

# Annual national direct and indirect cost estimates of the prevention and treatment of cervical cancer in Brazil

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**OBJECTIVE:** To estimate the annual direct and indirect costs of the prevention and treatment of cervical cancer in Brazil.

**METHODS:** This cost description study used a "gross-costing" methodology and adopted the health system and societal perspectives. The estimates were grouped into sets of procedures performed in phases of cervical cancer care: the screening, diagnosis and treatment of precancerous lesions and the treatment of cervical cancer. The costs were estimated for the public and private health systems, using data from national health information systems, population surveys, and literature reviews. The cost estimates are presented in 2006 USD.

**RESULTS:** From the societal perspective, the estimated total costs of the prevention and treatment of cervical cancer amounted to USD \$1,321,683,034, which was categorized as follows: procedures (USD \$213,199,490), visits (USD \$325,509,842), transportation (USD \$106,521,537) and productivity losses (USD \$676,452,166). Indirect costs represented 51% of the total costs, followed by direct medical costs (visits and procedures) at 41% and direct non-medical costs (transportation) at 8%. The public system represented 46% of the total costs, and the private system represented 54%.

**CONCLUSION:** Our national cost estimates of cervical cancer prevention and treatment, indicating the economic importance of cervical cancer screening and care, will be useful in monitoring the effect of the HPV vaccine introduction and are of interest in research and health care management.

**KEYWORDS:** Costs and cost analysis; Uterine cervical neoplasms; Early detection of cancer; Cost of illness; Cervical cancer screening.

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## INTRODUCTION

Cervical cancer is the second most frequent cancer in women in Brazil, with an estimated incidence rate of 19 per 100,000 women, according to the National Cancer Institute – INCA in 2010 (1). The average adjusted mortality rate was estimated to be 7 per 100,000 women in 2008 (2).

Secondary prevention (screening and treatment of precancerous lesions) has successfully reduced the incidence and mortality rates of cervical cancer in many high-income

countries. However, in low- and middle-income countries, screening programs have had less impact, mainly because of the limited coverage, poor performance of the Pap smear, and irregular access and quality of treatment (3). The primary prevention of cervical cancer and HPV infection involves health promotion, sexual education, condom use promotion, and, more recently, HPV vaccination (4,5). HPV vaccines are considered efficacious in preventing persistent HPV 16 and 18 infection and consequent precancerous cervical lesions, and post-marketing surveillance in developed countries has so far been positive regarding their effectiveness and safety (6,7).

In previously published economic evaluations, introducing the HPV vaccine as part of the routine immunization schedule in Brazil was considered cost-effective (8–11).

In 2009, the Brazilian Ministry of Health commissioned a cost-effectiveness study to investigate the introduction of the HPV vaccine as part of the National Immunization Program;

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the study found the HPV immunization of girls to be cost-effective (4). The universal HPV vaccination of girls aged 11 to 13 years was introduced in March 2014.

In Brazil, the public (*Sistema Único de Saúde, SUS*) and private health systems have made large investments in the prevention and treatment of cervical cancer, but no studies have been published with detailed cost estimates of the components and specific technologies involved. This study was the preliminary step of a cost-effectiveness analysis, and its objective was to estimate the annual direct and indirect costs of the prevention and treatment of cervical cancer in Brazil, based on national data available in public health information systems.

Knowing the cost of the prevention and treatment of cervical cancer in the health care system and for the population is important as baseline information for future budget effect analyses of the vaccination program. Additionally, these national public and private cost estimates are of interest for making other public health management and policy decisions and for international comparisons.

## ■ MATERIALS AND METHODS

This is a descriptive study of the costs of the prevention and treatment of cervical cancer in Brazil, in 2006.

Based on specialized publications and clinical guidelines (12), the estimates were grouped into sets of procedures performed in different phases of cervical cancer care: screening; diagnosis and treatment of precancerous lesions – cervical intraepithelial neoplasia (CIN-I and CIN-II/III); and treatment of cervical cancer. The costs were estimated for the public and private health systems.

