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THE QUALITY OF MORTALITY DATA

Summary: Measuring mortality is one of the most challenging tasks faced by demographers and epidemiologists. Collecting vital statistics on death and cause-of-death from different sources (e.g. civil registration systems, health care facilities) requires high quality of data to generate critical information to guide public health decision-making. In the first part of the study, selected quality criteria around 5 European Statistical System quality dimensions is discussed, while in the second part, the discussion is focused on three particular aspects of data quality, i.e. the completeness of the data, the age pattern of reported deaths, the plausibility of cause-of-death data.

Keywords: dimensions of quality, mortality rate, crude death rate, age-specific death rate.

JEL Classification: C80.

Introduction

The good quality and completeness of death data and the causes of death are unimaginable in the light of their use in research and analysis conducted by medical institutes and individual practitioners. The good quality of death data provides us proper:

- assessment of the population mortality pattern and determination its changes over time,
- identification regional differences in death rates and investigation reasons for these differences,
- monitoring trends in public health issues such as infant and maternal mortality, infectious diseases, accidents and suicides,

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- identification health risks associated with environmental and occupational factors and lifestyle,
 - determination health research and health care priorities and resources allocation,
 - planning health facilities, services and human resources,
 - planning prevention and screening programs, and assess the results of these programs, and
 - developing health promotion programs and evaluate their results.

With developments in some areas, including the increasing use of administrative data and more complex mixed source (survey and administrative data) combinations of data used to produce statistical outputs, a single list of a few key quality measures is no longer feasible. Thus, in the study, a few quality measures are highlighted as those that are key to providing users with an overall summary of output quality.

The purpose of the study is a data quality assessment and possible problems with the mortality data collection diagnose. We discuss chosen aspects of official statistics quality, with focus on the 5 quality dimensions of the European Statistical System, which are: relevance, accuracy and reliability, timeliness and punctuality, accessibility and clarity, coherence and comparability. Evaluation of data quality is carried out on an example of Poland.

1. The mortality measurement

Mortality indicators, and specifically mortality rates, are expressed and calculated in different ways.

1.1. Indicators of mortality and their measurements

The simplest measure of mortality is the number of deaths. However, this is not of much use for practical purposes since it is heavily influenced by the number of people who are at risk of dying, demographers typically measure mortality using rates. A death rate is defined as [Hinde, 2014, p. 8]:

$$\text{death rate} = \text{number of deaths in a specified time period} / \text{number of people exposed to the risk of dying during that time period.}$$

Data on the number of deaths are usually obtained from death registers, and data on the number of people exposed to the risk of dying are typically obtained from a population census. Survey data may also be used, especially in countries

where death registration is deficient, or the quality of census data is suspect.

The simplest conceivable death rate is the total number of deaths in a given time period divided by the total population. This measure is called the crude death rate [Hinde, 2014, p. 9]:

$$\text{crude death rate} = \text{total number of deaths in a given year} / \text{total population}.$$

The time period used here is typically one calendar year.

An immediate issue arises with the measurement of the total population. During any year, the population usually changes. Conventionally, the point chosen is half-way through the year and the population on 30 June is called the mid-year population.

However, the crude death rate does not provide a great deal of information about mortality. In particular, the risk of dying varies greatly with age and the crude death rate indicates nothing about this variation. Because of this, demographers often find it useful to use age-specific death rates. The age-specific death rate at age x years is defined as [Hinde, 2014, p. 9]:

$$\text{age specific death rate at age } x \text{ years} = \text{number of deaths of people aged } x \text{ years} / \text{population aged } x \text{ years}$$

in a given calendar year. When we refer to ‘age x years’, we mean ‘aged x last birthday’. The denominator, as before, is the mid-year population.

Age-specific death rates can be calculated for a single years of age or for age groups, and usually separately for males and females. Except of crude and age-specific mortality rate, demographers use the following indicators of mortality [Checci, Roberts, 2005, p. 5]:

- group-specific mortality rate (deaths in sub-group / sub-group population at risk x period of time),
- period-specific mortality rate (deaths during sub-period / population at risk during sub-period x duration of sub-period),
- cause-specific mortality rate (deaths due to given cause / population at risk x period of time),
- proportionate mortality (deaths due to given cause / total deaths) which is not a rate,
- case-fatality ratio (or rate) (deaths due to given cause or disease / total cases of given disease).

1.2. Data sources for measuring mortality

There are two major ways to collect the number of deaths in population:

- count deaths prospectively by implementing a surveillance system to count deaths as they occur (prospective surveys),
- count deaths retrospectively which have occurred in the recent past during a cross-sectional survey (retrospective surveys).

Almost every country in the world has a prospective death reporting system. In most countries, death registration is mandatory. Death reporting is often part of a vital statistics system which records information on births, deaths, marriages and divorces.

