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# Ill-defined causes of death in Brazil: a redistribution method based on the investigation of such causes

## Causas mal definidas de óbito no Brasil: método de redistribuição baseado na investigação do óbito

### ABSTRACT

**OBJECTIVE:** To propose a method of redistributing ill-defined causes of death (IDCD) based on the investigation of such causes.

**METHODS:** In 2010, an evaluation of the results of investigating the causes of death classified as IDCD in accordance with chapter 18 of the International Classification of Diseases (ICD-10) by the Mortality Information System was performed. The redistribution coefficients were calculated according to the proportional distribution of ill-defined causes reclassified after investigation in any chapter of the ICD-10, except for chapter 18, and used to redistribute the ill-defined causes not investigated and remaining by sex and age. The IDCD redistribution coefficient was compared with two usual methods of redistribution: a) Total redistribution coefficient, based on the proportional distribution of all the defined causes originally notified and b) Non-external redistribution coefficient, similar to the previous, but excluding external causes.

**RESULTS:** Of the 97,314 deaths by ill-defined causes reported in 2010, 30.3% were investigated, and 65.5% of those were reclassified as defined causes after the investigation. Endocrine diseases, mental disorders, and maternal causes had a higher representation among the reclassified ill-defined causes, contrary to infectious diseases, neoplasms, and genitourinary diseases, with higher proportions among the defined causes reported. External causes represented 9.3% of the ill-defined causes reclassified. The correction of mortality rates by the total redistribution coefficient and non-external redistribution coefficient increased the magnitude of the rates by a relatively similar factor for most causes, contrary to the IDCD redistribution coefficient that corrected the different causes of death with differentiated weights.

**CONCLUSIONS:** The proportional distribution of causes among the ill-defined causes reclassified after investigation was not similar to the original distribution of defined causes. Therefore, the redistribution of the remaining ill-defined causes based on the investigation allows for more appropriate estimates of the mortality risk due to specific causes.

**DESCRIPTORS:** Cause of Death. Mortality Registries. Underregistration. Vital Statistics. Information Systems.

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## RESUMO

**OBJETIVO:** Propor método de redistribuição de causas mal definidas de óbito baseado na investigação dessas causas.

**MÉTODOS:** Foram analisados os resultados das investigações dos óbitos notificados como causas mal definidas (CMD) do capítulo XVIII da Classificação Estatística Internacional de Doenças (CID-10), no Sistema de Informações de Mortalidade em 2010. Os coeficientes de redistribuição foram calculados segundo a distribuição proporcional das causas mal definidas reclassificadas após investigação em qualquer capítulo da CID-10, exceto o capítulo XVIII, e utilizados para redistribuir as causas mal definidas não investigadas e remanescentes, segundo sexo e idade. O coeficiente de redistribuição-CMD foi comparado com dois métodos usuais de redistribuição: a) coeficiente de redistribuição-Total, baseado na distribuição proporcional de todas as causas definidas notificadas; b) coeficiente de redistribuição-Não externas, similar ao anterior, com exclusão das causas externas.

**RESULTADOS:** Dos 97.314 óbitos por causas mal definidas notificados em 2010, 30,3% foram investigados. Desses, 65,5% foram reclassificados em causas definidas após investigação. As doenças endócrinas, transtornos mentais e causas maternas tiveram representação maior entre as causas mal definidas reclassificadas, ao contrário das doenças infecciosas, neoplasias e doenças do aparelho geniturinário, com proporções maiores entre causas definidas notificadas. As causas externas representaram 9,3% das causas mal definidas reclassificadas. A correção das taxas de mortalidade pelos critérios coeficiente de redistribuição-Total e coeficiente de redistribuição-Não externas aumentou a magnitude das taxas por fator relativamente semelhante para a maioria das causas, ao contrário do coeficiente de redistribuição-CMD, que corrigiu as diferentes causas de óbito com pesos diferenciados.

**CONCLUSÕES:** A distribuição proporcional de causas entre as causas mal definidas reclassificadas após investigação não foi semelhante à distribuição original de causas definidas. Portanto, a redistribuição das causas mal definidas remanescentes com base nas investigações permite estimativas mais adequadas do risco de mortalidade por causas específicas.

**DESCRITORES:** Causas de Morte. Registros de Mortalidade. Sub-Registro. Estatísticas Vitais. Sistemas de Informação.

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## INTRODUCTION

Mortality indicators are important for understanding the epidemiological profile of a population; they support both the planning and evaluation of health actions and are, therefore, relevant to analyze the health situation to direct public policies. However, due to problems with information quality, the analysis of trends and main causes in mortality in many low- and middle-income countries is generally restricted to either areas with a higher socioeconomic level or larger cities. In fact, the places with major problems related to the quality of information about deaths have the heaviest disease burden.<sup>9</sup> Therefore, some methodological proposals for indirect estimates and analyses of corrected

data from vital statistics systems have been used in Brazil<sup>4,6</sup> to include the population groups most at risk from death and disease.

