About Romania Data on Causes of Death

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General

According to the Law on the Organisation and Functioning of Official Statistics in Romania, the National Statistical System includes: a) the National Institute of Statistics[1] (NIS) (*Institutul Național de Statistică*), its territorial directorates and subordinate institutions; b) the statistical offices of central and local public administration and other public authorities and institutions; c) the National Bank of Romania.

NIS coordinates the National Statistical System (except the National Bank of Romania) and is a specialised central government body with legal status, subordinate to the government. NIS is the central authority responsible for producing and disseminating official statistics in Romania.

NIS operates based based on Law No. 226/2009[2], with subsequent amendments. Its headquarters are in Bucharest. Eight regional statistical directorates (organised at the level of development regions) and 34 county statistical directorates are subordinate to NIS.

Romania's central statistical office was established on 12 July 1859 by ordinance of ruler Alexandru Ioan Cuza. Since then, the institution has undergone various reorganisations and name changes but has consistently remained the central producer and coordinator of official statistics (*Table 1*).

Table 1. History of the National Institute of Statistics

English name	Romanian name	Period
Central Office for Administrative Statistics	Oficiului Central de Statistică Administrativă	1859-1892
State Directorate for General Statistics	Direcţia de Statistică Generală a Statului	1892-1925
State Institute for General Statistics	Institutul de Statistica Generală a Statului	1925-1936
Central Institute of Statistics	Institutul Central de Statistică	1936-1951
Central Directorate of Statistics	Direcţia Centrală de Statistică	1951-1989
National Commission for Statistics	Comisia Naţională pentru Statistică	1989-1998
National Institute of Statistics	Institutul Naţional de Statistică	1998- present

Source: NIS of Romania

Official cause-of-death statistics are produced through collaboration between NIS and the National Institute of Public Health (NIPH) (*Institutul Naţional de Sănătate Publică*), particularly through the National Centre for Health Statistics and Informatics (NCHSI) (*Centrul Naţional de Statistică şi Informatică în Sănătate Publică*) and their subordinate institutions.

NIPH is a public institution subordinate to the Ministry of Health. It coordinates activities nationally through four centres: a) the National Centre for Health Statistics and Informatics; b) the National Centre for Supervision and Control of Communicable Diseases; c) the National Centre for Community Environmental Risk Monitoring; d) the National Centre for Evaluation and Health Promotion.

Regionally, NIPH operates through six regional public health centres and coordinates 42 district public health directorates (*direcţii de sănătate publică*). NCHSI collaborates directly with NIS, NIPH, district public health directorates and the Bucharest Public Health Directorate, among others.

[1] http://www.insse.ro/cms/en

[2] Law on the organization and functioning of official statistics in Romania no. 226/2009 https://insse.ro/cms/en/cadru-legal

Romania has used the International Classification of Diseases (ICD) since 1948, with updates approximately every decade. In 1994, an abridged version of ICD-10 was adopted, followed by the full detailed 4-digit ICD-10 version in 1999 (see Section 6 for more detail).

Territorial coverage

The territorial coverage of Romania remained unchanged during the observation period.

Part I – Vital statistics and population censuses

1. Death count data

Coverage and completeness

Annual death counts, including cause-specific deaths, refer to the de jure population; that is, they include deaths of Romanian citizens with "legal residence" (or "permanent residence") in Romania, even if they died abroad (see Section 2). Since 2012, the NIS has also published death counts by sex and age for the population with "usual residence" in Romania. The difference between the two figures is about 0.8% for males and 0.6% for females, reaching 6–8% in certain age groups, especially among young adult males.

Specific details: infant mortality

The definition of "live birth" in Romania has been unclear. According to Gourbin and G. Masuy-Stroobant (1995), in 1991 Romania applied the WHO definition, but with a national restriction: newborns weighing under 1000 grams had to survive the legal registration period of 15 days to be considered a live birth. If the death occurred within this period, neither the birth nor the death was registered. This practice likely originated from a Ministry of Health order adopted in 1968 (Mureşanu, 2001).

During the communist period, doctors' salaries were partly tied to hospital perinatal and infant mortality statistics; these incentives were abolished after 1989 (Gourbin and Masuy-Stroobant, 1995). Following the 1989 Revolution, early neonatal mortality rates rose sharply, reflecting better registration practices. Between 1989 and 1992, the early neonatal mortality rate increased by 1.69 times (from 3.75 to 6.19 per 1000 births). We corrected this under-registration using the absolute correction method applied in Moldova (Penina, Meslé and Vallin, 2010) (*Correction 1 in Figure 1*).

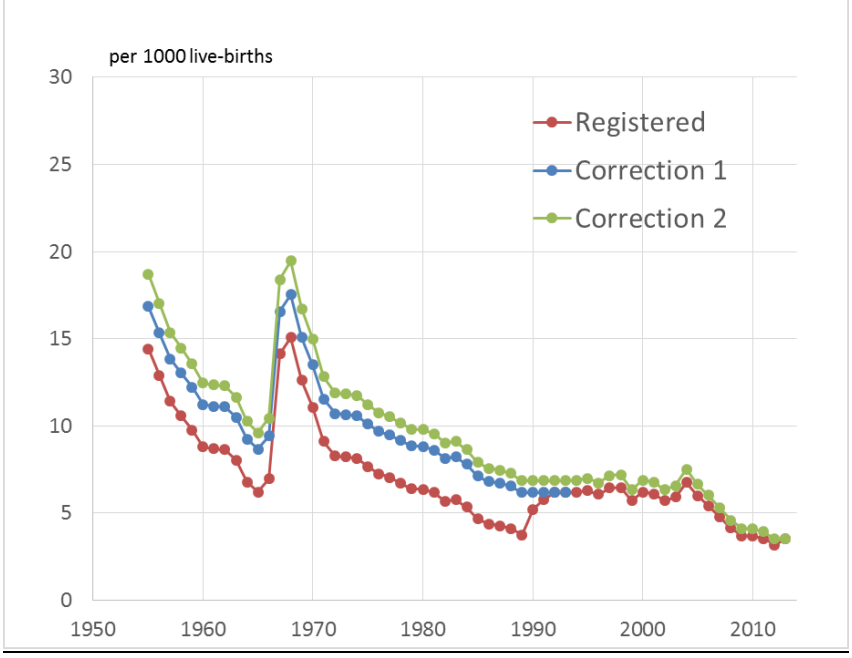


Figure 1. Early neonatal mortality rate in Romania: registered and corrected values, 1955-2013

Source: NIS of Romania (registered data)

In 2012, the Ministry of Health updated the live birth definition, aligning it with the WHO standard but setting a legal threshold at 24 full weeks of gestation. Newborns delivered before 24 weeks must survive this threshold to be officially registered. Otherwise, births and deaths are recorded only in medical documents, not in official statistics. This change led to an 11% rise in the early neonatal mortality rate between 2012 and 2013. Therefore, we applied a constant 11% adjustment to the 1955–2012 series[3] (*Correction 2 in Figure 1*).

The combined effect of the two corrections on infant mortality rates was 7–8% in the 1960s–1970s, 10–12% in the 1980s–early 1990s, and 3–4% after 1992.

Specific details: old age mortality

For some European countries of the former USSR, such as Russia or Ukraine, misreporting of age at 80 years and above is a known issue (Shkolnikov and Jdanov, 2016). In these countries, the official population counts at older ages are overestimated, leading to an underestimation of official death rates. In Romania, however, population estimates at older ages appear reliable throughout the entire study period. Life expectancy at age 80 is consistently lower compared to Sweden (*Figure 2*).

Figure 2. Life expectancy at age 80 in Romania (1977-2012) and Sweden (1975-2014), by sex

Source: Data for Sweden: the Human Mortality Database (www.mortality.org)

[3] It was decided to correct neonatal mortality rates for the age group 0-6 days, but not for age 0 days, due to the likely exchange of deaths between age 0 days and 1 day in Romania.

2. Population count data

Coverage and completeness

The history of population censuses in Romania is extensive, with two censuses conducted in the late 19th century, eight during the 20th century, and three in the 21st century. The 1930 Population Census covered the territory of Bessarabia, which represents the greater part of today's Republic of Moldova.

Table 2. Population censuses conducted in Romania

Nr.	Census
1.	Census 1859-1860
2.	General Population Census 1899, December
3.	General Population Census 1912, December 19
4.	General Population Census 1930, December 29
5.	General Population Census 1941, April 6
6.	Agricultural and Population Census 1948, January 25
7.	Population and Household Census 1956, February 21
8.	Population and Household Census 1966, March 15
9.	Population and Household Census 1977, January 5
10.	Population and Household Census 1992, January 7
11.	Population and Household Census 2002, March 18
12.	Population and Household Census 2011, October 20
13.	Population and Household Census 2021, December 1

Source: http://www.recensamantromania.ro/

Romanian statistics distinguish between two types of population: "usual resident" (*de facto*) and "legal or permanent resident" (*de jure*).

The first type refers to all persons of Romanian nationality, foreign citizens, or stateless individuals whose usual residence is in Romania. It excludes: (1) Romanian citizens, foreigners, or stateless persons whose usual residence is in Romania but who have been abroad for 12 months or more; and (2) foreigners or stateless persons residing in Romania for less than 12 months.

The second type includes all Romanian citizens with a "legal residence" in Romania. The legal residence is the address where a person declares their main dwelling, as indicated on their identity card and registered by the State's administrative bodies.

