Trends in Hospitalization and Mortality from Cervical Cancer in Brazil Are Linked to Socioeconomic and Care Indicators

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Abstract: We aimed, through an ecological survey of cervical cancer outcomes in Brazil, to analyze the influence of socioeconomic and care indicators of social vulnerability. The study sample (2010–2015) is composed of women diagnosed with cervical cancer, in different regions of the country. Data were collected from the Department of Health, in addition to searching the social vulnerability database of the Institute of Applied Economic Research. The incidence of age-standardized hospital admission declined over the years of the study in almost all regions but only one region showed a significant decline in indices of social vulnerability. In two other regions, one important indicator (human capital) significantly decreased. There was a positive correlation between vulnerability indices and age-standardized hospital admissions in most of the country. Decreasing vulnerability by easy access to cancer screening and early treatment improves cervical cancer outcomes.

Keywords: neoplasms of the cervix; mortality; length of hospitalization; epidemiology; social vulnerability

1. Introduction

In health, vulnerability can be transient, when the individual is exposed to social, territorial, and individual situations that predispose the individual or a population to an increased risk of developing morbidities; these situations may be social, individual, and institutional [1–4].

The study of social vulnerability aims to signal whether there is reasonable access to urban infrastructure, human capital and work income, the components whose access to or deprivation from determine the conditions of well-being of populations in societies. Through an awareness that there is an association between the type of cancer that is under study and low socioeconomic status, this study attempts to understand the most vulnerable groups living in locations in which there are barriers to accessing health services that arise from economic difficulties. These health services include early detection, the immediate treatment of pathology and its precursor lesions. For this reason, it is necessary to use the indicators of social vulnerability to learn more about the health of women diagnosed with cervical cancer [5,6].

The influence of social vulnerability in Brazil in terms of cervical cancer has been attributed to associations with low educational and economic levels [7]. Cervical cancer has a high incidence, with more than 500,000 cases, and high mortality, with more than 200,000 deaths worldwide, with 85% of the distribution of the disease concentrated in low- and middle-income countries [8]. In addition, this form of cancer significantly impairs the quality of life of women who survive the treatment, as it is correlated with sexual dysfunction and psychosocial damage [9,10].

The measurement of social vulnerability, as a multifactorial variable, described and used by governmental managers to assist in the resolution of public health issues, including...
in Brazil [11–14], has demonstrated the barriers to the diagnosis and early treatment of cervical cancer in vulnerability scenarios as a psychological, economic, and cultural partner, with the loss of quality of life and increases in the mortality rate of the population.

Wittet et al. [15] contextualized regional economic disparity and the correlation of social vulnerability with cervical cancer, where the incidence remained high with hospitalization rates falling steadily compared to more developed countries.

The influence of social vulnerability on the incidence of hospitalizations and mortality due to this type of cancer in developing countries, such as Brazil, where the quality of medical services is compromised by the social inequality present in the same state or territory, has rarely been demonstrated [16].

In this sense, the objective of the study is to analyze the influence of social vulnerability on the rates of hospitalization and mortality from cervical cancer among Brazilian regions.

2. Results

Only the Northern region had a significant decline in social vulnerability (IVS: $\beta = -0.02$, $p = 0.032$, $r^2 = 0.72$, IVS urban infrastructure: $\beta = -0.04$, $p = 0.032$, $r^2 = 0.72$, IVS human capital: $\beta = -0.02$, $p = 0.038$, $r^2 = 0.70$). On the other hand, the Southeast and South regions presented a statistically significant reduction only for the IVS human capital indicator, $\beta = -0.02$, $p = 0.021$, $r^2 = 0.77$ and $\beta = -0.02$, $p = 0.002$, $r^2 = 0.92$, respectively (Figure 1).

