births (53.6 abortions/100 live births) (Table 1).

Trends of unsafe abortion indicators, grouped by regions and states, are presented in Tables 2 and 3. The unsafe abortion rate presented a trend of significant and steady decline in the country (R^2: 94.0%; p < 0.001) (linear model), with distinct patterns among the regions and states. Similar to the national pattern observed, the Northeast (R^2: 93.0%; p < 0.001), the Southeast (R^2: 92.0%; p < 0.001) and Central-West (R^2: 64.0%; p < 0.001) regions presented trend of significant and steady decline in the period (linear model). The largest decrease was observed in the Northeast region, with an

Table 1. Distribution of hospital admissions by abortion, estimates of unsafe abortions and indicators of unsafe abortions by regions and states. Brazil, 1996-2012.

Region/States	Number of admissions due to abortions (in thousands)	Estimate of unsafe abortions[a] (in thousands)	Percentage of unsafe abortions (%)	Annual Average of unsafe abortions (in thousands)	Unsafe abortion rate (per 1,000 WCBA)[b]	Unsafe abortion ratio (per 100 NV)
North	364,431	1,537,443	90,438	9.1	20.2	30.3
Rondônia	29,877	126,044	7,414	0.7	15.4	26.0
Acre	24,894	105,022	6,178	0.6	32.0	38.6
Amazonas	85,000	358,594	21,094	2.1	21.4	30.9
Roraima	12,465	52,587	3,093	0.3	26.5	31.5
Pará	158,559	668,921	39,348	4.0	18.6	29.1
Amapá	25,916	109,333	6,431	0.6	35.9	43.8
Tocantins	27,720	116,944	6,879	0.7	17.4	26.1
Northeast	1,404,084	5,923,479	348,440	35.0	21.6	39.7
Maranhao	111,535	470,538	27,679	2.8	14.7	24.6
Piauí	80,699	340,449	20,026	2.0	20.9	39.7
Ceará	224,350	946,477	55,675	5.6	22.1	41.4
Rio Grande do Norte	51,097	215,565	12,680	1.3	13.4	24.0
Paraíba	59,830	252,408	14,848	1.5	13.1	25.0
Pernambuco	227,464	959,614	56,448	5.7	20.9	37.7
Alagoas	87,386	368,660	21,686	2.2	22.7	35.9
Sergipe	79,525	335,496	19,735	2.0	31.6	52.9
Bahia	482,198	2,034,273	119,663	12.0	27.1	53.6
Southeast	1,571,665	6,630,462	390,027	39.2	15.5	33.0
Minas Gerais	388,272	1,638,023	96,354	9.7	15.8	36.6
Espírito Santo	73,141	308,564	18,151	1.8	16.5	33.5
Rio de Janeiro	350,053	1,476,786	86,870	8.7	17.6	37.3
Sao Paulo	760,199	3,207,090	188,652	19.0	14.4	29.8
South	381,912	1,611,191	94,776	9.5	11.1	23.0
Paraná	149,830	632,095	37,182	3.7	11.3	22.3
Santa Catarina	103,578	436,970	25,704	2.6	13.7	28.9
Rio Grande do Sul	128,504	542,126	31,890	3.2	9.4	20.3
Central-West	263,207	1,110,405	65,318	6.6	15.4	28.8
Mato Grosso do Sul	47,231	199,256	11,721	1.2	16.2	28.8
Mato Grosso	42,966	181,263	10,663	1.1	12.0	21.4
Goiás	90,981	383,826	22,578	2.3	12.4	24.5
Federal District	82,029	346,060	20,356	2.0	25.1	45.1
Brazil	4,007,327	16,905,911	994,465	100.0	17.0	33.2

Source: Hospital Information System (SIH/SUS); Information System on Live Births (SINASC); Brazilian Institute of Geography and Statistics (IBGE).
WCBA: Women of childbearing age; NV: Live Births
[a] N_{AI} = (5) (1.125) (0.75) N_{IH}, where N_{AI}: number of unsafe abortions; N_{IH}: number of hospitalizations due to abortion.
[b] C_{AI}=N_{AI}/N_{WCBA} 1000, where C_{AI}: unsafe abortion rate; N_{WCBA}: number of women of childbearing age (10 to 49) (1996-2012).
[c] R_{AI} = N_{AI}/N_{NV} 100, where R_{AI}: unsafe abortion ratio per live births; N_{NV}: number of live births (1996-2011).

annual reduction of 0.63 abortions/1,000 women of childbearing age. In contrast, the North region (R^2: 39.0%; p = 0.030) showed a trend of significant and not constant increase (second order model), while the South region (R^2: 22.0%, p = 0.340) showed a stable trend (Table 2). Most states (16/27) showed a decline trend in the unsafe abortion rates in the period. The states of Amazonas, Amapá, Tocantins, Maranhao, Paraíba and Rio Grande do Sul showed significant increase trends over the period (Table 2).