The study adopted the health system perspective, estimating direct medical costs (outpatient visits, diagnostic tests, procedures, clinical treatment, surgical interventions, medications and hospitalizations) and the societal perspective, with estimations of direct non-medical costs (transportation) and indirect costs resulting from productivity losses related to illness.

The costing was performed using the "gross-costing" methodology. All the cost estimates were converted from Brazilian Reals (BRL) to 2006 United States dollars (USD) at the exchange rate of USD \$1 = BRL \$2.1642.

### Direct medical costs in the public health system (*SUS*)

The data sources used for estimating health service utilization and costs in the *SUS* were the Primary Care Information System (*SIAB*), the Outpatient Information System (*SLA/SUS*), the Authorizations for High Complexity Procedures (*APAC*), the Cervical Cancer Information System (*SISCOLO*), and the Hospitalization Information System (*SIH/SUS*).

Hospitalizations, procedures and visits were identified using the International Classification of Diseases (ICD-10) codes related to cervical cancer (C53.0, C53.1, C53.8 and C53.9). The codes for the procedures and their unit costs were retrieved from the Table of Procedures, Drugs, Orthotics, Prosthetics and Special Materials (*SIGTAP*) and The Health Prices Database (*BPS*) of the Ministry of Health.

To estimate screening costs, we identified the number of Pap smears performed and the number of medical and nursing visits associated with the procedure based on routine primary health care.

The diagnosis of precancerous lesions included colposcopy and cervical biopsy. The treatment of precancerous lesions (CIN-I, CIN-II/III) included cold knife conization, the loop electrosurgical excision procedure (LEEP), trachelectomy, vaginal enlarged amputation of the cervix, and hysterectomy.

The estimates for the surgical treatment of cervical cancer included all inpatient abdominal hysterectomies because of tumors. Leiomyomas are the most frequent cause of hysterectomy and, based on expert opinion and the literature, we assumed that cervical cancer was the cause of 20% of abdominal hysterectomies in 2006 in Brazil (13). For vaginal hysterectomies, we assumed that only 5% were performed to treat precancerous lesions, based on expert opinion. The clinical treatment of cervical cancer included hospitalizations, chemotherapy, radiotherapy and additional complementary complex procedures.

### Direct medical costs in the private health system

We estimated the level of participation in the private health system based on data from the 2008 Health Supplement of the National Survey of Household Samples (*PNAD*).

Frequencies of the procedures in the private health system were estimated based on the pattern of care provided by the *SUS*. To estimate costs in the private health system, the procedures were valued based on the National Table of Equivalence of Procedures (*TUNEP*).

### Direct non-medical costs

The direct non-medical costs were the costs of patient transportation for procedures and visits. They were estimated based on the average fare of public transportation in the Brazilian state capitals (USD \$0.87) obtained from the National Association of Urban Transport (*NTU*).

### Indirect costs

Indirect costs represent the working days lost by the patient and caregiver for preventing, diagnosing and treating the disease. We adopted the Human Capital Method and considered the average monthly income of women over 15 years weighted by the participation in the labor market to estimate the average daily income (USD \$11.05).

## ■ RESULTS

### Direct medical costs in the public health system (*SUS*)

Table 1 presents the estimates of the frequency and costs of procedures and visits related to the prevention and treatment of cervical cancer in the *SUS* and the private health system, in 2006 USD. Despite the low unit cost, screening was the procedure with the highest cost (USD \$47,794,327) because of its frequency and associated visits. The diagnosis and treatment of precancerous lesions were estimated to cost USD \$9,253,598 and USD \$3,653,569, respectively, which were approximately 20% and 8% of the screening costs. Inpatient surgical treatment was estimated at USD \$7,650,810, and clinical treatment, including hospital admissions, other clinical procedures and clinical oncology outpatient treatment of cervical cancer, was estimated at USD \$36,448,391.

