Cancer Incidence Among Adolescents and Young Adults (15 to 29 Years) in Brazil

Nathalie V. Balmant, BA, Rejane de Souza Reis, PhD,†*
Julio F. Pinto Oliveira, MSc,† Sima Ferman, MD, PhD,‡
Marceli de Oliveira Santos, PhD,† and Beatriz de Camargo, MD, PhD§

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Summary: The spectrum of cancers commonly found in adolescents and young adults (AYAs) differs from those in children and adults; therefore, the childhood classification is not appropriate for this population. Here we used a newly proposed classification system to reclassify cases of AYAs from Brazilian population-based cancer registries (PBCRs) in 5 geographic regions of Brazil. We aimed to describe the cancer incidence rates within this age group according to PBCR. Using the world population, incidence rates per million were analyzed in each diagnostic subgroup according to sex and age at diagnosis (15 to 19 y, 20 to 24 y, and 25 to 29 y). The median incidence rate was 232.31 per million for females and 218.07 per million for males. Incidence increased with age, with the highest rate observed for 25- to 29-year-olds in both sexes. Carcinomas, lymphomas, and skin tumors were most frequent among AYAs. High incidence rates of cervix-uterus carcinoma were observed in most PBCRs. AYAs present epidemiological characteristics that differ from those of children, reinforcing the need for a new classification. This study describes, for the first time, the cancer incidence rate in AYAs in Brazil, and we believe that our findings represent the Brazilian profile.

Key Words: cancer, adolescents, young adults, Brazil

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There is an increasing cancer rate among adolescents and young adults (AYAs) from 15 to 29 years of age, and cancer is currently 2.7 times more common in this age group than in childhood.[1] AYAs show a spectrum of cancers different from those commonly diagnosed among children and adults. Although leukemia is the most common childhood cancer, lymphomas are most frequent among 15- to 29-year-olds. In addition, among cancer patients of 15 to 24 years of age, 17% are diagnosed with carcinoma. The most frequent include thyroid, testicular, and nasopharyngeal carcinomas, and melanoma, showing a primary site distribution different from that found in adults.[2,3]

Because of these differences, the international classification of childhood cancer is not appropriate for AYAs.[4–6] Birch et al[5] proposed a new classification for this age group revised by the World Health Organization for AYA according to ICD-O3.[7] However, there is some study-to-study disagreement regarding the definition of adolescents and young adults. Various studies describe this age group as ranging from 15 to 24 or from 15 to 29 years of age, and more recently from 15 to 39 years of age.[5,8–15] This discrepancy makes it difficult to directly compare the available information in the literature. Recently, we used the newly proposed classification system to reclassify cases within the age group of 15 to 29 years from Brazilian population-based cancer registries (PBCRs).[5,6] The present study aimed to describe the incidence rate among adolescents and young adults based on data from 21 PBCRs in 5 geographic regions in Brazil.

MATERIALS AND METHODS

Data were obtained from 25 PBCRs covering 5 geographic regions of Brazil (North, Northeast, South, Southeast, and Middle-West). Four were excluded 3 because the data covered <3 years (Santos, Florianópolis, Campo Grande) and 1 (Campinas) because data were only available from 1991 to 1995. All 21 PBCRs meet the standard criteria recognized by International Agency for Research in Cancer. Table 1 show the period and population coverage for each PBCR. Tumors were reclassified using the histology-based classification scheme for adolescents and young adults proposed by Birch and colleagues and revised by World Health Organization in 2008 according to ICD-O3.[5,7] Incidence rates per million were analyzed in each diagnostic subgroup according to sex and age at diagnosis (stratified into 3 groups: 15 to 19 y, 20 to 24 y, and 25 to 29 y). Age-adjusted incidence rates were estimated by a direct method using the world population proposed for groups of less than 30 years old.[16] The median incidence rates were used to measure central tendency, to obtain an overall assessment of incidence rates. The 95% confidence intervals for incidence rates were calculated using Poisson approximation. Incidence trends were evaluated in 12 PBCR who had 8 years of consolidation on database. It was excluded for all the PBCR with rate value of zero. To identify significant changes in the trends for adolescents ages 1 to 19 incidence, the joinpoint regression analysis was performed; the annual average changes

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From the *Multiprofissional Residency Oncology Program; †Coordenação de Prevenção e Vigilância; ‡Pediatric Service, Hospital do Câncer I; and §Pediatric Hematology and Oncology Program, Research Center, Instituto Nacional de Câncer, Rio de Janeiro, Brazil.
N.V.B. reclassified all patients using the new classification system and analyzed the data. N.V.B., B.D.C., R.S.R., J.F.P.O., S.F., and M.O.S. reviewed, discussed, and analyzed the data and contributed to the writing of the manuscript. All authors participated in the interpretation of results, and read and approved the final manuscript.