The difference between these two types of population became significant after the December 1989 Revolution, while it was of minor importance during the communist period. Population censuses conducted in 1992, 2002, 2011 and 2021 refer to the *de facto* population, whereas earlier censuses referred to the *de jure* population.

The Romanian NIS calculated intercensal annual *de facto* population counts based on the results of the 2002 and 2011 censuses. From 2012 onward, annual *de facto* population data are post-censal estimates. Official intercensal population estimates before 2002 were not produced. However, the official 2002–2011 intercensal estimates are problematic, as they fail to accurately reflect the large differences between cohorts caused by the 1967 birth boom following the abortion ban (see Section 3). Therefore, we use the HMD-like population exposures calculated according to the standard HMD methodology for 1977–2011. For years after 2011, we rely on the official post-censal estimates, which appear to be reliable.

Figure 3 shows the total population number according to the last four censuses and official annual estimates produced by the NIS of Romania, covering both the "permanent residence" and "usual residence" populations. A sharp decrease in the number of "usual residents" in 2008 is explained by a spike in out-migration following Romania's accession to the European Union on January 1, 2007 (see Specific details: migration data).

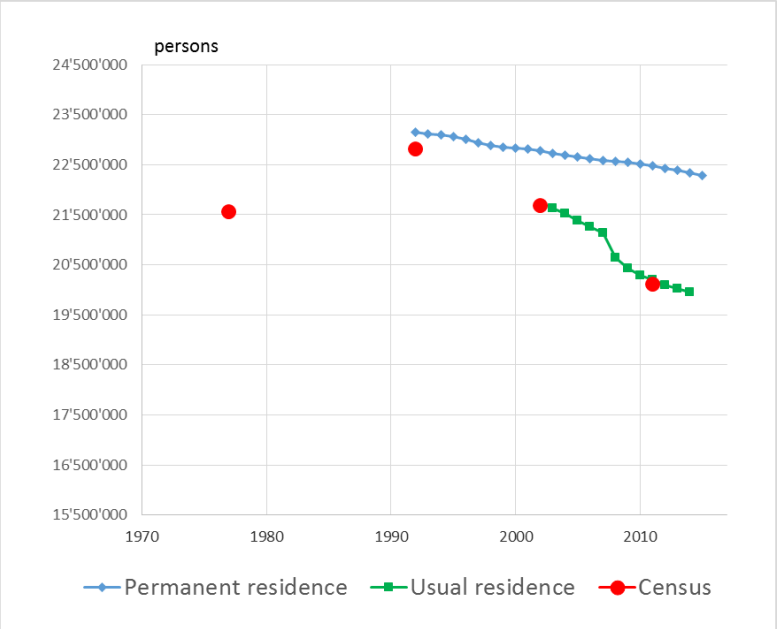


Figure 3. Total population number in Romania according to the censuses conducted in 1977, 1992, 2002 and 2011 and official annual estimates of the population with "permanent residence" (1992-2015) and "usual residence" (2003-2014), both sexes

Source: NIS of Romania

Out-migration during intercensal periods was initially distributed evenly across the years (*Figure 4*). This is a preliminary step toward estimating population exposure for Romania. In the future, the redistribution of intercensal out-migration will take into account the substantial fluctuations observed in migration statistics, particularly the sharp increase in out-migration in 2007 (see Specific details: migration data). Consequently, population estimates for intercensal periods will be updated.

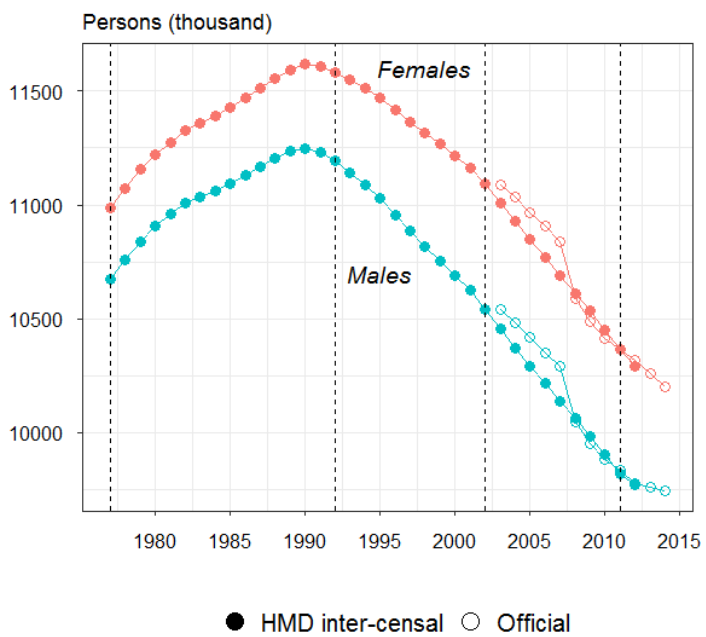


Figure 4. Population number in Romania, by sex. Official annual population estimates with "usual residence" (2003-2014) and intercensal estimates according to HMD methodology (1977-2012). Gray dashed lines mark census years (1977, 1992, 2002 and 2011).

Source: official estimates – NIS of Romania

Specific details: migration data

The Romanian NIS distinguishes two types of migration flows: between two types of migration flows: migration based on *permanent residence change* (permanent migrants) and migration based on usual residence change (temporary migrants).

Counts of immigrants and emigrants by permanent residence change are used to calculate population figures for individuals with a "permanent residence." In 2012-2013, the corresponding net migration has even turned positive (*Table 3*).

Table 3. Emigrants, immigrants and net migration by permanent residence change, 1990-2013

	Permanent emigrants	Permanent immigrants	Net migration (permanent migration)
1990	**96,929**	**0**	**-96,929**
1991	44,160	1,602	-42,558
1992	31,152	1,753	-29,399
1993	18,446	1,269	-17,177
1994	17,146	878	-16,268
1995	25,675	4,458	-21,217
1996	21,526	2,053	-19,473
1997	19,945	6,600	-13,345
1998	17,536	11,907	-5,629
1999	12,594	10,078	-2,516
2000	14,753	11,024	-3,729
2001	9,921	10,350	429
2002	8,154	6,582	-1,572
2003	10,673	3,267	-7,406
2004	13,082	2,987	-10,095
2005	10,938	3,704	-7,234
2006	14,197	7,714	-6,483
2007	8,830	9,575	745
2008	8,739	10,030	1,291
2009	10,211	8,606	-1,605
2010	7,906	7,059	-847
2011	18,307	15,538	-2,769
2012	18,001	21,684	3,683
2013	19,056	23,897	4,841

Source: Romanian NIS

The second type of migration flow refers to migration based on *usual residence change*. These flows are used to calculate annual counts of the population with a "usual residence." The Romanian NIS compiles these data from various sources: national administrative sources (e.g., the General Inspectorate for Immigration and other institutions), the Population and Housing Census of 2011, data on Romanian immigrants provided by statistical offices in Spain and Italy, "mirror statistics" on migration flows from the EUROSTAT database, and an econometric model.

Data on migration based on usual residence are available from 2004 onwards. The numbers of temporary emigrants are substantially higher than those of permanent emigrants (162,000 versus 19,000 in 2013). However, temporary immigration flows recorded by Romania are also quite significant (*Table 4*).

Table 4. Emigrants, immigrants and net migration by usual residence change, 2012-2014

	temporary emigrants	**temporary immigrants**	**net migration**
2012	170,186	167,266	-2,920
2013	161,755	153,646	-8,109
2014	172,871	136,035	-36,836

Source: Romanian NIS

Table 5 shows the number of immigrants from Romania according to EUROSTAT data. A significant proportion of Romanian emigrants move to Italy and Spain. Comparisons between EUROSTAT data and data

from the Italian statistical office generally show good consistency (data not shown). According to EUROSTAT, when Romania joined the European Union in 2007, the number of registered Romanian immigrants peaked at around 500,000 individuals.

Table 5. Number of immigrants from Romania, according to EUROSTAT data, 2003-2013

	EUROSTAT
2004	191,134
2005	172,038
2006	184,353
2007	**507,150**
2008	300,614
2009	167,256
2010	166,180
2011	174,579
2012	143,423
2013	119,341

Source: EUROSTAT, https://ec.europa.eu/eurostat

3. Birth count data

Coverage and completeness

We use official figures for live births that refer to the population with "permanent residence", not "usual residence". The difference between the two is about 10% (see Table **Error! Reference source not found.**).

The Medical birth certificate (C*ertificat medical constatator al născutului viu*) is completed by a medical doctor who certifies the live birth. This certificate includes the newborn's Personal Identification Number (*Codul Numeric Personal*, PIN) and consists of two parts. The detachable part, containing the PIN, is given to the family, who must then present it at the district civil registration office.

The act of birth is drawn up at the district civil registration office within the Public Community Service of Personal Records. If no such office exists, registration occurs at the town hall (*primăria*) of the district where the birth took place. The birth is officially recorded based on the medical certificate of live birth issued by the attending physician. In the case of a stillbirth, only the act of birth is drawn up, based on the medical certificate of stillbirth completed by the certifying doctor.

The legal timeframe for registering a birth is 15 days for a live-born child and three days for a stillborn child. If a live-born child dies within 15 days of birth, the registration must occur within 24 hours of death. The legally prescribed period includes both the day of birth and the day of declaration. *Figure 8* shows the system of birth registration in Romania.