In contrast to the pattern of decline observed in the unsafe abortion rate, the unsafe abortion ratio/live births presented a stable trend at the national level (R^2: 46.0%; p = 0.052). The North (R^2: 60.0%; p < 0.001), South (R^2: 78.0%; p < 0.001) and Central-West (R^2: 23.0%; p = 0.006) regions presented trends of significant and steady increase in the period (linear model). The North (R^2: 57.0%; p = 0.001) and Southeast (R^2: 25.0%; p = 0.047) regions presented trends of significant and steady decline of this indicator (linear model) (Table 3). Over 40.0% of the states (12/27) presented increase trends in the period. The states of Rondônia, Amazonas, Roraima, Amapá, Tocantins, in Northern Brazil, Paraiba, Northeastern Brazil, Paraná, Rio Grande do Sul, Southern Brazil, Mato Grosso and Goiás, Central-Western Brazil, presented trends of steady increase (linear model) (Table 3).

During the period, 99.9% (5,560/5,565) of municipalities recorded at least one case of hospitalization due to abortion. The distribution of average unsafe abortion rates among municipalities ranged from zero to 124.5 abortions/1,000 women of childbearing age, while the smoothed rates ranged from 0.4 to 122.3. Figures 1 and 2 show maps of the spatial

Table 2. Trend analysis of unsafe abortion rates by regions and states. Brazil, 1996-2012.

Regions/States	Model[a]	R^{2b}	p	Trend
North	$Y = 21.139 + 0.66x - 0.044x^2$	0.393	0.03	Increasing, not constant
Rondônia	$Y = 15.363 - 0.079x + 0.011x^2 + 0.003x^3$	0.061	0.838	Stable
Acre	$Y = 31.433 - 0.538x$	0.328	0.016	Decreasing and constant
Amazonas	$Y = 25.043 + 0.416x - 0.165x^2$	0.710	< 0.001	Increasing, not constant
Roraima	$Y = 22.496 + 1.035x + 0.148x^2$	0.135	0.362	Stable
Pará	$Y = 18.533 - 0.276x$	0.728	< 0.001	Decreasing and constant
Amapá	$Y = 34.636 + 1.122x$	0.335	0.015	Increasing and constant
Tocantins	$Y = 17.140 + 0.454x$	0.380	0.008	Increasing and constant
Northeast	$Y = 21.747 - 0.631x$	0.930	< 0.001	Decreasing and constant
Maranhao	$Y = 14.529 + 0.248x$	0.443	0.004	Increasing and constant
Piauí	$Y = 21.160 - 0.609x$	0.863	< 0.001	Decreasing and constant
Ceará	$Y = 22.342 - 0.778x$	0.873	< 0.001	Decreasing and constant
Rio Grande do Norte	$Y = 12.267 - 0.550x + 0.048x^2 + 0.009x^3$	0.368	0.103	Stable
Paraíba	$Y = 12.835 + 0.630x$	0.686	< 0.001	Increasing and constant
Pernambuco	$Y = 21.073 - 0.724x$	0.927	< 0.001	Decreasing and constant
Alagoas	$Y = 22.931 - 0.741x$	0.747	< 0.001	Decreasing and constant
Sergipe	$Y = 32.287 - 1.513x$	0.956	< 0.001	Decreasing and constant
Bahia	$Y = 27.321 - 1.113x$	0.921	< 0.001	Decreasing and constant
Southeast	$Y = 15.817 - 0.431x$	0.921	< 0.001	Decreasing and constant
Minas Gerais	$Y = 16.105 - 0.457x$	0.881	< 0.001	Decreasing and constant
Espírito Santo	$Y = 17.110 - 0.760x$	0.911	< 0.001	Decreasing and constant
Rio de Janeiro	$Y = 17.938 - 0.609x$	0.768	< 0.001	Decreasing and constant
Sao Paulo	$Y = 14.770 - 0.323x$	0.894	< 0.001	Decreasing and constant
South	$Y = 11.358 - 0.122x - 0.005x^2 + 0.003x^3$	0.220	0.340	Stable
Paraná	$Y = 11.461 - 0.110x$	0.268	0.033	Decreasing and constant
Santa Catarina	$Y = 13.991 - 0.355x$	0.698	< 0.001	Decreasing and constant
Rio Grande do Sul	$Y = 9.569 + 0.354x$	0.508	0.001	Increasing and constant
Central-West	$Y = 15.542 - 0.274x$	0.637	< 0.001	Decreasing and constant
Mato Grosso do Sul	$Y = 16.412 - 0.521x$	0.866	< 0.001	Decreasing and constant
Mato Grosso	$Y = 11.682 + 0.077x + 0.016x^2 - 0.003x^3$	0.215	0.352	Stable
Goiás	$Y = 13.647 - 0.117x - 0.047x^2$	0.683	< 0.001	Decreasing, not constant
Federal District	$Y = 25.275 - 0.662x$	0.534	0.001	Decreasing and constant
Brazil	$Y = 17.221 - 0.396x$	0.942	< 0.001	Decreasing and constant

