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Cancer incidence estimates at the national and district levels in Colombia

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Abstract

Objectives. To estimate national and district cancer incidence for 18 major cancer sites in Colombia. **Materials and Methods.** National and district incidence was estimated by applying a set of age, sex and site-specific incidence/mortality ratios, obtained from a population-based cancer registry, to national and regional mortality. The work was done in Bogotá (Colombia) and Lyon (France) between May 2003 and August 2004. **Results**. The annual total number of cases expected (all cancers but skin) was 17 819 in men and 18 772 in women. Among males the most frequent cancers were those of the prostate (45.8 per 100 000), stomach (36.0), and lung (20.0). In females the most frequent were those of the cervix uteri (36.8 per 100 000), breast (30.0), and stomach (20.7). Districts with the lowest death certification coverage yielded the highest incidence rates. **Conclusions**. In the absence of national population-based cancer registry data, estimates of incidence provide valuable information at national and regional levels. As mortality data are an important source for the estimation, the quality of death certification should be considered as a possible cause of bias.

Key words: incidence; neoplasms; epidemiology; Colombia

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Resumen

Objetivos. Determinar la incidencia nacional y departamental para 18 tipos de cáncer en Colombia. **Material y métodos**. Se estimaron casos y tasas de incidencia ajustadas por edad a partir de razones incidencia/mortalidad según edad, sexo y tipo de cáncer. Los casos se tomaron de un registro poblacional y se usó la información oficial de mortalidad. El trabajo se realizó en Bogotá (Colombia) y en Lyon (Francia) entre mayo de 2003 y agosto de 2004. **Resultados**. El número anual de casos esperados (todos los cánceres) fue 17 819 en hombres y 18 772 en mujeres. Los principales cánceres en hombres fueron los de próstata (45.8 por 100 000), estómago (36.0) y pulmón (20.0); en mujeres fueron los de cuello uterino (36.8 por 100 000), mama (30.0) y estómago (20.7). Los departamentos con baja cobertura del certificado de defunción presentaron tasas altas de incidencia. **Conclusiones**. En ausencia de un registro nacional de tumores, la estimación de incidencia proporciona información valiosa a nivel nacional y departamental. La calidad y cobertura de los certificados de defunción puede ser una fuente de error en los datos calculados.

Palabras clave: incidencia; neoplasias; epidemiología; Colombia

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Data on cancer incidence are traditionally obtained from population-based cancer registries.[1] Colombia has the oldest cancer registry in Latin America, the Cali Cancer Registry, which provides information for the urban population of Cali since 1962, and meets standards of data quality required for inclusion in successive volumes of the "Cancer Incidence in Five Continents" series.[2]

Given the cultural, geographical and social variability of Colombia, the incidence data of the Cali Cancer Registry are insufficient to provide a nationwide picture of cancer incidence, nor for regions outside its coverage area.This has motivated the establishment of additional cancer registries in other areas of the country, although at present, these registries have been going on for only a few years and do not provide additional data to complement existing sources of information on cancer incidence in Colombia.

Despite the recent publication of a Mortality Atlas for Colombia[3] –that provides a clear picture of differing risks according to geographical areas for the major cancer sites– there is still the necessity for the attainment of suitable information on cancer incidence for the planning of treatment and prevention services at the district and national level.

In the absence of national incidence information, the International Agency for Research on Cancer (IARC) developed an estimation method based on national mortality and on local incidence and mortality data; this method is frequently used to obtain information at the country level.[4-7] GLOBOCAN[8] provides an estimation of cancer incidence at the national level, but the estimation is based on mortality data, and incidence data from the Cali Cancer Registry as well as from other Latin American registries. The cancer patterns in these external populations may be of little relevance to the epidemiological profile of Colombia and the true picture of national incidence.

The purpose of this study was to examine the aforementioned method in estimating cancer incidence at the national and subnational levels in Colombia. Estimates of incidence rates and the number of new cases are presented for the 18 most common cancer sites by sex.

Material and Methods

The present publication is a component of the study "Present state of the cancer situation in Colombia: Incidence and mortality" , approved by the Ethics Committee at the Instituto Nacional de Cancerología in Bogotá, Colombia.

Incidence and mortality data were extracted by sex and for 18 common cancer sites using the International Classification of Diseases, 10th edition (ICD-10): oral cavity and pharynx (C00-14), oesophagus (C15), stomach (C16), colon-rectum (C18-21), liver (C22), gallbladder (C23-4), pancreas (C25), larynx (C32), lung (C33-4), female breast (C50), cervix uteri (C53), corpus uteri (C54), prostate (C61), bladder (C67), brain-central nervous system (C70-2), non-Hodgkin lymphoma (C82-5,C96), leukaemia (C91-5) and for all cancers combined (but non-melanoma skin cancer, C00-96 but C44). After analysis, the data were partitioned into eight age groups: 0-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74 and 75 years and over.