The total estimated costs of the screening, diagnosis and treatment of precancerous lesions and the surgical and clinical treatment of cervical cancer, paid by *SUS* in 2006, was USD \$104,966,045: 45.7% on screening, 8.8% on diagnostic



**Table 1** - Estimates of direct medical costs for the screening, diagnosis and treatment of precancerous lesions and the diagnosis and treatment of cervical cancer in public and private health systems in Brazil, in 2006 United States dollars (USD).

Cervical cancer care components	Public Health System			Private Health System		
	Number of procedures	Cost per unit	Total costs	Number of procedures	Cost per unit	Total costs
<b>Screening</b>						
Pap smears	11,701,728	2.48	29,035,338.40	6,552,968	15.53	101,737,235.38
Visits	23,403,456	0.81	18,924,336.01	13,105,936	20.33	266,454,664.08
<b>Total</b>			<b>47,959,674.41</b>			<b>368,191,899.45</b>
<b>Diagnosis of precancerous lesions</b>						
Colposcopy	972,764	0.78	759,620.72	340,467	20.84	7,095,028.97
Cervical biopsy	124,124	6.77	840,799.30	43,443	17.08	741,915.39
Subtotal - Procedures	1,096,888		<b>1,600,420.02</b>	383,910		7,836,944.36
Visits	2,193,776	3.49	7,653,178.45	614,257	20.33	24,976,719.34
<b>Total</b>			<b>9,253,598.47</b>			<b>32,813,663.70</b>
<b>Treatment of precancerous lesions</b>						
Loop electrosurgical excisional procedure (LEEP)	66,870	8.71	582,432.08	23,405	89.46	2,093,710.38
Cold knife conization	8,766	176.91	1,550,758.14	3,068	377.20	1,157,240.75
Vaginal hysterectomy	641	188.22	120,650.29	224	701.64	157,168.47
Trachelectomy	2,986	251.64	751,398.02	1,045	463.25	484,093.52
Vaginal enlarged amputation of the cervix	217	432.19	93,785.67	76	636.75	48,392.85
Subtotal - Procedures	79,480		<b>3,099,024.19</b>	27,818		3,940,605.97
Visits	158,960	3.49	554,545.79	44,509	20.33	1,809,810.55
<b>Total</b>			<b>3,653,569.98</b>			<b>5,750,416.52</b>
<b>Surgical treatment of cervical cancer</b>						
Radical hysterectomy (Wertheim-Meigs)	1,474	304.20	448,391.05	516	803.29	414,497.59
Total hysterectomy	12,008	234.32	2,813,684.91	4,203	735.36	3,090,725.63
Extended radical hysterectomy	3,231	1,215.06	3,925,869.53	1,131	2,087.46	2,360,916.77
Tumor total hysterectomy	642	438.06	281,231.72	225	2,183.26	491,234.41
Subtotal - Procedures	17,355		<b>7,469,177.20</b>	6,075		6,357,374.40
Visits	52,065	3.49	181,633.28	9,718	20.33	592,725.26
<b>Total</b>			<b>7,650,810.48</b>			<b>6,950,099.65</b>
<b>Clinical treatment of cervical cancer</b>						
Hospitalizations	28,057	301.78	8,467,141.60	9,820	488.43	4,796,427.04
Other medical procedures	10,223	264.07	2,699,586.22	3,578	488.43	1,747,618.73
Complex medical procedures listed in APAC*				20,789	488.43	10,154,065.35
Subtotal - Procedures	97,760		<b>35,425,259.03</b>	34,187		16,698,111.12
Visits	293,280	3.49	1,023,132.80	54,746	20.33	3,339,096.20
<b>Total - Clinical treatment</b>			<b>36,448,391.83</b>			<b>20,037,207.32</b>
<b>TOTAL</b>			<b>104,966,045.17</b>			<b>433,743,286.66</b>

\*APAC = Authorizations for High Complexity Procedures (*Autorizações de Procedimentos de Alta Complexidade*)

Source of data for the Public Health System: the Table of Procedures, Drugs, Orthotics, Prosthetics and Special Materials (*Tabela de Procedimentos, Medicamentos e Órteses, Próteses e Materiais especiais do SUS*) and the Outpatient Information System (*Sistema de Informações Ambulatoriais do SUS, SIA/SUS*).