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Reprints: Beatriz de Camargo, MD, PhD, Pediatric Hematology and Oncology Program, Research Center, Instituto Nacional de Câncer, Rua Marques de Pombal 125, Rio de Janeiro 20230-240, Brazil (e-mail: bdecamar@terra.com.br).
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TABLE 1. Population at Risk According to City and Region in Brazil

Regions	PBCR	Male	Female	Total	Average Annual
North	Belém (1999-2003)	1,244,631	1,380,946	2,625,577	525,115
	Manaus (2001-2005)	1,096,460	1,188,595	2,285,055	457,011
	Palmas (2006-2010)	127,776	140,833	268,609	53,721
	Roraima (2003-2005)	145,179	145,452	290,631	96,877
Northeast	Aracaju (2005-2009)	341,725	387,550	729,275	145,855
	Fortaleza (2002-2006)	1,489,960	1,692,215	3,182,175	636,435
	João Pessoa (2003-2007)	420,555	470,180	890,735	178,147
	Recife (2003-2007)	988,650	1,065,395	2,054,045	410,809
	Natal (2001-2005)	498,485	549,045	1,047,530	209,506
	Salvador (2001-2005)	1,864,460	2,061,235	3,925,695	785,139
	Teresina (2000-2002)	1,234,740	1,253,952	2,488,692	829,564
Middlewest	Cuiabá (2003-2007)	531,440	560,555	1,091,995	218,399
	Distrito Federal (1999-2002)	1,224,160	1,355,820	2,579,980	644,995
	Goiânia (2005-2009)	822,905	894,885	1,717,790	343,558
Southeast	Belo Horizonte (2001-2005)	1,578,330	1,681,000	3,259,330	651,866
	Grande Vitória (2004-2008)	1,031,560	1,073,385	2,104,945	420,989
	Jahu (2007-2011)	96,045	95,850	191,895	38,379
	Poços de Caldas (2007-2011)	93,444	92,401	185,845	37,169
	São Paulo (2006-2010)	25,809,780	26,100,770	51,910,550	10,382,110
Southeast	Curitiba (2004-2008)	1,119,975	1,160,840	2,280,815	456,163
	Porto Alegre (2002-2006)	876,090	899,360	1,775,450	355,090

PBCRs indicates population-based cancer registries.

(average annual percent change) were estimated. The best cut-point period for measuring the trends is described elsewhere (http://www.srab.cancer.gov/joinpoint). Significance was determined with the Monte Carlo Permutation method.[17]

RESULTS

The overall median age-adjusted incidence rates were 232.31 per million for females and 218.07 for males (Fig. 1). The age-specific incidence rates increased with increasing age for all cancers (Table 2). Compared with males, females showed lowest incidence rates in the 15 to 19 years and 20 to 24 years. Among the age group 25- to 29-year females had a higher incidence rate (Table 2). The highest age-adjusted incidence rates of lymphomas were seen in Goiania, with 63 cases per million. The lowest incidence rates were seen in Teresina (5 cases per million) and Curitiba (6 cases per million). The number of cases can be seen on

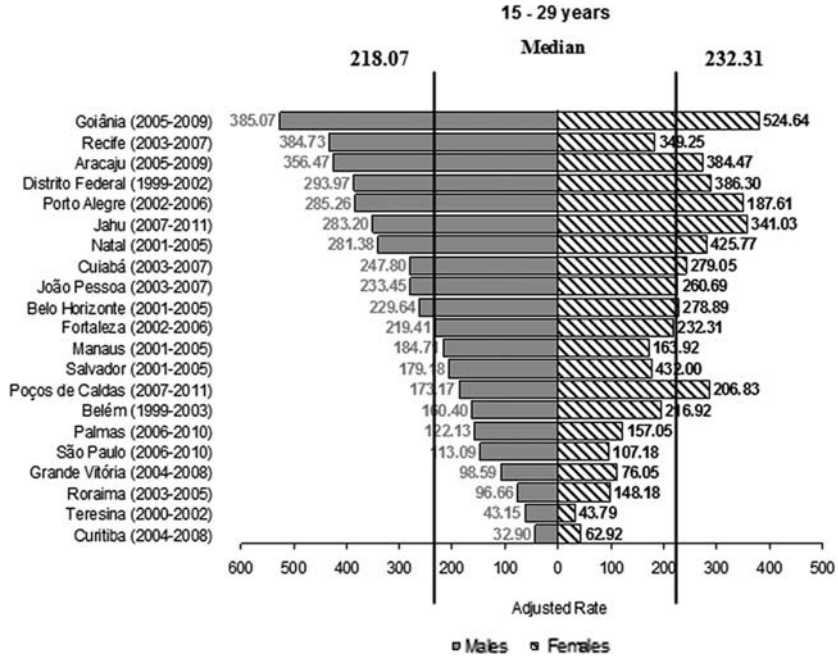

FIGURE 1. Distribution age-adjusted rate (per million) for cancers in adolescents and young adults (15-29 y) in 21 Brazilian population-based cancer registries (PBCR).