[a] Model: y = unsafe abortion rate (per 1,000 WCBA); x = year of abortion – middle year of period studied (2004).
[b] R^2: coefficient of determination.

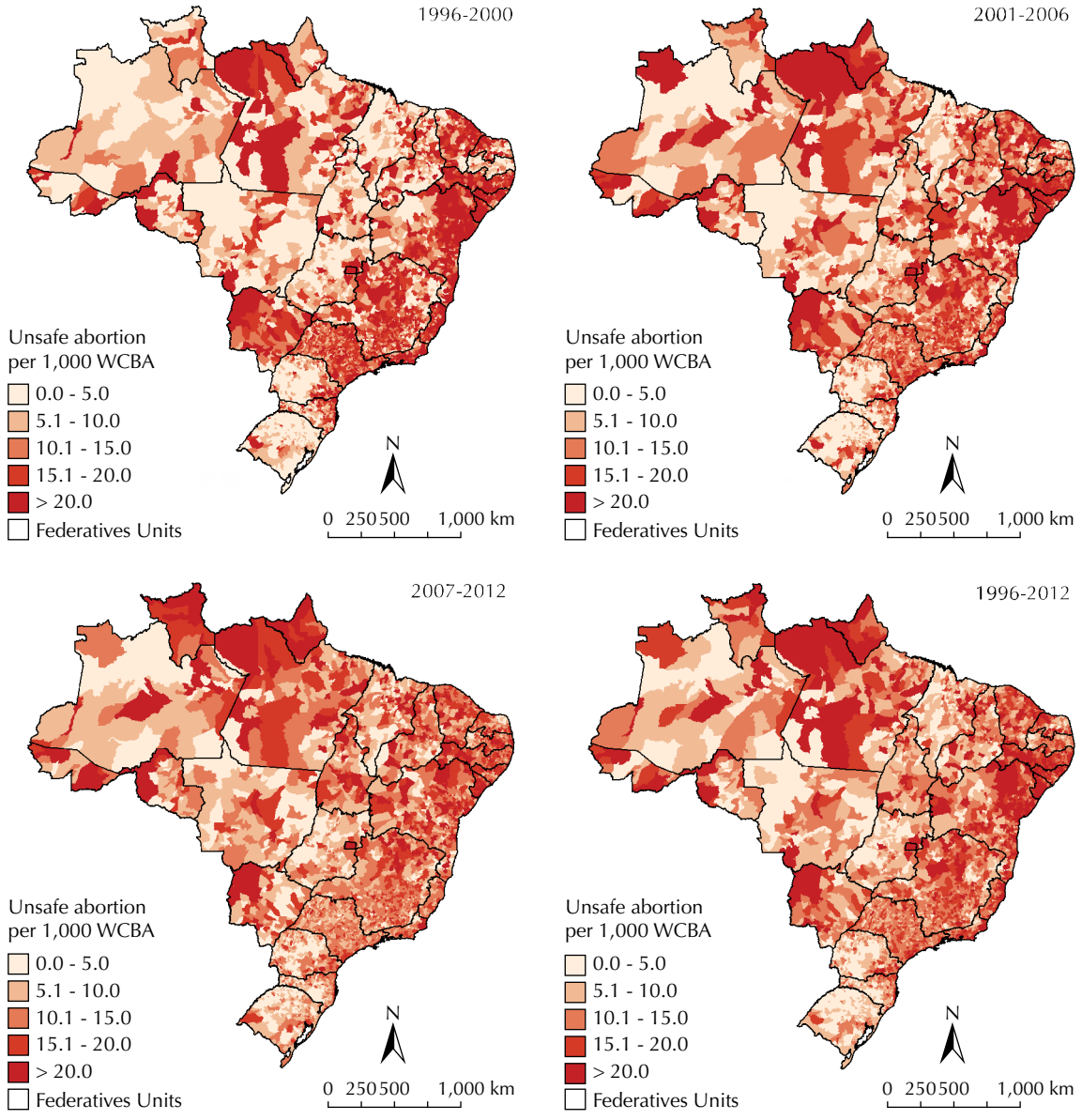
distribution of average crude and adjusted (smoothed) unsafe abortion rates, respectively. In general, both maps show municipalities and/or clusters of municipalities with high unsafe abortion rates (> 20 abortions/1,000 women of childbearing age) in almost all states, located mainly in North, Northeast, Southeast and Central-West regions (Figures 1 and 2). The Northeast and North regions concentrate most of these municipalities, covering important areas with high rates in all states (Figures 1 and 2). Furthermore, important clusters of municipalities with high rates in west of Mato Grosso do Sul, south of Mato Grosso, east of Goiás, the Federal District and north of Minas Gerais were found (Figures 1 and 2).