The high proportions of deaths from ill-defined causes in Brazil are worrisome, as they indicate problems related to the access and quality of medical care received by the population, in addition to compromising the reliability of mortality statistics for causes of death.<sup>8,10,20</sup> These deaths corresponded to 14.3% of the total in 2000, with wide variability between cities and even regions: proportions ranged from 28.4% in the Northeast to 6.3% in the South.<sup>a</sup>

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<sup>a</sup> Ministério da Saúde. Datasus. Brasília (DF); [s.d.] [cited 2013 Jun]. Available from: [www.datasus.gov.br](http://www.datasus.gov.br)

The ideal method for clarifying a cause listed as ill-defined on the death certificate (DC) is investigating records from hospitals and other health services, or interviews with family and health professionals. However, few Brazilian researchers reported field investigations reclassifying causes of death that were listed as ill-defined on the death certificate,<sup>1,10</sup> or cross-checking records to reclassify these causes.<sup>20</sup>

Beginning in 2005, the Ministry of Health initiated a project to upgrade the mortality information with a focus on the country's Northern and Northeastern regions. The main actions were: contracting supporters for the states; developing instruments to investigate deaths, as well as applications to support and monitor municipalities in the process of investigating deaths from ill-defined causes; linking records from the *Sistema de Informações de Mortalidade* (SIM – Mortality Information System) with other information systems; setting investigation goals; continuous monitoring of investigation results and the “percentage of deaths from ill-defined causes” indicator in each state.<sup>b</sup> Since issuing a DC is an integral part of medical care,<sup>c</sup> a new instruction manual for completing it was widely publicized,<sup>d</sup> to raise physicians' awareness of the importance of DC.

The proportion of ill-defined causes of death (IDCD) decreased from 8.6% to 7.0% among reported deaths, after including the results of IDCD reclassification in the official statistics published in Brazil in 2010. However, this proportion is relatively high and there are still great differentials between the states and regions. This variation also occurs intra-regionally, with IDCD proportions close to 30.0% in some states' macro-regions.<sup>a,b</sup> It has thus become important that analyses cause-specific mortality include methods for correcting deaths through the remaining IDCD. The rates' magnitude is affected by these causes, introducing bias into comparisons between places with different proportions of IDCD and in studies of temporal trends.

Redistributing IDCD into defined causes represents a proposal to minimize this problem. Statistical methods for this correction are used based on the behavior of the defined causes that were reported.<sup>13</sup> More common is the use of proportional redistribution according to the defined causes, registered by sex and age, considering all causes<sup>11,12,14,19</sup> or only the non-external causes, as proposed in the 1990 Global Burden of Disease Study.<sup>16-18,e</sup> However, these redistribution methodologies are not considered satisfactory.<sup>10</sup> The redistribution methodology based on death distribution of non-external causes

is particularly questionable, after findings of violence and accidents among the IDCD investigated.<sup>1,10,20</sup>

The investigation of IDCD represents an important gain in clarifying the cause of death. From this perspective, this study proposes a method for redistributing IDCD based on an investigation of these causes.

## METHODS

Cross-sectional study on the IDCD allocated in chapter 18 (Symptoms, Signs and Abnormal Clinical and Laboratory Findings, Not Elsewhere Classified) of the International Classification of Diseases and Health-Related Problems, 10<sup>th</sup> Revision (ICD-10). All deaths registered in the SIM in 2010 were considered.

Investigations of IDCD comprises collecting information about the deceased's terminal illness in health services, such as the basic health units in the Family Health Strategy or health facilities, in the case of hospitalization; as well as collecting information obtained from other sources, such as the Disease Notification Information System, Hospital Information System, *Serviço de Verificação de Óbito* (SVO – Death Verification Service), and *Instituto Médico Legal* (IML – Forensic Institute). In cases where the information obtained from the health services prohibits the cause of death to be identified, an investigation should be conducted through a home interview by a health professional; data should be collected on a standardized verbal autopsy form, which seeks to obtain information about the signs and symptoms presented by the patient in the period prior to death and were observed by family members who lived with the deceased during this period. Analyzing all the information present on the form, an accredited physician should determine the sequence of causes that led to the death, as well as its underlying cause, and then complete the DC.<sup>b</sup> An evaluation study of the process of investigating IDCD in Alagoas in 2010 indicates that the professionals responsible for conducting the interviews are mostly nurses; the presence of the physician responsible for certifying the underlying cause after investigation was listed on the forms in approximately 1/3 of the verbal autopsies conducted. A physician defined the underlying cause of death in 12 out of the 18 randomly selected municipalities; in four cities, this task was the responsibility of a multidisciplinary technical team that included the participation of physicians.<sup>3</sup>