National mortality and population data

Mortality and population data were obtained for the period 1995-1999 at both the national level and district level from the Departamento Administrativo Nacional de Estadística (DANE), the official source for such information in Colombia.[9,10] Mortality data were first adjusted for under-registration at a district level and then by age and sex, using the information provided by a Colombian study on completeness of death information for the year 1993.[11] The number of deaths coded as 'uterus unspecified' (ICD-10 C55) was reallocated to either uterine cervix (C53) or uterine corpus (C54) cancer, on the basis of their respective age specific proportions, following international recommendations.[12]

Finally, for each combination of cancer site and sex, cases of unknown age were partitioned proportionally within the eight age groups, therefore assuming that such cases were missing age at random and had the same age distribution as the known cases. This method is the one followed by the IARC in the different "Cancer incidence in five continents" publications.[2]

Incidence estimates

The following formula was used in the estimation process:

$$I_N = M_N \times [I_R / M_R]$$

Where:

I_N= national/district incidence
M_N= national/district mortality (1995-1999)
I_R= regional incidence from Cali (1992-1996)[2]
M_R= regional mortality from Cali (1992-1996),

assuming a similar I/M ratio for each district and for Colombia as a whole.

National and district cancer incidence was estimated through a Poisson log-linear model of incidence and

mortality by sex and site, adjusted for age, obtained from the Cali cancer registry. These I_R/M_R ratios were then applied to the national and district mortality. Cervix (C53) and corpus uteri (C54) cancer deaths and new cancer cases registered in Cali were adjusted for age, to correct for the varying proportions of these attributed to ICD code 'Uterus unspecified' (ICD-10 C55). For the category 'all cancers but non-melanoma skin', estimates were obtained by summing the number of cases at the 17 specific sites included in this study, and a category for 'all other cancers but non-melanoma skin' (including cancer of unknown primary site). This method has been used in compilations at the international level.[8,13] The estimated incidence and corrected mortality are presented as crude and age-standardized rates per 100 000, using the world standard population, as originally proposed by Segi,[14] and modified by Doll.[15]

Age-specific incidence rates for the main sites, namely stomach cancer, breast cancer and cervix cancer are presented in comparison to age-specific incidence rates from other Latin American countries and the United States of America, provided by GLOBOCAN 2000 (figures 1 and 2).

Validation

In selecting a final model to be used in the estimations, we performed a validation procedure using different sources of under-registration to correct the mortality (WHO indicators or local information) and using incidence information from different registries (only Cali or Cali, Quito and Costa Rica). Estimated incidence was obtained for Cali and Pasto, using the following four combinations: mortality (Cali, Pasto) corrected with WHO indicators and incidence from Cali only; mortality (Cali, Pasto) corrected with local information and incidence from Cali only; mortality (Cali, Pasto) corrected with WHO indicators and incidence from the three registries combined; mortality (Cali, Pasto) corrected with local information and incidence from the three registries combined. The estimated data were then compared with the Cali incidence and with the Pasto incidence from the existing population based cancer registries in these two cities.[2,16] This validation procedure has been published previously[17] and yielded best results with a "Colombian model" e.g. correcting mortality with local information and using the incidence data only from the Cali Registry.

Results

Age-adjusted cancer incidence rates in men were 213.6 and 212.9 in women (tables I and II). The estimated average annual number of incident cases for 1995-1999 was 28 130 in men and 33 500 in women (tables I and II). The number of cases for the 17 specific sites accounted for 77.3% of the total number of cases in males and for 73.5% in females.

After correction for under-registration, the total number of annual cancer deaths among males and fe-

