Methodology Note

Towards comparable statistics on mortality by socioeconomic status in EU Member States

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Abstract

Overall levels of mortality have declined in all socioeconomic status (SES) groups in the EU, but there are indications that relative mortality differences between those in low and high SES groups have increased. EU policy groups and departments expressed the need to address this issue but noted that comparable and high quality systems of data collection and statistics required for the monitoring and evaluation of policies addressing this issue, are not yet in place in all Member States. Although all National Statistical Institutes (NSI) in Member States collect and compile mortality data, they differ regarding the kind of SES characteristics that are collected. Educational attainment, occupation, and less so economic status, are main SES indicators for which data are collected and compiled. Yet evidence suggests that data and data sources differ considerably concerning accessibility, completeness, coverage, quality, and employed database record-linkage methods. Furthermore, capabilities of NSIs differ as regards the routine derivation of mortality statistics by SES, and they often use different definitions and measures, notably of SES. Based on a rapid appraisal of data sources maintained by NSIs, a review of relevant studies on mortality differentials by SES, including database record-linkage literature, our main recommendations are the following.

First, Member States should preferably work towards improving and harmonizing their data sources on SES and mortality, by adopting a prospective, linked approach. Application of different record linkage methods of datasets should be explored, including deterministic and probabilistic methods and use of special-purpose software. Second, we recommend exploring other ways of deriving mortality statistics by SES, such as by (a) incorporating educational attainment and last occupation on death certificates; (b) covering the conventional SES indicators of educational attainment, occupational status and economic status in the forthcoming 2011 round of censuses in the EU; (c) collecting in the census the latter type of information, by proxy, of recently deceased household members; (d) covering the aforementioned issues in a sample survey built into the census (i.e. use of a more elaborate questionnaire in every k-th household), if costs of covering them in census questionnaires are too high. Third, we recommend that both absolute and relative measures are used in analyses and publications, such as rate ratios and rate differences in mortality of lowest versus highest socio-economic groups, relative index of inequality, and slope index of inequality. Fourth, to assist Members States, a technical cooperation and assistance project must be developed that starts out with the production of country-specific assessment studies covering: (a) organisational and technical details of existing health, mortality and SES data collection and compilation sources and procedures, including indicators and definitions used; (b) legislative, logistical, financial, technical, and human resources constraints, including training needs; (c) identification and formulation of feasible strategies to overcome these constraints. The evaluation of assessment reports at regional workshops should translate into the development and implementation of realistic work plans which, by the end of the project, result in (1) harmonized systems of data collection and compilation on mortality by SES, and (2) country reports, describing and analyzing health and mortality conditions by socioeconomic status, using comparable measures and methods of analysis, and common formats of presentation of findings.

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1. Introduction

Health and mortality inequalities are commonly understood as the systematic and avoidable differences in health outcomes between social groups, such that those in lower socioeconomic status (SES) groups are more likely to have illnesses and disabilities, and shorter lives, than those who are in higher SES groups (Whitehead, 1990). Educational attainments, status of occupation, level of income and, less so, wealth status are most frequently used as SES indicators.

Since the 19th century, socioeconomic progress and public health measures lead to life expectancy increases mainly a result of reduced mortality in early life. Of more recent date are increases in life expectancies resulting from mortality declines in mid- and late life. Historical accounts suggest that there are differences between socioeconomic groups regarding the risk of mortality. Only in the nineteenth century empirical data became available, notably in England and France, which actually demonstrates existence of mortality differentials by SES. Since that period, *absolute* differences in mortality rates of those in low and high SES groups have declined as a result of the general overall decline in mortality. However, recent studies (e.g. Mackenbach et al., 2002, 2003, 2008) revealed that *relative* differences in mortality between SES groups have actually increased in a number of countries, and that the magnitude of such difference vary widely across Europe. For instance, in their most recent study, Mackenbach (*et al.,* 2008) found that inequalities in mortality rates are rather small in some southern European countries but very large in most countries in the eastern and Baltic regions. Geographical differences seem to be attributable in part to socioeconomic status differentials in causes of death, notable those related to smoking, alcohol use and access to health care.

These findings are consistent with findings of earlier studies that show that the excess risk of premature mortality (e.g. death before age 65) among middle-aged men in manual occupations compared to those in non-manual occupations ranged between 33 and 71 per cent in a comparative study on the situation in Western Europe the 1980s (Mackenbach *et al.,* 1997a). Other studies revealed that differences in life expectancy between lower and higher SES groups increased in Europe from four to six life-expectancy years in men, and from two to four life-expectancy years in women. Furthermore, differences between these groups in terms of healthy life years and self-perceived healthy life years have even increased to about 15 years. Also, life expectancy appears to be higher in the economically more developed old EU Member States (i.e. EU 15), i.e. 82.4 years for men and 76.7 years for women, than in the economically less developed and new Member states (i.e. EU 25-15)[1], i.e. 78.7 and 70.4 years for women and men, respectively (Eurostat, 2008; Graham 2004; Kunst and Mackenbach, 1994; Valkonen, 2001; Wikinson and Pickett, 2005, 2006).