The DC that originally showed IDCD were categorized into: (i) IDCD investigated and reclassified (cause clarified/changed after investigation): certificates that ended up having a defined underlying cause of death,

<sup>b</sup> Ministério da Saúde. Manual para investigação do óbito com causa mal definida. Brasília (DF): 2009. (Série A. Normas e Manuais Técnicos).

<sup>c</sup> Conselho Federal de Medicina. Resolução 1779. *Diário Oficial Uniao*. 5 Dez 2005;Seção 1:121.

<sup>d</sup> Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Análise de Situação de Saúde. Manual de Instruções para o preenchimento da Declaração de Óbito. Brasília (DF): 2011.

<sup>e</sup> Murray CJL, Lopez AD. Estimating causes of death: new methods and global and regional applications for 1990. Boston: Harvard School of Public Health; 1996. The global burden of disease. p. 118-200.

i.e., belonging to any chapter of ICD-10 except chapter 18; the new causes were arranged in the respective classes, in this case, the chapters and groups of ICD-10; (ii) IDCD not reclassified (an investigation of the IDCD was not performed or the cause was not clarified/changed after investigation): certificates that continued to be included in chapter 18 of ICD-10. This category also encompasses deaths from causes not originally classified under any chapter of ICD-10 or from chapters of defined causes (usually deaths of women of childbearing age or children) that were moved to chapter 18 after investigation. The total comprises the group that is, here, called remaining IDCD.

Investigated IDCD are reported in a specific field in the SIM application. The underlying causes presented by the system, called final causes, include the investigated and reclassified cases (when the IDCD is replaced by an underlying cause not belonging to chapter 18 of ICD-10 in the SIM). The cause of death (COD) before investigation is called the original COD. The CODs of the DC originally classified as IDCD were analyzed by crosschecking the classifications of the original COD with the final ones.

The proposed method includes redistributing the remaining IDCD according to the reclassification obtained in the first group. The assumption is that the profile of causes among the remaining IDCD will be similar to those of the reclassified IDCD. The redistribution should be performed according to the proportional distribution of causes observed among the investigated and reclassified IDCDs, i.e., according to the redistribution coefficient RC-IDCD, which provides a redistribution factor of the remaining IDCDs for the ICD-10 chapters that concern defined causes. This redistribution was performed according to the following steps:

1. Calculation of the RC-IDCD based on the IDCD reclassified for each chapter of the ICD-10, by age and sex;
2. The RC-IDCD obtained were applied to the non-reclassified IDCD, and redistributed into the chapters of defined causes;
3. The total number of deaths corrected with a defined cause was calculated by the sum of the deaths registered in the chapter with a defined cause after including the deaths reclassified in IDCD investigation plus the deaths redistributed in the prior step. As an example, the number of deaths corrected by the RC-IDCD for neoplasms (Corrected Deaths RC-IDCD<sub>neo</sub>) was estimated, by age and sex:

Corrected Deaths RC-IDCD<sub>neo</sub> = original deaths from neoplasm + IDCD reclassified as neoplasm + IDCD\* RC - IDCD for neoplasm; in which RC-IDCD<sub>neo</sub> = number of IDCD investigated and reclassified as neoplasm/total number of investigated and reclassified IDCD.

The method of using the RC-IDCD was compared with two other commonly used redistribution methods: a) according to the distribution of all defined causes (IDCD redistributed according to the proportional distribution of the originally defined causes by sex and age – redistribution coefficient called RC-Total); b) according to the distribution of the non-external defined causes (IDCD redistributed according to the proportional distribution of the originally defined causes by sex and age, excluding external causes – redistribution coefficient RC-Non-external).

The corrections were made according to sex and quinquennial age group. The data with unknown sex and age were redistributed proportionally among the data with known sex and age. Mortality rates for uncorrected selected causes were calculated from the number of deaths reported in the SIM in 2010; those with correction were calculated from the number of deaths corrected by the RC-IDCD and other redistribution coefficients evaluated. The population considered was the 2010 Brazilian Census.