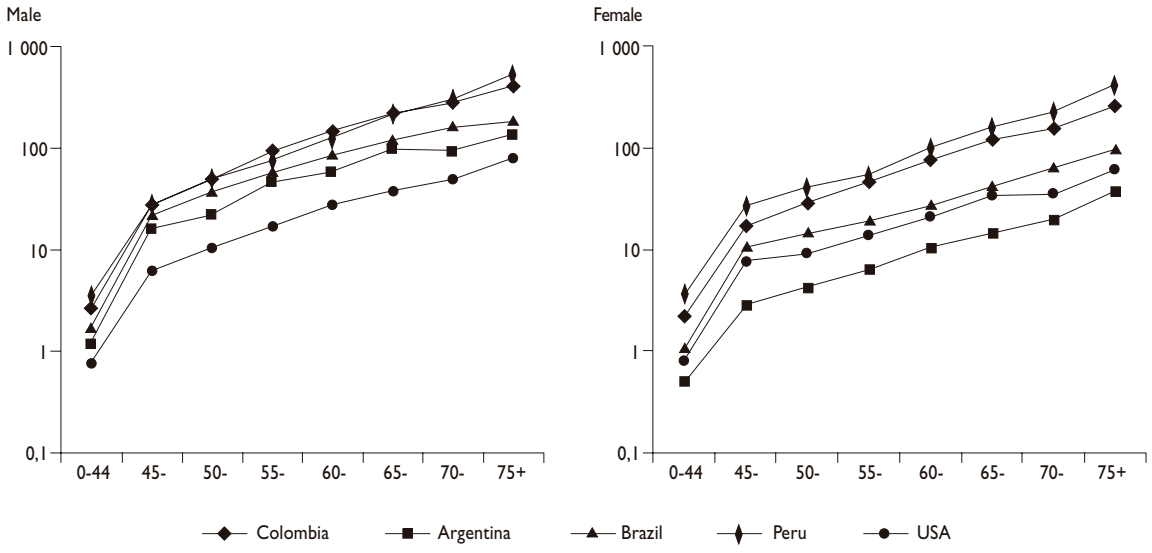

FIGURE 1. AGE-SPECIFIC INCIDENCE RATES OF STOMACH CANCER, COMPARING DIFFERENT LATIN AMERICAN COUNTRIES AND THE USA, 2000

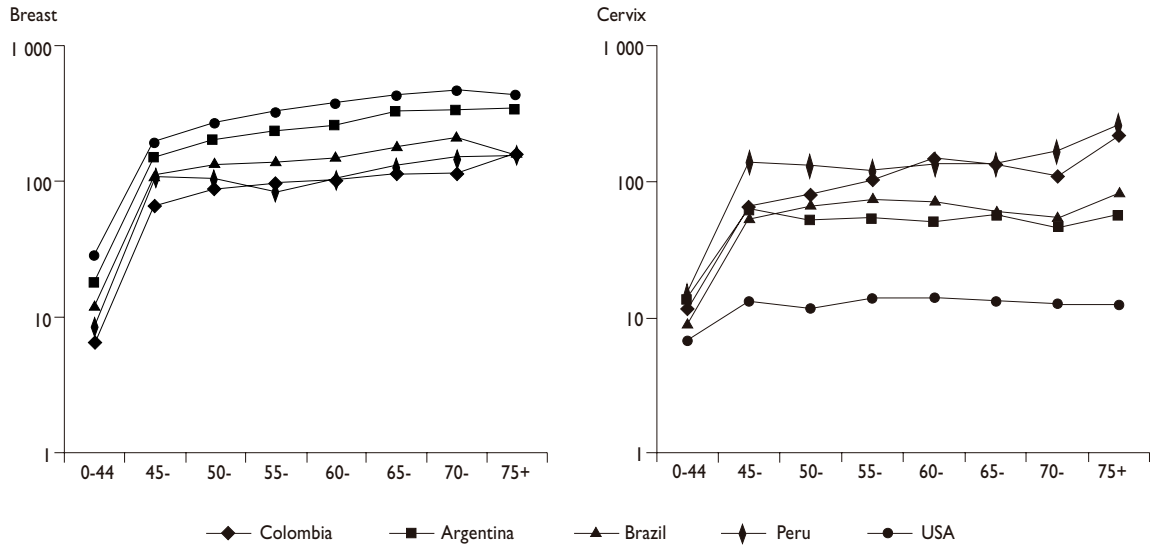

FIGURE 2. AGE-SPECIFIC INCIDENCE RATES OF BREAST AND CERVICAL CANCER AMONG WOMEN, COMPARING DIFFERENT LATIN AMERICAN COUNTRIES AND THE USA, 2000

Table I
AVERAGE ANNUAL CANCER INCIDENCE AND MORTALITY PER 100 000. MEN, COLOMBIA, 1995-1999

		Corrected mortality			Incidence		
ICD-10	*Sites*	*Deaths*	*Crude rate*	*ASR(W)*	*Cases*	*Crude rate*	*ASR(W)*
C00-14	Lip, oral cavity and pharynx	345	1.7	2.7	885	4.5	6.7
C15	Oesophagus	578	2.9	4.7	583	2.9	4.7
C16	Stomach	3455	17.4	27.6	4529	22.9	35.9
C18-21	Colon, rectum and anus	922	4.6	7.1	1504	7.6	11.4
C22	Liver	983	5.0	7.8	429	2.2	3.4
C23-4	Gallbladder	235	1.2	1.9	345	1.7	2.7
C25	Pancreas	561	2.8	4.5	555	2.8	4.43
C32	Larynx	475	2.4	3.9	884	4.5	7.5
C33-4	Lung (incl. trachea and bronchus)	2413	12.2	19.8	2432	12.3	20.0
C61	Prostate	2478	12.5	19.6	5552	28.0	45.9
C67	Bladder	240	1.2	1.9	818	4.1	6.4
C70-2	Brain, central nervous system	566	2.8	3.8	826	4.2	5.2
C82-5,C96	Non-Hodgkin lymphoma	487	2.5	3.3	979	4.9	6.4
C91-5	Leukaemia	1058	5.3	6.2	1427	7.20	8.4
C00-96 but C44	All but skin but non-melanoma skin cancers	17819	89.9	137.5	28130	141.9	213.6

males together, was 36 591 deaths; 17 819 in men and 18 772 in women, with a mortality rate of 137.5 among men and of 121.7 among women (tables I, II). The I/M ratio was 1.6 in men and 1.8 in women.