Specific details

The number of births for the period 1980–2012 has been re-estimated by incorporating two sets of corrections related to early neonatal mortality.

Part II – Information on CoD collection

4. Death certificate

The medical death certificate (*Certificat medical constatator al decesului*) in Romania is almost identical to the international model recommended by the World Health Organization (WHO) for certifying causes of death. The only notable exception is the absence of a column recording the interval between the presumed onset of each listed morbid condition and the date of death. Additionally, the medical death certificate does

not include the four-digit code corresponding to the International Classification of Diseases (ICD) for each disease or morbid condition.

The medical death certificate includes the decedent's Personal Identification Number (PIN) and consists of two parts. The detachable section containing the PIN is given to a relative, who must present it at the district civil registration office.

It is important to note that the certifying medical doctor does not code the cause of death on the certificate. Instead, the coding is performed by trained staff at the district public health directorate (see Section 5).

The medical certificate of stillbirth (C*ertificat medical constatator al născutului mort*) is completed by the doctor who certifies the stillbirth. In Romania, this certificate was introduced by the National Centre for Health Statistics and Informatics (NCHSI) in 1993. Prior to that, information on stillbirths was included in the medical birth certificate. The introduction of the stillbirth certificate was accompanied by the adoption of the statistical stillbirth bulletin designed by the National Institute of Statistics (NIS) of Romania.

Beyond the medical death certificate, several additional medical and statistical forms are used to document deaths, including by causes of death.

Medical forms for infants, children and pregnant females

The infant death form (*Fişa decesului sub un an*): Completed in the case of death under one year of age, including early neonatal deaths (0–6 days). It is filled out by the certifying medical doctor and records 44 variables, including detailed causes of death.

The perinatal death form (*Fişa decesului perinatal*) Completed by the obstetrician (for stillbirths) or by the certifying doctor (for live-born deaths at 0–6 days). This form contains 52 variables.

In cases of early neonatal death, both the perinatal death form and the infant death form must be completed.

The form for death at age 1-4 years (*Fişa decesului 1-4 ani*): Completed by the certifying doctor for deaths occurring at ages 1–4 years. It includes 30 variables.

The form for death associated with pregnancy, childbirth and the puerperium (*Fişa decesului prin complicaţii ale sarcinii, naşterii şi lăuzei*): Completed within 24 hours by the certifying doctor, together with the medical death certificate, for deaths caused by complications of pregnancy, childbirth, or the postpartum period. It records 45 variables.

The indirect maternal death form (*Fişa decesului mamei prin cause indirecte*): Used for deaths of pregnant women resulting from causes unrelated to pregnancy (including external causes). Completed with the medical death certificate within 24 hours, it contains 41 variables.

Statistical forms

Statistical death bulletin (form no. 3). The primary source of statistical data on deaths, including by cause. It includes 20 demographic and social variables related to the decedent. Following WHO recommendations and ICD structure, the bulletin divides causes of death into two sections: I-a (direct cause); I-b (antecedent cause); I-c and I-d (initial morbid condition), and II (other significant morbid conditions).

Statistical stillbirth bulletin (form no. 2). Introduced in 1993 alongside the perinatal death form. It includes 21 demographic and social variables regarding the stillborn child, delivery details, and maternal characteristics. The section on causes of death records: a) The principal disease or morbid condition leading to the death of the foetus; and b) Other contributing diseases or conditions.

5. Cause-of-death coding

In Romania, the death registration system (including the codification of causes of death) is decentralized and performed at the county (*judeţ)* level.

The medical death certificate is handed over to the deceased's nearest relatives or, if there are none, to the medical unit, either of whom must present it to the civil registration office (*serviciul de stare civilă*) in the

district where the death occurred. The death must be declared within three days, including both the day of death and the day of declaration. In cases of non-natural death or if the deceased's identity is unknown, the death must be declared within 48 hours.

The death certificate is issued at the district civil registration office, operating under the Public Community Service of Personal Records (*Serviciul Public Comunitar Local de Evidență a Persoanelor*) or, if absent, at the town hall (*primăria*) of the administrative-territorial unit where the death occurred. The declarant receives the administrative (civil) death certificate in exchange for the medical death certificate, which is required for the burial or cremation of the deceased.

At the district civil registration office, the **statistical death bulletin** is completed following the technical norms established by the National Institute of Statistics (NIS). All information concerning the causes of death (parts I and II) is transcribed from the medical death certificate into the statistical death bulletin. The bulletin is then sent to the district statistical directorate (*Direcția Județeană de Statistică*), where it is checked and processed. An exchange of information on the statistical death bulletin takes place between the district statistical directorate (subordinate to NIS) and the district public health directorate (*Direcția de Sănătate Publică Județeană*), which is subordinate to the National Institute of Public Health.

The trained staff at the district public health directorate is responsible for codifying the causes of death according to the 10th revision of the International Classification of Diseases and Causes of Death (ICD-10), applying a 4-digit coding system. The statistical death bulletin is then sent to the NIS to produce the official cause-of-death statistics, based on the underlying cause.[4]

Figure 6 presents the system of death registration in Romania.

In the case of deaths under one year of age, the medical doctor who certifies the death must complete the infant death form. In the case of deaths occurring at 0–6 days of life, the perinatal death form must also be completed. These forms are sent directly to the district public health directorate for data processing, including the codification of causes of death. In Romania, shortly after the adoption of ICD-9 in 1980, the Ministry of Health introduced the medical perinatal death certificate following WHO recommendations. In cases of death at 0–6 days of age, two medical death certificates had to be completed: the standard medical death certificate and the perinatal medical death certificate (Petru Mureşan, 1983 Although the perinatal medical death certificate is no longer used, in cases of early neonatal death, the medical death certificate must still be completed together with both the perinatal death form and the infant death form.

In the case of deaths at ages 1–4 years, the death form for 1–4 years must be completed. For maternal deaths, two specialized forms are used: one for deaths associated with pregnancy, childbirth, and the puerperium, and another for indirect maternal deaths. All these medical forms (infant death form, perinatal death form, death form for 1–4 years, and the two maternal death forms) must be completed alongside the medical death certificate (or, in the case of stillbirths, the medical certificate of stillbirth). The codification of causes of death in these medical forms is carried out at the district public health directorate level.

Figure 7 illustrates the flow of medical and statistical documentation in the case of infant deaths.

6. Classifications in use and collected data

6.1 Classification changes

In Romania, the codification of causes of death has been performed since 1999 using the detailed list of the 10th revision of the International Classification of Diseases (ICD-10). Between 1994 and 1998, Romania used the abridged version of ICD-10. Prior to that, during the period 1979–1993, the country applied the abridged list of the 9th revision (ICD-9). Earlier revisions of the ICD used in Romania are presented in Table 6.

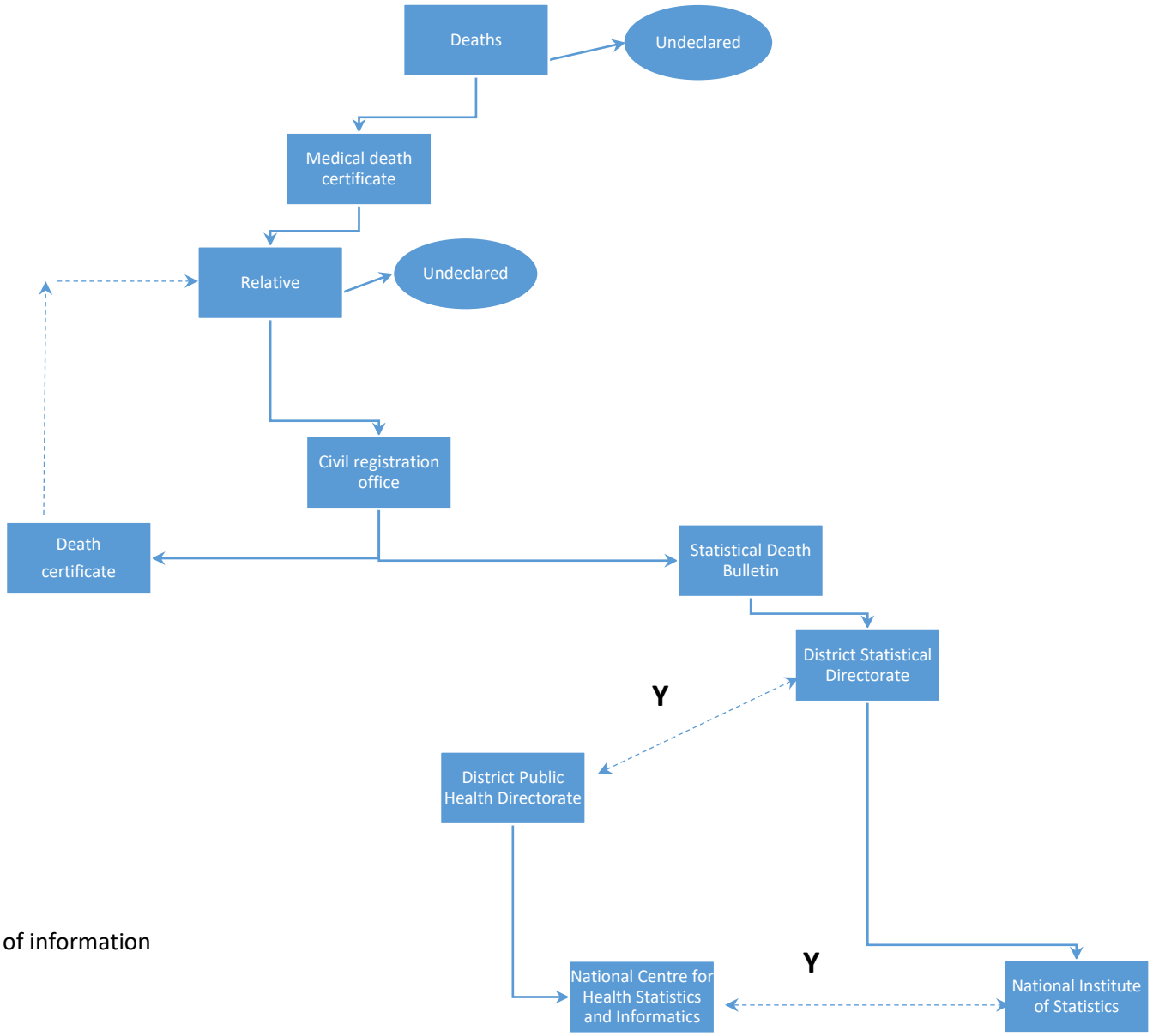
[4] ORDER No. 1078 of July 27, 2010, regarding the approval of the regulations for the organization and functioning, and the organizational structure of the county and Bucharest public health directorates, https://legislatie.just.ro/Public/DetaliiDocumentAfis/121234