## RESULTS

In 2010, 8.6% of 1,136,947 deaths that were reported to the SIM were originally classified as IDCD. Investigations of these causes occurred in all regions of the country, particularly in the Midwest and Northeast, which also had proportionately more cases of IDCD reclassified. The proportions of the remaining IDCD were different among the regions (from 11.8% in the North to 4.0% in the Midwest) (Table 1).

About 20.0% of IDCD were reclassified in all age groups and both sexes, with a small increase among women of childbearing age and smaller proportions in the extreme age groups (Table 2).

Among those reported, 1,037,967 deaths resulted from defined causes and 97,314 were from IDCD. After investigating these causes, 19.8% of the deaths were reclassified as defined causes of death. These were added to the other defined causes, totaling 1,057,325 deaths from defined causes in the SIM database. In addition to the 78,011 IDCD that were not reclassified (67,827 were originally IDCD and were not investigated and 10,183 were investigated and not reclassified), 1,611 more deaths were added to the IDCD group for two main reasons: 1) deaths originally not classified in any chapter of the ICD-10; 2) deaths from other chapters and not in chapter 18 of ICD-10, and which changed to IDCD after investigation. Therefore, 79,622 deaths continued to be IDCD, to be subsequently redistributed (Figure).

The proportions of defined causes among the IDCD that were reclassified and represented by RC-IDCD were different from the proportions among the reported deaths, with a higher proportion of endocrine diseases,

**Table 1.** Number and proportion of deaths from ill-defined causes after investigation. Brazil and regions, 2010.

Variable	North	Northeast	Southeast	South	Midwest	Brazil
Deaths originally reported as IDCD	8,813	30,527	43,524	10,178	4,272	97,314
Proportion of deaths originally reported as IDCD (%) <sup>a</sup>	13.5	10.7	8.1	5.7	5.9	8.6
Proportion of investigated IDCD (%) <sup>b</sup>	22.4	37.6	26.2	27.4	43.0	30.3
Reclassified IDCD	1,156	8,566	6,538	1,610	1,433	19,303
Proportion of reclassified IDCD (%) <sup>b</sup>	13.1	28.1	15.0	15.8	33.5	19.8
Remaining IDCD after including those reclassified	7,657	21,961	36,986	8,568	2,839	78,011
IDCD from other investigations	75	235	1,061	175	65	1,611
Remaining IDCD (n)	7,732	22,196	38,047	8,743	2,904	79,622
Proportion of remaining IDCD (%) <sup>a</sup>	11.8	7.8	7.1	4.9	4.0	7.0
Total deaths	65,425	284,635	534,495	179,428	72,964	1,136,947

IDCD: ill-defined causes of death

<sup>a</sup> (%) calculated relative to the total number of reported deaths.<sup>b</sup> (%) calculated relative to the deaths reported as being from ill-defined causes.**Table 2.** Number and proportion of deaths from ill-defined causes reclassified according to age and sex. Brazil, 2010.