Further gains in life expectancy are contingent on a decline in unhealthy life style behavior, including smoking, poor diet, lack of physical exercise and excessive alcohol consumption, and availability of and access to (specialized) medical treatment. Acknowledged risk factors of unhealthy lifestyles include the following: long-term unemployment, long-term low-income, low quality employment and work environment, poor educational qualifications and leaving school early, growing up in a family vulnerable to social exclusion, disability, poor health, homelessness

[1] (EU-15)=Member States before 1 May 2004 (Belgium, Germany, France, Italy, Luxemburg, Nederland, Denmark, Ireland, U.K., Griekenland, Portugal, Spanje, Zweden, Finland, Oostenrijk). (EU 25-15)=new Member States between 1 May 2004 and 1 January 2007 (Cyprus, Malta, Estonia, Lithuania, Latvia, Poland, Slovenia, Hungary, Czech Republic, Slovakia). Bulgaria and Rumania (EU Member States after 1 January 2007) have not been included in this comparison.

or precarious housing, immigration, ethnic background and risk of racial discrimination. Such risk factors are frequently poverty related, and thus may apply to the 75 million EU citizens who live below the poverty line (Adler and Stewart, 2007; European Commission, 2007; Lynch *et al.*, 2000; Mackenbach, *et al*., 1995, 2002; Stegeman, 2007). At the EU policy level this has been acknowledged for some time now, leading to various EU policy reports[2] and policy initiatives with the objective to reduce health and mortality disparities in the EU.

For many years, UNDP has been compiling and analysing socioeconomic development, health and mortality statistics at the aggregate level of nations. In their annual Human Development Reports they demonstrate the inverse relationship between economic development-level of countries and life expectancies of populations. Based on a methodology of index construction for SES and mortality, countries are classified into level-of-development groups. More specifically, the sub-indices of education, gross domestic product and life expectancy at birth are pooled to generate an overall index[3] of socioeconomic development (i.e. Human Development Index, HDI) (e.g. UNDP, 2007).

Such types of analyses are the exception rather than the rule if the unit of observation becomes the "individual citizen" instead of "country". In the context of the EU this is because most countries do not systematically collect and compile for each citizen the combined information on health, survival and socioeconomic status in a single system of linked databases, or, technical or privacy legislation prevent making the required linkages. These and other issues were subject of deliberations of an EU Task Force meeting on 'Life Expectancy by Socioeconomic Groups' in October 2006, as representatives from policy groups (EU Social Protection Committee) and policy departments (EMPL, ECFIN) expressed the need to address with appropriate measures inequalities in mortality by socioeconomic status in EU Member States. However, policies to reduce gaps require the presence in each Member State of a set of appropriate (i.e. policy-responsive), comparable indicators and measures of SES and mortality, and timely input data. To date, and in spite of the presence of the EU collaborative "Open Method of Co-ordination (OMC)"-framework, these requirements are not fulfilled, preventing the design, monitoring and evaluation of appropriate and effective policies (EUTFLESG, 2006).

Main objective of this methodology note[4] is to contribute to making of informed choices about the development of a harmonized system of data collection and compilation on mortality and socioeconomic status leading to the use and publication of comparable statistics on mortality by socioeconomic status.

Below, we start out with a review of major indicators, data sources and measures of socioeconomic status and mortality (sections 2 and 3), followed by section 4 in which strategies are discussed to derive mortality statistics by SES, including different record-linkage methods. In section 5 appropriate measures to capture SES differentials in mortality are discussed. Section 6 reviews the current state of affairs regarding collection and publication of mortality by SES in EU

[2] E.g.: the Atkinson report (Atkinson *et al.* 2002), the EU Health in All Policies (HiAP) initiative, the Amsterdam Treaty (1999) on social policy goals; Lisbon Summit (2000) on poverty eradication in EU by 2010; Gothenburg Summit (2001) on employment and quality work in an aging but competitive EU.

[3] For the interpretation and calculation of these indices, see: UNDP (2005, p. 341).

[4] Authors: George Groenewold (Sections 1,2,3,4,7,8), Jeroen van Ginneken (sections 4,5,8), Cristina Masseria (sections 6,8). National experts in EU countries contributed by giving information in their capacity as knowledgeable persons about the situation in their county, but the information and views provided by them and our interpretations do not necessarily represent the official position of the government of the various countries or of the EU.

Member States, while in section 7 we elaborate on avenues for future data collection and analyses. In section 8 main conclusions and recommendations are presented.

2. Socioeconomic status (SES): indicators, data sources and measures

There is no single indicator or set of indicators that can describe a person's socioeconomic status in an unambiguous and undisputable way. Different SES indicators generally affect health and mortality in a different way. Furthermore, across-country comparative studies show that although the direction of the effect of SES indicators may be the same, the strength of the effect of each of SES indicator on health and mortality differs depending on the context in which study takes place (e.g. Duncan *et al*., 2002*).*

In this section we briefly review features and measures of three indicators of SES, educational attainment, occupational status and economic status (i.e. income and wealth status). There are some fundamental differences between the three. Educational attainment and occupational status are typical individual-level characteristics and are exclusively collected at that level, but income and wealth status data are frequently collected at the aggregate level of the household. Depending on the situation, total household income may then be subdivided over household members by some computational procedure. The data of SES indicators, notably those on educational attainment and occupation are usually collected in national censuses and nationally representative household surveys (e.g. income and expenditure surveys, health monitoring surveys). Only in a few countries such indicators of SES are recorded in death registration systems and population registers. Some scholars advocate combining the aforementioned SES indicators, together with other potentially relevant SES indicators, to derive a composite SES index and classify persons accordingly. There is a great variety in SES index construction and debate about the appropriateness of the approach, which we think is beyond the scope of this note (for example, see: Duncan *et al.,* 2002; Sinclair *et al.,* 2002; Warren, 1998).