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TABLE 2. Age-adjusted Incidence Rate (Per Million) of Cancers in Adolescents and Young Adults According to Age and Sex in 21 Brazilian PBCR

	Males						Females					
	15-19 y		20-24 y		25-29 y		15-19 y		20-24 y		25-29 y	
PBCR	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
North												
Belém (1999-2003)	147.19	(87.68-151.50)	194.01	(147.81-240.20)	248.99	(192.21-305.78)	87.09	(61.03-113.14)	122.08	(90.36-153.81)	292.20	(238.95-345.45)
Manaus (2001-2005)	157.82	(118.52-197.11)	164.29	(123.69-204.89)	194.10	(145.34-242.86)	117.78	(85.11-150.44)	155.47	(117.33-193.60)	389.91	(323.47-456.35)
Palmas (2006-2010)	168.00	(43.35-292.65)	66.01	(8.70-140.73)	126.65	(15.53-237.78)	146.20	(37.70-254.69)	160.20	(49.13-271.26)	166.12	(42.63-289.61)
Roraima (2003-2005)	36.24	(14.06-86.54)	143.72	(37.11-250.33)	123.61	(15.27-231.96)	36.27	(−14.10-86.65)	42.48	(−16.39-101.34)	154.36	(30.55-278.18)
Median	152.51		154.01		160.38		102.44		138.78		229.16	
Northeast												
Aracaju (2005-2009)	140.79	(75.63-205.95)	259.48	(166.44-352.51)	437.47	(305.51-569.93)	165.43	(97.75-233.10)	375.40	(271.16-479.64)	769.02	(607.32-930.71)
Fortaleza (2002-2006)	148.33	(116.41-180.25)	230.56	(188.15-272.98)	284.02	(233.40-334.65)	132.53	(103.82-161.24)	194.89	(158.57-231.22)	381.99	(327.64-436.33)
João Pessoa (2003-2007)	203.13	(132.72-273.53)	192.55	(121.16-263.95)	287.31	(190.59-384.03)	148.03	(89.92-206.14)	250.78	(172.98-328.59)	454.21	(342.88-565.55)
Recife (2003-2007)	128.97	(91.66-166.27)	187.66	(141.29-234.03)	241.04	(184.93-297.15)	233.51	(175.36-271.66)	402.55	(336.79-468.31)	696.01	(606.23-785.79)
Natal (2001-2005)	181.88	(121.60-242.16)	223.89	(152.53-295.24)	450.80	(337.56-564.00)	161.89	(106.62-217.16)	334.92	(250.71-419.13)	548.66	(433.27-664.06)
Salvador (2001-2005)	120.69	(94.69-146.70)	161.00	(129.83-192.16)	258.22	(214.96-301.47)	93.11	(70.94-115.28)	180.12	(148.97-211.27)	361.47	(313.46-409.49)
Teresina (2000-2002)	27.14	(12.90-41.38)	28.68	(12.43-44.92)	40.11	(17.38-62.84)	29.79	(14.69-44.89)	44.84	(24.60-65.09)	118.27	(80.58-155.95)
Median	140.79		192.55		284.02		148.03		250.78		454.21	
Midwest												
Cuiabá (2003-2007)	165.07	(107.86-222.27)	198.96	(133.91-264.01)	370.80	(274.44-467.17)	171.00	(113.50-228.51)	276.05	(201.66-350.43)	403.62	(306.86-500.37)
Distrito Federal (1999-2002)	201.02	(158.23-243.81)	224.65	(179.68-269.61)	452.50	(383.82-521.18)	173.80	(136.10-211.51)	332.26	(280.26-384.25)	679.40	(599.78-759.02)
Goiânia (2005-2009)	254.12	(195.62-312.61)	322.53	(257.31-387.75)	578.65	(482.65-674.66)	212.97	(161.87-264.08)	437.38	(364.37-510.39)	962.51	(844.49-1080.53)
Median	201.02		224.65		452.50		173.80		332.26		679.40	
Southeast												
Belo Horizonte (2001-2005)	175.00	(139.71-210.29)	226.01	(186.34-265.68)	293.87	(245.00-342.73)	130.50	(100.82-160.18)	256.41	(215.59-297.22)	411.45	(355.93-466.97)
Grande Vitória (2004-2008)	93.84	(63.15-124.52)	119.79	(83.53-156.04)	128.04	(87.30-168.78)	54.31	(31.05-77.57)	97.43	(65.57-129.30)	176.41	(130.19-222.62)
Jahu (2007-2011)	134.84	(2.60-267.07)	184.37	(36.75-331.98)	782.20	(481.43-1082.98)	208.26	(41.60-374.93)	332.79	(136.14-529.45)	524.30	(282.03-766.58)
Poços de Caldas (2007-2011)	157.44	(19.31-295.56)	313.75	(119.27-508.24)	400.56	(173.97-627.15)	162.08	(19.91-304.25)	124.65	(2.45-246.85)	279.27	(84.37-474.17)
São Paulo (2006-2010)	51.04	(46.40-55.69)	90.92	(84.59-97.24)	155.12	(146.44-163.79)	54.25	(49.47-59.03)	130.81	(123.26-138.36)	271.21	(259.84-282.58)
Median	134.84		184.37		293.87		130.50		130.81		279.27	
South												
Curitiba (2004-2008)	42.10	(20.77-63.43)	35.45	(16.87-54.03)	52.04	(27.99-76.09)	56.49	(32.27-80.72)	24.67	(9.37-39.97)	48.63	(26.16-71.11)
Porto Alegre (2002-2006)	182.30	(134.88-229.71)	412.63	(339.94-485.32)	480.47	(395.86-565.08)	133.76	(92.70-174.81)	344.62	(279.59-409.64)	706.37	(606.17-806.58)
Median	112.20		224.04		266.26		95.13		184.65		377.50	