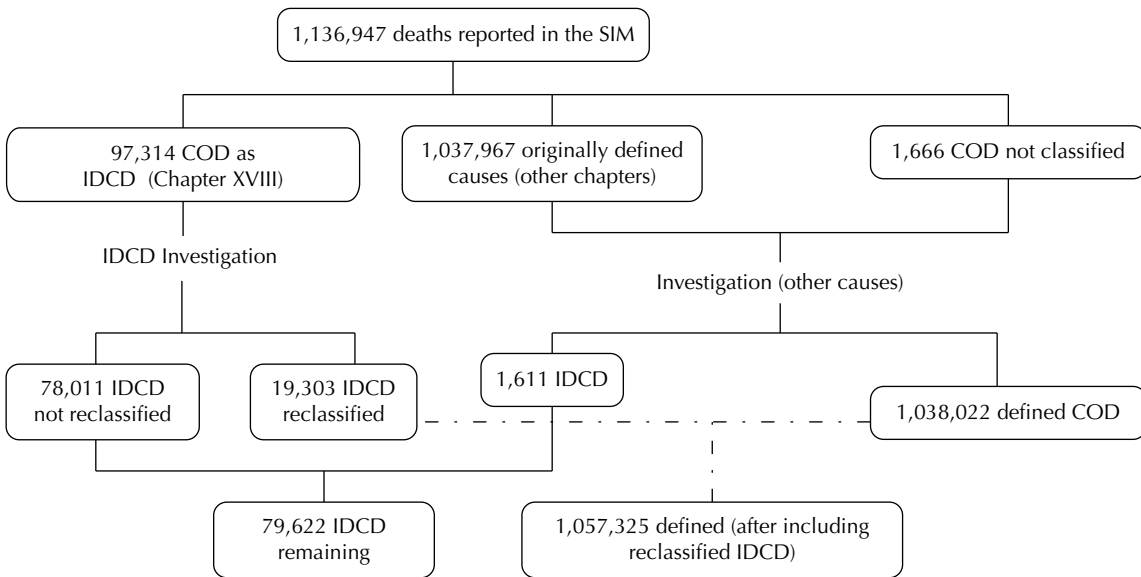
Sex/Age group (years) <sup>a</sup>	Male			Female			Total		
	IDCD-total	IDCD-reclassified		IDCD-total	IDCD-reclassified		IDCD-total	IDCD-reclassified	
	n	n	%	n	n	%	n	n	%
< 1	1,028	191	18.5	713	127	17.8	1,741	317	18.2
1 to 4	369	74	20.1	291	52	17.9	660	126	19.2
5 to 9	181	42	23.3	139	28	20.1	320	70	21.9
10 to 14	235	47	20.1	198	45	22.8	432	92	21.4
15 to 19	667	132	19.7	344	109	31.7	1,011	241	23.8
20 to 24	954	196	20.5	397	125	31.5	1,350	321	23.8
25 to 29	1,191	268	22.5	500	143	28.6	1,691	411	24.3
30 to 34	1,610	309	19.2	679	196	28.9	2,290	506	22.1
35 to 39	1,960	403	20.6	804	222	27.6	2,763	625	22.6
40 to 44	2,657	547	20.6	1,122	300	26.8	3,779	847	22.4
45 to 49	3,394	693	20.4	1,528	395	25.9	4,922	1,089	22.1
50 to 54	4,040	755	18.7	1,755	380	21.7	5,795	1,136	19.6
55 to 59	4,139	864	20.9	1,933	377	19.5	6,072	1,241	20.4
60 to 64	4,505	919	20.4	2,404	548	22.8	6,909	1,467	21.2
65 to 69	4,583	897	19.6	2,845	583	20.5	7,428	1,480	19.9
70 to 74	5,147	1,003	19.5	3,790	772	20.4	8,937	1,775	19.9
75 to 79	5,184	1,073	20.7	4,283	837	19.5	9,467	1,910	20.2
80 to 84	5,120	967	18.9	5,346	1,008	18.8	10,466	1,975	18.9
85 +	8,555	1,542	18.0	12,724	2,132	16.8	21,279	3,673	17.3
Total	55,518	10,923	19.7	41,796	8,380	20.1	97,314	19,303	19.8

IDCD: ill-defined causes of death

<sup>a</sup> Unknown age and sex were redistributed.

mental disorders, nervous system diseases, circulatory diseases and maternal causes among the IDCD. Infectious diseases, neoplasms, respiratory diseases, genitourinary diseases, perinatal disorders and congenital malformations occurred in a relatively smaller

proportion (Table 3). Neoplasms showed different proportions in different parts of the country (higher in the North and Northeast and lower in the South, Southeast, and Midwest) (data not presented). There was a relatively significant proportion of external causes among



SIM: Mortality Information System; COD: cause of death; ICDC: ill-defined causes of death

**Figure.** Flowchart of investigations conducted for ill-defined causes of death. Brazil, 2010.

the ICDC (9.3% of the ICDCs reclassified for Brazil), higher in men (10.5%). While, the proportion of endocrine diseases among the ICDC was higher in women (13.1%), the proportion of mental and behavioral disorders was higher in men (8.7%) (data not presented). There was an increase in the number of deaths for all the chapters of defined causes according to the three criteria considered, without implying changes in the rank of leading causes of death (Table 3).

With the exception of perinatal diseases, congenital malformations, and external causes, there was a similar percentage increase for risk of death for almost all causes when using RC-Total and RC-Non-external, unlike the proposed new criterion based on RC-ICDC, which corrected the different causes of death with different weights. By this criterion, endocrine diseases, particularly diabetes, diseases of the circulatory system and, particularly, maternal causes and mental disorders, had greater representation than they did using the other two criteria. In contrast, neoplasms, infectious diseases, and genitourinary diseases showed smaller relative increases. External causes were not addressed in the redistribution process using RC-Non-external and only had a small increase among the redistributed causes due to correction for unknown age and sex. RC-ICDC considered a relatively smaller weight for them among the ICDC when compared to RC-Total (Table 4).

## DISCUSSION

This study indicates that the proportional distribution of causes among the ICDC reclassified after investigation differed from the original distribution of defined causes.

Therefore, we consider that the method proposed here for redistributing ICDC based on the results of investigations conducted by the health services enables more reliable estimates of mortality risk for specific causes, when compared to the usual redistribution methods.