Comparison of these two approaches is presented in Table 1. Surveillance enables real-time monitoring of mortality trends. However, it requires some regular epidemiological supervision and its quality may not be sustainable over many months. Surveys can generate very reliable data, but do not reflect trends in sufficient detail. They can be adapted to almost any setting, however, remote and arduous, and constitute a one-time effort.

Table 1. Comparison of surveys and surveillance for estimating mortality

Retrospective survey	Prospective (real-time) surveillance
<i>Strengths</i>	<i>Weaknesses</i>
<ul style="list-style-type: none"> – Can obtain mortality rate estimate without knowing population size – Can be performed in rural or camp settings – Epidemiological input needed, but only for duration of survey – Requires minimal epidemiologist supervision – Can analyze mortality rate by sub-area – Data quality can be highly controlled – Requires a team of surveyors for a short period 	<ul style="list-style-type: none"> – Needs updated, accurate population size – Only feasible in camps or regimented populations – If cluster design is used, no sub-area analysis is possible – Requires large teams of home visitors on a long-term basis
<i>Weaknesses</i>	<i>Strengths</i>
<ul style="list-style-type: none"> – Mortality rate estimate comes after the fact and often too late for meaningful intervention – Mortality rate is an average of past period, may not reflect trends in the past few days/weeks – Impact difficult to measure due to lack of sub-period detail (weekly mortality rate obtainable from surveys is very imprecise) – High possibility of bias, especially response bias (population may perceive that the survey is a registration- or distribution- connected activity) 	<ul style="list-style-type: none"> – Enables real-time monitoring of trends, quick response – Highlights fluctuations in mortality rate – Detects impact of specific interventions immediately – May minimize response bias (population becomes used to surveillance)

Source: Checci, Roberts [2005, p. 19].

Other issue is collection of information on causes of deaths. Statistics on the causes of death are based on two pillars: medical information contained on death certificates, which may be used as a basis for ascertaining the cause of death, and the coding of causes of death following the WHO-ICD system¹. All deaths in the population are identified by the underlying cause of death, which means: “the disease or injury that initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury” [www 1].

The Medical Certificate of Cause of Death is the source of mortality statistics that set up the basis of the oldest and most extensive public health surveillance systems (Fig. 1). Death certificates provide information on the characteristics of the people who died and the causes of death. Causes of death are the most critical and difficult statistical research part on the death certificate, because they provide the basis for describing trends in human health and mortality and for analyzing the conditions leading to death. Mortality statistics provide a basis for the epidemiological studies that focus on the leading causes of death by age, sex or other demographic variables. They also provide a basis for research in disease etiology and the evaluation of diagnostic techniques, which in turn lead to improvements in patient care [Italian National Institute of Statistics, 2003, p. 9].

It is very important that all the people concerned in the registration of the deaths provide accurate, complete, reliable and prompt information. These statistical data are used by national and regional governments to set public health policies and goals, researchers and clinicians, educational institutions and many others for many purposes. Mortality data are the most important indicator to measure and compare health status at local, national and international levels, because they are regularly and extensively collected in every developed country and in the most of the developing ones.

¹ The International Classification of Diseases (ICD) is the global standard for reporting and categorizing diseases, health-related conditions and external causes of disease and injury.

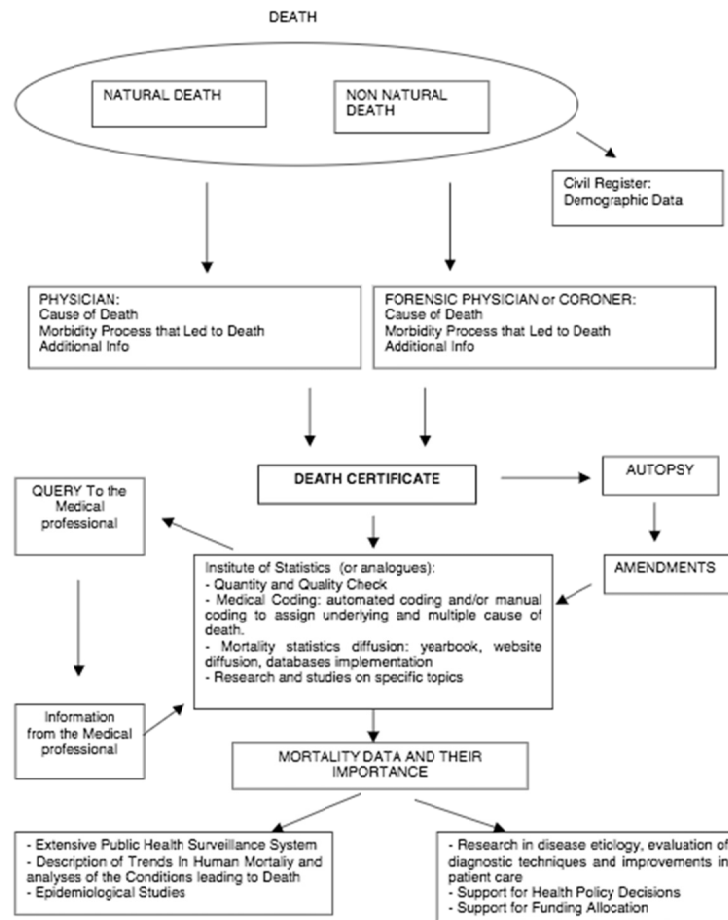


Fig. 1. Generalized scheme on mortality data production

Source: Italian National Institute of Statistics [2003, p. 10].