- *Educational attainment*

Education is an important determinant of an individual's work and economic circumstances, and these are themselves linked to health and survival status through specific work conditions and levels of consumption. Education is also associated with health and survival status through its connections with health risk behaviour and psychosocial conditions, because the higher one's level of education is, the more likely it is that a person engages in health-enhancing self-maintenance activities, and avoids or feels confident to successfully modify adverse health risk behaviours (also see section 7, figure 7.2). There is considerable evidence demonstrating that an individual's educational status is an important predictor of mortality and morbidity (e.g. see: Duncan *et al.,* 2002; Kunst, 1994; Valkonen, 1989, 2001; Preston and Elo, 1995). Elo and Preston (1996) give two main reasons for preferring educational attainment to other commonly used markers of socioeconomic status such occupation or income. First, educational attainment can, in principle, be determined for all individuals, whereas not everyone has an occupation or an income (e.g., persons in educational programmes, retired persons, homemakers). This aspect is of particular importance, because in the latter situation age-sex selectivity is introduced leading to biased life tables and life expectancies in SES groups. Second, health impairments emerging in adulthood rarely negatively affect formal educational attainment because educational attainment is normally completed in early adulthood, before age 25, and before decrements to health occur that accompany aging. Functional knowledge (e.g. health knowledge) may increase as a result of experiencing an illness. Furthermore, using educational attainment as SES indicator also largely

avoids the potential contamination of reverse causation inherent in other standard SES indicators (occupation, economic status).

But the use of education as SES indicator also has limitations. Although years of completed schooling (or highest level of education attained) are reported with reasonable ease and reliability, it poses problems when international comparisons are made. Educational systems vary widely and levels attained are actually difficult to compare due to a lack of some 'golden' standard. Another problem with education is censoring. Very young children have not yet entered the educational system (i.e. fully left censored) and those in school may not yet have completed their educational career (right censored). This can of course be resolved by examining only the SES-mortality relation for a particular age-range (adult mortality) or, the attained level of education of parents could be used as a guide to classify very young persons into SES groups. Yet another problem is that educational attainment does not capture the importance of on-the-job training and other career investments made by individuals with similar levels of formal schooling. Furthermore, the strength of effect of a specific level of educational attainment on health and mortality is subject to inflation over time ((e.g. see: Cleland and van Ginneken, 2008; Duncan *et al.* 2002).

Two main educational status measures are: (1) years of educational attainment, and (2) highest level of successfully attained education (i.e. completed with a certificate). The former is obtained by asking: what is the highest grade or year of regular school you have completed? The latter, and preferred one, is obtained by asking: what is the highest degree/certificate or diploma you earned? (e.g. see Krieger and Fee, 1994).

- *Occupational status*

Occupational status summarizes the power, income and educational requirements associated with various positions in the occupational structure. Two major prospective investigations clearly demonstrated the existence of an inverse relationship between occupational status vis-à-vis health and mortality: the Whitehall I and II studies of British civil servants and the Wisconsin Longitudinal Survey of men and women graduating from high schools in 1957 (e.g. see: Marmot, 1991; 1995; Marmot *et al*. 1997).

Occupational status is hypothesized to affect health and mortality, because: (1) it determines the position of individuals within a social structure, as well as access to resources and constraints affecting health and mortality (e.g. Moore and Hayward, 1990)l; (2) it influences health and mortality risk in the form of physical hazards, psychological stress, and lifestyle factors such as drinking, smoking, and obesity (e.g. House *et al*,. 1986); (3) the income and prestige associated with occupational status affects health and mortality through choice of community setting and social networks, access to high quality medical care, choice of healthy food and a safe living environment.

Occupational status has several advantages over educational attainment and income. First, it reflects the *outcome* of educational attainment and it includes skills and credentials required to obtain a job and an associated level of income. Second, occupational status is likely to be a better indicator of income over the long term than is income because income can be quite unstable so that measured income at the time of a census or survey can be quite misleading (Williams and Collins, 1995). Third, occupational status is a proxy for social position and provides information about job characteristics, such as environmental and working conditions, decision-making latitude, and psychological demands of the job.

Use of occupational status as SES indicator has limitations too. When the association between occupational status and mortality is examined using a cross-sectional survey data and a single point time reference for a person's occupation status, the analysis may be affected by an unknown degree of reverse causation as occupation status dependents on (past) health and morbidity experiences (e.g. a disability preventing a person to continue working in his profession) (e.g. Waitzman and Smith, 1994). A related issue is that a person's current of last occupation may be unrelated to past negative health conditions, which could have occurred during periods of unemployment. Thus, ideally, a life course approach (e.g. occupational status history and health status history) should be followed in the measurement of occupational status and in the analysis of its effect on health and morbidity (e.g. Pavalko *et al.,* 1993). Additional problems are that it is difficult to assign occupational status to persons outside the formal labour force.

The following three types of occupation-based SES measures have been developed to classify persons, some of which require the collection of additional occupation-related data or classification of persons according to some international standard, such as the ILO International Standard Classification of Occupations, i.e. ISCO88 (for details see: Ganzeboom and Treiman, 1996).