Pro rata distribution is the most commonly used method for redistributing ICDC. The redistribution coefficient is calculated based on the distribution of underlying causes of death by sex and age group, considering all defined causes<sup>11,12,14,19</sup> or only non-external causes.<sup>16-18</sup> On the other hand, redistribution based on empirical studies is less used in Brazil, having been reported for specific causes such as cancer as well as maternal and external causes.<sup>4,6,17</sup>

Some authors propose statistical methods for correcting information, such as Cavalini et al<sup>2</sup> (2007), which used the Bayesian estimators of James-Stein to correct underreporting and redistribute ICDC for deaths and hospitalizations; they observed an increase in the number of deaths and a modification in the structure of proportional mortality in the North and Northeast. Paes & Gouveia<sup>13</sup> (2010) employed the Lederman method to redistribute ICDC to non-external causes, with greater gains for circulatory diseases and smaller gains for infectious and parasitic diseases.

Few published Brazilian studies exist on clarifying ICDC. Mello Jorge et al<sup>10</sup> investigated 294 ICDC in hospitals, Forensic Institutes (IML), and households in 13 municipalities in the states of Sergipe, Sao Paulo, and Mato Grosso, in 2000. Of these, 61.9% were reclassified into defined causes after investigation. Campos

**Table 3.** Comparison of criteria used (RC-Total and RC-Non-external) with the new criteria proposed (RC-IDCD) for redistribution of ill-defined causes of death. Brazil, 2010.

Underlying Cause (Chapter ICD-10)	Original defined causes among reported deaths			Reclassified IDCD		Ratio (RC-IDCD/ RC-Total)	Causes corrected by RC-Total		Causes corrected by RC-Non-external		Causes corrected by RC-IDCD	
	N	% (RC-Total) <sup>a</sup>	% (RC-Non-external) <sup>b</sup>	n	% (RC-IDCD) <sup>c</sup>		n	%	n	%	n	%
Infectious diseases	48,488	4.7	5.4	676	3.5	0.7	53,103	4.7	54,544	4.8	51,509	4.5
Neoplasms	176,402	17.0	19.7	1,792	9.3	0.5	193,098	17.0	195,236	17.2	186,357	16.4
Immunohematological diseases	6,290	0.6	0.7	92	0.5	0.8	6,891	0.6	7,072	0.6	6,667	0.6
Endocrine diseases	67,863	6.5	7.6	1,974	10.2	1.6	74,529	6.6	75,143	6.6	78,603	6.9
Mental disorders	11,374	1.1	1.3	1,232	6.4	5.8	12,549	1.1	12,898	1.1	17,655	1.6
Nervous system disorders	24,468	2.4	2.7	613	3.2	1.3	26,961	2.4	27,523	2.4	27,809	2.4
Circulatory diseases	317,674	30.6	35.4	8,182	42.4	1.4	349,580	30.7	352,579	31.0	360,565	31.7
Respiratory diseases	119,334	11.5	13.3	1,526	7.9	0.7	131,653	11.6	132,950	11.7	125,469	11.0
Digestive diseases	57,239	5.5	6.4	828	4.3	0.8	62,866	5.5	64,024	5.6	61,402	5.4
Diseases of the skin and subcutaneous tissue	3,282	0.3	0.4	54	0.3	0.9	3,621	0.3	3,663	0.3	3,459	0.3
Diseases of the musculoskeletal system and connective tissue	4,396	0.4	0.5	80	0.4	1.0	4,826	0.4	4,900	0.4	4,878	0.4
Genitourinary disease	24,613	2.4	2.7	194	1.0	0.4	27,142	2.4	27,416	2.4	25,305	2.2
Maternal causes	1,422	0.1	0.2	76	0.4	2.9	1,554	0.1	1,618	0.1	1,916	0.2
Perinatal conditions	23,723	2.3	2.6	104	0.5	0.2	24,837	2.2	24,869	2.2	24,199	2.1
Congenital malformations	9,869	1.0	1.1	72	0.4	0.4	10,438	0.9	10,571	0.9	10,496	0.9
External causes	141,360	13.6	0.0	1,796	9.3	0.7	153,111	13.5	141,750	12.5	150,451	13.2
Total <sup>d</sup>	1,037,967	100.0	100.0	19,303	100.0	1.0	1,136,947	100	1,136,947	100	1,136,947	100.0

RC: redistribution coefficient; IDCD: ill-defined causes of death

<sup>a</sup> Based on the total number of deaths from original defined causes, except IDCD (n = 97,314) and not classified (n = 1,666).

<sup>b</sup> Based on the total number of deaths from original defined causes, except IDCD (n = 97,314), not classified (n = 1,666) and external (n = 141,360).