The number of hospitalizations and deaths by all types of neoplasms and CC between regions was as follows. During the study period, the Southeast region ($n = 698,927$, $\beta: 0.36$, $p: 0.005$; $r^2$: 0.88) showed higher admission values for all types of neoplasms; however, only the North ($N = 117.035$; $\beta$: −0.19; $p$: 0.190; $r^2$: 0.38) showed a reduction. For the number of deaths, the Southeast regions (all neoplasms: $\beta$: −0.005; $p$: 0.475; $r^2$: 0.13; CCU-$\beta$: −0.004; $p$: 0.120; $r^2$: 0.36) and South (all neoplasms: $\beta$: −0.015; $p$: 0.298; $r^2$: 0.26; CCU: $\beta$: −0.001; $p$: 0.875; $r^2$: 0.01) showed a decline for both of the cited outcomes, but it was not significant.

The incidence of age-standardized hospital admission varied negatively in all regions, with the South ($\beta = -0.18$, $p < 0.001$, $r^2 = 0.98$) and Midwest ($\beta = -0.17$, $p = 0.001$, $r^2 = 0.94$) showing the greatest reductions between the years 2010 and 2015 (Table 1).

For the age-standardized CC mortality in the North ($\beta = 0.012$, $p = 0.076$, $r^2 = 0.48$), the Northeast ($\beta = 0.002$, $p = 0.455$, $r^2 = 0.06$), and the Midwest ($\beta = 0.001$, $p = 0.958$, $r^2 = 0.01$), a slight increase was observed, with the opposite occurring in the Southeast region ($\beta = 0.004$, $p = 0.120$, $r^2 = 0.36$), in the South ($\beta = 0.001$; $p = 0.875$, $r^2 = 0.01$), and when analyzing Brazil ($\beta = -0.001$; $p = 0.701$, $r^2 = 0.04$) as a whole; however, the reductions were not significant (Table 1).

The present study identified a positive correlation of vulnerability indices with age-standardized hospital admissions in the Midwest (IVS: rho = 0.82, $p = 0.041$, IVS human capital: rho = 0.84, $p = 0.035$), the Southeast (IVS: rho = 0.83, $p = 0.039$, IVS urban infrastructure: rho = 0.81, $p = 0.046$, IVS human capital: rho = 0.94, $p = 0.003$), and the South (IVS human capital: rho = 0.97; IVS income and work: rho = 0.81, $p = 0.048$) (Table 2).
**Figure 1.** Cont.
Figure 1. Social vulnerability index and its three dimensions according to the Brazilian regions during the period from 2010 to 2015. \(\beta\): regression slope; \(r^2\): predictive capacity; 95% CI: 95% confidence interval. Source: IPEA—Institute of Applied Economic Research.

Table 1. Mortality * and incidence * of hospitalization per 10,000 inhabitants (95% confidence interval) between 2010 and 2015, according to the regions of the country, linear regression estimates.

| Brazil/Regions   | Age-Standardized Incidence * (95% CI) of Hospital Admissions for Cervical Cancer † (×10,000 Inhabitants) | Linear Regression Admissions |
|------------------|----------------------------------------------------------------------------------------------------------|-------------------------------|
|                  | 2010       | 2011       | 2012       | 2013       | 2014       | 2015       | \(\beta\) | \(p\) | \(r^2\) |
| North            | 1.57 (1.56; 1.57) | 1.58 (1.57; 1.58) | 1.56 (1.55; 1.56) | 1.56 (1.55; 1.56) | 1.38 (1.37; 1.38) | 1.39 (1.38; 1.39) | -0.04 | 0.032 | 0.65 |
| Northeast        | 2.10 (2.09; 2.11) | 2.02 (2.01; 2.03) | 1.99 (1.98; 1.99) | 1.99 (1.98; 1.99) | 1.76 (1.75; 1.77) | 1.67 (1.66; 1.67) | -0.08 | 0.006 | 0.84 |
| Southeast        | 1.70 (1.69; 1.70) | 1.49 (1.48; 1.50) | 1.53 (1.52; 1.54) | 1.43 (1.42; 1.43) | 1.32 (1.31; 1.33) | 1.33 (1.32; 1.34) | -0.07 | 0.007 | 0.83 |
| South            | 2.83 (2.82; 2.83) | 2.62 (2.61; 2.62) | 2.43 (2.42; 2.43) | 2.21 (2.20; 2.21) | 2.01 (2.00; 2.01) | 1.94 (1.93; 1.94) | -0.18 | <0.001 | 0.98 |
| Central-West     | 2.28 (2.27; 2.28) | 1.99 (1.98; 2.00) | 1.87 (1.87; 1.88) | 1.63 (1.62; 1.63) | 1.44 (1.44; 1.44) | 1.43 (1.42; 1.43) | -0.17 | 0.001 | 0.94 |
| Brazil           | 2.00 (1.99; 2.01) | 1.84 (1.84; 1.84) | 1.81 (1.80; 1.82) | 1.71 (1.70; 1.71) | 1.55 (1.54; 1.56) | 1.51 (1.50; 1.51) | -0.09 | <0.001 | 0.95 |
Table 1. Cont.