Among males, major incidence rates for specific cancer sites were prostate cancer (ASRW 45.8) followed by stomach cancer (ASRW 36.0), lung (ASRW 20.0) colon/rectum (ASRW 11.4) and leukemia (ASRW 8.4). Among females, the main cancers were those of the cervix uteri (ASRW 36.8), breast (ASRW 30.0), stomach (ASRW 20.7), colon/rectum (ASRW 13.9) and lung (ASRW 9.9).

Table II
AVERAGE ANNUAL CANCER INCIDENCE AND MORTALITY PER 100 000 – WOMEN, COLOMBIA, 1995-1999

		Corrected mortality			*Incidence*		
ICD-10	*Sites*	*Deaths*	*Crude rate*	*ASR(W)*	*Cases*	*Crude rate*	*ASR(W)*
C00-14	Lip, oral cavity and pharynx	257	1.3	1.7	624	3.1	4.0
C15	Oesophagus	327	1.6	2.1	328	1.6	2.1
C16	Stomach	2440	12.1	15.9	3179	15.7	20.7
C18-21	Colon, rectum and anus	1121	5.5	7.2	2158	10.7	13.9
C22	Liver	1076	5.3	7.2	467	2.3	3.1
C23-4	Gallbladder	638	3.2	4.4	908	4.5	6.1
C25	Pancreas	661	3.3	4.5	660	3.3	4.4
C32	Larynx	174	0.9	1.1	156	0.8	1.1
C33-4	Lung (incl. trachea and bronchus)	1455	7.2	9.9	1463	7.3	9.9
C50	Breast	1905	9.4	12.3	4677	23.2	30.0
C53	Cervix uteri	2853	14.1	18.4	5936	29.4	36.8
C54	Corpus uteri	226	1.1	1.6	953	4.7	6.7
C67	Bladder	136	0.7	0.9	473	2.3	3.1
C70-2	Brain, central nervous system	468	2.3	2.9	668	3.3	3.9
C82-5,C96	Non-Hodgkin lymphoma	358	1.8	2.3	692	3.4	4.3
C91-5	Leukemia	951	4.7	5.2	1284	6.4	7.0
C00-96 but C44	All but skin but non-melanoma skin cancers	18772	93.0	121.7	33500	165.9	212.9

Among men, the estimated age-specific incidence rates of stomach cancer were highest in Colombia and Peru; among women, the Colombian age-specific rates were slightly lower than those observed in Peru but still higher than in other countries.

The Colombian age-specific rates of cervical cancer were relatively high, with a peak for the age group 60-64 followed by a subsequent decline. In women aged 75 or over, cervix cancer rates showed a strong increase again, which was difficult to interpret. Breast cancer age specific rates, show the lowest rates in Colombia compared to other countries, but similar patterns ocurr until age 74, when a new rise is seen in the rates. The pattern observed in the age-specific rates for these cancers show an opposite shape: the countries with lower rates for cervical cancer have the highest rates for breast cancer.

At the district level, the estimated incidence rates for all cancers combined (excluding non-melanoma) were highest in both sexes for those districts with low death certificate coverage (less than 50%) and small population sizes (Chocó, Arauca, and San Andrés, with populations of 404 063, 215 410 and 67 612 for 1997 respectively) (table III).

Discussion

The cancer incidence estimates shown in this paper are the first estimates incorporating both national and regional data sources solely within Colombia; namely, incidence data from the Cali Cancer Registry and national mortality data from official sources in Colombia.

The total number of cases estimated for each sex, as well as the rates for all sites but skin, are close to estimates derived from GLOBOCAN 2000.[8] Overall cancer rates were of a similar order of magnitude between the sexes, as reported in previous estimates for the region.[4] They do however differ from the patterns observed in North America, for which rates are higher among men with male to female ratios of 1.1.[8,18]

The rank order and magnitude of the incidence rates estimated for the main sites differ slightly from both the GLOBOCAN 2000 estimates and the Cali registry data. Among men in this study, cancer of the prostate was the most common, followed by cancers of the stomach, lung and colon/rectum. For GLOBOCAN 2000, the corresponding placed stomach cancer above prostate cancers. The use of more recent mortality data in the present study (mortality data 1995-1999), as compared to GLOBOCAN 2000 (mortality data 1992-94), may contribute to the observed differences; stomach cancer mortality continues to decline in Colombia, whereas prostate cancer has been increasing recently.[3,19]