2. Chosen aspects of official statistics quality

2.1. Data quality

Quality has many different meanings, depending on the context in which it is used. According to the International Organization for Standardization (ISO 8402: 1986, 3.1.), quality is: “The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs” [www 2].

In official statistics, great importance has always been attached to the quality of statistical data. A number of systems for measurement and reporting of data quality have been introduced internationally.

Ensuring high data quality is one of the main functions of the European Statistical System (ESS). The European Statistics Code of Practice (15 principles of the European statistics) defines the quality assurance guidelines regarding the institutional framework of statistics production (6 principles), the statistical processes (4 principles) and the statistical output (5 principles).

The quality of statistical outputs is most usefully defined in terms of how well outputs meet user needs, or whether they are “fit for purpose” [Eurostat, 2014]. In order to enable users to determine whether outputs meet their needs, it is recommended that output producers report quality in terms of the 5 quality dimensions of the European Statistical System which are: relevance, accuracy and reliability, timeliness and punctuality, accessibility and clarity, coherence and comparability (Table 2).

Table 2. Dimensions of quality

Definition <i>1</i>	Key aspects <i>2</i>
<p>Relevance The degree to which statistics meet current and potential needs of the users. It refers to whether all statistics that are needed are produced and the extent to which concepts used (definitions, classifications, etc.) reflect user needs</p>	<p>Any assessment of relevance needs to consider:</p> <ul style="list-style-type: none"> – who are the current and potential users of the statistics – what are their needs – how well the output meets these needs
<p>Accuracy and reliability The closeness between an estimated result and the (unknown) true value</p>	<p>Accuracy can be split into sampling error and non-sampling error, where non-sampling error includes:</p> <ul style="list-style-type: none"> – coverage error – non-response error – measurement error – processing error – model assumption error
<p>Timeliness and punctuality Timeliness reflects the length of time between availability and the event or phenomenon described. Punctuality refers to the time lag between the actual and planned dates of publication</p>	<p>An assessment of timeliness and punctuality should consider the following:</p> <ul style="list-style-type: none"> – production time – frequency of release – punctuality of release
<p>Accessibility and clarity Accessibility is the ease with which users are able to access the data. It also relates to the format(s) in which the data are available and the availability of supporting information. Clarity is the extent to which easily comprehensible metadata are available, where these metadata are necessary to give a full understanding of the statistical data</p>	<p>Specific areas where accessibility and clarity may be addressed include:</p> <ul style="list-style-type: none"> – needs of analysts – assistance to locate information – clarity – dissemination format

Table 2 cont.

<i>1</i>	<i>2</i>
<p>Coherence and comparability Coherence is the degree to which the statistical processes, by which two or more outputs are generated, use the same concepts and harmonized methods. Comparability is the degree to which data can be compared over time, region or other domain</p>	<p>Coherence should be addressed in terms of coherence between:</p> <ul style="list-style-type: none"> – data produced at different frequencies – other statistics in the same socio-economic domain – sources and outputs <p>Comparability should be addressed in terms of comparability over:</p> <ul style="list-style-type: none"> – time – spatial domains (e.g. sub-national, national, international) – domain or sub-population (e.g. industrial sector, household type)

Source: Office for National Statistics [2013, p. 8].

Within Europe, the statistical codes of practice maintained by the National Statistics Offices (NSOs) include sections on data quality. Most NSOs have developed a comprehensive approach to quality measurement and reporting which includes quality measurement guidelines and definitions of key quality measures.

2.2. The quality measures and indicators

The quality measures and indicators have been developed around the 5 ESS quality dimensions (see: Table 3). Data completeness rate shows to what extent statistics are available compared to what should be available (the target value is 100%). The smaller sampling error (the coefficient of variation) and the width of confidence intervals the more accurate is the estimator. The target value of the following indicators is as much as possible close to 0: the rate of over-coverage², common units³, unit non-response⁴, the item non-response rate for a given variable⁵. A high item non-response rate indicates difficulties in providing information, e.g. a sensitive question or unclear wording for social statistics or information not available in the accounting system for business statistics. The Mean Absolute Revision (MAR) provides an idea of the average size of a given revision step for a key item step over the time. A value of imputation rate equal or

² The proportion of units accessible via the frame that do not belong to the target population (are out-of-scope).