SES classifications based on attributed prestige of stated occupation.
Occupational prestige is a measure that captures either a relationship of deference or derogation between role incumbents, or the general desirability or goodness of an occupation. Prestige is based on rankings of occupations by survey respondents on the basis of goodness, worth, status, and power associated with occupations, and such ratings have proven to be robust measures. An example is Treiman's Standard International Occupational Prestige Scale (SIOPS). Prestige rating of occupation shows remarkably little difference when ratings are compared of men and women, of members of different ethnic groups and persons of different social class (e.g. see: Siegel 1971; Treiman 1977).

SES classifications based on occupation-related social classes.
Measures of social class aim to capture power relationships and therefore require, in addition to questions about a person's current or last occupation, questions about issues such as supervisory or managerial experience, ownership of capital assets, size of the work establishment. By combining this information, a typology of social class or social class index can be derived to classify persons. Examples of methods that accomplish this are Wright's typology of social class (see: Wright, 1996), and the Erikson-Goldthorpe 11 category graded social class hierarchy (i.e. the EGP classification) (see: Erikson and Goldthorpe, 1992). To contribute to the development of an occupation-based SES indicator for across-country comparative research, the European Socio-economic Classification (ESeC) has been developed. An ESeC category can be derived if persons have been classified at the minor-group level of ISCO88, and if information about employment status and size of organization is available (ESeC, 2008).

SES classifications based on occupation-related educational requirements and remuneration.
Some occupational status measures are based on a combination of job-related educational requirements and income associated with occupational positions, such as the British Registrar General Scale, the Duncan and the International Socioeconomic Index (SEI and ISEI scales). The British Registrar General Scale, developed in 1913, is based on a graded hierarchy of occupations ranked by skill requirements resulting in five major 'Social Class' grades. The scale is still used and proved to be useful in, for example, demonstrating differences in morbidity/mortality risks among employed men (Marmot *et al.,* 1995). The SEI and ISEI scales build on an amalgam of occupational-prestige and occupation rankings, and are frequently used in analyses (Duncan, 1961, 2002; Warren *et al.,* 1998).

- *Economic status (income and wealth status)*

Economic status can be defined in terms of earned income or wealth status (i.e. permanent income in the form of durable and luxury assets owned such as a house, car, and jewellery, and access to certain amenities, and housing quality, and population density of living arrangement).

Economic status affects health status and mortality risks through a person's level of education, lifestyle, feelings of security, sense of power and control, use of time for health promoting and leisure activities, access to Medicare, etc. Income represents a, potentially fluctuating, flow of resources over some period, while wealth status (a.k.a. permanent income) represents the stock of assets accumulated over a longer period of time, and thus it reflects economic reserves. Wealth status is a source of economic security providing a household with the ability to meet emergencies or absorb economic shocks and its importance as a source of economic security varies among societies as it depends on how the social welfare system is organised to absorb emergencies and economic shocks in the population. Income and wealth status are positively correlated, but they are not interchangeable, as shown by the example of an elderly person with a modest fixed income but substantial accumulated wealth (Mirowsky *et al.*, 2000; Pearlin, 1999).

Income data are usually collected in a Census or Income and Expenditure survey, and generally include a time-reference such as income earned in the past month, a particular calendar year, or in the 12-month period preceding the census or survey. Amounts recorded are often *gross* amounts that should be inflated to take account of differences in taxation, receipt of subsidies, household size and composition. In a census or survey, respondents are frequently asked to classify themselves into broad income groups (e.g. income-deciles, -quartiles, or –quintiles). However, if income or income-proxy data is not recorded on death certificates, assessment of SES differentials in mortality may be difficult to carry out, unless, for instance, such data is collected in a census and records of dead persons can be linked to the census population. Also, the problem would be resolved if person records in death registers could be linked to person records in State income tax databases. Legislation (i.e. privacy laws in Member States) though may prevent linkage of person records in different types of databases, or this linkage cannot be carried out due to lack of one or more common variables in both databases (e.g. see section 4, section 6, table 6.1).

Advantages of using income as SES indicator are, first, that it is amenable to change through redistributive policies, e.g. by means of tax relaxation or direct income-supplementation policies, second, that it captures people at all levels of socioeconomic development from low (the depths of poverty) to high (extreme wealth). Some limitations are that income is sensitive to reverse causation because an illness or disability experience in the past may have been responsible for the observed income-level. Furthermore, income is an unstable measure and sensitive to changes in life circumstances. Also, the collection of precise income data is a sensitive operation and precise measurement actually involves a large number of questions, and this may lead to high reporting errors and non-response. Last, income varies within occupations and it may be only moderately correlated with education (Wilkinson and Pickett, 2005; 2006).

Wealth status is a potentially useful SES indicator, as information on the ownership of certain durable and luxury assets and access to particular amenities allow construction of a wealth status index (WSI) so that populations can be classified into wealth status classes based on their WSI score. This type of measurement of wealth status is relatively new though it has already been successfully applied in analyses of Demographic and Health Surveys (DHS), World Bank living conditions surveys, UNICEF's multiple indicator cluster surveys (MICS), and WHO World Health Surveys(e.g. see: Filmer and Pritchett, 2001; Ferguson *et al.*, 2003).

Advantages of a wealth status index as SES indicator are: wealth status is less unstable and may be more strongly linked to social class position than earned current income, and wealth status may be associated with health independent of other SES indicators. Possible limitations of wealth status indices are that the wealth-status items that reflect wealth in one country may be appropriate items to measure wealth status in another country. Moreover, wealth status information may be perceived as sensitive, resulting in greater reporting errors and non-response.