| Brazil/Regions | Age-Standardized Mortality * (95% CI) from Cervical Cancer † (× 10,000 inhabitants) | Linear Regression Mortality |
|----------------|----------------------------------------------------------------------------------|-----------------------------|
|                | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | B    | p    | r² |
| North          | 0.71 (0.70; 0.71) | 0.70 (0.69; 0.71) | 0.72 (0.71; 0.73) | 0.78 (0.77; 0.79) | 0.77 (0.76; 0.78) | 0.75 (0.74; 0.75) | 0.012 | 0.076 | 0.48 |
| Northeast      | 0.40 (0.39; 0.41) | 0.41 (0.40; 0.42) | 0.43 (0.42; 0.43) | 0.41 (0.40; 0.41) | 0.43 (0.42; 0.43) | 0.41 (0.40; 0.42) | 0.002 | 0.455 | 0.06 |
| Southeast      | 0.27 (0.26; 0.27) | 0.26 (0.25; 0.27) | 0.24 (0.23; 0.25) | 0.25 (0.24; 0.25) | 0.24 (0.23; 0.24) | 0.25 (0.24; 0.25) | −0.004 | 0.120 | 0.36 |
| South          | 0.31 (0.30; 0.31) | 0.32 (0.31; 0.33) | 0.32 (0.31; 0.32) | 0.32 (0.31; 0.33) | 0.29 (0.28; 0.29) | 0.33 (0.32; 0.33) | −0.001 | 0.875 | 0.01 |
| Central-West   | 0.42 (0.41; 0.42) | 0.36 (0.35; 0.38) | 0.36 (0.35; 0.36) | 0.36 (0.36; 0.37) | 0.38 (0.37; 0.38) | 0.41 (0.40; 0.41) | 0.001 | 0.958 | 0.01 |
| Brazil         | 0.34 (0.33; 0.34) | 0.34 (0.33; 0.35) | 0.34 (0.33; 0.34) | 0.34 (0.34; 0.34) | 0.34 (0.33; 0.34) | 0.35 (0.35; 0.36) | −0.001 | 0.701 | 0.04 |

* Standardized for age according to the world population data from the World Health Organization. † International classification of diseases, 10th revision. Code C53. β: regression slope; r²: predictive capacity; 95% CI: 95% confidence interval. Source: Mortality Information System (SIM) and Hospital Information System (SIH/SUS). Data made available by the Department of Informatics of the National Health System (DATASUS—www.datasus.gov.br). Ministry of Health, Brazil.

Table 2. Correlation between the incidence of hospitalizations * and Mortality * per 10,000 inhabitants according to the social vulnerability indices of the Brazilian regions in the period between 2010 and 2015.

| Vulnerability Indexes | Brazil/Regions | Age-Standardized Incidence * of Hospital Admissions for Cervical Cancer † (× 10,000 Inhabitants) |
|----------------------|---------------|------------------------------------------------------------------------------------------------|
|                      | Central-West  | Northeast | North | Southeast | South | Brazil |
|                      | rho    | p    | rho    | p    | rho    | p    | rho    | p    | rho    | p    | rho    | p    |
| IVS                  | 0.82   | 0.041| 0.62   | 0.181| 0.61   | 0.202| 0.83   | 0.039| 0.78   | 0.065| 0.80   | 0.057|
| IVS Urban Infrastructure | 0.75  | 0.084| 0.58   | 0.223| 0.64   | 0.174| 0.81   | 0.046| 0.07   | 0.891| 0.79   | 0.061|
| IVS Human Capital    | 0.84   | 0.035| 0.65   | 0.155| 0.59   | 0.211| 0.94   | 0.003| 0.97   | 0.001| 0.86   | 0.028|
| IVS Income and Work  | 0.75   | 0.079| 0.61   | 0.199| 0.53   | 0.280| 0.41   | 0.422| 0.81   | 0.048| 0.66   | 0.153|
Table 2. Cont.