³ The proportion of units covered by both the survey and the administrative sources in relation to the total number of units in the survey.

⁴ The ratio of the number of units with no information or not usable information (non-response, etc.) to the total number of in-scope (eligible) units.

⁵ The (weighted) ratio between in-scope units that have not responded and in-scope units that are required to respond to the particular item.

close to zero is desirable. Imputation indicates missing and invalid values. The target values of time-lag usually are fixed by legislation. Nevertheless, smaller values denote higher timeliness. Punctuality measured by rate of punctuality of data publication / data delivery should be 0, which means that there is no delay on the delivery / transmission of data. The value of coefficient of asymmetry for mirror flows statistics should be as close to zero as possible. A long time series may seem desirable, but it may be motivated to make changes, e.g. since reality motivates new concepts or to achieve coherence with other statistics. The target value of rate of metadata completeness is 1 meaning that 100% of metadata is available from what is required/applicable to the statistical process.

Table 3. General quality indicators broken down by quality dimensions

Relevance	Accuracy and reliability	Timeliness and punctuality	Accessibility and clarity	Coherence and comparability
– Data completeness (rate)	– Sampling error (indicators) – Over-coverage (rate) – Common units – proportion – Unit non-response (rate) – Item non-response (rate) – Data revision – average size – Imputation (rate)	– Time lag – first results – Punctuality – delivery and publication	– Asymmetry for mirror flows statistics (coefficient) – Length of comparable time series	– Data tables – consultations – Metadata – consultations – Metadata completeness (rate)

Source: Eurostat [2014, p. 122-137].

Most of those indicators are possible to measure only by data producers or Eurostat domain managers. However, there are many ideas and choices of measuring quality of mortality data. Usually, selection of indicators is based the following criteria: they could be empirically quantified, were comparable across data sources, and likely to be indicative of their corresponding dimension of vital statistics performance. Phillips et al. [2014] created a *Vital Statistics Performance Index*, a composite of six dimensions of vital statistics strength, each assessed by a separate empirical indicator in order to assess the quality of data on mortality⁶. These six dimensions include: quality of cause of death reporting, quality of age and sex reporting, internal consistency, completeness of death

⁶ Authors computed this index for all country-years of VS in the Global Burden of Disease 2013 cause of death database, yielding annual estimates of overall vital statistics system performance for 148 countries or territories.

reporting, level of cause-specific detail and data availability/timeliness. The quality of cause of death was measured by percentage of “garbage code”, quality of age and sex – by age or sex unspecified, internal consistency – by medically impossible diagnoses, level of cause-specific detail – by length of cause list.

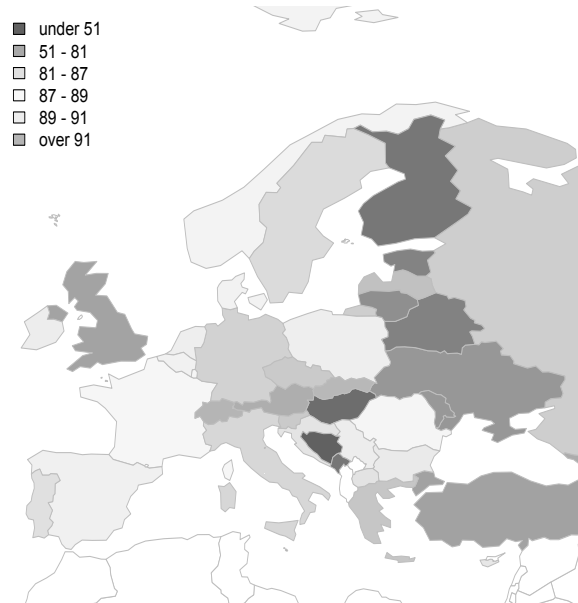


Fig. 2. Vital Statistics Performance Index (calculated for most recent year with data available, post-2005)

Source: On the basis of results of Phillips et al. [2014, p. 10] with R package rworldmap

According to the authors’ calculations among high-income European countries, Finland the United Kingdom had the highest-performing VS systems, with index values of 94.4 and 91.5, respectively. Hungary, Moldova, Lithuania and Estonia achieved values above or equal to 93.0 since 2010 which means that their VS were at least 93% representative of the epidemiological situation of the country [Phillips et al., 2014, p. 8]. Switzerland, due to data being reported in recent years using tabulation cause list rather than for detailed ICD codes, has low VS performance relative to its neighbors. The value of index in Poland was 84.6 (data from 2011) and overtakes such countries as: Bulgaria, Cyprus, Macedonia, Portugal, Italy, Russia, Greece, Armenia, Switzerland, Georgia, Turkey, Ukraine, Kazakhstan, Belarus, Montenegro, Azerbaijan, Bosnia and Herzegovina.