In light of producing comparable mortality rates by SES groups in different EU countries, it is recommended that the forthcoming 2011 round of censuses in EU countries are used as a vehicle to derive mortality rates by SES groups. Furthermore, the use of more than one SES indicator for each country is to be preferred because each indicator has inherent limitations and captures a somewhat different dimension of socioeconomic status. Educational attainment and current or last occupational status are already routinely collected in most censuses though not of household members who recently deceased, for instance in the past 12 or 24 months. Collection of income and wealth status data in forthcoming censuses may be an attractive idea as income and wealth status represent the widest possible range of socioeconomic groups but the caveat is that precise measurement of income and wealth status also involves serious in-dept questioning on income, savings and debts. A general question that requests respondents to position themselves in predefined meaningful income classes, as well as a question about ownership of assets, housing quality and access to certain amenities, could be included in forthcoming EU censuses. A possibility might also be to use the census as a sampling frame for a large nationally representative sample survey so that, at the time of the census or shortly after, every k-th household is visited by interviewers with an additional, more elaborate questionnaire that records event-history type of information on education, occupation, income and health/morbidity. That information could also be collected, by proxy, of recently deceased persons in the household.

3. Mortality: indicators, data sources and measures

The general terms ‘mortality rate’ or ‘death rate’ encompass all the rates measuring the frequency of deaths per unit of population (e.g. 1,000 or 100,000). Where the expression death rate is used without any qualifying adjective, *crude* death rate is usually meant. Crude rates cannot be compared across countries or over time unless they are transformed into *standardized* rates (see below). Indicators of mortality generally pertain to mortality in the total population of a country (e.g. Crude Death Rate, Premature Mortality Rate), to specific sub-populations (e.g. Maternal Mortality Rate, area-specific average mortality rate), or to specific age- and sex groups (e.g. infancy (0-1 year old), childhood (1-4 years old), adulthood (15-45 years old), very old persons (80+ years old)). For each of these sub-groups, particular measures have been developed, some of which are discussed below.

We will first discuss issues related to mortality data sources and we then describe commonly-used measures in studies on SES differentials in mortality (for a more complete list of mortality measures, see IUSSP (1982)).

Knowledge about levels of mortality in a country is generally obtained from data on numbers of deaths recorded in the country’s vital statistics system (i.e. death certificates compiled in the death register), and/or from periodic population censuses. In general terms, the former system provides numbers of persons in the numerator of death rates, while the later provide numbers of persons in the denominator of such rates. Some (EU) countries record information on socioeconomic and demographic characteristics on death certificates so that SES differentials in

mortality can readily be examined. In countries with an up-to-date population registers (a.k.a. continues population census), information on persons alive and those who died (withdrawals from the register other than those resulting from migration) are recorded in an integrative way. In countries with less reliable mortality registration systems, one or more direct and/or indirect questions on deaths occurring in the household can be included in the census questionnaire. The presence of a death registration system though does not mean that the quality of death statistics derived from it are accurate and comparable across nations because the extent of completeness of death registers and geographical coverage are known to vary over time and across nations (for details see for example Hill *et al.* (2005).

Main mortality measures relevant to the discussion on reducing SES differentials in mortality in EU Member States include:

- *Age Specific Death Rate (ASDR)*

This measure describes the level of mortality experienced by persons in a particular age group in a given period. ASDR is defined as the total number of deaths in a particular age-group in a particular period (e.g. year) in country X divided by the average number of persons at risk of mortality in country X during that period. ASDRs are nearly always computed separately for men and women (as are all other mortality and health status measures). ASDR's are reported by five or single year age groups and their main analytical value is that they are used to standardize crude death rates. This is most conveniently done by converting ASDRs into life table probabilities of dying so that a full or abridge life-table is derived.

- *Infant Mortality Rate (IMR)*

Infant mortality is defined as the number of deaths occurring between birth and first birthday in a particular calendar year divided by the number of live births in that calendar year. It is generally considered to be one of the best mortality indicators reflecting overall socioeconomic development. IMR is sensitive to policy measures that directly or indirectly affect the health of infants, for instance, policies directed towards the availability and access to mother and child health services, and those directed towards the education of women. IMR, but also the underfive mortality rate, are therefore included as one of the 60 Millennium Development Goal Indicators that are used to monitor progress in socioeconomic development and health targets set for the year 2015 (UN, 2007). IMRs can thus be used to express SES differentials in mortality in EU countries. IMR and life expectancy at birth (see below) are closely related.

- *Age-adjusted Death Rate.*

CDR is a general indicator of the mortality level in a country, computed as the total number of deaths in a calendar year divided by the average number of persons alive in that calendar year. CDRs of different countries cannot directly be compared; they need to be first transformed into standardized CDRs. This is because any CDR depends on the shape of the underlying age and sex distribution of a country's population. If countries have different age-sex distributions, then the confounding effect of age needs to be explicitly controlled for. This can be done by applying a procedure called standardization to the CDRs leading to age-adjusted death rates. To do this, for each country, deaths must be grouped into broad age groups so that age-specific death rates can be derived. These are then multiplied by the total population in concomitant age groups of some reference population (e.g. EU population), and the total number of predicted deaths is then derived by summing the predicted deaths over the age groups. The resulting total is then divided by the total population of the reference population and multiplied by 1000 producing age-adjusted death rate. Age-adjusted death rates by sex and by SES group can now be compared across countries.