| Vulnerability Indexes Brazil/Regions | Age-Standardized Mortality * from Cervical Cancer † (× 10,000 Inhabitants) | Central-West | Northeast | North | Southeast | South | Brazil |
|-------------------------------------|--------------------------------------------------------------------------------|-------------|-----------|--------|-----------|-------|--------|
|                                     |                                                                              | rho        | p         | rho    | p         | rho   | p      | rho   | p       | rho   | p     |
| IVS                                 |                                                                              | 0.59       | 0.216     | -0.70  | 0.115     | 0.211 | 0.68   | 0.136 | 0.047   | 0.710 | 0.46  | 0.354 |
| IVS Urban Infrastructure             |                                                                              | 0.43       | 0.383     | -0.63  | 0.177     | 0.318 | 0.42   | 0.400 | 0.456   | 0.485 | 0.34  | 0.509 |
| IVS Human Capital                   |                                                                              | 0.46       | 0.347     | -0.69  | 0.125     | 0.184 | 0.68   | 0.131 | 0.040   | 0.952 | 0.37  | 0.481 |
| IVS Income and Work                 |                                                                              | 0.73       | 0.103     | -0.75  | 0.083     | 0.126 | 0.75   | 0.084 | 0.140   | 0.800 | 0.66  | 0.156 |

* Standardized for age according to the world population data from the World Health Organization. † International classification of diseases, 10th revision. Codes C53. rho: Pearson correlation; p: p-value. Source: Mortality Information System (SIM) and Hospital Information System (SIH/SUS). Data made available by the Department of Informatics of the National Health System (DATASUS—www.datasus.gov.br). Ministry of Health, Brazil. Source: IPEA—Institute of Applied Economic Research.
3. Discussion

The main finding of the present study was the identification of the positive correlation of the vulnerability indices with the hospital admissions standardized by age in the Midwest, Southeast, and South regions. In addition, there was a reduction in the mean value of the IVS and its three dimensions in the North, Southeast, and South regions.

In relation to the incidence of hospital admission standardized by age, all of the regions studied presented a reduction, with the South and Midwest regions having the greatest reductions between the years 2010 and 2015.

In Latin American countries, cervical cancer accounts for about 25% of all cancers affecting women, and its incidence is considered to be one of the highest in the world [17]; these results can be explained by the existence of a socioeconomic exclusion profile in this region, a factor that influences the non-performance of preventive cytological tests [18]. Research indicates the role of prophylactic vaccines in reducing cervical cancer, indicating that the incorporation of this new technology into the public health service in Brazil may help to promote primary prevention actions, such as the provision of the HPV vaccine, condoms, and educational material [19,20].

It is noteworthy that social prevalence is associated with limited health access, independent of the country’s level of development [21]. For Brazil, inequality in access to health services is still a much-discussed subject, with a clear influence on the high incidence, the diagnosis in more advanced stages, and the high mortality rate of CCU. This fact corroborates the theory that, although the number of preventive exams has increased in recent years, the differences in access to health services according to the socioeconomic level in the country prevail [22].

The research conducted on the prevention and control of cervical cancer in Brazil is productive; however, it seeks mainly to benefit the CC screening programs, not understanding the main aspects that involve adherence, including sociodemographic factors, income, and schooling, which influence access to the actions offered in the scope of primary care [7].

In a study in the state of Roraima, the researchers found that the women with CC were mostly brown, unemployed, single, with low schooling, low socioeconomic status, living in households without basic sanitation, and 71% either did not have a Pap smear regularly or had never had one. This was also the case in low-income developing countries such as Harare (54/100,000), Zimbabwe; Kampala (42/100,000), Uganda; Bamako (36/100,000), Mali; and Madras (35/100,000), in India [17].