3. Evaluating mortality data quality: the example of Poland

Statistical cards attached to the Death Certificates, reported by civil status offices, are the main source of information on deaths for Central Statistical Office of Poland (CSO). The information collected through the Death Certificate is used by the public statistics in a secondary way. Information on deaths and mortality is conducted by the CSO in cooperation with the Ministry of Health (as it is defined in the annual program of statistical surveys of public statistics). CSO is responsible for the study, i.e. organization, data processing and dissemination of results, and the responsibility of Ministry of Health is focused on coding the causes of death, i.e. on the merit and quality of data on the causes of death.

The individual death records are aggregated and tabulated on deaths by age, sex and causes (using ICD-10 codes). As a minimum, the tabula include:

- numbers of deaths for a specified year,
- by sex (for males and females separately),
- by age at death using the following age groupings: 0 years, between completed years 1 and 4, completed years 5-9, completed years 10-14 and so on, by 5-year age groups, up to completed years 85-89; additionally death are reported for groups: 65 and more, 70 and more, 85 and more, 90 and more,
- by ICD-10 list of causes.

In addition, deaths are reported by voivodships, place of residence (rural, urban area), marital status, educational level and source of maintenance. Infant deaths are more detailed, i.e. quarterly and monthly, by age of mother, education level of mother, weight of newborn infant, mother's gestation period, birth order, education level of mother⁷.

To evaluate quality of Poland's mortality data, in first part selected quality criteria around 5 ESS quality dimensions were employed. In the second step, the discussion is focused on three particular aspects of data quality, i.e. the completeness of the data, the age pattern of reported deaths, the plausibility of cause-of-death data.

3.1. Discussion on quality criteria around 5 ESS quality dimensions

Criterion 1: Relevance

National Statistics Office in Poland uses mortality statistics to:

- produce population estimates and population projections,
- produce life expectancy estimates,

⁷ All vital statistics are reported every year in Demographic Yearbook of Poland published by CSO in Poland.

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- quality assure census estimates,
 - report on social and demographic trends,
 - conduct health analysis,
 - further analyze mortality, for example, life expectancies and causes of death,
 - further analyze infant mortality where infant deaths are linked to their corresponding birth record to enable more detailed analyses on characteristics, such as age of parents, birth weight and whether the child was born as part of a multiple birth.

The Ministry of Health is a key user of mortality statistics. Data are used, for example, to inform policy decisions and monitor child mortality. Other key users of the data are local authorities and other government departments for planning and resource allocation. The Ministry of Family, Labour and Social Policy uses detailed mortality statistics to feed into statistical models for calculating pensions and benefits. Private sector organizations such as banks, insurance and investment companies are particularly interested in deaths by single year of age and region, which supplies risk estimation models. Other users include academics, demographers and health researchers who conduct research into trends and characteristics. Organizations such as Eurostat, WHO and the UN use mortality statistics for making international comparisons. The media also report on trends and statistics.

Criterion 2: Timeliness and punctuality

The process of data recording, as well as their development, has two phases (first phase – development without causes of death, and the second – with causes of death) [Cierniak-Piotrowska, Marciniak, Stańczak, 2015, p. 49-50]. Duration of the process has huge impact on the timeliness of mortality data.

At the first phase, all information (except for the cause of death) is recorded and subjected to complete control – formal and range, and logical control. This stage is the basis for the development of annual data on deceased persons in various settings (gender, age, marital status, education level, labor market status and place of residence of the deceased, and place and circumstances of death). These data are also part of the balance of the civilian population and the basis for the development of life tables. Annual data on deaths not related to causes of deaths are available in March (basic data) and in May (full data) in the next year.

The result of the second phase is to determine the cause of death. This process is computerized, although the coding is based on the original records on death certificates made by the physician stating the death. Paper documents are

scanned and, in a properly prepared program, are forwarded to physician-coders. In a dedicated application, the physician-coder reads the causes of death from the image and analyzes the reason for the code in the corresponding form of the electronic form. The coding process involves direct contact with a physician who has died – for consultation, as well as the possibility of referring to individual medical records. The results of the development of death data by cause are available at the end of the next year.

Thus, mortality statistics based on the year of occurrence is much less timely.

Criterion 3: Accuracy and reliability

Poland has no problems with registration of deaths, but very low quality information about the causes of death is a problem. According to data for 2013, 29.5% of deaths (more than 114,000) of deaths were reported incorrectly by the physicians describing its causes [Cierniak-Piotrowska, Marciniak, Stańczak, 2015, p. 51].

The coded causes of death are controlled – including the program for validating the causes of death in relation to gender and the age of the deceased. The next step in the development of information on the causes of death is the verification of data made by scientific medical institutes (Institute of Oncology, Mother and Child, Cardiology and National Institute of Public Health). Subsequently, instances of judicial review are reviewed by the institute (by physician coders) by referring to a specific death card and consulting with the physician adjudicating the death, as well as medical documentation. Codes of cause of death are given in accordance with the International Statistical Classification of Diseases and Health Problems – X Revision (ICD-10), which has been in force in Poland since 1997 on the causes of death (in terms of morbidity – since 1996). ICD-10 contains about 12 thousand codes – in Poland about 3 thousand cause codes of deaths.