Among women in this study, the most common neoplasms are cancer of the cervix, followed by cancers of the breast, stomach and colon/rectum. In GLOBOCAN 2000, breast cancer ranked first, followed by cer-

Table III
DEATH CERTIFICATE COVERAGE AND CANCER ESTIMATED INCIDENCE BY DISTRICT, ALL SITES (EXCLUDING SKIN). COLOMBIA, 1995-1999

District	Death certificate coverage*		Annual incidence estimates					
			Male			Female		
	Male %	Female %	Cases	Crude rate	ASR(W)	Cases	Crude rate	ASR(W)
Death certificate coverage under 50%								
Chocó	15.4	15.6	401	189.44	298.59	348	180.74	242.45
Bolívar	33.3	23.2	1298	138.76	228.24	1444	156.91	214.42
Arauca	33.3	23.2	179	164.24	334.91	233	220.93	409.24
Casanare	33.3	23.2	138	102.05	174.30	177	140.95	212.63
Putumayo	33.3	23.2	111	69.78	124.02	126	86.49	146.95
San Andrés, Providencia	33.3	23.2	60	179.42	361.75	59	174.15	278.22
Amazonas	33.3	23.2	18	55.27	164.56	28	87.91	167.95
Guainía	33.3	23.2	11	63.38	141.49	17	110.37	298.86
Guaviare	33.3	23.2	19	32.39	99.57	27	55.85	127.62
Vaupés	33.3	23.2	4	28.56	64.92	4	30.03	57.28
Vichada	33.3	23.2	16	42.76	87.08	22	63.95	94.90
Magdalena	27.8	25.2	924	149.51	248.76	954	161.69	237.73
Guajira	35.0	26.8	221	96.31	195.65	308	134.27	202.01
Córdoba	30.7	30.8	903	138.29	216.25	875	140.14	194.30
Nariño	35.2	32.5	1089	141.88	203.79	1803	233.18	300.48
Cesar	40.3	35.5	345	74.33	130.18	347	77.97	127.03
Sucre	36.8	40.0	463	121.38	186.25	440	119.64	161.98
Caquetá	35.6	43.1	275	136.14	233.33	272	141.32	217.16
Cauca	47.0	46.8	832	137.82	202.55	958	162.81	212.57
Death certificate coverage between 50 and 75%								
Boyacá	59.6	61.1	868	129.54	161.98	912	137.59	149.82
Meta	62.5	61.3	428	127.26	215.01	407	125.65	204.04
Norte de Santander	68.0	64.0	779	124.44	196.32	951	150.92	200.86
Cundinamarca	68.3	66.4	1145	113.83	138.43	1174	117.03	127.70
Huila	68.5	68.1	569	129.18	196.73	610	137.62	183.97
Atlántico	66.9	69.1	1340	137.74	220.69	1524	149.80	195.69
Risaralda	74.9	69.6	714	161.28	229.49	906	200.22	245.48
Quindío	70.1	70.1	475	179.30	232.30	516	194.91	233.00
Caldas	69.6	70.5	908	169.96	231.70	1126	211.05	248.99
Antioquia	71.1	70.7	4272	171.78	257.87	5142	193.79	239.06
Santander	70.6	70.9	1315	140.58	198.90	1483	155.97	189.36
Tolima	70.9	72.2	947	143.86	180.90	959	153.08	176.49
Death certificate coverage over 75%								
Valle	82.9	78.5	2890	150.19	213.34	3460	170.21	208.14
Bogotá	84.9	78.6	4171	146.14	248.18	5887	188.78	247.14

vical and stomach cancer.[8] The differing pattern in the main sites among women regarding breast cancer may at least in part be explained by the wider number of cancer registries included in the estimation process with GLOBOCAN 2000; the inclusion of data from other Latin American registries pertaining to wealthier countries than Colombia, where breast cancer rates are considerably higher than cervical rates. In Concordia, Argentina, breast cancer rates (ASWR) are 60.2 whilst cervical cancer rates (ASWR) are 32.0, while in Cali,

figures for breast and cervix cancer are pretty similar with rates of 38.8 and 34.4 respectively.[2] In addition, the national mortality data used in the estimation process in this study may have been affected by the higher correction for under-registration among sparsely populated districts –which also had some of the highest cervical cancer mortality rates in the country.[3]

The figures differ also from those of the Cali cancer registry. For the last period of registration available (1992-96), the highest incidence rates among men were reported as cancers of the prostate, stomach and lung, whilst for women they were cancers of the breast, cervix, and stomach.[2] The difference is possibly explained by the fact that Cali serves only an urban, and accounts for about 5% of the total population of Colombia.[20] High levels of industrialization, a more favourable mean socioeconomic status and change in lifestyle patterns, could be some of the factors why both stomach and cervical cancer have been on the decline (Luis Bravo, personal communication).