Table 6. Revisions of the International Classification of Diseases used in Romania after World War II

ICD revision	Year of ICD revision	Adopted by Romania
ICD-6	1948	1948*
ICD-7	1955	1959**
ICD-8	1965	1969**
ICD-9 abridged list	1975 (detailed)	1979*
ICD-10 abridged list	1993 (detailed)	1994
ICD-10 detailed list		1999

* According to P. Mureşanu, 2001.
** Year according to the WHO Mortality Database (http://www.who.int/healthinfo/mortality_data/en/). For Romania, the first available year in this database is 1959, although it can be assumed that the adoption of ICD-7 occurred earlier.

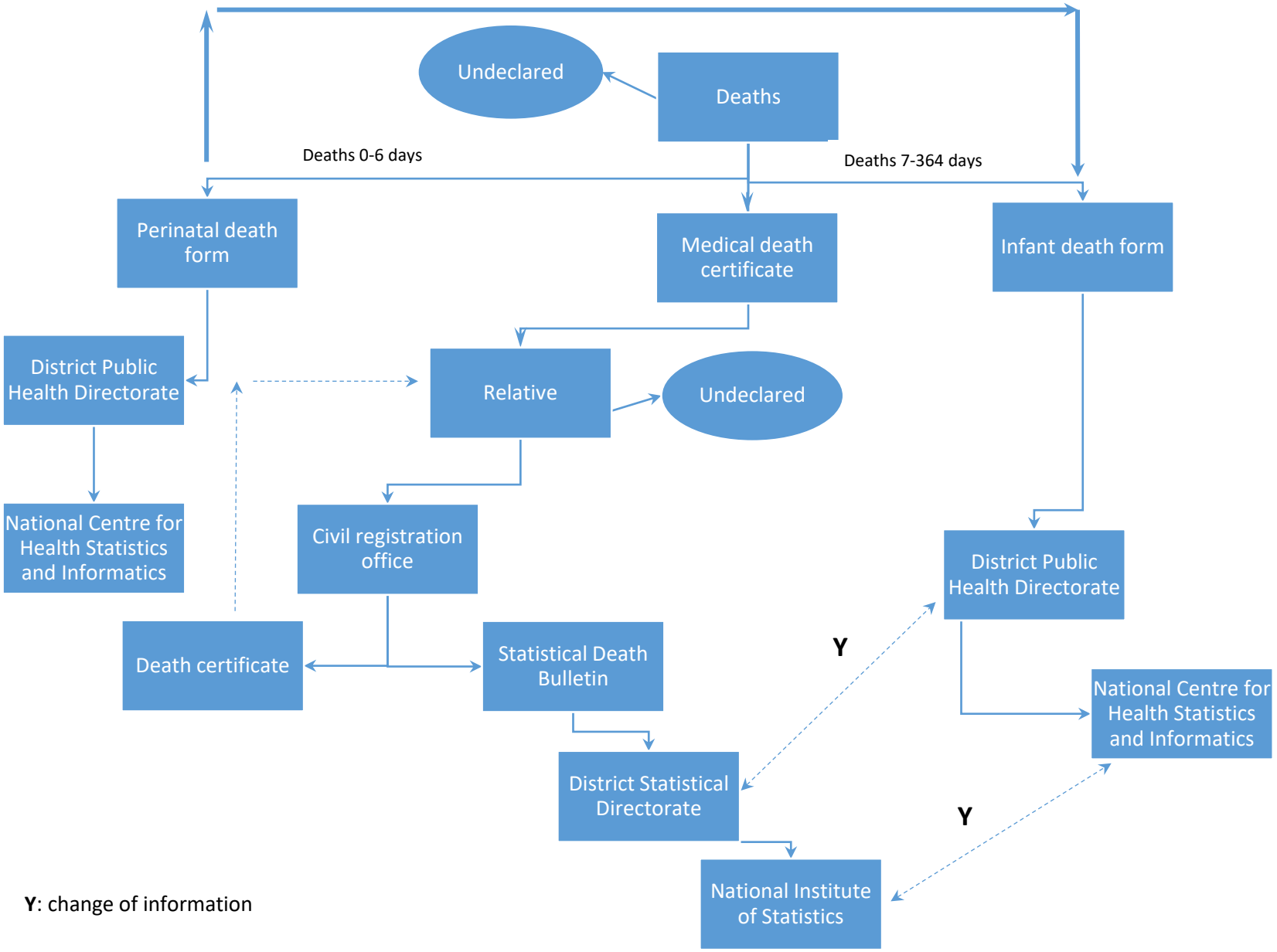
Figure 5. System of death registration in Romania



Y: change of information

Source: NCHSI with some modifications

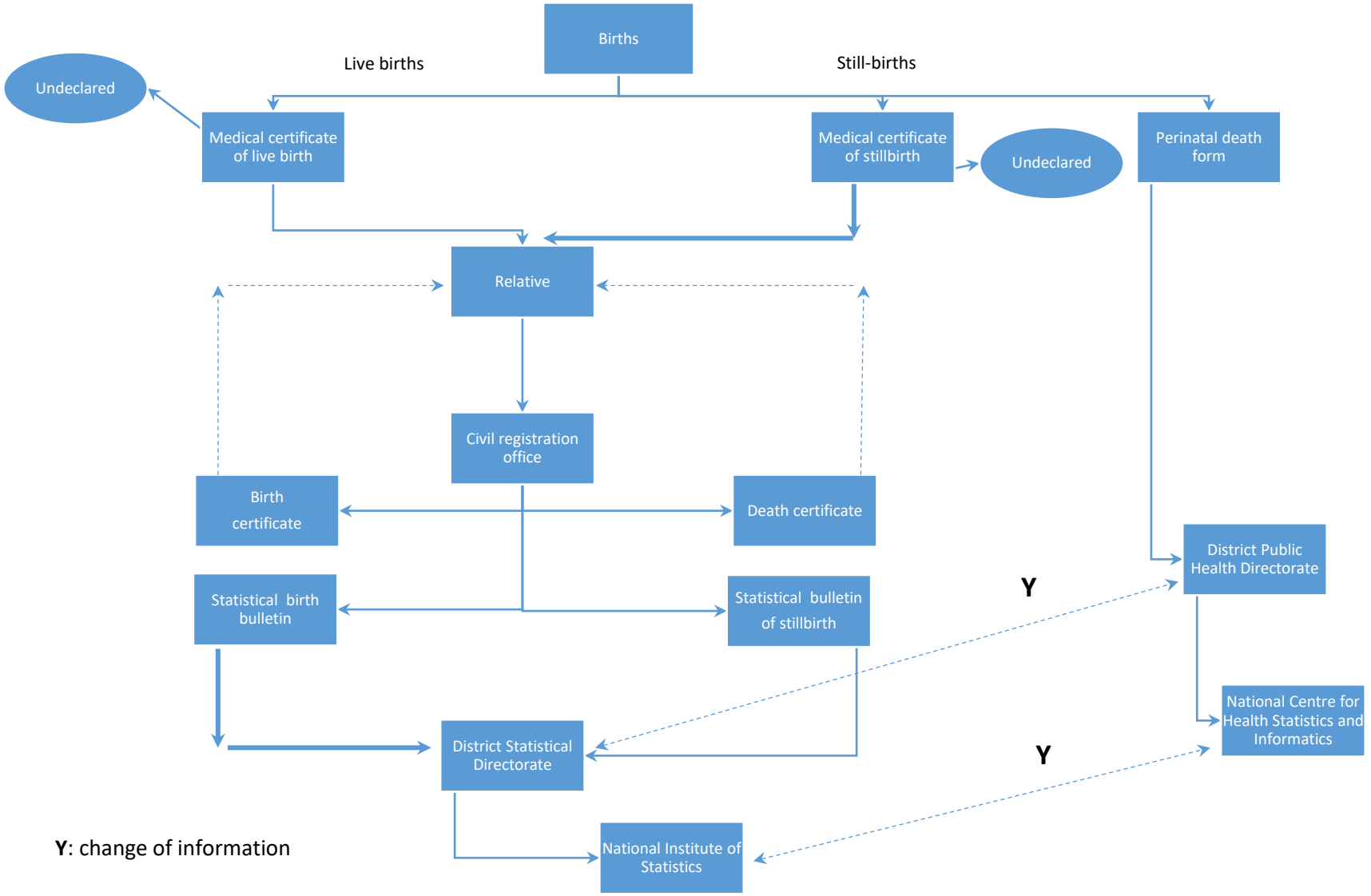
Figure 6. System of infant death registration in Romania



Y: change of information

Source: NCHSI with some modifications

Figure 7. System of birth registration in Romania



Y: change of information

Source: NCHSI with some modifications

ICD-9 abridged list

Instead of the detailed ICD-9 list, Romania used the ICD-9 abridged list between 1980 and 1993. This classification included 353 causes of death, including 24 external causes under the E-classification.