Source of data for the Private Health System: the National Table of Equivalence of Procedures (*Tabela Única Nacional de Equivalência de Procedimentos, TUNEP*), the Health Supplement of the National Survey of Household Samples (*Pesquisa Nacional por Amostra de Domicílios, PNAD*), and the Hospitalization Information System (*Sistema de Informações Hospitalares do SUS, SIH/SUS*).

procedures of precancerous lesions, 3.5% on therapeutic procedures for precancerous lesions, 7.3% on surgical interventions for cancer, and 34.7% on clinical treatment for cervical cancer (Figure 1).

The costs of medical visits were an important component of the estimated costs of screening (USD \$18,924,336) and the diagnosis of precancerous lesions (USD \$7,653,178). The estimated total cost of the visits was USD \$28,336,826, which accounted for 27% of the total direct medical costs.

### Direct medical costs in the private health system

According to a national household survey, the PNAD 2008, 25.9% of the Brazilian population had private health insurance and access to private healthcare, but the utilization of the private health system varied according to the complexity of care; the utilization was 35.8% for cervical cancer screening and 26.9% for the diagnosis and treatment of

precancerous lesions and cervical cancer. These proportions were used to estimate the number of procedures in the private health system.

Screening was by far the procedure with the highest cost (USD \$368,191,899) because of its frequency, associated visits and associated higher costs in the private system (Table 1). The estimated costs for the diagnosis and treatment of precancerous lesions (USD \$32,813,663 and USD \$5,750,416) were approximately 9% and 1.5% of the screening costs, respectively. Inpatient surgical treatment was estimated at USD \$6,950,099, and clinical treatment, including hospital admissions, clinical procedures and clinical oncology outpatient treatment of cervical cancer, was estimated at USD \$20,037,207.

The estimated costs related to cervical cancer in the private health system were USD \$433,743,286 in 2006, with 84.9% spent on screening, 7.6% on diagnostics, 1.3% on therapeutic procedures for precancerous lesions, 1.6% on surgical

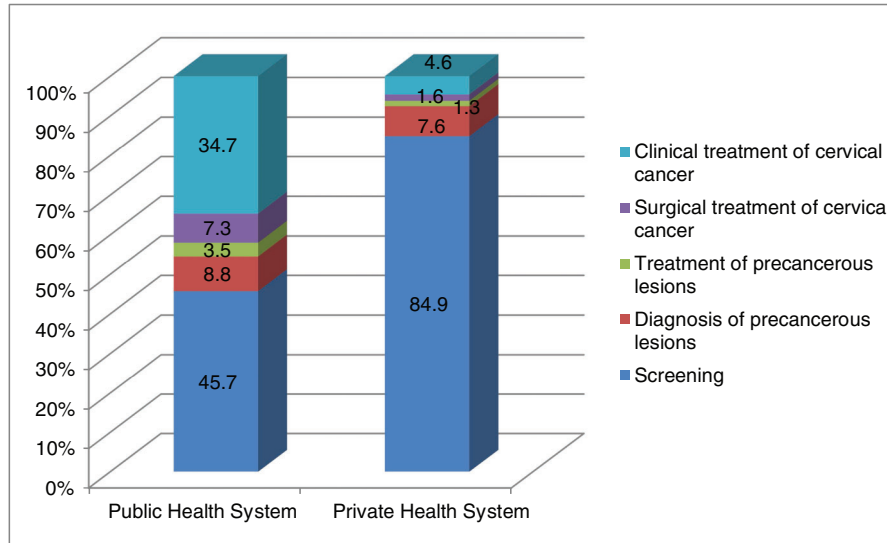


Figure 1 - Estimates costs distribution (%) by cervical cancer care components in Brazil, 2006.