The observed age-specific incidence pattern of cervical cancer is different in Colombia than in the other countries. Screening coverage for cervical cancer in postmenopausal women, although covered by the Colombian health system, seems not to be very favourable according to the perception of many health care providers, and it could be related to the fact that the screening activities are a component of the sexual and reproductive health programme. Another factor that could influence the age specific pattern, could probably be also related to the prevalence and incidence of human papillomavirus infection, which in a previous study among Colombian women showed an increase in women aged 55 years or more.[21,22]

The high incidence figure for prostate cancer deserves a cautious interpretation; the effect of the introduction of PSAtesting in the allocation of cause of death has not been established in Colombia; a recent study in North America found that misattribution of the prostate cancer deaths, over-attributing prostate cancer as cause of death in prevalent cases, could account for a very important proportion of the observed mortality rate increase.[23] There is also evidence that coding rules for mortality favour an over-reporting of prostate cancer, in spite of a high level of agreement observed between underlying causes of death and information from medical records.[24]

The other cancer site worth a comment regarding quality is liver cancer, for which the estimated incidence rates and number of new cases were lower than the corrected mortality; this reflects a well-known problem observed in other countries and is explained by the fact that the majority of liver cancer deaths are "liver cancer not specified if primary or secondary" that probably correspond to metastatic cancers, but that are certified as primary liver cancers.[25]

A similar result was observed with pancreatic cancer, where mortality rates were slightly higher than estimated incidence rates. This discordant situation has also been observed in other countries and could be due to underestimation of the incidence, since it is a site with difficult access to a histological diagnosis, and to occurrence generally in old persons who prefer dying at home without medical care. At the same time, mortality due to pancreatic cancer has been shown to be overestimated.[25]

At a district level, the most valuable data obtained from the analysis reported in this paper were the absolute number of cases and the crude rates that may help in the planning of cancer care, making available for the first time data that can be used as the potential expected demand for delivering cancer services, and related to the actual provision of specialized cancer care services in the country. In contrast, the standardized incidence rates obtained play a role in comparing rates among districts with different age structures, as could be the case when comparing Bogotá with some of the districts in the Amazon region, and also for international comparisons as we used the world standard population in the standardization of rates;[26] these comparisons could also be used to identify priority areas for intervention

The higher estimates obtained for those districts where mortality coverage is under 50% have to be interpreted cautiously, as they can be overestimated for different reasons: most of the districts with low mortality coverage are also districts with small population sizes, for which rates may be unstable and coverage estimates were only estimated for one year, namely, 1993 (the year of the census). In addition, those are districts with low socio-economic conditions and are expected to have low cancer risk, except for cancers associated with poverty, such as cervical cancer. Finally, Colombia faced a new organization of the System of Vital Statistics in 1997 with clear guidelines for collection of vital statistics;[27] as a result, districts that formerly had very low coverage are expected to have improved it in a significant way. This was not considered in the correction of underestimation, as it used only data from 1993, even though mortality data from 1995 to 1998 were available. Therefore, future estimation exercises should aggregate districts with sparse populations before estimation, and should examine carefully how to correct for mortality underestimation with more recently data, if available.

It seems also worthwhile to evaluate the variations in the district estimates when correcting mortality for

quality indicators; differences in quality among districts have shown to be very important.[3] For example, the proportion of cancer deaths from unspecified sites, which may comprise up to a 10% of total cancer deaths in Colombia, highlights problems in the accuracy of the death certificate and in diagnostic capacity, which in turn affects the estimation of cancer occurrence.

Three approaches to missing data may be used: ignoring missing data by excluding cases (listwise or pairwise), redistributing missing data according to observed values, and replacing missing data by statistical estimates from observed values (mean imputation, regression imputation, hot-deck imputation and multiple imputation). Ignoring missing data is feasible when there is a low impact on sample size; redistributing missing data is an alternative to reduce the impact on sample size and it is viable when the mechanism causing missing data is random; replacing missing data is reasonable if a statistical method that needs a complete data set is required. Previous analysis shows that entailing If a complete data set is needed and having a small sample size with random occurrences of missing data or a big sample size with non random occurrences of missing data, compels using the replacing technique , but, if obtaining a complete data set is not the objective, imputation of missing values could incur in biases.* The present study replaced missing data of age on the basis of a random occurrence, and following a "historical procedure" carried out at IARC.