CI indicates confidence interval; PBCR, population-based cancer registries.

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TABLE 3. Age-adjusted Incidence Rate (Per Million) for Cancers in Adolescents and Young Adults (AYA) (15-29 y) According to AYA Classification in 21 Brazilian PBCR

	Leukemias		Lymphomas		CNS		Bones		Sarcomas		Germ Cell		Skin Carcinoma Melanoma		Carcinomas		Miscellanea		Nonspecific	
PBCR	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**	**Rate**	**M/F**
North																				
Belém (1999-2003)	25.58	1.44	21.19	1.50	8.14	2.17	8.63	2.00	7.40	1.43	8.04	8.50	5.98	0.44	61.13	0.37	1.29	2.00	29.58	1.33
Manaus (2001-2005)	30.71	1.12	17.46	2.00	14.58	0.94	14.57	1.06	13.01	0.58	11.29	1.36	12.24	3.02	59.97	0.19	0.44	0.00	20.72	0.96
Palmas (2006-2010)	10.89	0.50	22.56	5.00	13.03	2.00	7.71	1.00	4.27	0.00	7.06	1.00	11.43	2.00	63.09	0.23	0.00	0.00	0.00	0.00
Roraima (2003-2005)	0.00	0.00	0.00	0.00	17.96	0.67	0.00	0.00	7.06	0.00	0.00	0.00	18.25	1.50	16.83	0.30	0.00	0.00	27.28	7.00
Median	18.24		19.33		13.81		8.17		7.23		7.55		11.84		60.55		0.22		24.00	
Northeast																				
Aracaju (2005-2009)	19.47	1.00	31.00	0.77	12.28	1.25	12.23	1.25	16.42	2.00	18.45	1.17	82.46	0.89	157.81	0.30	4.06	0.00	1.40	0.00
Fortaleza (2002-2006)	21.19	1.16	38.11	1.12	19.04	1.22	10.64	2.40	9.88	1.07	10.45	2.30	21.31	1.08	70.01	0.36	2.13	0.75	23.18	1.06
João Pessoa (2003-2007)	25.66	2.29	44.67	0.95	17.04	0.88	26.40	2.43	11.84	1.75	9.17	3.00	11.52	0.67	88.15	0.16	2.41	0.00	18.55	0.45
Natal (2001-2005)	33.19	1.00	31.47	1.13	19.82	1.86	7.99	2.00	11.63	0.50	12.81	0.86	37.25	1.00	111.96	0.42	2.61	2.00	44.34	0.88
Recife (2003-2007)	22.34	0.64	28.69	0.87	14.90	2.33	10.76	1.75	15.91	1.20	6.12	1.60	17.62	1.00	175.59	0.13	2.50	1.50	19.59	0.54
Salvador (2001-2005)	16.22	1.37	24.98	1.55	16.82	1.78	9.06	1.25	12.34	1.29	7.99	0.52	19.72	1.05	64.70	0.33	1.03	0.33	20.53	0.84
Teresina (2000-2002)	6.05	0.60	5.34	0.86	5.84	1.33	0.85	1.00	4.70	0.83	2.75	0.17	3.03	2.00	14.53	0.21	1.21	0.00	3.45	0.33
Median	21.19		31.00		16.82		10.64		11.84		9.17		19.72		88.15		2.41		19.59	
Midwest																				
Cuiabá (2003-2007)	23.99	1.36	34.68	1.53	20.97	1.09	9.38	2.33	13.79	0.88	15.60	1.83	43.44	1.04	75.02	0.22	5.23	0.67	18.92	1.50
Distrito Federal (1999-2002)	17.37	3.00	36.93	1.54	26.51	1.27	13.88	2.50	14.55	1.53	11.30	0.81	37.93	0.85	99.02	0.33	0.79	0.00	81.92	0.40
Goiânia (2005-2009)	23.10	1.86	63.53	1.00	33.54	1.43	15.59	1.60	27.43	0.96	23.33	4.71	74.75	0.61	172.51	0.27	11.03	0.90	11.03	1.11
Median	23.10		36.93		26.51		13.88		14.55		15.60		43.44		99.02		5.23		18.92	
Southeast																				
Belo Horizonte (2001-2005)	19.36	1.63	38.87	0.70	22.49	1.12	11.53	1.47	15.32	1.22	18.47	3.54	26.84	0.68	75.79	0.43	2.29	0.75	14.92	0.69
Grande Vitória (2004-2008)	19.85	1.33	17.16	1.25	13.43	3.00	7.53	1.67	3.73	0.60	3.55	2.50	4.53	0.50	30.03	0.51	0.47	0.00	9.99	0.75
Jahu (2007-2011)	19.34	0.00	49.96	1.00	21.55	1.00	12.87	1.00	14.11	0.50	26.07	0.00	116.27	1.33	77.15	0.34	6.10	0.00	9.68	0.00
Poços de Caldas (2007-2011)	10.62	1.00	32.94	1.00	5.07	0.00	5.96	0.00	21.59	3.00	54.65	9.00	41.67	7.00	48.27	0.27	10.30	0.00	5.22	0.00
São Paulo (2006-2010)	5.95	1.15	16.32	1.08	3.79	1.20	3.30	1.85	3.64	1.19	5.25	14.78	12.53	0.95	48.80	0.32	0.87	0.69	22.04	0.49
Median	19.34		32.94		13.43		7.53		14.11		18.47		26.84		48.80		2.23		9.99	
South																				
Curitiba (2004-2008)	4.57	1.50	6.01	1.60	3.46	1.67	4.47	0.80	3.22	2.50	8.13	2.00	2.12	0.67	9.73	0.17	1.32	0.50	0.41	0.00
Porto Alegre (2002-2006)	23.43	1.63	61.43	0.98	14.22	2.57	13.80	1.08	22.67	1.50	41.15	11.44	48.75	0.71	112.82	0.29	2.81	0.67	27.61	1.04
Median	14.00		33.72		8.84		9.14		12.95		24.64		25.44		61.28		2.07		14.01	
Median	19.47		31.00		14.90		9.38		12.34		10.45		19.72		70.01		2.13		18.92	