The validity and reliability of statistics on the causes of death rely, to some degree, on the quality of the data provided by certifying physicians. Inaccuracies may result from several reasons, including [www 3]:

- errors when issuing the death certificate,
- problems associated with the medical diagnosis,
- the selection of the main cause of death,
- the coding of the cause of death.

For many years, the CSO in Poland has been working to improve the quality of death statistics by cause. Among them are mainly current control and veri-

fication work performed with medical institutes, trainings organized for physicians-coders, as well as information through articles or publications about problems related to misrepresentation of causes of death [www 4]. In regional statistical offices works on IRIS⁸ system implementation have been ongoing.

The WHO in its 2013 report once again excluded Poland from comparative analysis of cause-based mortality [www 5]. The cause is more than 25% of the deaths attributed to “useless terms/descriptions of the causes” (so called: garbage codes). However, in 2016 WHO – in report on methods and data sources for child causes of death (for years 2000-2015) – considered data on child causes of death (neonatal and postneonatal) to be high quality, because the following criteria were met: (a) reasonable distribution of deaths by cause were reported without excessive use of implausible codes or certain codes, and (b) sufficient details of the coding was provided so that deaths could be grouped into appropriate categories used in the analysis [www 6].

Criterion 4: Accessibility and clarity

CSO's recommended format for accessible content is a combination of HTML webpages for tables, charts and maps with data being provided in usable formats such as CSV (multidimensional and relational table) and XLS (multidimensional, pivot and relational table). Data are provided on the website (in Polish and English): Local Data Bank⁹ [www 7]. In addition, the methodology information relevant to each release is available. Death data from Local Data Bank are available from 1999 for death by causes and deaths by sex and age groups, from 2002 for deaths by causes for powiats, from 2004 for deaths by sex and age, from 2005 – infant deaths (quarterly data). However, from Statistical Yearbook and Demographic Yearbook of Poland published by CSO in Poland it is possible to get some earlier data.

Criterion 5: Coherence and comparability

The issue of changing the weighting of Age Standardized Mortality Rates (ASMRs) within the European Standard Population (ESP)¹⁰ concerns all European countries. Originally the European Standard Population (ESP) published in

⁸ IRIS is the automated coding system, for the improvement and better comparability of causes of death data in Europe.

⁹ Local Data Bank is Poland's largest database of the economy, society and the environment.

¹⁰ ESP is an artificial population structure used in the weighting of Age Standardized Mortality Rates.

1976, Eurostat updated it in 2013. The 2013 ESP structure allocates a greater weight to the older population to better reflect the ageing population. This change has had a significant impact on ASMRs, so ASMRs, based on the 1976 ESP, are not comparable with those based on the 2013 ESP.

Due to the changes in administrative division (number and boundaries of powiat¹¹, reinstatement of the powiat status to the urban gmina) comparison of deaths can be complicated or even impossible.

CSO in Poland publishes several internationally-recognized indicators which facilitate comparisons which include:

- deaths by causes (per 100 thousand population, per 100 thousand population – females/males, deaths of females under the age of 65, due to particular disease per 100 thousand females/males in this age),
- infant mortality rates (deaths under 1 year per 1 000 live births),
- deaths of persons under the age of 65 years per 1000 population in this age group,
- deaths per 1000 live births,
- crude death rates (total deaths per 1000 population).

CSO in Poland do not publish directly age-standardized mortality rates (deaths per 100 000 population standardized to the European Standard Population), which enable comparisons between populations with different age structures, including between males and females and over time, facilitating comparisons with other European countries.

3.2. Internal validity and coherence of mortality data

This chapter describes simple ways of analyzing the internal validity and coherence of mortality data and shows how comparisons with other external sources of mortality data can be used to assess data consistency and plausibility. The idea of analyzing the quality of data was presented originally by AbouZahr et al. [2010] as a result of cooperation of WHO and the Health Information Systems Knowledge Hub at the University of Queensland.

Crude death rate (CDR) provides a useful indicator of possible problems with the completeness of mortality data. To better understand trends in the CDR, it is useful to compare the CDR with trends in other related indicators, such as under five mortality rates, life expectancy and the proportion of the population

¹¹ The following territorial unit is considered: locality, gmina, powiat, subregion, voivodship, region or the entire Poland.

aged 65 years and older. This comparison is presented in Fig. 3. A level of CDR less than 5 per 1000 would be strongly indicative of incomplete registration of deaths. Any rapid fluctuations from year to year indicate possible data problems. Examination CDR trend over time and comparison with trends in other measures indicates the lack of completeness death data from the registration perspective.