- *Life expectancy (e(x))*

Life expectancies at any age, for men and women separately, become available after a life table has been constructed out of a set of age and sex specific death rates (ASDR). Life expectancy at age X represents the average number of years a person or group of persons can expect to life beyond age X, provided that current mortality conditions, expressed by current levels of ASDRs, remain unchanged in the future. Life expectancy at birth, a.k.a. e(0), is the main summary measure of a life table, encompassing the mortality experience in all ages. However, other important demographic measures for the study of SES differentials in mortality can also be derived from the life table, such as standardized CDR, IMR, probability of dying in certain policy relevant age groups (e.g. working-age range 20-64 (i.e. 20q64), probability of dying in adolescence 15-24 (i.e. 15q24)), and life expectancy of the very old (e.g. e(80+)). A life table is derived by converting ASDRs into age-specific probabilities of dying (ASPD), and by repeatedly applying these ASPDs to birth cohorts of fixed size (e.g. 100,000) and to the survivors of these birth cohorts at subsequent ages. Thus, the life table is the most comprehensive account of the mortality experience of a population, and it allows the derivation of a large number of (standardized) mortality measures that can be used to examine differences between population and population sub-groups (e.g. SES groups).

While the above measures of mortality are useful for identifying and quantifying public health problems, they hide underlying age and sex specific morbidity, disability and cause-of-death characteristics in populations. There are several health policy-sensitive measures that link mortality to its antecedents, morbidity and disability, and to health status in general. The following conceptually and computationally related measures have been developed, and these could be used to expand insight in SES differentials in health and mortality.

- *Potential Years of Life Lost (PYLL)*

The concept of PYLL more explicitly links mortality to its antecedent, health status, notably to premature mortality, e.g. deaths occurring before age 65 (other reference ages are also in use). The *total* PYLL is a useful measure of premature mortality and it can be calculated in various ways, depending on the type of available data (i.e. person-level or group-aggregate). One way is to subtract age-at-death from age 65 for each decedent in a particular year and then adding all these differences to derive total PYLL. It is common practice to express PYLL per 100,000 persons in the population and, depending on the type of comparisons to be made, to compute age-standardized PYLLs. The statistic can also be derived directly from a life table by multiplying the number of deaths by the standard life expectancy at the age at which death occurs. If data permit, cause-of-death could be included as stratification variable to reflect that various causes-of-death are specific to particular age groups, such as accidents and congenital anomalies to children, sexually transmitted diseases to adolescents and adults, and coronary heart disease and specific cancers to the elderly. PYLL by cause-of-death group and by SES are of help to monitor the impact of health policies. PYLL estimates for EU countries have recently been produced by Eurostat, in collaboration with NIDI (Eurostat, 2008).

- *Disability Free Life Expectancy (DFLE)*

If information on morbidity and disability status is available, so-called Disability Free Life Expectancies (DFLE) can be derived and compared to ordinary or gross life expectancies. DFLE is the average number of years an individual is expected to live free of disability if current patterns of mortality and disability prevail. For more details, see: Murray *et al.* (2002). Recently, the European Health Expectancy Monitoring Unit (EHEMU) derived and compared DFLEs for EU countries for the period 1991-2003 using European Community Household Panel survey data (ECHP), though not yet by SES group (see: Robine *et al.* 2005).

- *Disability Adjusted Life Years (DALY)*

A DALY is a health-gap measure that extends the PYLL concept to include equivalent years of 'healthy' life lost as a result of being in states of poor health or disability. The DALY combines in one measure the time lived with disability and the time lost due to premature mortality. DALYs for a disease or health condition are calculated as the sum of years of potential life lost due to premature mortality (PYLL) in the population plus the years lost due to disability (YLD) for incident cases of the health condition. PYLL for a specific cause, age, sex and SES group for a particular period, correspond to the number of deaths multiplied by the standard life expectancy at the age at which death occurs, while YLD is estimated by multiplying the number of incident (=new) cases (I), by the average duration of the disease (D) and by a weight factor (W). This factor reflects the severity of the disease on a scale from 0 (perfect health) to 1 (dead)[5].

To conclude, across-country comparisons of SES differentials in mortality and related statistics require that such statistics are age-standardized. Life table-related statistics are by definition age-standardised. Age-specificity in morbidity and mortality implies that different types of measures must be used to examine and publish about SES differentials in mortality.

In light of harmonising the production and dissemination of comparable statistics on mortality in EU Member States - and at a later stage health status-, we recommend, in a first phase, to focus on producing selected life table-related summary statistics (e.g. IMR, 20q64, e(65+), e(80+), and PYLL) by SES group. In a second phase, once morbidity, disability and cause-of-death data are available, the production and analysis of more refined mortality and health-status measures by SES group should be undertaken, such as DFLE and, later, DALY statistics. Although our focus is primarily on the production of mortality statistics by SES for policy development and implementation at the national level, it is also imperative, if data permit, that the above statistics be produced for main health-planning regions in Member States allowing targeted interventions and allocation of national health budgets to regions.

4. Mortality by socioeconomic status: linked and unlinked study designs

Derivation of statistics on mortality by SES in a particular country usually requires that data must be retrieved from two different data collection systems, such as the death registration system and the census. Depending on the data-retrieval and data-linkage strategies used, studies on mortality differentials by SES can be grouped into four categories.