Table 2 - Estimates of non-medical direct costs (transportation) associated with the screening, diagnosis and treatment of precancerous lesions and the diagnosis and treatment of cervical cancer in the public and private health systems in Brazil, in 2006 United States dollars.

Cervical cancer care components	Transportation costs			
	Public System		Private System	
	Procedures	Visits	Procedures	Visits
<b>Screening</b>				
Pap smears	20,438,282.89	40,876,565.79	11,445,438.42	22,890,876.84
<b>Total Screening</b>	<b>20,438,282.89</b>	<b>40,876,565.79</b>	<b>11,445,438.42</b>	<b>22,890,876.84</b>
<b>Diagnosis of precancerous lesions</b>				
Colposcopy	1,699,033.32	3,398,066.65	951,458.66	1,902,917.32
Cervical biopsy	216,795.45	433,590.91	121,405.45	242,810.91
<b>Total diagnosis of precancerous lesions</b>	<b>1,915,828.78</b>	<b>3,831,657.55</b>	<b>1,072,864.12</b>	<b>2,145,728.23</b>
<b>Treatment of precancerous lesions</b>				
Loop electrosurgical excisional procedure (LEEP)	116,795.40	233,590.80	65,405.42	130,810.84
Cold knife conization	15,310.73	30,621.46	8,574.01	17,148.02
Vaginal hysterectomy	1,119.57	2,239.15	626.96	1,253.92
Trachelectomy	5,215.36	10,430.72	2,920.60	5,841.20
Vaginal enlarged amputation of the cervix	379.01	758.03	212.25	424.49
<b>Total treatment of precancerous lesions</b>	<b>138,820.07</b>	<b>277,640.14</b>	<b>77,739.24</b>	<b>155,478.48</b>
<b>Surgical treatment of cervical cancer</b>				
Radical hysterectomy (Wertheim-Meigs procedure)	2,574.49	7,723.48	1,441.72	4,325.15
Total hysterectomy	20,973.22	62,919.66	11,745.00	35,235.01
Extended radical hysterectomy	5,643.28	16,929.83	3,160.23	9,480.70
Tumor total hysterectomy	1,121.32	3,363.96	627.94	1,883.82
<b>Total surgical treatment</b>	<b>30,312.31</b>	<b>90,936.93</b>	<b>16,974.89</b>	<b>50,924.68</b>
<b>Clinical treatment of cervical cancer</b>				
Hospitalizations	49,004.46	147,013.39	27,442.50	82,327.50
Other medical procedures	17,855.53	53,566.59	9,999.10	29,997.29
Complex procedures (listed in APAC)	103,888.00	311,663.99	58,177.28	174,531.83
<b>Total clinical treatment</b>	<b>170,747.99</b>	<b>512,243.97</b>	<b>95,618.88</b>	<b>286,856.62</b>
<b>Subtotal</b>	<b>22,693,992.04</b>	<b>45,589,044.39</b>	<b>12,708,635.55</b>	<b>25,529,864.86</b>
<b>Total (by system)</b>	<b>68,283,036.43</b>		<b>38,238,500.40</b>	
<b>TOTAL</b>	<b>106,521,536.83</b>			

Source: Estimates based on the average public transport fare in the Brazilian capitals from the National Association of Urban Transport (*Associação Nacional das Empresas de Transportes Urbanos – NTU*) in 2006.

interventions and 4.6% on clinical treatment for cervical cancer (Table 1, Figure 1).