ICD-10 abridged list

For the period 1994–1998, the ICD-10 abridged list was used. This version covered 895 codes, including 17 codes related to external causes of death.

ICD-10 detailed list

Starting in 1999, Romania adopted the detailed 4-digit ICD-10 classification. However, three-digit codes are still used for some causes of death for which four-digit codes exist in more recent ICD-10 versions. For example, codes such as A09, C80, K85, L89, and O96 exist as three-digit codes in the 1992 version of ICD-10, while they appear as four-digit codes in the 2010 version.

Romania has also adopted some specific ICD-10 updates. Codes such as D47.1, D30.4, K28.1, D72.9, and M33.0 do not appear in the 1992 version but are included in the 2010 version of ICD-10. Additionally, a few non-existent codes were used for specific years and received special treatment (see Section 6.4).

Certain three-digit codes for external causes of death were used alongside their corresponding four-digit codes within the same year. These cases were also subject to special handling (see Section 6.4).

6.2 Collected data

For the years 1980–1992, data on causes of death (including external causes by character of trauma) were manually computerized by personnel at the National Institute of Statistics (NIS). Since 1993, cause-specific data based on ICD-9 have been available in computerized form. The first age group is 0-4 years for 1980-1992 and 0 years for 1993. Additionally, cause-specific data on infant mortality (including external causes of death by character of trauma) were provided separately for the years 1980–1992.

Table 7. Format of raw data on death counts by sex, age and causes of death for Romania

ICD revision	Period	Number of items	Age groups	Data format	Comments
ICD-9 abridged list	1980-1992	353, incl. 24 external causes + 26 external causes by character of trauma	0-4, 5-9, 10-14, …, 85-99, 100+	Manually computerised by NIS of Romania	Data on infant deaths by cause are provided as separate files. External causes for 1980 and 1988 are missing. Data on external causes for 1982 are incomplete. No information on infant deaths provoked by external causes.
	1993	353, incl. 24 external causes + 26 external causes by character of trauma	0, 1-4, 5-9, 10-14, …, 85-99, 100+	Computerised	
ICD-10 abridged list	1994-1998	895, incl. 17 external causes + 97 external causes by character of trauma	0-4, 5-9, 10-14, …, 85-99, 100+	Computerised	Data on external causes of death (17 causes) are provided as separate files.
ICD-10 detailed	1999-2012	4212 ever registered codes, incl. external	0,1,2,3,4,5,6…,98,99, 100+	Computerised	

ICD revision	Period	Number of items	Age groups	Data format	Comments
(four-digit) list		causes (without external causes by character of trauma)			
	2013-2019		0,1,2,3,4,5-9, 10-14, …,90-94, 95+	WHOMDB	

Data on external causes of death, classified according to the E-classification, were provided separately by the NIS. We used death counts redistributed under this classification.

Since 2013, mortality data available at the 4-digit ICD-10 level have been sourced from the WHO Mortality Database. Table 9 summarizes the raw ICD data collected for Romania for the period 1980–2019.

6.3 Data sources

The data covering the period 1980–2012 were obtained from unpublished databases maintained by the National Institute of Statistics of Romania. Cause-specific death counts by sex and age for the years 2013–2018 were downloaded from the WHO Mortality Database (WHO, 2022)

6.4 Specific treatment of the raw data

Several treatments were applied to the raw data before reconstruction.

ICD-9 (1980-1993)

For the years 1980 and 1988, data according to the E-classification are missing. For these years, we estimated external death counts by sex, age, and cause of death based on coefficients calculated, respectively, for 1981 and 1987. The choice of 1987 as a reference year for 1988 is explained by significant fluctuations in mortality from external causes recorded in 1989, provoked by the December Revolution. The coefficients were applied to the total external death counts codified under the character of trauma in 1980 and 1988.

An important discrepancy exists for 1982 between the total number of external deaths codified under the E-classification and those classified by character of trauma. External death counts under the E-classification are 1,044 cases fewer than external deaths classified by character of trauma. The same discrepancy is observed for the total number of deaths in that year. An examination of annual trends in external death counts did not reveal any specific cause of death to which these missing deaths could be attributed. Consequently, the difference between death counts by character of trauma and those under E-classification was redistributed proportionally across all external causes classified under E-classification for 1982.

The first age group for external causes of death under the E-classification is 0–4 years for 1980–1992 and 0 years for 1993. To separate infant deaths from deaths at ages 1–4 years, we used the corresponding coefficients computed for external causes of death by sex and age for 1993. Death totals by cause of death were adjusted to match the death totals by age group.

ICD-10 abridged list (1994-1998)

Raw ICD-10 data based on the abridged list of causes of death were not subject to any specific treatment.

ICD-10 detailed list (1999-2012) provided by the NIS of Romania

For certain years, non-existent 4-digit codes were identified in the raw ICD-10 detailed data provided by the NIS. These codes are C14.1, Q63.4, Q90.3, E51.3, and O15.3. The total number of deaths registered under these non-existent codes was very small (fewer than 10 deaths for the entire observation period), except for code C14.1, which accounted for approximately 100 deaths during 1999–2002.

The 3-digit code C14 refers to *Malignant neoplasm of other and ill-defined sites in the lip, oral cavity, and pharynx*. Deaths registered under the non-existent code C14.1 were re-codified as C14.0, *Malignant neoplasm of pharynx, unspecified*. An examination of annual trends in deaths from C14.0 after recodification did not reveal any inconsistencies in the time series. Other non-existent codes were re-codified into the corresponding codes with a fourth digit of .9 (unspecified).

For certain external causes of death, three-digit ICD-10 codes were found together with their corresponding four-digit codes in the same year. These codes are: V03, V05, V43, V66, V89, W01, W11, W18, W19, W20, W29, W55, W69, W70, W74, W79, W80, X09, X31, X59, X66, X68, X69, X70, X77, X78, X80, X91, X99, Y00, Y09 and Y34. The total number of deaths codified under these three-digit codes was insignificant (fewer than 10 deaths). These cases were re-codified into their corresponding four-digit codes by assigning the fourth digit .9 (unspecified).

In the 1999–2012 data provided by the NIS of Romania, a few codes were used that are no longer valid in the current version of ICD-10 (at least from the 2010 version onward). In total, 30 such codes were identified, as listed below.

List of ICD-10 codes no longer valid but used by the NIS of Romania in 1999–2012:

A09, C80, C832, C834, C836, C842, C843, C850, C912, C932, C941, C945, C952, C961, C963, D463, D752, D760, K350, K351, K359, K511, K85, L89, N180, N188, O96, Q314, Q350, Q354.

ICD-10 detailed list (2013-2019) downloaded from WHOMDB

For the years 2013-2019, we used the data downloaded from the World Health Organization Mortality Database (WHOMDB). The National Institute of Statistics (NIS) of Romania provides WHO with cause-of-death mortality statistics, meaning that for years before 2013, the two data sources coincide entirely. The only difference concerns the list of non-valid ICD-10 codes mentioned above. Starting from 2010, these non-valid ICD-10 codes were no longer used for Romania in WHOMDB, although they were still present in the original datasets provided by NIS for 2010-2012. In WHOMDB, the non-valid codes were recoded into valid ones.

For example, the three-digit code A09 (*Other gastroenteritis and colitis of infectious and unspecified origin*), which existed in the NIS database for 2010–2012, was recoded in WHOMDB as A090 (*Other and unspecified gastroenteritis and colitis of infectious origin*) for 2010 and as A099 in 2011. Considering that there were no deaths coded under other four-digit subdivisions of A09 for 2013–2019, we chose to maintain the three-digit code A09 in the reconstructed time series database.

Another example concerns *Chronic kidney disease* (N18). In the current ICD-10 version, chronic kidney disease is categorized into five stages (N18.1 to N18.5) and unspecified chronic kidney disease (N18.9), whereas in previous versions, a distinction was made between end-stage renal disease (N18.0), other chronic renal failure (N18.8), and unspecified chronic kidney disease (N18.9). Since the NIS of Romania continued to use the older version of ICD-10 for this pathology, WHOMDB presented deaths only under the unspecified category (N18.9). Consequently, as with A09, reconstructed death counts for chronic kidney disease are presented at the three-digit level (N18).