Countries such as Spain and Canada report that in addition to lack of knowledge about the disease and the existence of organized cancer screening programs, low social vulnerability strongly interfered with the incidence of neoplasia [23,24], findings that are in line with the results of the present study.

In a study carried out in France, the results showed that social vulnerability (since 2014) appeared as a factor that negatively impacted participation in at least one cancer screening test, highlighting CC, showing that women in conditions of vulnerability are less likely to have diagnostic tests compared to non-vulnerable women (54.3 and 62.5%, \( p = 0.020 \), respectively) [25].

Research conducted in the USA has shown that women living in places with high poverty are 20% (95% CI: 1.00; 1.40) more likely to be diagnosed with CC compared to those with low poverty, and the stratified survival rates (low, medium, and high level of poverty) were 79.1% (95% CI: 78.0, 80.2) for low poverty, 75.6% (95% CI: 73.9, 77.2) for medium poverty, and 72.6% (95% CI: 70.9, 74.3) for high poverty levels [23].

4. Materials and Methods

This is a population-based ecological study that focuses on Brazil, in which a temporal trend of hospitalization and mortality from cervical cancer was observed in the Brazilian population from January 2010 to December 2015, stratified by the administrative regions of Brazil. It should be noted that ecological studies are used to analyze well-defined
populations or population groups in specific areas by dispensing the peculiarities of each individual and studying the analyzed data corresponding to that particular population.

The study population is comprised of women diagnosed with cervical cancer aged 25 to 64 years, the age range referenced by the National Cancer Institute (INCA) to begin screening for uterine neoplasia [26].

Following the list of morbidities offered in the Hospital Information System (SIH), the hospitalization data were selected according to their presentation by the chapter of the International Classification of Diseases (ICD-10).

The Hospital Information System (SIH/SUS) is freely accessible and provides content on demographic and clinical data, allowing the description of hospital morbidity and mortality in the scope of the SUS’s own contracted services [15]. For this study, the collection of information on CC hospitalizations was extracted according to the following steps: (i) epidemiology and morbidities; (ii) hospital morbidity of SUS (SIH/SUS); (iii) general, by place of residence, from 2008 and general, by place of residence from 1995 to 2007; and (iv) geographical coverage. We selected the variables: (i) regions; (ii) list of ICD-10 morbidity (malignant neoplasm of cervix); (iii) sex; and (iv) age group 2.

To collect the data on cervical cancer deaths, we used the national database on all national deaths, DATASUS (Data from the Department of Informatics of the Unified Health System) and SIM (Information System on Mortality), as the SIM allows free access.

To classify the topographic location of the uterine lesion, we used the coding reported in the 10th International Classification of Diseases (ICD-10) as a reference, which defines malignant neoplasm of the cervix as C53.

To access data on deaths within the DATASUS system, the following steps were taken: (i) vital statistics; (ii) mortality between 2010 and 2015 by ICD-10; (iii) general mortality; and (iv) geographical coverage.

Upon arriving in the initial environment of the SIM, the sequence of collecting information on deaths by CC followed the steps below:

(a) We selected separately the code (C53), within the item called category in the ICD-10;
(b) Deaths related to the code were stratified according to the variables: age group (ranging from 25 to 64 years old, divided into 5-year age groups); location (administrative regions); and year (2010 to 2015).

The data from the population census were taken from the Brazilian Institute of Geography and Statistics (IBGE) available in censuses and intercensorial population projections on the DATASUS website, using the following steps: (i) demographic and socioeconomic; (ii) resident population; (iii) censuses (1980, 1991, 2000, and 2010), score (1996) and intercensorial projections (1981 to 2012), according to age, sex, and domicile; and (iv) geographical coverage.

The crude mortality rates were calculated by 10,000 women, age group, and year for the Brazilian regions. Finally, based on the age distribution of the World Health Organization’s population data, mortality was standardized by age using the direct method [21].