The effect of introducing correction for quality and coverage in the estimation procedure has to be carefully validated before put into practice. Nevertheless, these estimates provide the best current estimates of cancer burden in Colombia, and have been incorporated into the current edition of GLOBOCAN, which provides worldwide cancer estimates for the year 2002.[28]

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Appendix

Table a
CANCER INCIDENCE ESTIMATION - RESULTS OF THE VALIDATION USING INFORMATION FROM THE CALI CANCER REGISTRY

	Corrected mortality (1995-1999)				Reported incidence		Estimated incidence (1995-1999)							
	Under regist A (Flórez)		Under regist B (WHO)		(1992-1996)		Process 1A		Process 1B		Process 2A		Process 2B	
Site, sex	Deaths	ASR	Deaths	ASR	Cases	ASR	Cases	ASR	Cases	ASR	Cases	ASR	Cases	ASR
Male														
Oral cavity	84	3.08	87	3.18	170	6.07	218	7.6	227	7.89	212	7.47	221	7.76
Oesophagus	98	3.73	101	3.84	100	3.82	112	4.25	115	4.37	97	3.67	100	3.78
Stomach	765	28.22	789	29.09	842	30.58	1024	37.66	1057	38.91	977	35.62	1009	36.78
Colon, rectum	271	9.71	279	9.99	341	12.17	480	17.05	496	17.6	473	16.68	488	17.21
Liver	186	6.94	192	7.16	81	3	133	4.91	137	5.08	79	2.91	81	3.01
Gallbladder	73	2.76	76	2.85	69	2.58	101	3.79	104	3.92	96	3.59	99	3.72
Pancreas	171	6.35	177	6.57	124	4.57	171	6.38	177	6.6	167	6.18	173	6.4
Larynx	97	3.65	99	3.73	132	4.95	174	6.54	179	6.71	165	6.41	169	6.59
Bronchus, lung	664	25.28	686	26.11	584	22.26	681	25.9	703	26.75	659	25.12	680	25.93
Prostate	741	27.63	754	28.16	1086	41.63	1500	57.71	1537	59.24	1510	58.23	1547	59.76
Bladder	80	2.95	82	3.02	165	6.07	273	10.02	280	10.29	245	8.89	251	9.14
Brain, nervous system	175	5.68	178	5.81	162	4.98	248	7.66	252	7.82	241	7.36	245	7.51
Non-Hodgkin lymphoma	134	4.58	139	4.74	230	7.36	282	9.24	291	9.56	250	8.21	258	8.5
Leukaemia	283	8.49	279	8.48	283	8.42	439	12.66	432	12.58	372	11.11	368	11.09
All sites	4515	163.23	4629	167.7	5399	192.17	8404	298.32	8635	307.06	6967	248.53	7158	255.79
Female														
Oral cavity	59	1.67	62	1.78	141	4.09	127	3.6	137	3.88	128	3.62	137	3.89
Oesophagus	70	2.02	75	2.17	61	1.77	79	2.3	85	2.47	69	1.99	74	2.14
Stomach	632	17.79	672	19	650	18.85	832	23.62	892	25.43	806	22.62	863	24.31
Colon, rectum	386	10.82	408	11.53	484	13.96	647	18.41	692	19.81	653	18.3	696	19.62
Liver	250	7.28	266	7.79	85	2.47	175	5.12	187	5.49	104	3.03	111	3.25
Gallbladder	181	5.45	195	5.89	210	6.53	255	7.71	275	8.37	241	7.28	261	7.91
Pancreas	197	5.79	210	6.19	149	4.39	199	5.84	212	6.25	195	5.66	207	6.05
Larynx	39	1.15	42	1.23	29	0.91	30	0.89	33	0.96	34	1.03	36	1.12
Bronchus, lung	417	12.27	446	13.21	321	9.58	428	12.59	458	13.55	414	12.16	442	13.07
Breast	643	18.57	699	20.24	1306	37.28	1596	46.23	1752	50.76	1490	43.36	1635	47.6
Cervix	551	15.75	601	17.2	1130	31.01	1128	31.32	1244	34.53	1077	30.03	1190	33.15
Corpus uteri	58	1.82	63	1.99	201	6.06	209	6.31	231	6.98	205	6.5	226	7.18
Bladder	49	1.41	50	1.46	75	2.14	109	3.2	113	3.36	138	4.11	145	4.35
Brain, nervous system	141	3.88	150	4.18	135	3.58	195	5.25	208	5.64	189	5.04	201	5.41
Non-Hodgkin lymphoma	129	3.64	135	3.86	205	5.96	265	7.29	277	7.71	235	6.48	246	6.85
Leukaemia	223	5.59	230	5.82	275	6.93	308	7.56	318	7.87	293	7.32	302	7.63
All sites	5024	143.38	5369	154.11	7028	199.34	10141	287.61	10926	311.21	8421	238.86	9088	258.8

Process 1A= incidence from Quito, Costa Rica y Cali + mortality correction using Flórez *et al*
Process 1B= incidence from Quito, Costa Rica y Cali + mortality correction using WHO
Process 2A= incidence form Cali only+ mortality correction using Flórez *et al*
Process 2B= incidence form Cali only+ mortality correction using WHO