Table 8. Non-valid ICD-10 codes used by NIS of Romania between 2010 and 2012, with corresponding codes used in WHOMDB and the Human Cause-of-Death (HCD) data series

	Non-valid ICD-10 code used by NIS	**Coded to in WHOMDB**	**Coded to in HCD data series**
1.	A09	A090 (2010, 2012-2018) A099 (2011)	A09
2.	C80	C800	C80
3.	C832	C859	C859

	Non-valid ICD-10 code used by NIS	Coded to in WHOMDB	Coded to in HCD data series
4.	C834	C859	C859
5.	C836	C859	C859
6.	C842	C844	C844
7.	C843	C844	C844
8.	C850	C859	C859
9.	C912	C919	C919
10.	C932*	C932	C939
11.	C941*	C944	C944
12.	C945	C944	C944
13.	C952	C959	C959
14.	C961	C968	C968
15.	C963	C968	C968
	C97	C809	C97, redistributed proportionally among C00-C76 and C81-C96
16.	D463	C930	C930
17.	D752	D473	D473
18.	D760*	D760	D763
19.	K350	K352	K352
20.	K351	K353	K353
21.	K359	K358	K358
22.	K511*	K511	K519
23.	K85	K850 (2010, 2012-2016) K859 (2006-2009, 2011)	K85
24.	L89	L890 (2010, 2012-2016) L899 (2011)	L89
25.	N180	N189	N18
26.	N188	N189	N18
27.	O96*	O96	O96
28.	Q314	Q319	Q319
29.	Q350	Q351	Q351
30.	Q354	Q355	Q355

* Deaths under these non-valid ICD-10 codes were registered before 2010.

In WHOMDB, deaths attributed to "Malignant neoplasms, without specification of site" (C80) after 2010 were split into "Malignant neoplasms, primary site unknown, so stated" (C80.0) and "Malignant neoplasm, primary site unspecified" (C80.9). Although the code C80.9 does not appear in the 1999–2012 NIS data, it exists in WHOMDB starting from 2010.

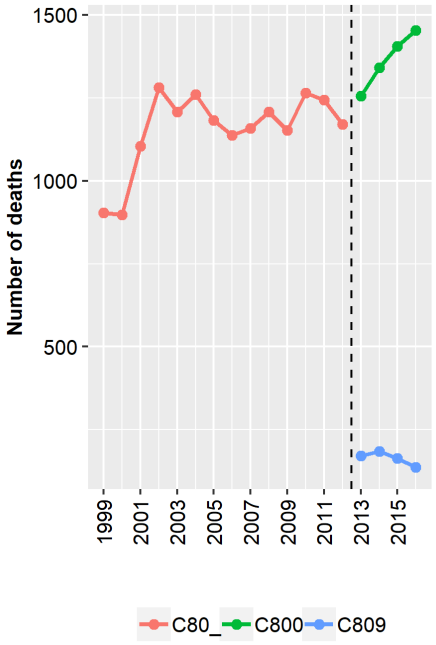


Figure 8. Death counts from Malignant neoplasms without specification of site (C80, C80.1 and C80.9), Romania, 1999-2016

Source: 1999-2012 – NIS of Romania; 2013-2016 – WHOMDB

In the case of *Chronic kidney disease*, deaths previously coded under N18.0 (End-stage renal disease) and N18.8 (Other chronic renal failure) were merged with N18.9 (Chronic kidney disease, unspecified).

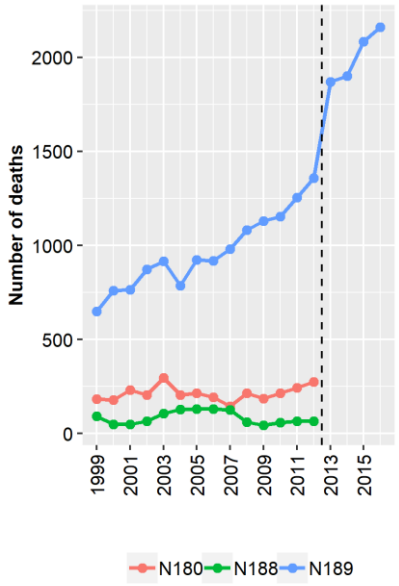


Figure 9. Death counts from Chronic kidney disease (N18.0, N18.8 and N18.9), Romania, 1999-2016

Source: 1999-2012 – NIS of Romania; 2013-2016 – WHOMDB

Regarding *Acute appendicitis*, deaths for 1999–2012 were coded under K350, K351, and K359. From 2013, these non-valid codes were replaced by K352, K353, and K359, according to the updated ICD-10 version.

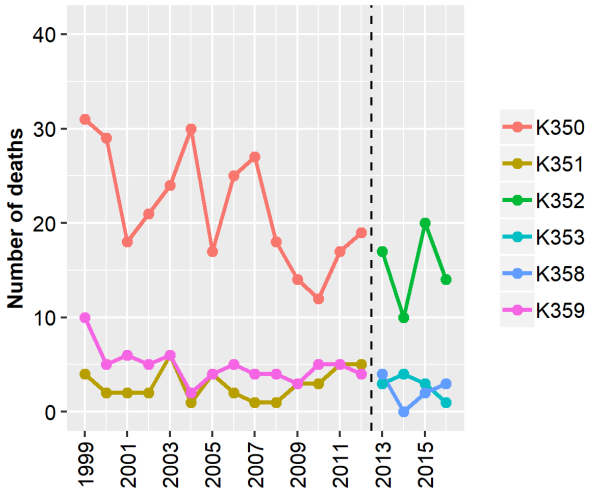


Figure 10. Death counts from Acute appendicitis coded under non-valid (K350, K351 and K359) and valid (K352, K353 and K359) ICD-10 codes, Romania, 1999-2016

Source: 1999-2012 – NIS of Romania; 2013-2016 – WHOMDB

Since 2016, following updates to ICD-10, the codes "G23.2" (Multiple system atrophy, parkinsonian type) and "G23.3" (Multiple system atrophy, cerebellar type) have been introduced, replacing the earlier code "G23.2" (Striatonigral degeneration). Given that only a few deaths were recorded under the new code G23.3, they were recoded into the former G23.2 to maintain continuity.

Similarly, for "Sudden infant death syndrome," the earlier three-digit code (R95) was subdivided into R950 (with autopsy) and R959 (without autopsy). In WHOMDB, deaths attributed to sudden infant death syndrome are coded as R950 from 2013 onwards and as R95 before 2013. In the HCD data series, we retained the three-digit coding for this syndrome (R95).

7. Specific transition documents

We used the correspondence table between the abridged ICD-9 list and the abridged ICD-10 list, with corresponding detailed ICD codes, elaborated by NCHSI (Mureşanu, 2001). This correspondence table was applied for both transitions: from the abridged ICD-9 list to the abridged ICD-10 list, and from the abridged ICD-10 list to the detailed ICD-10 list.

Part III – Reconstruction information

8. Reconstruction of coherent time series

Transition from abridged ICD-9 list to abridged ICD-10 list

Correspondence tables

We used a correspondence table (produced by NCHSI) between the abridged ICD-9 and ICD-10 lists (Mureşanu, 2001). The official correspondence table was reviewed by comparing both classifications, and we introduced modifications due to the omission of certain codes in the abridged ICD-9 and detailed ICD-10 lists.

Fundamental associations of items (FAIs)

Based on medical correspondence, we identified 289 associations and checked their statistical coherence. A statistically-oriented method was used to predict mortality trends and apply user-defined cut-offs for statistical significance (Camarda and Pechholdová, 2014). After detecting disruptions in associations, we adjusted the problematic associations accordingly and, as a result, obtained 240 associations. The distribution of FAIs by type and number of deaths registered in the transition year (1994) is presented in *Table 9*. Notably, 131 of the 240 fundamental associations are simple, but only account for 14% of the total deaths. Split (1:n) and merge (n:1) associations cover 26% and 3%, respectively, while complex associations (n:n) concentrate 77% of total deaths.

Table 9. Distribution of FAIs between abridged ICD-9 to abridged ICD-10, by type and death counts

	Abridged ICD-10			
	Associations		Deaths (in 1994)	
Association type	Number	Proportion, %	Number	Proportion, %
type 1:1	131	55	36277	14
type 1:n	63	26	23316	9
type n:1	6	3	1412	1
type n:n	40	17	205096	77
Total	240	100	266101	100

Transition coefficients

Initially, transition coefficients were calculated for all ages and applied to the 1980-1993 ICD-9 death time series. These were then supplemented with the 1994-2012 death series according to the abridged ICD-10 list. After reviewing age-specific trends, we selected 28 associations covering 313 ICD-10 codes, for which transition coefficients led to disruptions in the death series. For these associations, transition coefficients were calculated for five main age groups: 0-19, 20-39, 40-59, 60-79, and 80+, and interpolated by 5-year age groups. This resulted in coherent 1980-1998 death series under the abridged ICD-10 classification, completed with 1999-2012 data.

Figures 9-11 illustrate examples of the transition between ICD-9 and ICD-10 for various types of associations, both before and after applying the transition coefficients. Association 61 is of type splitting (1:n) and refers to *Malignant neoplasm of lip, oral cavity, and pharynx*. Association 236 represents the type merging (n:1) and includes the items related to *Accidental poisoning by and exposure to noxious substance.* Finally, association 65 is an example of a type complex (n:n) with two ICD-9 and four ICD-10 items concerning *Malignant neoplasm of colon, rectum rectosigmoid junction and anus*.