The Global Moran's I index for the entire period and sub-periods showed positive (ranging from 0.18 to 0.28) and significant ($p < 0.01$) values, indicating global spatial autocorrelation with similar patterns in Brazil. Figure 3 shows the clusters of municipalities identified according to the Local Moran's index for the unsafe abortion rates and visualized by Moran Map. During this period, were identified clusters of municipalities with high rates (high/high) located from the north and east of Sao Paulo, extending to

Table 3. Trend analysis of unsafe abortion ratios by regions and states. Brazil, 1996-2011.

Region/States	Model[a]	R^{2b}	p	Trend
North	$Y = 30.106 + 0.554x$	0.60	< 0.001	Increasing and constant
Rondônia	$Y = 26.405 + 0.992x$	0.602	< 0.001	Increasing and constant
Acre	$Y = 38.152 + 0.900x + 0.021x^2 - 0.023x^3$	0.150	0.568	Stable
Amazonas	$Y = 30.299 + 1.066x$	0.486	0.003	Increasing and constant
Roraima	$Y = 31.435 + 2.385x$	0.288	0.032	Increasing and constant
Pará	$Y = 29.306 - 0.307x$	0.380	0.011	Decreasing and constant
Amapá	$Y = 43.603 + 2.947x$	0.725	< 0.001	Increasing and constant
Tocantins	$Y = 26.281 + 1.315x$	0.634	< 0.001	Increasing and constant
Northeast	$Y = 39.775 - 0.623x$	0.572	0.001	Decreasing and constant
Maranhao	$Y = 22.347 - 0.073x + 0.122x^2$	0.436	0.024	Decreasing, not constant
Piauí	$Y = 40.617 - 1.337x$	0.533	0.001	Decreasing and constant
Ceará	$Y = 41.403 - 0.573x$	0.428	0.006	Decreasing and constant
Rio Grande do Norte	$Y = 22.033 - 0.594x + 0.097x^2 + 0.027x^3$	0.474	0.046	Decreasing, not constant
Paraíba	$Y = 24.841 + 1,296x$	0.627	< 0.001	Increasing and constant
Pernambuco	$Y = 37.614 - 0.407x$	0.418	0.007	Decreasing and constant
Alagoas	$Y = 38.496 - 0.090x - 0.122x^2$	0.383	0.043	Decreasing, not constant
Sergipe	$Y = 52.718 - 0.730x$	0.361	0.014	Decreasing and constant
Bahia	$Y = 53.733 - 1,574x$	0.641	< 0.001	Decreasing and constant
Southeast	$Y = 32.943 - 0.210x$	0.254	0.047	Decreasing and constant
Minas Gerais	$Y = 37.378 - 1,079x$	0.424	0.006	Decreasing and constant
Espírito Santo	$Y = 33.396 - 0.692x$	0.798	< 0.001	Decreasing and constant
Rio de Janeiro	$Y = 41.354 - 0.282x - 0.194x^2$	0.744	< 0.001	Decreasing, not constant
Sao Paulo	$Y = 31.884 + 0.072x - 0.093x^2$	0.677	0.001	Decreasing, not constant
South	$Y = 23.314 + 0.695x$	0.781	< 0.001	Increasing and constant
Paraná	$Y = 22.495 + 0.380x$	0.557	< 0.001	Increasing and constant
Santa Catarina	$Y = 28.592 + 0.027x + 0.015x^2 + 0.001x^3$	0.106	0.705	Stable
Rio Grande do Sul	$Y = 21.104 + 1,357x$	0.744	< 0.001	Increasing and constant
Central-West	$Y = 28.815 + 0.268x$	0.231	0.006	Increasing and constant
Mato Grosso do Sul	$Y = 28.851 - 0.367x$	0.392	0.009	Decreasing and constant
Mato Grosso	$Y = 21.365 + 0.404x$	0.631	< 0.001	Increasing and constant
Goiás	$Y = 24.685 + 0.487x$	0.377	0.011	Increasing and constant
Distrito Federal	$Y = 50.223 + 0.273x - 0.241x^2$	0.798	< 0.001	Decreasing, not constant
Brazil	$Y = 33.606 + 0.290x - 0.019x^2 - 0.011x^3$	0.462	0.052	Stable

[a] Model: y = unsafe abortion ratio (per 100 live births); x = year of abortion – middle year of the period studied (2003,5).
[b] R^2: coefficient of determination.