- *Prospective, linked record studies using a single and unique person identification number*

In these studies, information on the number of deceased persons comes usually from the death registration system. Information on the socio-economic characteristics of the deceased persons such as their education, occupation and income is obtained from a census of a country (or sometimes from the death registration system). The census is used to estimate the population at risk or the number of person-years of observation. Linking of the death records with the census can be accomplished by means of a unique personal identity number (e.g., social security number). Death records are usually selected in a prospective manner which implies that the deaths took place, say, half a year, one year or several years *after* the date of the census. Following a successful linkage of databases, person-records can then be classified into SES groups, based on some SES indicator variable(s), so that probabilities of dying by SES are derived or mortality rates by SES. The census populations in each SES group thus constitute

[5] YLD=I x D x W

populations *at risk* and denominators, while the deaths in concomitant groups constitute the numerators.

The advantage of the prospective, linked approach is that the information on the socio-economic characteristics of the deceased persons is derived from the same source as the information on the risk population, and this means that the so-called numerator/denominator bias in mortality statistics is avoided (for details see below). One of the first of this type of study was the Longitudinal Study 1971-75 conducted by Office of Population Censuses and Surveys (OPCS) in England and Wales (Goldblatt, 1990). Use of this design is particularly feasible in Nordic countries where the availability of a unique, personal identity number makes the computerized linkage of death and census records convenient. Different variants of this method can be distinguished. In the United Kingdom and France studies have also been carried out based on samples of the population. For example, a one percent sample of all census records was drawn and then linked to death records. Another variant of this type of study is often conducted by epidemiologists. A sub-population is selected, for example, employees in an industrial firm or civil servants in a government unit. Data on the socio-economic and other characteristics of these groups are then collected in a baseline survey and they are followed-up for a number of years in order to identify deaths that have occurred.

- *Prospective, linked studies using deterministic and probabilistic record linkage methods*

Often, a unique person identifier is not present in both databases, so that another record linkage method must be followed, such as *deterministic* linkage and/or *probabilistic* linkage. Deterministic linkage is applied when records in two databases are linked based on the *exact correspondence* of values in a set of variables present in both databases. Records with missing values are ignored. A probabilistic linkage strategy is more complex and involves a number of decision rules that pertain to the likelihood that two records in two different databases come from the same person (or household). This method also depends on the correspondence of values in a set of variables that are present in both databases. For each linkage of two records, a probability value of a match is estimated and only matches with predicted probabilities exceeding a predefined threshold level are actually linked and are assumed to refer to the same person (or household). Those matches with below-threshold probabilities are excluded. The applicability of the method of probability record linkage has improved considerably in recent years due to advancements in high-speed computers and development of special-purpose software[6] (Nadeau et al. 2006; Pinder and Chong, 2002). Case-studies in Ireland and Switzerland illustrate how innovative record-matching and -linkage strategies can be applied to derive better mortality estimates for groups with different socioeconomic, demographic and geographic characteristics.

In Ireland, in spring 2008, a pilot project was carried out by the Central Statistics Office (CSO) of Ireland with the objective to match and link Vital Statistics death records with records in the database of the 2006 census. The result was that 87% of a sample of 2,350 death records taken from the Vital Statistics database was successfully matched with concomitant records in the census database. Records pertained to persons who deceased in the one-year period following Census Night (i.e. 23-04-2006). Records in both data files were linked using the following matching variables: date of birth, age, sex, county, election area (EA), and electoral division. These encouraging results led CSO Ireland to give the go-ahead for a project, to be executed in late 2008, that aims to match and link *all* death records - approximately 30,000 - pertaining to the year following the census. The matching is facilitated by the Statistics Act 1993 (CSO, 2008).

[6] Probability record linkage involves complex computation and weighting algorithms, requiring specialized software, such as: GRLS (Generalized Record Linkage System by Statistics Canada), Linkpro (Infosoft Incorporated, Canada), DataFlux (subsidiary of SAS company), Supermatch (Ascential Software

In Switzerland, too, death records of the Vital Statistics register were successfully linked to records in a recent census, to create, what has been named the Swiss National Cohort study database. About 93% of all death records (937,637) pertaining to the period 1990 (starting the day after the census) to the end of 2005 were matched and linked to records of the 1990 census database, while about 82% of the 1990 census records could be also be linked to database records of the 2000 census. Though earlier censuses (1980, 1970) only recorded year of birth, still a substantial proportion of 1990 census records could also be linked to database records of the 1970 and 1980 census. This record-matching endeavour started out by matching and linking records of databases using information on date of birth, sex, marital status, nationality, religion and place of residence. In subsequent steps, probabilistic record linkage, using GRLS software developed by Statistics Canada (e.g. see: Fair, 1996, 2004), was applied to estimate the probability that a pair of records from different databases relates to the same person. Additional information, notably on a person's spouse and family structure, was used in this process. Based on probability weights, possible matches were accepted or rejected. Eventually, this resulted in better mortality estimates for different socioeconomic status groups in Switzerland, compared to those obtained by earlier methods using the unlinked approach (e.g. Bopp et al., 2008).

- *Cross-sectional, unlinked studies*

This approach has been used with occupation as the most often used indicator of socio-economic status. There are a few examples in which education was used. Figures on mortality by last or current occupation or occupational classes are obtained from two sources: the death register and the census (or population register). The numerator is derived from the tabulation of deaths classified by the last occupation stated on the death certificate. The denominator consists of data on the population sizes of the various occupational classes obtained from a census taken roughly in the middle of the period covered by the death records. The oldest and most renowned example of this approach is the one in use in the United Kingdom. Since 1851, the Registrar General of Great Britain publishes these results once every ten years in the Decennial Supplements on Occupational Mortality (OPCS, 1986; Drever and Whitehead, 1997). The most serious limitation of this approach is the numerator/denominator bias due to lack of comparability of the occupational information on the death certificates with that of the census (see below for details). .