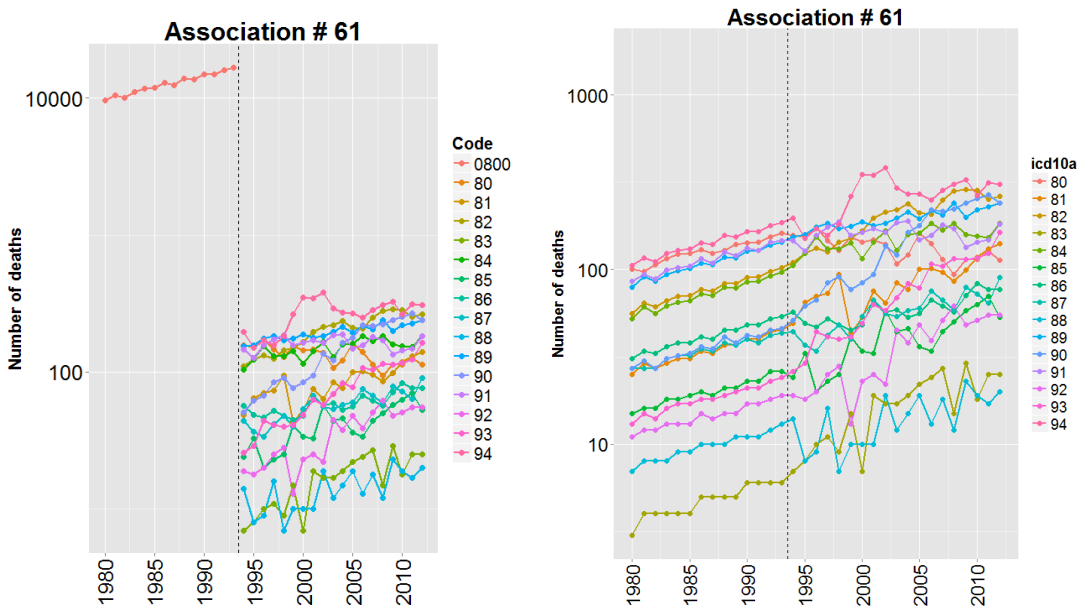


Figure 11. Transition from ICD-9 to ICD-10: annual trends in deaths for *Malignant neoplasm of lip, oral cavity, and pharynx* before reconstruction (left) and after reconstruction (right) (splitting association, type 1:n)

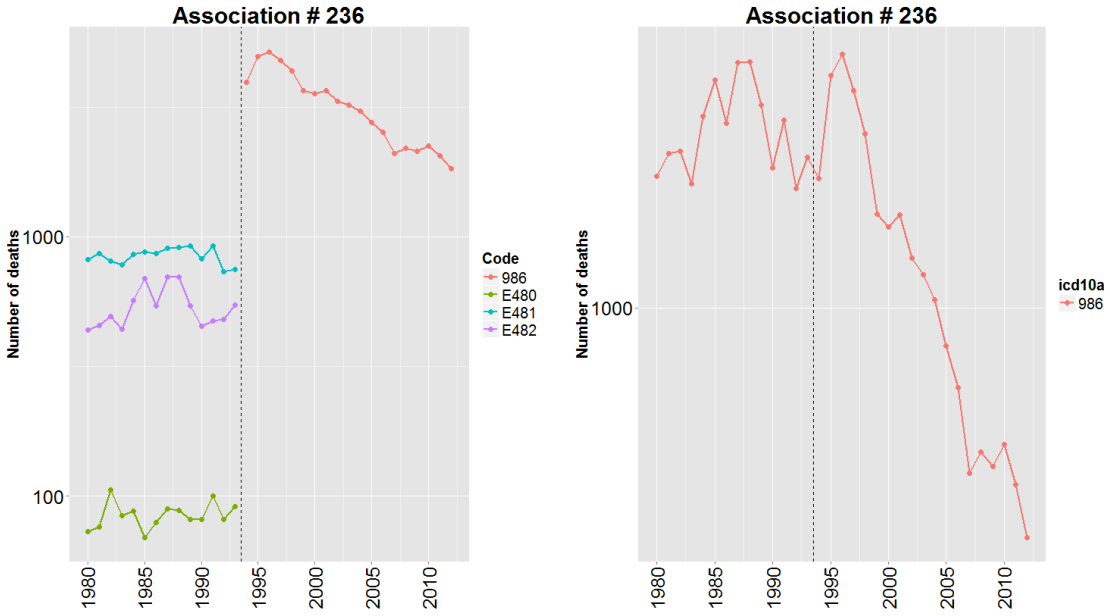


Figure 12. Transition from ICD-9 to ICD-10: annual trends in deaths for *Accidental poisoning by and exposure to noxious substance* before reconstruction (left) and after reconstruction (right) (merging association, type n:1)

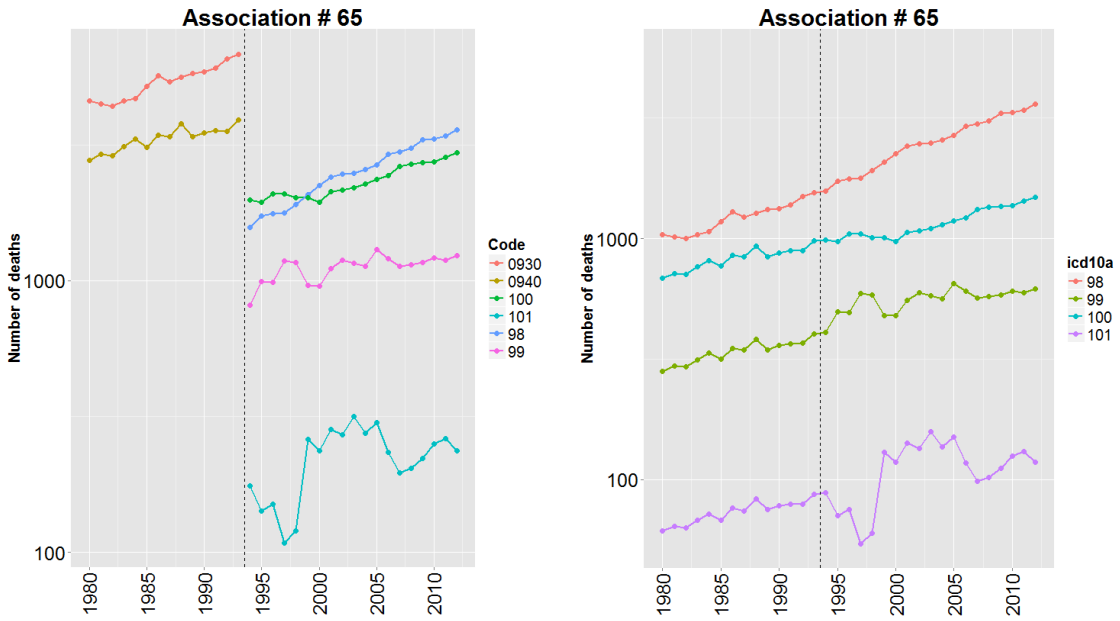


Figure 13. Transition from ICD-9 to ICD-10: annual trends in deaths for *Malignant neoplasm of colon, rectum rectosigmoid junction and anus* before reconstruction (left) and after reconstruction (right) (complex association, type n:n)

Transition from ICD-10 abridged list to ICD-10 detailed (4-digit) list

Correspondence table

We used a detailed ICD-10 list developed by Dr. Pechholdová, which includes two official WHO ICD-10 versions: one from 1992 and another from 2010. After merging these versions, the final list covers three types of codes: those common to both versions, those exclusive to the 1992 version, and those exclusive to the 2010 version. For Romania, we used codes from both versions, including six additional codes from 2010 that were ever registered (D471, D304, D729, K281, M330, and V850). In total, the detailed ICD-10 list contains 10,195 codes, with 4,212 codes ever registered in Romania.

Fundamental associations of items (FAIs)

Based on medical correspondence, we identified 895 associations, initially all classified as splitting (1:n). However, after examining them, we identified statistical disruptions and corrected them by creating complex associations. This resulted in 795 associations: 106 simple (1:1), 45 complex (n:n), and the remainder as splitting (1:n). Complex associations, which represent 50% of total deaths, highlight the complexity of the transition from the abridged ICD-10 to the detailed ICD-10, accompanied by codification changes independent of the theoretical item definitions. The distribution of fundamental associations by type and death counts is presented in *Table 10*.

Table 10. Distribution of FAIs between abridged ICD-10 to detailed ICD-10, by type and death counts

	ICD10			
	Associations		Deaths (1999)*	
Type of associations	Number	Proportion, %	Number	Proportion, %
type 1:1	106	13	56908	22
type 1:n	644	81	75629	29
type n:1	0	0	0	0
type n:n	45	6	131992	50
Total	795	100	264529	100

* For certain ICD10 detailed items, the transition year is other than 1999.