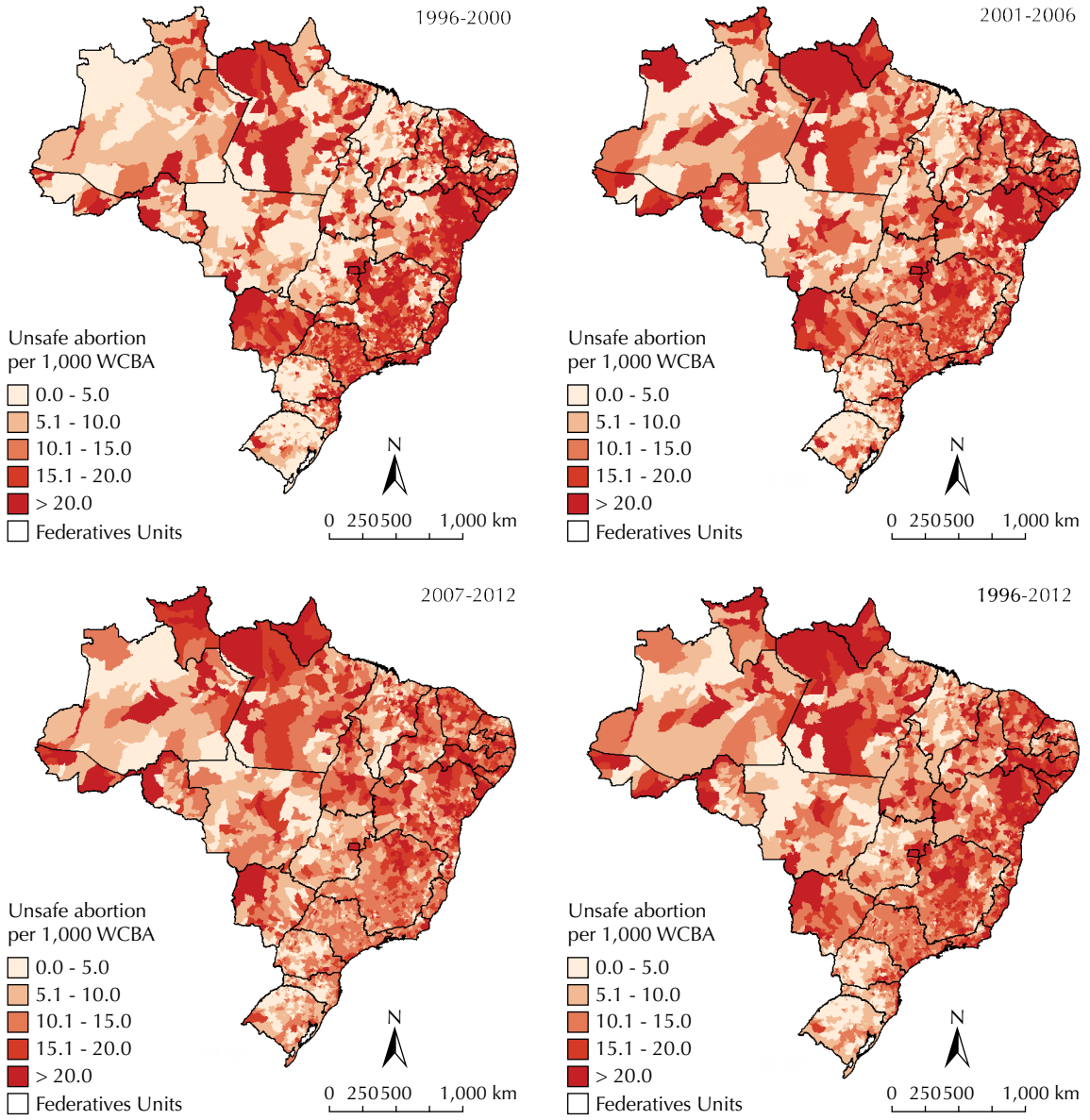
WCBA: women of childbearing age

Figure 1. Spatial distribution of unsafe abortion rates per 1,000 women of childbearing age, by municipalities of residence. Brazil, 1996-2012.

north of Ceará and east of Piauí. An important concentric *cluster* covered municipalities in south, east and northeast of Bahia, covering most municipalities of the states of Alagoas, Sergipe and Pernambuco and bordering the south of the states of Paraíba and Ceará. In the North region, four other areas with high values of this indicator were identified, highlighting the cluster which covers almost the entire state of Acre and northwest Pará (Figure 3). Clusters of municipalities with low values (low/low) were found covering almost the entire South region, large part of the Central-West region and the state of Maranhao, as well as in isolated areas in the North, Northeast and Southeast regions (Figure 3).