CNS indicates central nervous system; PBCR, population-based cancer registries.

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TABLE 4. Age-adjusted Incidence Rate (Per Million) for the 4 Most Incident Subgroups of Group 8 (Except Skin) According to Sex in 21 Brazilian PBCR

	Colorectal				Thyroid				Breast				Cervical	
	Males		Females		Males		Females		Males		Females		Females	
PBCR	No. Cases	Rate	No. Cases	Rate	No. Cases	Rate	No. Cases	Rate	No. Cases	Rate	No. Cases	Rate	No. Cases	Rate
North														
Belém (1999-2003)	11	11.14	4	2.75	4	3.47	8	6.22	0	0.00	16	12.66	52	40.30
Manaus (2001-2005)	4	3.93	8	7.20	1	1.00	10	8.40	0	0.00	15	13.61	53	50.86
Palmas (2006-2010)	1	8.61	2	13.43	0	0.00	4	28.14	0	0.00	2	15.86	6	41.91
Roraima (2003-2005)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	17.53
Median		6.27		4.98		0.50		7.31		0.00		13.14		41.11
Northeast														
Aracaju (2005-2009)	2	5.67	2	5.77	10	31.15	48	132.43	0	0.00	9	24.36	16	43.82
Fortaleza (2002-2006)	10	6.64	4	2.49	9	5.91	55	33.43	0	0.00	29	18.50	45	28.28
João Pessoa (2003-2007)	5	12.34	2	4.44	1	2.36	14	29.05	0	0.00	8	17.37	26	58.90
Recife (2003-2007)	4	4.06	6	5.77	4	4.1	18	16.75	0	0.00	45	42.77	205	193.28
Natal (2001-2005)	1	1.96	4	7.64	11	23.44	43	90.01	0	0.00	8	19.81	18	34.57
Salvador (2001-2005)	8	4.39	12	5.99	7	3.89	48	24.21	0	0.00	54	28.31	21	10.67
Teresina (2000-2002)	2	1.88	1	1.05	0	0.00	4	3.71	0	0.00	6	5.96	10	8.90
Median		4.39		5.77		4.10		29.05		0.00		19.81		34.57
Midwest														
Cuiabá (2003-2007)	5	9.75	2	3.43	3	5.57	10	17.01	0	0.00	9	16.05	27	50.56
Distrito Federal (1999-2002)	9	7.65	19	14.46	7	6.00	50	36.93	0	0.00	30	23.12	46	34.97
Goiânia (2005-2009)	10	12.92	14	16.29	14	17.74	82	91.10	1	1.14	36	41.69	55	65.30
Median		9.75		14.46		6.00		36.93		0.00		23.12		50.56
Southeast														
Belo Horizonte (2001-2005)	19	12.16	14	8.58	12	7.82	48	28.88	0	0.00	40	24.11	34	20.75
Grande Vitória (2004-2008)	6	6.07	6	5.43	1	0.97	1	0.81	0	0.00	20	19.72	5	5.09
Jahu (2007-2011)	1	9.61	0	0.00	0	0.00	6	55.26	0	0.00	0	0.00	1	9.49
Poços de Caldas (2007-2011)	1	10.71	0	0.00	0	0.00	3	33.95	0	0.00	4	43.87	0	0.00
São Paulo (2006-2010)	70	2.77	87	3.36	155	6.12	801	30.92	15	0.57	327	12.75	182	7.10
Median		9.61		3.36		0.97		30.92		0.00		19.72		7.10
South														
Curitiba (2004-2008)	0	0.00	1	0.86	1	0.95	5	4.27	0	0.00	2	1.69	5	4.10
Porto Alegre (2002-2006)	8	9.26	15	17.02	7	7.93	21	23.14	1	1.02	39	45.78	47	54.77
Median		4.63		8.94		4.44		13.71		0.51		23.74		29.44