Additional transition from ICD-10 abridged list to ICD-10 detailed (4-digit) list

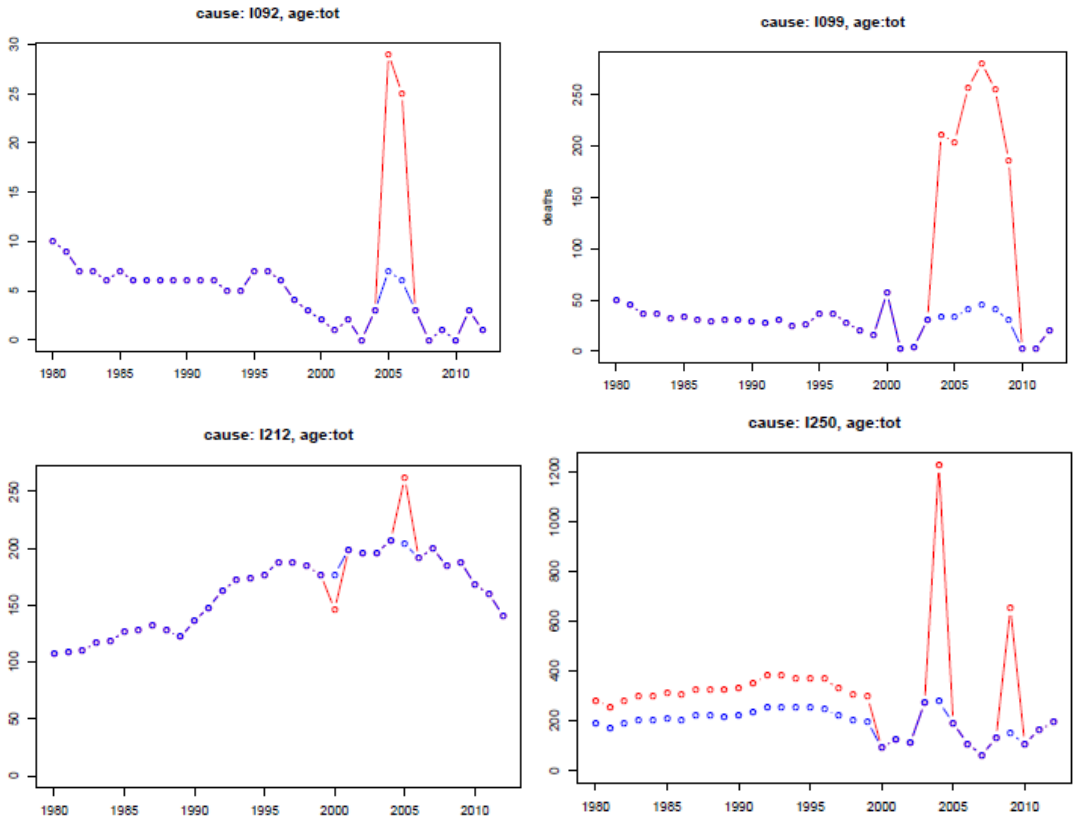
Transition coefficients

Transition coefficients were initially calculated for all ages, and then refined for age-specific ICD-10 codes. A total of 50 associations, covering 3,668 detailed ICD-10 codes and 100 abridged ICD-10 codes, were selected. Transition coefficients for these associations were calculated by 5-year age groups, as described earlier.

A posteriori corrections

A posteriori corrections were applied in two rounds: first after reclassifying the 1980-1993 data under the abridged ICD-10 list and adding it to the 1994-1999 data, and second after reclassifying the 1980-1998 death series under the detailed ICD-10 list, followed by integration with the 1999-2019 data.

Figure 12 shows examples of a posteriori corrections for cardiovascular diseases, where Romania's NIS introduced, then quickly abandoned, certain changes in codification. For example, unexpected spikes in deaths were observed for codes like I092 (*Chronic rheumatic pericarditis*) and I512 (*Rupture of papillary muscle*), which were corrected in later years.



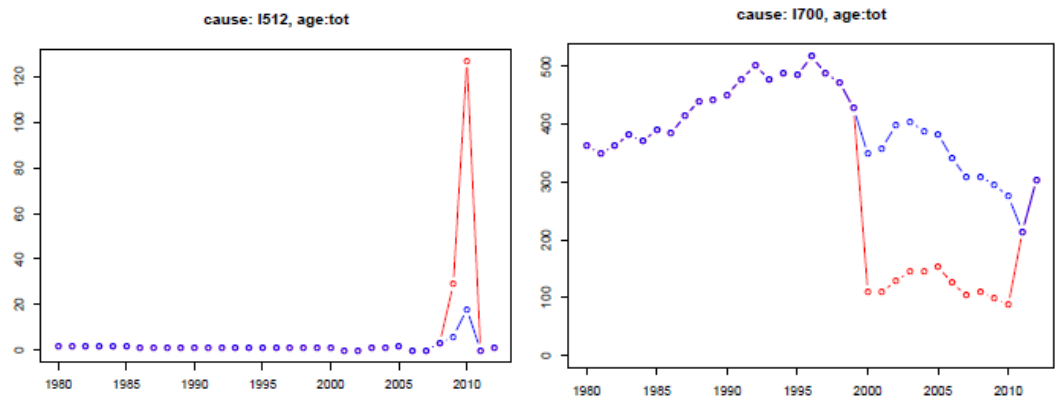


Figure 14. Annual trends in number of deaths for certain detailed ICD-10 items referring to the diseases of the cardiovascular system before (red line) and after (blue line) *a posteriori* corrections.

Specific correction: ICD-10 codes not to be used as underlying causes of death

For Romania, we adopted the WHO list of ICD-10 codes not to be used as underlying causes of death (non-UCD) from the WHO ICD-10 manual (WHO, 2016, pp. 98–99), presented in *Table 12*. These codes typically account for a small number of deaths, including those that were recodified to R99, *Other ill-defined and unspecified causes of mortality*.

Deaths coded under C97, *Malignant neoplasms of independent (primary) multiple sites*, were redistributed proportionally between codes C00-C76 and C81-C96.

Although WHO recommends coding F10.0, *Mental and behavioural disorders due to use of alcohol, acute intoxication,* to external causes of deaths (X45, X65, X85 or Y15), for Romania we kept this code as an underlying cause of death. *Table 11* lists the ICD-10 codes not to be used as underlying cause codes.

Table 11. List of ICD-10 codes not to be used as underlying cause code

ICD-10 codes not to be used as underlying code	Coded to
R572, R650, R651, R659	A419
B956-B958	A490
B950, B951, B952, B953, B954, B955	A491
B963	A492
B960	A493
B961, B962, B964, B965, B966, B967, B968, B980, B981	A498
B970	B340
B971	B341
B972	B342
B973, B976	B343
B977	B344
B974, B975, B978	B348
C770, C771, C772, C773, C774, C775, C778, C779, C780, C781, C782, C783, C784, C785, C786, C787, C788, C790, C791, C792, C793, C794, C795, C796, C797, C798	C80
C97	Proportional redistribution between C00-C76 and C81-C96

ICD-10 codes not to be used as underlying code	Coded to
I152	E349
I230, I231, I232, I233, I234, I235, I236, I238, I220, I221, I228, I229, I240	I219
I252	I258
I650, I651, I652, I653, I658, I659, I660, I661, I662, I663, I664, I668, I669	I639
I151	N289
O080, O081, O082, O083, O084, O085, O086, O087, O088, O089	O069
O800, O801, O808, O809, O810, O811, O812, O813, O814, O815, O820, O821, O822, O828, O829, O830, O831, O832, O833, O834, O838, O839, O840, O841, O842, O848, O849	O759
P703, P704, P708, P709, P710, P711, P712, P713, P714, P718, P719, P720, P722, P728, P729, P740, P741, P742, P743, P744, P745, P748, P749	P969
B900, B901, B902, B908, B909, B91_, B92_, B940, B941, B942, B948, B949, E640, E641, E642, E643, E648, E649, E68_, G09_, I690, I691, I692, I693, I694, I698, O97_, Y850, Y859, Y86_, Y870, Y871, Y872, Y880, Y881, Y882, Y883, Y890, Y891, Y899, E890, E891, E892, E893, E894, E895, E896, E898, E899, F03_, F04_, F050, F051, F058, F059, F060, F061, F062, F063, F064, F065, F066, F067, F068, F069, F070, F071, F072, F078, F079, F09_, F700, F701, F708, F709, F710, F711, F718, F719, F720, F721, F728, F729, F730, F731, F738, F739, F780, F781, F788, F789, F790, F791, F798, F799, F800, F801, F802, F803, F808, F809, F810, F811, F812, F813, F818, F819, G970, G971, G972, G978, G979, G810, G811, G819, H590, H598, H599, G820, G821, G822, G823, G824, G825, H950, H951, H958, H959, G830, G831, G832, G833, G834, G838, G839, I150, I158, I159, H540, H541, H542, H543, H544, H545, H546, H547, H900, H901, H902, H903, H904, H905, H906, H907, H908, H910, H911, H912, H913, H918, H919, N46_, N970, N971, N972, N973, N974, N978, N979, O300, O301, O302, O308, O309, I970, I971, I972, I978, I979, P070, P071, P072, P073, P080, P081, P082, J950, J951, J952, J953, J954, J955, J958, J959, K910, K911, K912, K913, K914, K915, K918, K919, M960, M961, M962, M963, M964, M965, M966, M968, M969, N990, N991, N992, N993, N994, N995, N998, N999, R69_	R99
F130, F150	Y119
F110, F120, F140, F160	Y129
F180	Y169
F170, F190	Y199

9. Redistribution of ill-defined causes

At the final reconstruction step, ill-defined causes of death (codes R00-R94, R96, R98, R99) were redistributed proportionally among other causes.

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List of acronyms

FAI – Fundamental Association of Items

HCD – Human Cause-of-Death

ICD – International Classification of Diseases

NCHSI - National Centre for Health Statistics and Informatics

NIPH - National Institute of Public Health

NIS - National Institute of Statistics

UCD – underlying cause of death

WHOMDB – World Health Organization Mortality Database