DISCUSSION

This national population-based study provides a comprehensive overview of unsafe abortion and measures its magnitude as a public health problem in Brazil. Although unsafe abortion shows a national decline trend, there are different patterns among the regions. Unsafe abortion has a widespread geographic distribution in the country, with records in almost all



WCBA: women of childbearing age

Figure 2. Spatial distribution of unsafe abortion rates per 1,000 women of childbearing age after smoothing by the Local Empirical Bayesian method, by municipalities of residence. Brazil, 1996-2012.

municipalities. Furthermore, the existence of clusters of municipalities with high values of unsafe abortions has been identified, especially in states of the North, Northeast and Southeast regions.

A network of high complexity of determinants and conditioning factors, including social, cultural, religious, moral, and legal aspects, inhibits women from declaring their abortions, compromising the existence of more accurate information, thus hindering identification of its real magnitude.[h] The situation of illegality in which abortion is performed in Brazil affects the reliability of the statistics that could potentially subsidize the implementation of more precise policies for the different regional realities and age groups.[18,h]

Despite the illegality of abortion in Brazil, as in other countries with restrictive laws,[1,22,23,a,b] a high number of hospital admissions for abortion was observed. The criminalization of abortion does not prevent women

[h] Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas Estratégicas. Área Técnica de Saúde da Mulher. Atenção humanizada ao abortamento: norma técnica. Brasília (DF); 2011.

from interrupting an unwanted or unplanned pregnancy. It only exposes the indiscriminate, unsafe, dehumanized practices with high risk of death, that generate high economic, political and social costs.[9,20]

There was significant heterogeneity of estimated unsafe abortions among Brazilian regions and states. The North and Northeast regions showed the highest values of the indicators analyzed. The distribution of the indicators by state is consistent with the regions with high indicators, mainly in the North and Northeast.[18] The unsafe abortion rates showed decline nationally and in most regions (Northeast, Southeast and Central-West), while in the North region there was an increasing trend. The estimated number of unsafe abortions was equivalent to 33.2% of total live births. This indicator showed a stable trend at national level and increase in North, South and Central-West regions. The observed pattern suggests that, despite the decline of unsafe abortion in relation to the population of women of reproductive age in most regions and states, in some of these geographic areas there is an increase in the number of pregnancies that result in abortions rather than births.[18]

The reduction in the number of unsafe abortions can be explained by better access to modern and effective contraception, declining fertility rates, increased medication abortion (misoprostol) and expansion of the jurisprudence in cases of legal abortions provided by law.[12,18,h] Currently, women suffering sexual violence