PBCR indicates population-based cancer registries.

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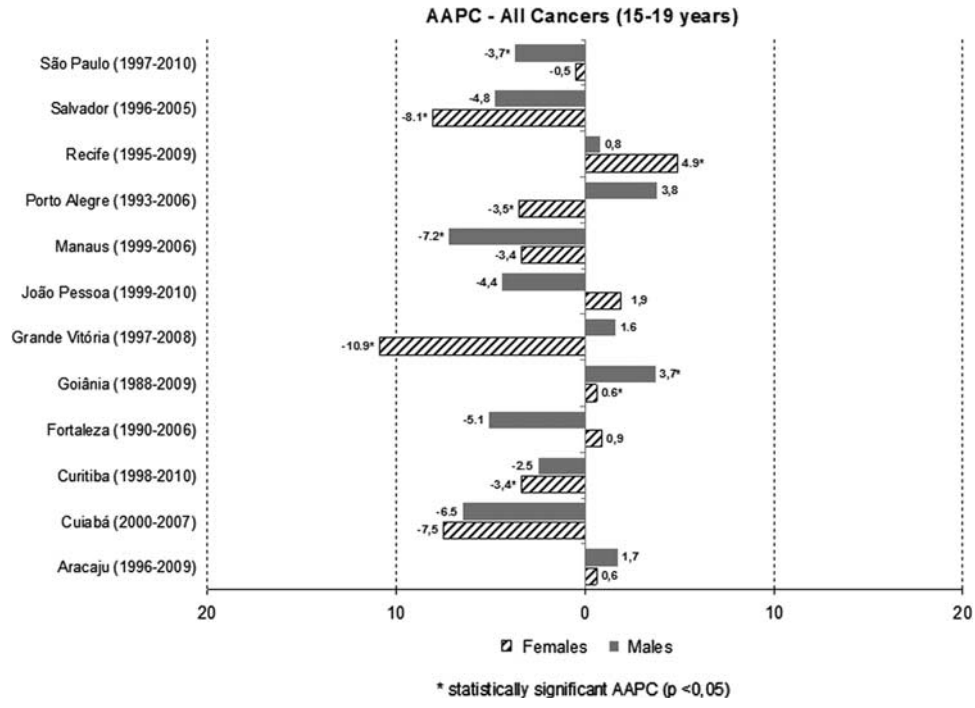

FIGURE 2. Average annual percent change (AAPC) of incidence rate for cancers in adolescents (15 to 19 y) according to sex in 21 Brazilian population-based cancer registries (PBCR).

supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/JPHO/A138.

Carcinomas occurred with high age-adjusted incidence rates among most PBCRs in different geographic regions (Table 3). The ratio M/F of carcinoma was < 1 in all PBCR (Table 3). Colorectal, thyroid, breast, and cervical carcinomas had the highest incidence rates in group 8 of AYA Classification. The primary site distribution revealed that cervix/uterus showed the highest age-adjusted incidence rate in most PBCRs, and that thyroid carcinoma was more common among females than males, mainly in southeast region (Table 4). Germ cell tumors, skin carcinomas, and melanoma had the highest age-adjusted incidence rates among males.

Males had a higher incidence rate of lymphoma compared with females. There was small difference between lymphoma subtypes (Supplemental Table 2, Supplemental Digital Content 2, http://links.lww.com/JPHO/A139).