A search was carried out in the social vulnerability database of the Institute of Applied Economic Research (IPEA), a public institution linked to the Secretariat of Strategic Affairs of the Presidency of the Republic (SAE), responsible for studying the economic, financial, demographic, educational, health, housing, and labor markets, providing technical and institutional support to Brazil’s governmental actions [27].

In order to classify the vulnerability of the study population, the Social Vulnerability Index (IVS) was used, which is composed of the average of three dimensions: urban infrastructure, human capital (variables that involve the two aspects that determine the social inclusion of individuals: health and education), and income and labor, which are composed of the sixteen indicators listed below [28,29]:

IVS urban infrastructure: (a) percentage of people in households with inadequate water supply and sewage; (b) percentage of the population living in urban households without a garbage collection service; (c) percentage of people living in households with per
capita incomes less than half a minimum wage (from 2010) and spending more than an hour commuting to and from work of the total of people who are working and vulnerable;

IVS human capital: (a) mortality up to one year of age; (b) percentage of 0–5-year-olds who do not attend school; (c) percentage of 6 to 14-year-olds who do not attend school; (d) percentage of women aged 10 to 17 years old who have children; (e) percentage of mothers who are heads of households without full primary education and with at least one child under 15 years old of the total number of female heads of household; (f) illiteracy rate of the population aged 15 years and over; (g) percentage of children living in households where none of the residents have completed elementary school; (h) percentage of 15–24-year-olds who do not study or work, and have a per capita household income equal to or less than half the minimum wage (2010) of the total population of that age group;

IVS income and work: (a) proportion of persons with per capita household income equal to or less than half the minimum wage (2010); (b) unemployment rate of population aged 18 years or over; (c) percentage of people aged 18 years or older without full employment and in an informal occupation; (d) percentage of people in households with per capita income less than half the minimum wage (from 2010) and dependent on the elderly; (e) activity rate of people aged 10 to 14 years old.

The index scores ranged from 0.000 (minimum vulnerability situation) to 1.000 (maximum vulnerability situation); they are classified as very low (values between 0.000 and 0.200), low (between 0.201 and 0.300), medium (between 0.301 and 0.400), high (0.401 and 0.500), and very high social vulnerability (between 0.500 and 1.000) [30].

To analyze cervical cancer during the time trend (2010 to 2015) a regression model was used, allocating the hospitalization rate and mortality by CC (dependent variables, Y) and time (independent variable, X).

The Pearson correlation test was performed to analyze the relationship between the adjusted and corrected social vulnerability indices for the period 2010 and 2015, with the incidence of hospitalizations and mortality (per 10,000 inhabitants) per CC according to the parents. The values used to classify the correlation were: strong correlation of 0.70 to 1, moderate from 0.30 to 0.69, and weak from 0 to 0.29, classifying in the same way these cut points in their negative form. The confidence level adopted for all of the analyses was 95%, and the statistical program Data Analysis and Statistical Software for Professionals (Stata) version 16.0® was used.

5. Conclusions

The profile of social vulnerability among women with cervical cancer in Brazil follows the findings found in several studies, showing that high vulnerability is a negative factor in the relationship with CC screening, making early diagnosis and immediate treatment difficult.

6. Limitations

The present results are important to improve the understanding of the trends of cervical cancer in Brazilian women. However, some limitations should be highlighted: (i) the coverage of the Mortality Information System and Hospital Information in Brazil, which may have resulted in underreported cases, (ii) incorrect registration of CID codes to classify the CC may underestimate the cases found; that is, misdiagnosed cases may have underestimated our findings.

Author Contributions: L.V.d.A.S. elaborated the research question and conducted the study; L.d.S.P. and F.L.A.F. performed the data collection; S.d.S.A.A., L.E.W.d.C. and F.A. performed the analysis and wrote the article. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Not applicable.

Data Availability Statement: Only the data contained in this manuscript (article) will be available. If any reader wants to see the complete bank, through an appropriate request to the corresponding author, the author can send the requested database.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

CC Cervical cancer
SIM Information System Mortality
DATASUS Data from the Department of Informatics of the Unified Health System
ICD International Classification of Diseases
IBGE Brazilian Institute of Geography and Statistics
SIH Hospital Information System (SIH), Hospital Inpatient Authorization

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