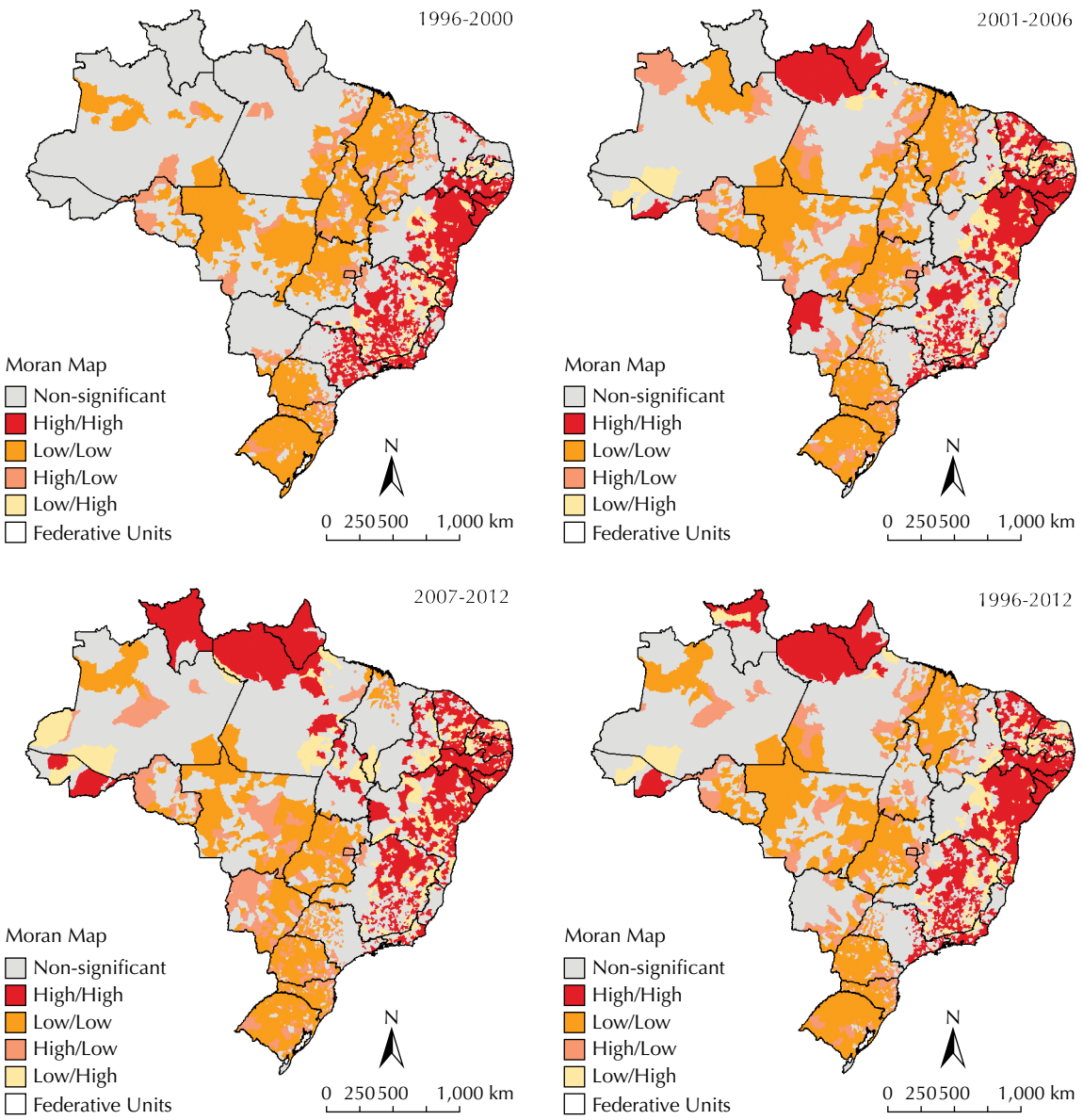


Figure 3. Moran Maps of unsafe abortion rates by municipalities of residence. Brazil, 1996-2012.

can turn to public health services to carry out the termination of pregnancy in an assisted and safe manner.[17] Regional differences can be attributed in part to increased access and adherence to contraception in regions/states with the lowest indicators of unsafe abortions.[18] It is emphasized the possible effect of increased use of misoprostol for induction of abortion, reducing the frequency of complications and consequently resulting in lower number of hospital admissions, which could partly explain the reduction in the period studied.[18] The National Survey of Abortion in Brazil, conducted in 2010, found that misoprostol was the method of choice most cited by women for induction of abortion.[10] Misoprostol reduces the frequency of complications caused by the use of methods associated with high rates of infection, such as foreign bodies from entering and use of other invasive techniques for inducing abortion.[19] However, additional studies are needed to assess the impact of the use of misoprostol for the induction and incidence of abortion in Brazil.[10,18] The highest fertility rates can make the female population more vulnerable to unsafe abortion risks.[18] Although the fertility rates have declined in all Brazilian regions between 2000 and 2010, there are still significant regional differences, with higher levels of fertility in the North and Northeast regions.[18]

It is undeniable that there have been improvements in access to family planning, mainly to the expansion of the National Family Planning Policy, as well as the quantitative availability of some effective contraceptive methods distributed for free by the SUS.[i] However, there was little change in the diversity in options for contraception used by women with lower socioeconomic status.[21] In 2006, the main methods used by the population with greater social and economic vulnerability were female sterilization and oral contraception.[i] The results of this study suggest that there are still important gaps in the provision of reproductive health services and that greater efforts to improve access and adherence to the use of contraceptives are needed.[18]

In this study, spatial patterns of rates among municipalities were assessed, identifying clusters of municipalities with higher unsafe abortion rates in states in the North, Northeast and Southeast regions. Analyses revealed a pattern of extreme concentration of municipalities with higher unsafe abortion rates in geographic range that runs from the north of Sao Paulo to the north of Ceará, as well as clusters in areas of the North regions. These findings reiterate the marked regional differences in the occurrence of unsafe abortion in Brazil, and show a larger impact in municipalities with poor socioeconomic and access to health care conditions.[17,18]