To evaluate the incidence rates trends of adolescents age 15 to 19 years in different Brazilian region, joinpoint regression models were applied and a significant decline were observed in 5 PBCR (Sao Paulo, Salvador, Porto Alegre, Grande Vitoria, and Cutitiba). Increased rates were observed in 2 PBCR (Recife and Goiania) (Fig. 2).

DISCUSSION

This report is the first descriptive incidence profile of cancer cases among adolescents and young adults in Brazil. Although we previously described cancer incidence among children and adolescents from 0 to 19 years of age, the incidence among AYAs from 15 to 29 years of age in Brazil has never before been investigated.[18] Increased cancer incidence among AYAs has been reported in Asia, Europe, and the United States.[1,5,12]

Table 5 shows previously reported cancer incidence rates in AYAs among different countries. Among adolescents of 15 to 19 years of age, incidence rates did not differ between sexes in our present study as well as in previous reports. In this age group, the highest overall incidence rates are reported in France (219.40 cases per million) and the USA (221 cases per million).[1,2,9] In all countries, as in our present findings, the age-adjusted incidence rates increase with increasing age groups.

In young Brazilian adults of 20 to 24 years of age, there were not great differences in incidence rates of females compared with males. Higher incidence of female was seen in Korea and USA.[2,11] Analysis of the overall age-adjusted incidence rates in this age group shows the highest values in the USA (379 cases per million) and Canada (327 cases per million).[8]

Among the countries in which the incidence rate is described in young adults over 24 years of age, higher incidence rates are reported in females compared with males. Females in USA and Korea show the highest incidence rates (692 and 663 cases per million, respectively) among young adults with ages ranging from 25 to 29 years. The overall highest incidence rate in this age group is reported in the USA (610 cases per million).[2,11]

Lymphomas are the most common cancer diagnosed among AYAs, corresponding to 20% of all cancers affecting this population according to data from the Surveillance, Epidemiology, and End Results (SEER) program.[19] Our present data also indicated that lymphomas were the most frequent tumor type in AYAs, for both sexes and with no differences between the different analyzed age groups. Among AYAs in England, the rates of non-Hodgkin

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TABLE 5. Incidence Rates (Per Million) for Cancers in Adolescents and Young Adults (15-29 y)

Source/Country	References	15-19 y			20-24 y			25-29 y		
		M	F	T	M	F	T	M	F	T
PBCR, France (2000-2008)	Desandes et al[10]	218.80	220.10	219.40	307.70	278.20	293.10	—	—	—
NCR, England (1979-1997)	Birch et al[5]	158.00	128.00	144.00	238.00	214.00	226.00	—	—	—
NCR, Nothern England (1968-1995)	Cotterill et al[12]			144.30			209.30			
PBCR, Portugal (1997-2006)	Carreira et al[13]	—	—	198.30	—	—	306.20	—	—	—
PBCR, Ontario, Canada (1990-2001)	Furlong et al[8]	—	—	198.00	—	—	327.00	—	—	535.00
SEER, USA (2007-2011)		229.00	211.00	221.00	351.00	407.00	379.00	530.00	692.00	610.00
PBCR, The Netherlands (1989-2009)*	Aben et all[15]	221.00	181.00	—	335.00	295.00	—	468.00	534.00	—
KCCR, Korea (1999-2010)†	Moon et al[11]	150.90	160.40	—	170.70	305.60	—	273.40	663.30	—
PBCR, Brazil	This study (median)	148.33	133.76	153.60	192.55	194.89	219.50	266.26	377.50	339.62

*ESR (European standardized rates).
†Age-specific incidence rates.
KCCR indicates Korea Central Cancer Registry; PBCR, population-based cancer registries; NCR, National Cancer Registry; SEER, Surveillance, Epidemiology, and End Results.

lymphoma were significantly higher among males than females, whereas Hodgkin lymphomas occurred with similar rates for both sexes.[3]

Compared with males, females showed higher age-adjusted incidence rates in the present study among young people over 24 years of age. This difference has also been shown in Korea and the USA.[9,11,14] In other countries, the age-adjusted incidence rates are similar for both sexes.[3,8,10,12,13,15]

It has previously been reported that females show high rates of epithelial tumors in childhood, and that this rate increases with age though adolescence and early adulthood.[3,20] In our series, this sex-based difference in incidence rate was largely due to the high incidence of cervix-uterus carcinoma. Cervical cancer related to infection with human papillomavirus (HPV) as shown by abnormal Papanicolaou smears has become an important public health issue. Although the majority of cytologic abnormalities in adolescents may regress over time, cervical cancer risk appears to also be related to other risk factors. Smoking, early sexual debut, high numbers of lifetime sexual partners, and low socioeconomic conditions are risk factors for lower screening rates and for development of aggressive cervical lesions.[21]