<sup>c</sup> Based on the total number of deaths from defined causes among the reclassified IDCD.

<sup>d</sup> Includes chapters on eye and adnexa diseases, ear and mastoid process diseases, and injuries, poisoning and certain other consequences of external causes (n = 170 for original defined causes, n = 12 for reclassified IDCD, n = 186 for corrected causes-RC-Total, n = 191 for corrected causes-RC-Non-external, n = 206 for corrected causes-RC-IDCD).

et al<sup>1</sup> (2010) investigated 202 IDCD in households, using the verbal autopsy method, in health services and IML, in a sample of 10 municipalities in the macro-region of Minas Gerais, Southeastern Brazil, in 2007; the COD was reclassified in 63.9% of the cases. Teixeira et al<sup>20</sup> (2006) sought to clarify IDCD in Rio de Janeiro, Southeastern Brazil, in 1998 by relating data from the SIM and Hospital Information System. Of the 12,633 IDCD, 16.3% were reclassified, which diminished the importance of IDCD in proportional mortality by causes. Similar findings were observed in this study: 65.5% of IDCD investigated in the country had their cause reclassified after investigation (19.8% of IDCD reported in 2010).

The project to qualify the Brazilian Mortality Information System has enabled the clarification of IDCD, with a significant reduction in its proportion since 2005.<sup>b</sup> 132,056 IDCD between 2006 and 2010 were investigated in the country, and 64.2% of IDCD investigated were reclassified into a defined group of causes of death and included

in the official statistics available on the Internet. The profile of causes of death among the reclassified IDCD differs from those observed among the defined causes that were reported,<sup>5</sup> confirming previous findings<sup>10</sup> and those of this study.

Despite the importance of correction for IDCD, there is no standardization in the redistribution methods or terminology used, which hinders its routine use in mortality statistics. The very definition of grouping IDCD is not consensual. Various codes considered incomplete or “garbage codes” from chapters other than chapter 18 of ICD-10 have been added to the IDCD group, since they do not characterize the cause of death.<sup>9</sup> The present study only considered IDCD with codes from chapter 18, which have more recognized redistribution methodologies.

Various terms are used for IDCD with a defined COD after investigation, such as reallocated, recovered, clarified, altered or reclassified IDCD.<sup>1,10,20</sup> We opted to use the term reclassified IDCD, which was considered more appropriate for this analysis since the allocation of the

**Table 4.** Cause-specific mortality rates corrected<sup>a</sup> according to different redistribution criteria for ill-defined causes of death. Brazil, 2010.

Underlying Cause (ICD-10 Chapter)	Rate with no correction <sup>b</sup>	Corrected rate (RC-Total) <sup>c</sup>		Corrected rate (RC-Non-external) <sup>c</sup>		Corrected rate (RC-IDCD) <sup>c</sup>	
		Rate <sup>b</sup>	Increase (%)	Rate <sup>b</sup>	Increase (%)	Rate <sup>b</sup>	Increase (%)
	(a)	(b)	(b/a)	(c)	(c/a)	(d)	(d/a)
Infectious diseases	25.42	27.84	9.5	28.59	12.5	27.00	6.2
Neoplasms	92.48	101.23	9.5	102.35	10.7	97.69	5.6
Immuno-hematological diseases	3.30	3.61	9.5	3.71	12.4	3.50	6.0
Endocrine diseases	35.58	39.07	9.8	39.39	10.7	41.21	15.8
Mental disorders	5.96	6.58	10.3	6.76	13.4	9.26	55.2
Nervous system disorders	12.83	14.13	10.2	14.43	12.5	14.58	13.7
Circulatory diseases	166.53	183.26	10.0	184.83	11.0	189.02	13.5
Respiratory diseases	62.56	69.02	10.3	69.70	11.4	65.77	5.1
Digestive diseases	30.01	32.96	9.8	33.56	11.9	32.19	7.3
Diseases of the skin and subcutaneous tissue	1.72	1.90	10.3	1.92	11.6	1.81	5.4
Diseases of the musculoskeletal system and connective tissue	2.30	2.53	9.8	2.57	11.5	2.56	11.0
Genitourinary disease	12.90	14.23	10.3	14.37	11.4	13.27	2.8
Maternal causes	0.75	0.81	9.3	0.85	13.8	1.00	34.8
Perinatal conditions	12.44	13.02	4.7	13.04	4.8	12.69	2.0
Congenital malformations	5.17	5.47	5.8	5.54	7.1	5.50	6.4
External causes	74.11	80.27	8.3	74.31	0.3	78.87	6.4

<sup>a</sup> In calculating the rates, the correction of death underreporting was not considered (completeness of total deaths estimated at 94.2%).