Abortion performed in unsafe conditions is among the main causes of maternal mortality in Brazil[16] and it is an important cause of institutional discrimination and violence against women in health services. Violence represented by the delay of care, lack of easy access and quality care, or explicit discrimination with negative, prejudiced and judgmental attitudes,[4] besides the negligence of preventive actions of recurrence of abortions.[h]

Despite Brazil being a signatory to international agreements, the impact of unsafe abortion on maternal morbidity and mortality hinders the achievement of targets of the Millennium Development Goals (MDG) and does not guarantee, in its entirety, sexual and reproductive rights of women.[h] Addressing this problem touches upon deep questions of social justice, ethics, civil legislation and citizenship.[17] Regardless of the legal question that encompasses the abortion, the importance of ensuring access and qualified care to maternal health is emphasized.[12,21] Strategies for prevention of unsafe abortions and consequently, resulting deaths, involve integrated actions at all levels of prevention in the health services network, such as: reduction of unwanted pregnancies, quality health care during the abortion procedure, recognition and appropriate management of complications and pre-and post-abortion family planning.[12]

The need for timely care is imperative, given the difficulty for women to recognize signs of possible complications, combined with factors that may delay seeking care. From the perspective of comprehensiveness of care, health professionals must not only provide immediate individualized care for women in abortion situations, but also provide contraceptive alternatives, avoiding the resource of repeated abortions, and involve the family, especially the partners.[h] For women with spontaneous abortions and wishing new pregnancies, suitable care for their needs must be guaranteed. The desired quality of care includes aspects related to its humanization, encouraging health professionals, regardless of their moral and religious precepts, to show an ethical posture, ensuring respect for women's human rights.[h]

Public policies will only be effective when guided by greater knowledge of the causality chain of unsafe abortion, which can be achieved through a larger number of studies with specific methodology. There is a need for studies with direct estimation techniques to determine the real magnitude of unsafe abortion.[17] Moreover, there is clear need to expand efforts to develop research to better analyze the real impact of unsafe abortion on women, families, and the health sector.[14]

This study has some limitations that should be taken into account in the interpretation of the results. The application of the indirect estimation technique depends

[i] Ministério da Saúde. Secretaria de Ciência, Tecnologia e Insumos Estratégicos. Departamento de Ciência e Tecnologia. PNDS 2006: Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher. Brasília (DF); 2008.

on the data quality of hospital admissions.[14,17,18] The use of secondary data may have inconsistencies in the quantity and quality of the information.[19] We used data from the SIH, which records the procedures performed in hospitals linked to the SUS, not considered admissions by abortion performed in hospitals not affiliated with the SUS.[17,18] Additionally, this information system may not detect inconsistencies in the classification of the cause of hospital admission recorded, i.e., faults in the coding of cause of hospital admission may interfere in the results, requiring careful interpretation. Due to the stigma associated with the procedure and the illegality of abortion, there may have been underreporting of the occurrences of abortion by women and providers of health services, even when they are directly involved in the care.[13] Indirect methods for estimating the magnitude of unsafe abortion through secondary data are approximate and are based on assumptions for performing the calculation.[13] We used the method developed in 1994[2] and previously used in large-scale studies in Brazil.[17,18] This technique assumes that 20.0% of abortions resulted in hospital admissions recorded by the SUS.[2,18] However, this parameter may not be valid, especially because of regional and temporal variations of the admissions by abortions, the increased use of misoprostol, and the decreased fertility occurred in recent years. Despite these limitations, this study provides rough estimates that contribute to the knowledge, even if still insufficient, of the distribution of unsafe abortion in Brazil.We conclude that unsafe abortion, despite the decline at a national level, still constitutes an important public health problem and is a neglected event in Brazil. Expansion of access to care, qualification and humanization of assistance for women in abortion situations, including post-abortion contraceptive counseling services are needed.

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The authors declare that there is no conflict of interest.

HIGHLIGHTS

The results presented in this article show that unsafe abortion is a significant public health problem, characterized as a neglected event in this country. Although there was a decline over the period studied, there are still significant differences between regions, with higher concentrations in the socioeconomically poorer regions.

The scale and social relevance of the problem indicate the need to create strategies to deal with it.

The context of inequality indicates the need for reinforcing health care actions in the areas of highest risk, offering safe alternatives.

The health care system urgently needs to increase access, qualify care and humanize health care actions for women, especially with regards to reproductive and pre- and post-abortion aspects.

Professor Rita de Cássia Barradas Barata
Scientific Editor