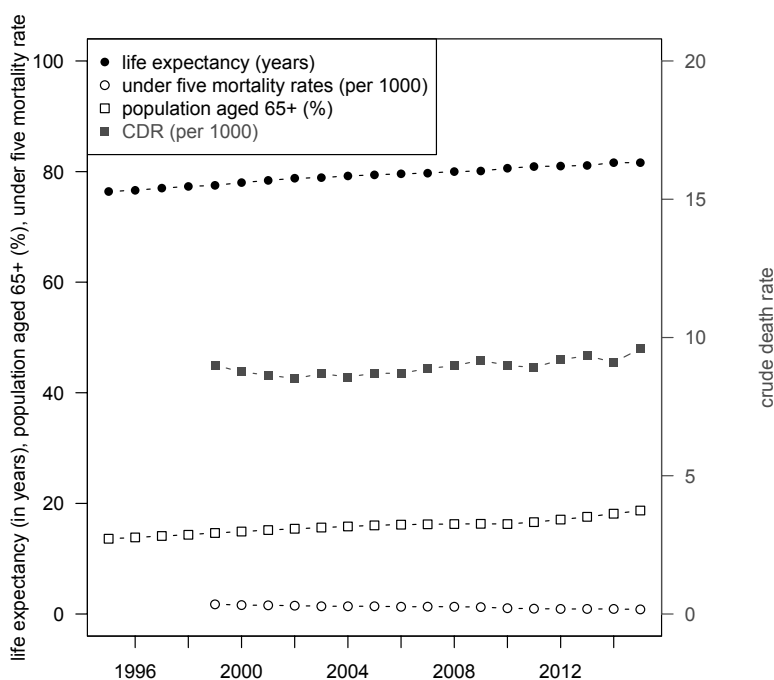


Fig. 3. Major demographic trends in Poland, females (from 1995 or 1999 to 2015)

Source: Own calculations with R, data collected from CSO in Poland.

Investigation of age pattern of reported deaths enables assessing of data plausibility. Fig. 4 shows patterns of mortality across age for Poland, where death registration is complete. Mortality rates are very low up to the age of about 15 years old, and death rates begin to rise sharply after about age 55 years what is typical of most low-mortality populations [AbouZahr et al., 2010, p. 12]. An examination of the age-specific mortality rate across all age groups for each sex separately enables assessment of completeness data, if there is a pattern of relatively high mortality in the 0-4 years age group, very low mortality in the age groups 5-14 and an exponentially increasing mortality rate after the age of about 35.

Beyond about 35 years of age, death rates rise exponentially with age. Therefore, the natural logarithm of the age-specific death rate should be a straight line as age increases. Fig. 5 shows examples of logarithm of the age-specific

death rate for Poland in 1999 and 2015. Fig. 5 helps to identify, if there are any age groups where deaths are being selectively underreported. It is worth to compare this type of graph for selected population with a neighboring country with good quality mortality data, it will be possible to assess whether, and to what extent, deaths are being systematically underreported at all ages (if the natural logarithm of the age-specific death rate is systematically lower, than the graph for a neighboring population). Summing, it should increase smoothly and linearly with age after about 35 years old.

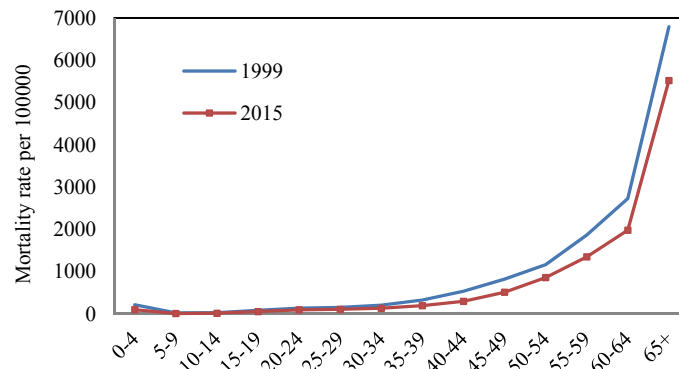


Fig. 4. Age-specific mortality rates for Poland, males (for two selected years 1999 and 2015)

Source: Own calculations, data collected from CSO in Poland.



Fig. 5. Log of female age-specific death rates for Poland

Source: Own calculations, data collected from CSO in Poland.

Reviewing the distribution of major causes-of-death, age patterns of major causes-of-death, and leading causes-of-deaths provide an assessment of the plausibility of data on causes-of-death. Unfortunately, in Poland, both numbers of garbage codes are growing steadily. Between 2000 and 2013, the share of junk codes in the case law of death causes increased by 4.7 percentage points, from 24.8% in 2000 to 29.5% in 2013 [Cierniak-Piotrowska, Marciniak, Stańczak, 2015, p. 7]. This increase is mainly related to the useless terms of cardiovascular disease which are used primarily in the case of deaths of the elderly. This is the reason why it is impossible to present precise calculations in this area. We confine the discussion only to the theoretical aspects.