<sup>b</sup> Per 100,000 inhabitants.

<sup>c</sup> Ill-defined causes redistributed according to sex and age, with redistribution of unknown sex and age.



new COD was performed using an existing classification, the ICD-10. The term redistributed IDCD refers to the certificates that underwent processing after redistribution among the defined causes of death.

When comparing the IDCD redistribution method used in this study with the usual methods, a greater relative proportion of endocrine diseases, mental disorders, and maternal causes exists. This suggests a possible underestimation of these causes when using the usual redistribution methods. Results similar to those of this study were observed in 13 Brazilian municipalities in 2000,<sup>10</sup> which also found a higher incidence of deaths from mental disorders among the investigated IDCD (6.6%) than among the reported deaths (1.1%). The same occurred for maternal causes (0.8% of IDCD) and endocrine diseases, mainly diabetes. However, a study in Thailand<sup>15</sup> found that verbal autopsy may overestimate the importance of diabetes post-investigation.

The increase in the number of deaths due to maternal causes when using RC-IDCD is likely related to the investigations conducted by maternal death prevention committees, active in most municipalities. On the other hand, proportional mortality by neoplasms decreased with the use of correction based on this coefficient, possibly due to a better certification of these causes than the others among IDCD.<sup>6,10</sup> The finding is consistent with the different proportions among the regions, higher in the North and Northeast and lower in the South, Southeast, and Midwest, where the coverage of deaths and access to diagnosis are probably better.

External causes are considered to be well recorded and, therefore, would not be part of the IDCD group.<sup>13,17,18</sup> However, there was a relatively significant proportion of these causes among IDCD (9.3% of the reclassified IDCD for Brazil in 2010), probably related to the active

search for clarifying IDCD that was conducted in the IML in various municipalities. Studies in Brazilian municipalities also showed significant proportions of external causes among IDCD.<sup>1,10,20</sup> Khosravi et al<sup>7</sup> (2008) observed that 9.6% of IDCD in adults referred to external causes in Iran.

The redistribution of deaths from ill-defined causes may result in overestimating or underestimating specific mortality rates by causes. However, while the quality of information is “questionable”, it will be necessary to provide more reliable estimates of mortality rates by age and sex. As information quality improves, the contribution of this correction will diminish. Therefore, it is necessary to decrease the proportion of IDCD cases that need to be reclassified and redistributed, which can be achieved with better care and better completion of DC by physicians.

This study did not seek to define a cutoff point for the proportion of IDCD to which the redistribution method should be applied, which would require another type of design. In general, it is considered that the proportion of IDCD from chapter 18 of ICD-10, together with other selected, poorly designed codes (I46.1, I46.9, I95.9, I99, J96.0, J96.9, P28.0, C76, C80, C97, Y10-Y34, and Y87.2), should not exceed 5.0% for deaths of non-elderly individuals (< 65 years),<sup>f</sup> which was not achieved in either Brazil or its regions in 2010.

This study, by proposing the use of empirical data to redistribute IDCD, allows more suitable estimates for risk of cause-specific mortality, and values and encourages the health services' enormous effort to investigate deaths with an undefined underlying cause. Strategies to improve information quality should be encouraged, including the role of physicians and their participation in the appropriate completion of DC.

<sup>f</sup> AbouZahr C, Mikkelsen L, Rampatige R, Lopez A. Mortality statistics: a tool to enhance understanding and improve quality. Brisbane: Health Information Systems Knowledge Hub; 2010 [cited 2014 Feb]. (Working Paper Series, 13). Available from: <http://www.uq.edu.au/hishub/docs/WP13/HISHUB-WP13-KP-05-WEB-9Mar12.pdf>

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## HIGHLIGHTS

This study proposes a methodology for redistributing ill-defined causes of death (IDCD), based on empirical data from investigations conducted in 2010, in health services and households, using standardized verbal autopsy forms.

The redistribution of IDCD using the proposed methodology not only improves the quality of mortality statistics in Brazil but also increases the potential for using mortality indicators to make decisions based on evidence.

The distribution of reclassified IDCD differs from that observed among deaths with defined causes, with a higher proportion of endocrine diseases, mental disorders, nervous system diseases, circulatory diseases, and maternal causes among the IDCD.

The results of this research can be incorporated by the managers of the Mortality Information System and by Health Surveillance professionals, in the three spheres of government, to redistribute IDCD and produce epidemiological indicators with corrected mortality rates in the states and, therefore, with more appropriate estimates for mortality risk by specific causes.

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