The costs of medical visits were estimated separately and were a particularly important aspect of the estimated costs of

screening (USD \$266,454,664) and the diagnosis of precancerous lesions (USD \$24,976,719). The estimated total cost of the visits was USD \$297,173,015, accounting for 69% of the total direct medical costs.



**Table 3** - Estimates of indirect costs (productivity loss) associated with the screening, diagnosis and treatment of precancerous lesions and the diagnosis and treatment of cervical cancer in the public and private health systems in Brazil, in 2006 United States dollars.

Cervical cancer care components	No of days lost	Productivity loss			
		Public System		Private System	
		Procedures	Visits	Procedures	Visits
<b>Screening</b>					
Pap smears	1	129,280,250	258,560,499	72,396,940	144,793,879
<b>Total screening</b>		<b>129,280,250</b>	<b>258,560,499</b>	<b>72,396,940</b>	<b>144,793,879</b>
<b>Diagnosis of precancerous lesions</b>					
Colposcopy	1	10,747,060	21,494,120	6,018,354	12,036,707
Cervical biopsy	1	1,371,317	2,742,635	767,938	1,535,875
<b>Total diagnosis of precancerous lesions</b>		<b>12,118,377</b>	<b>24,236,754</b>	<b>6,786,291</b>	<b>13,572,582</b>
<b>Treatment of precancerous lesions</b>					
Loop electrosurgical excisional procedure (LEEP)	1	738,777	1,477,554	413,715	827,430
Cold knife conization	2	154,954	193,693	86,774	108,468
Vaginal hysterectomy	3	24,078	14,164	13,484	7,931
Trachelectomy	2	62,680	65,979	35,101	36,948
Vaginal enlarged amputation of the cervix	3	6,473	4,795	3,625	2,685
<b>Total treatment of precancerous lesions</b>		<b>986,962</b>	<b>1,756,184</b>	<b>552,699</b>	<b>983,463</b>
<b>Surgical treatment of cervical cancer</b>					
Radical hysterectomy (Wertheim-Meigs procedure)	5	74,909	48,854	41,949	27,358
Total hysterectomy	3	424,525	397,992	237,734	222,875
Extended radical hysterectomy	6	207,037	107,088	115,940	59,969
Tumor total hysterectomy	4	28,371	21,279	15,888	11,916
<b>Total surgical treatment</b>		<b>734,842</b>	<b>575,213</b>	<b>411,511</b>	<b>322,119</b>
<b>Clinical treatment of cervical cancer</b>					
Hospitalizations	4	1,363,880	929,918	763,773	520,754
Other medical procedures	1	112,943	338,830	63,248	189,745
Complex procedures(listed in APAC)	1	657,133	1,971,398	367,994	1,103,983
<b>Total clinical treatment</b>		<b>2,133,956</b>	<b>3,240,146</b>	<b>1,195,015</b>	<b>1,814,482</b>
<b>Subtotal</b>		<b>145,254,387</b>	<b>288,368,797</b>	<b>81,342,456</b>	<b>161,486,525</b>
<b>Total (by system)</b>		<b>433,623,184</b>		<b>242,828,982</b>	
<b>TOTAL</b>		<b>676,452,166</b>			

Source: Estimates based on the Health Supplement of the National Survey of Household Samples (*Pesquisa Nacional por Amostra de Domicílios, PNAD*) and the Hospitalization Information System (*Sistema de Informações Hospitalares do SUS, SIH/SUS*).

**Table 4** - Total annual costs of prevention and treatment of cervical cancer in Brazil according to health system, in 2006 United States dollars.