Table b
CANCER INCIDENCE ESTIMATION - RESULTS OF THE VALIDATION USING INFORMATION FROM THE PASTO CANCER REGISTRY

	Corrected mortality (1995-1999)				*Reported incidence*		*Estimated incidence (1995-1999)*							
	Under regist A (Flórez)		*Under regist B (WHO)*		*(1992-1996)*		*Process 1A*		*Process 1B*		*Process 2A*		*Process 2B*	
Site sex	*Deaths*	*ASR*	*Deaths*	*ASR*	*Cases*	*ASR*	*Cases*	*ASR*	*Cases*	*ASR*	*Cases*	*ASR*	*Cases*	*ASR*
Male														
Oral cavity	8	1.16	4	0.54	10	2.54	15	2.46	7	1.13	16	2.5	7	1.16
Oesophagus	34	4.39	17	2.16	14	3.29	38	4.91	19	2.41	32	4.17	16	2.04
Stomach	421	59.53	201	27.75	176	39.97	571	82.21	266	37.61	540	76.94	253	35.28
Colon, rectum	50	7.29	23	3.3	27	6.11	88	13.06	40	5.84	86	12.64	39	5.67
Liver	71	10.42	35	4.95	17	3.97	50	7.39	24	3.48	30	4.38	14	2.06
Gallbladder	23	3.07	13	1.67	9	2.01	30	3.99	17	2.15	30	4.06	16	2.15
Pancreas	31	4.02	16	1.94	14	3.53	32	4.04	16	1.96	31	3.93	16	1.92
Larynx	17	2.24	8	1.08	3	0.73	40	5.19	18	2.36	31	4.32	15	1.99
Bronchus, lung	147	19.45	69	8.96	31	6.52	151	20	70	9.2	144	19.12	68	8.85
Prostate	133	17.28	72	9.02	86	18.98	299	43.19	151	21.03	300	43.39	152	21.14
Bladder	12	1.75	6	0.82	19	4.37	45	6.55	21	2.97	41	6.04	19	2.7
Brain, nervous system	47	5.86	19	2.48	15	3.12	70	8.4	28	3.46	69	8.2	28	3.35
Non-Hodgkin lymphoma	64	7.09	24	2.71	33	6.74	161	17.61	58	6.5	140	15.41	51	5.7
Leukaemia	76	8.4	29	3.25	17	2.93	126	13.65	47	5.15	101	11.14	38	4.29
All sites	1298	173.32	611	80.3	583	128.86	2354	314.12	1063	141.08	1956	262.4	887	118.16
Female														
Oral cavity	8	1.14	4	0.48	10	2.55	16	2.34	7	0.94	16	2.39	7	0.97
Oesophagus	29	4.37	11	1.65	11	2.61	34	5.06	13	1.9	30	4.45	12	1.67
Stomach	393	54.71	163	21.8	124	28.79	540	76.24	218	29.71	514	71.71	210	28.13
Colon, rectum	87	12.26	34	4.7	43	10.11	161	22.91	62	8.62	155	21.67	60	8.22
Liver	130	19.11	52	7.37	28	5.98	94	13.89	37	5.3	56	8.28	22	3.16
Gallbladder	136	19.13	58	7.78	34	8.01	186	26.8	78	10.68	170	24.59	71	9.78
Pancreas	79	11.35	34	4.61	12	2.94	80	11.42	35	4.66	78	11.09	34	4.55
Larynx	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bronchus, lung	68	10.18	28	3.96	15	3.53	70	10.46	29	4.06	67	10.04	28	3.92
Breast	185	26.04	72	9.87	124	27.95	470	66.23	178	24.6	442	62.54	168	23.24
Cervix	288	42.51	110	15.85	214	47.25	546	79.59	204	29.13	534	78.2	199	28.63
Corpus uteri	0	0	0	0	11	2.72	0	0	0	0	0	0	0	0
Bladder	16	2.3	6	0.89	9	2.23	35	5.33	14	2.02	44	6.81	17	2.56
Brain, nervous system	62	8.15	24	3.09	8	1.58	88	11.36	33	4.24	85	10.98	32	4.08
Non-Hodgkin lymphoma	41	5.52	16	2.15	38	8.5	82	11.32	32	4.27	73	10.04	28	3.8
Leukaemia	113	13.71	42	5.02	16	2.92	165	19.51	60	7.08	150	18.11	55	6.62
All sites	2013	282.2	808	109.34	903	203.53	3975	551.44	1557	209.96	3306	459.58	1290	174.44

Process 1A= incidence from Quito, Costa Rica y Cali + mortality correction using Flórez *et al*
Process 1B= incidence from Quito, Costa Rica y Cali + mortality correction using WHO
Process 2A= incidence form Cali only+ mortality correction using Flórez *et al*
Process 2B= incidence form Cali only+ mortality correction using WHO