A first step in any quality assessment of cause-of-death data is the calculation the percentage of death distribution by broad disease groups and compare the results with what would be expected given the level of life expectancy for the population [AbouZahr et al., 2010, p. 20]. These expected patterns have been developed by demographers and epidemiologists on the basis of many years of data and observations on patterns of causes-of-death in different settings. Any significant deviation from the expected pattern that cannot be explained by some local, external factor should be viewed as a potential problem with the quality of the cause-of-death data [AbouZahr et al., 2010, p. 20].

Causes of death and burden of disease are classified into three very broad cause groups: group I – communicable, maternal, perinatal and nutritional conditions, group II – non-communicable diseases (like cancer, diabetes, heart disease, mental health conditions), group III – injuries. With average life expectancy at birth of 70 years, the expected distribution of cause-of-death should be as follows¹²: group I¹³ – 11%, group II¹⁴ – 78%, and group III¹⁵ – 11%. Significant departures from them suggest potential problems with the certification or coding of causes-of-death. In case of Poland, creating only group III is does not cause problems – this group represents 5.9% of whole causes (9.1% for male, and 2.1% for female).

¹² It is obvious that this distribution varies in different countries according to where they stand in relation to the health transition. As a general rule, countries with low life expectancy are characterized by high levels of mortality due to infectious and parasitic diseases especially in childhood, along with high maternal mortality (group I). As life expectancy rises, the pattern of mortality changes, with more deaths occurring in older age groups due to non-communicable conditions such as cardiovascular diseases and cancers (group II causes).

¹³ ICD-10: A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E40-E46, E50, D50-D53, D64.9, E51-64.

¹⁴ CD-10: C00-C97, D00-D48, D55-D64 (exclude: D64.9) D65-D89, E03-E07, E10-E16, E20-E34, E65-E88, F01-F99, G06-G98, H00-H61, H68-H93, I00-I99, J3-J98, K00-K92, N00-N64, N75-N98, L00-L98, M00-M99, Q00-Q99.

¹⁵ ICD-10: V01-Y89.

The second step would be plotting the cause-of-death patterns by sex and age group, and compare findings with the typical patterns for groups I, II and III [AbouZahr et al., 2010, p. 24]:

- the proportion of deaths due to group I causes should be high among children, but declines thereafter to very low levels, although it may rise again at older ages (above approximately 80 years old) due to pneumonia,
- the proportion of deaths due to group II causes should be relatively high in children (e.g. due to some cancers), declines in adulthood, but rises significantly at older ages due to the increasing incidence of cancers, cardiovascular diseases and stroke,
- the proportion of deaths due to group III causes (i.e. external causes-of-death including accidents and violence) should be generally highest in young adulthood, and especially among males.

Significant departures from this pattern should be closely investigated, as they are suggestive of problems such as poor death certification and coding practices, and age-specific misreporting of deaths.

An analysis of leading causes-of-death can also indicate the reliability of cause-of-death data and can be another way to check reporting in the civil registration system. According to the OECD, Poland belongs to the group of countries with high-income. Thus, the leading causes of death should be as follows: ischaemic heart disease, cerebrovascular disease, trachea, bronchus and lung disease, lower respiratory infections, COPD, Alzheimer and other dementias, colon and rectum cancers, diabetes mellitus, breast cancer and hypertensive diseases.

Conclusion

All countries face the issue of quality in recording number and causes of death. These depend very much on the quality of diagnoses, on the system for registering and coding causes, system of current control and verification, on the training given in medical schools, and on practitioners' habits and priorities. In most developed countries, there is no problem with timeliness and punctuality, accessibility and clarity, coherence and comparability of mortality data, there remains much room for improvement on accuracy and reliability quality. The study provides some ideas how to assess data quality, especially: a) the completeness of the register data, b) the age pattern of reported deaths in order to detect, if there are any serious age-specific misreporting or underreporting, and c) the plausibility of cause-of-death data.

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JAKOŚĆ DANYCH O UMIERALNOŚCI

Streszczenie: Pomiar umieralności jest jednym z najtrudniejszych zadań, z którymi mierzą się demografowie i epidemiolodzy. Dane o zgonach i przyczynach zgonów pochodzą z różnych źródeł, co wpływa na konieczność zapewnienia dobrej jakości tych

danych, by informacje z nich pozyskiwane mogły być dalej wykorzystane w procesach decyzyjnych chociażby w obrębie opieki medycznej. W pierwszej części pracy omówiono 5 kryteriów Europejskiego Systemu Statystycznego, natomiast w drugiej – 3 aspekty jakości danych, tj. kompletność danych, struktura danych o zgonach ze względu na wiek oraz wiarygodność danych o przyczynach zgonów.

Słowa kluczowe: wymiary jakości, współczynnik zgonów, surowy współczynnik umieralności, współczynnik zgonów według wieku.