Cervical cancer care components	Public System			Private System		
	Direct	Indirect	Total	Direct	Indirect	Total
<b>Health System Perspective</b>						
Screening	47,959,674		47,959,674	368,191,899		368,191,899
Diagnosis of precancerous lesions	9,253,598		9,253,598	32,813,664		32,813,664
Treatment of precancerous lesions	3,653,570		3,653,570	5,750,417		5,750,417
Surgical treatment of cervical cancer	7,650,810		7,650,810	6,950,100		6,950,100
Clinical treatment of cervical cancer	36,448,392		36,448,392	20,037,207		20,037,207
<b>Total</b>	<b>104,966,045</b>		<b>104,966,045</b>	<b>433,743,287</b>		<b>433,743,287</b>
<b>Total by system</b>			<b>104,966,045</b>			<b>433,743,287</b>
<b>TOTAL</b>						<b>538,709,332</b>
<b>Societal Perspective</b>						
Screening	109,274,523	387,840,749	497,115,272	402,528,215	217,190,819	619,719,034
Diagnosis of precancerous lesions	15,001,085	36,355,132	51,356,216	36,032,256	20,358,874	56,391,130
Treatment of precancerous lesions	4,070,030	2,743,146	6,813,176	5,983,634	1,536,162	7,519,796
Surgical treatment of cervical cancer	7,772,060	1,310,055	9,082,114	7,017,999	733,630	7,751,629
Clinical treatment of cervical cancer	37,131,384	5,374,103	42,505,486	20,419,683	3,009,497	23,429,180
<b>Total</b>	<b>173,249,082</b>	<b>433,623,184</b>	<b>606,872,266</b>	<b>471,981,787</b>	<b>242,828,982</b>	<b>714,810,769</b>
<b>Total by system</b>			<b>606,872,266</b>			<b>714,810,769</b>
<b>TOTAL</b>						<b>1,321,683,034</b>

Summing the estimated direct medical costs in the public (USD \$104,966,045) and private health systems (USD \$433,743,287), the estimated total direct medical cost of cervical cancer was USD \$538,709,332 in 2006.

#### Direct non-medical costs

The total estimated cost of transportation was USD \$106,521,536 (Table 2), 64% of which was related to care in the public health system because of higher procedure



and visit frequencies. The direct non-medical costs were highest for screening in both the public and private health systems.

### Indirect costs

The estimated total indirect cost was USD \$676,452,166. Working days lost as the result of medical procedures and visits in the public system represented 21% and 43% of indirect costs, respectively, whereas working days lost as the result of procedures and visits in the private health system represented 12% and 24%, respectively (Table 3).

Table 4 presents the estimated total costs of the prevention and treatment of cervical cancer in Brazil from a societal perspective, which amounts to USD \$1,321,683,034, which was spent on procedures (USD \$213,199,490), visits (USD \$325,509,842), transportation (USD \$106,521,537) and productivity losses (USD \$676,452,166).

The indirect costs represented 51% of the total costs, followed by direct medical costs (visits and procedures) at 41% and direct non-medical costs (transportation) at 8%. The public health system represented 46% of the total costs, and the private health care system represented 54%.

## DISCUSSION

Studies of the economic burden of cervical cancer in developed countries use different methodological strategies regarding the population under study (national or specific groups), health services utilization and cost sources (individual health care data, health information systems and literature), diseases included (all HPV-related cancers, all genital cancers or cervical cancer only), and study design and perspective (14–16). The national annual cost of illness results are dependent on the population size and are influenced by the characteristics of the healthcare system.

In Belgium, the national annual cost of the management of cervical cancer was estimated at approximately €\$8 million from a societal perspective (14). In France, the national direct annual medical costs for invasive cervical cancer were estimated at €\$84 million (15).

A study that estimated the annual direct costs of the screening, diagnosis and treatment of precancerous lesions and the treatment of cervical cancer for the US in 2010 was more similar to our study (16). The total estimated annual direct costs related to cervical cancer were USD \$7 billion: 76% on screening, 18% on the diagnosis and treatment of precancerous lesions, and 6% on cervical cancer treatment. Another US study estimated that in 2005, the annual direct costs of screening were USD \$3.5 billion: 70% on screening, 19% on precancerous lesions and 11% on cervical cancer treatment (17).