Among adolescents in Goiania, Brazil, HPV DNA has been detected in 28% of cervical specimens (95% confidence interval, 23.9-32.5).[22] A study in the city of Rio de Janeiro analyzed the incidence of cervical intraepithelial lesions among adolescents younger than 20 years of age, and found a 24.1% prevalence of lesions in adolescents within the first year following sexual debut.[23] Another study followed adolescents in Sao Paulo, Brazil over 9 years, and found a 76.5% to 100% prevalence of low-grade lesions in cases with abnormal Pap smears.[24] A study of AYAs (15 to 20 y of age) in the North of Brazil showed that 6.4% had abnormal PAP smears, of which 94.2% corresponded to epithelial lesions and 5.8% to adenocarcinoma.[25] In Canada, a study investigated the incidence of cervical neoplasia among 15- to 29-year-old women between 1970 and 2007, and reported a declining trend during this period, mainly with regards to squamous cell carcinomas.[26] They also found an extremely low incidence of adenocarcinomas in this population.

In 1998, Brazil adopted a cervical cancer control program in women aged between 25 and 60 years of age, which included a yearly Pap examination, with follow-up every 3 years after 2 consecutive negative results. This led to a decreasing trend in the incidence of invasive tumors in most populations, even though the rate of in situ tumors has increased. The diagnosis of tumors in situ is more common in younger women.[27] The high rate of HPV detection in adolescents emphases the advantages of early vaccination, before the onset of sexual activity. Vaccination will clearly have a substantial impact on the rates of invasive cervical cancer and its precursors. Recent studies have shown decreases in cervical cancer rates due to HPV vaccination at an earlier age.[28–32] The most effective strategy combines vaccination with screening protocols. HPV vaccination was initiated in Brazil in 2014, and the effects should be evaluated in future investigations.

Our present results also showed a high incidence of thyroid carcinoma among AYAs, especially in females. A recent study used data from the SEER program to examine the incidence of thyroid tumors among AYAs of < 30 years of age between 1984 and 2010. The analysis

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of tumor size in this study led to the conclusion that the incidence rate was high regardless of the tumor evolution. This is in contrast with the concept that increasing thyroid cancer incidence is due to higher detection of smaller tumors at early ages.[33] Socioeconomic data may be an important variable despite that our PBCR are limited to capitals and the Human development index has only small difference among the capitals. Furthers analysis need to be done.

Several countries have also seen substantially increased incidence of skin tumors in recent years. This increase is observed among AYAs, especially within the white populations of North America and Europe, Australia, and New Zealand.[34–36] In all Brazilian PBCRs, we found higher skin tumor incidence rates within the 20- to 24-year and 25- to 29-year age groups. Skin carcinomas are generally less common than melanoma.[37,38] In Tunisia, skin carcinoma is exceptionally prevalent among 15- to 19-year-olds, with rates of 7.8 per million for males and 16.5 per million for females.[39] In our present series, among AYAs, the median incidence of melanoma was 3 cases per million, whereas the median incidence of skin carcinomas was 18 cases per million, and these rates increased with age. All Brazilian PBCRs collect data on basal carcinoma, which may be the reason for the higher incidence rate. Exposure to ultraviolet radiation plays a key role in melanoma and carcinoma development, and sun exposure habits are high in children in Brazil.[40]

Within the new classification system, the 10th group corresponds to unspecific neoplasms. In our data, we observed very high rates of unspecific neoplasms in 2 PBCRs: 81.92 per million in Distrito Federal and 44.34 per million in Natal. These high rates could be due to a lack of specific diagnoses in these PBCRs as well as to incorrect data in the systems. In the Ontario Cancer Registry, increased rates of unspecified diagnoses were found to increase with age, with a lower rate in the 15- to 19-year age group compared with the 20- to 24-year and 25- to 29-year age groups ($P < 0.001$).[8]

The decrease rate observed on some PBCR must be interpreted with caution because it may reflect the access to health care, the improvement of diagnosis procedure especially among adolescents with cervical cancer and the quality of data collection. For this analysis we used only the PBCR with at least 8 years of consolidation, but longer follow-up is necessary to better evaluate.

Our present results confirm that cancer among adolescents and young adults presents epidemiological characteristics that differ from those seen in children, reinforcing the need for a new classification system that includes tumor histologic types that are closer to those found in adults. Incidence rates of cancer in AYA in Brazil vary by geographic regions being the highest at Midwest and Northeast and the lowest in the South and North regions. Carcinomas, lymphomas were the most frequent malignancies in 10 registries. Previous data leukemia, lymphoma, and central nervous system were the most frequent among children and adolescent (0 to 19 y).[18] Further environment factors need to be explored. Our findings show a high incidence rate of cervical cancer, indicating a need for further investigation regarding disease prevention and screening programs. The major limitations of the present study are that all of the Brazilian PBCRs were confined to capital cities and different periods. This study describes, for the first time, the cancer incidence rate in adolescents and young adults in Brazil. Despite the study limitations, we believe that the present data represent the Brazilian profile.

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