The estimated costs of diseases are lower in Brazil than in high-income countries because of more limited access and utilization of health services, lower average costs of healthcare and lower family income; this also applies to cervical cancer. The total annual direct costs in Brazil in 2006 were estimated at USD \$538,709,332: 77% on screening, 10% on precancerous lesions and 13% on cervical cancer treatment. However, the estimated cost distribution in the public health care system was 46%, 12% and 42% and in the private health care system was 85%, 9% and 6%, respectively, revealing very important differences in the proportional weight of the components in the two systems.

These differences are a consequence of the different relative weights of the estimated costs of procedures in the two systems, with a larger difference in screening procedure estimates than in cervical cancer treatment estimates; however, the differences could also signal a higher incidence of cervical cancer in the public health system population. In a population with an effective screening program, it is to be expected that the cervical cancer incidence is low, and treatment costs will also be low. The effect of screening on precancerous lesion costs is more uncertain, although a reduction could also be expected.

Implementing an HPV immunization program for girls will not have a short-term effect on precancerous lesions and cervical cancer costs. New screening technologies and programs will affect all cost estimates, possibly even from a short-term perspective.

Non-medical direct costs and indirect costs comprise 60% of the total estimated costs; however, these costs are more subject to uncertainties than direct medical costs. This finding signaled the importance of including these estimates in the annual costs of cervical cancer care for society. The high number of procedures required for prevention and care results in large transportation expenses and many work-days lost, and the socio-economic consequences of cervical cancer on patients and families is a social cost that should not be ignored (18).

A detailed analysis of care components and specific technologies allows for additional interesting observations, particularly for the pattern of surgical procedures for precancerous lesions and cervical cancer. Hysterectomies for benign indications have been falling in most developed countries, and less aggressive procedures have become more frequent, whereas their number remains relatively stable for gynecologic cancer and represents approximately 10% of all hysterectomies in the US (19–22). Radical hysterectomy remains an essential treatment option for women with cancer in the early stages of cervical cancer, alongside radiotherapy, but less intensive interventions are also being considered. Our results indicate a predominance of the more invasive surgical procedures (23,24).

To develop the estimates of health service utilization and costs of the prevention and treatment of cervical cancer, this study sought to optimize the use of available data in health information systems and secondary databases, supplemented with data from literature reviews. The cost methodology adopted—"gross costing", which is based on the average reimbursement of procedures—is a recommended alternative to costing health services, particularly from a national perspective (25). Cost estimates tend to be more conservative but have the advantage of national representativeness, reproducibility and comparability with other studies.

An important methodological issue is the uncertainty regarding the frequency and remuneration of diagnostic and therapeutic procedures for precancerous lesions and of surgical interventions for cancer in the private health system. The costs of the clinical treatment of cancer in the private system may be more comparable to the public system; there are no significant differences in treatment protocols.

The frequency of medical visits for the clinical treatment of cancer may have been underestimated in both public and private health systems.

There is uncertainty in the estimates of productivity losses as the result of surgical interventions in both the public and private health systems. Furthermore, in the clinical treatment of cervical cancer, the loss of productivity other than days



lost for performing the procedures was not included, nor were the costs for families requiring drugs and other products and services not provided by health services, resulting in an underestimation of indirect costs.

Our cost estimates for cervical cancer prevention and treatment, albeit subject to uncertainties and underestimation, reveal little known values and patterns of direct and indirect costs for the components of care in the public and private health systems, indicating the complexity and economic importance of cervical cancer screening and care, and are of interest in research and health care management.

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## ■ AUTHOR CONTRIBUTIONS

Novaes HM, Itria A, Azevedo e Silva G, Sartori AC and Rama CH were responsible for the health service utilization estimates. Novaes HM, Itria A and De Soárez PC were responsible for the cost estimates. Novaes HM coordinated the study. All authors have reviewed and approved the final version of the article.

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