- *Ecological studies*

A frequently used design in countries with limited data is to determine death rates for small areas within a country and to correlate these data with socio-economic information for these areas (using for example a multiple regression approach). Such studies have been carried out in, for example, Italy, Belgium and The Netherlands. These studies are relatively easy to implement and cheap, but they suffer from the well-known 'fallacy' of ecological analysis. This fallacy consists of making inferences about the nature of individuals based solely on aggregate statistics collected for the group or unit to which these individuals belong. It thus assumes that all members of a group or unit exhibit characteristics of the group at large (e.g., stereotyping).

While each of these four categories of studies has various advantages and disadvantages, we will not go into all of them, but will draw attention to one salient disadvantage of the, frequently applied, cross-sectional, unlinked approach. A major problem of this approach as used, for example, with respect to occupation in the census, concerns biases introduced by the handling of groups with answers such as: without occupation, permanently sick, retired, and with inadequately described occupations. For example, in the U.K. men who were recorded as permanently sick by the census were assumed never to have worked and their occupations were, therefore, not recorded. This and other groups are, therefore, under-represented in the denominator that is derived from the census. However, their occupations were recorded on the

death registration forms. This discrepancy has led to a bias in the death rates by occupation-based SES groups, because it has been found (in other studies) that certain groups are over-represented in the lowest SES groups (Status Classes IV and V). Thus, for these lowest groups a combination of under-representation of groups is present, such as the permanently sick in the denominator, and an over-representation of such groups in the numerator, leading to an exaggeration of the SES gradient. For example, the UK Decennial Supplement found, according to the unlinked approach, that the standardised mortality rates (SMRs) of men aged 15-64 by socioeconomic group ranged from 77 to 137 between Status Class I and V. However, according to results of the OPCS Longitudinal Study 1971-75, a gradient by SES continues to exist, but it is less steep (with SMRs ranging from approximately 80 to 120 between Class I and V) (Goldblatt and Fox,1978).

A second example of biased results obtained after application of the unlinked approach comes from a recently completed study in Lithuania. Results of an unlinked with a linked design were compared in a study in which data on education were used to classify persons into SES groups. In this study, the records of 140,000 deaths occurring in 2001-2004 were linked to records of the population census of 2001. Unlinked and linked estimates of life expectancies at age 30 and corresponding rate ratios were calculated. Comparison of the unlinked with the linked estimates showed that the unlinked approach under-estimated life expectancy (and over-estimated mortality) in disadvantaged groups and over-estimated life expectancy (and under-estimated mortality) in advantaged groups. For instance, the difference in life expectancy at age 30 for women between the highest and the lowest educational group was 11.7 years according to the unlinked approach, while for the linked approach this was 6.8 years (Shkolnikov *et al.*, 2007).

Our recommendation is to follow a prospective, linked approach in the development and harmonization of statistical data collection systems in EU countries on mortality and socio-economic status. The preferred linkage method is of course by means of a single and unique person identity number. To date, this is only possible in certain EU countries where such numbers are in use *and* where there is legislation in force allowing linkage of two or more data sets. When those two conditions do not apply, we recommend use of deterministic or probabilistic linkage approaches. When this is also not feasible, the only remaining two options are the cross-sectional, unlinked design and the design focusing on small areas within a country as the unit of data collection. The latter two approaches can still yield important information, but this information is often limited in scope (e.g., limited to occupation) and policy makers should be aware of the danger of bias. Advantages of the latter two approaches are further that their implementation is relatively cheap and that they can provide considerable details on cause of death patterns.

5. Measuring the strength of association of mortality with socio-economic status

Measures of association on socio-economic inequalities in health are important when comparing a number of European countries at one point in time and when comparing changes over time within one country. A total of twelve measures have been developed to determine such differences in inequality (Kunst *et al.*, 2000; Mackenbach and Kunst, 1997;). Of these twelve, four are the most frequently used.

- *Rate ratio of the lowest versus highest socioeconomic group (RR).*

This is a relative measure requiring mortality rates for the various socio-economic groups. It is calculated by dividing the mortality rate in the lowest socio-economic group by that of the highest group.

- *Rate difference of lowest versus highest socio-economic groups (RD*).

This is an absolute impact measure reflecting the difference between mortality rates in the lowest and highest socio-economic groups.

- *Relative Index of Inequality* (*RII*).

This is both a relative as well as sophisticated measure of inequality in health requiring multiple-regression based techniques. It also takes into account of differences in the percentage distribution of the various socio-economic groups in several countries or changes in these distributions over time within countries. It can be interpreted as: "the ratio of the… mortality rates of those at the bottom of the SES hierarchy compared with those at the top of the hierarchy, estimated on the basis of the …association between… mortality and socio-economic status for all groups" (Mackenbach and Kunst, 1997, page 761). The larger is the RII score, the larger is the mortality difference between high and low positions in the SES hierarchy.

- *Slope Index of Inequality (SII)*

This is the absolute version of the Relative Index of Inequality and it indicates the health inequality between the top and the bottom of the social hierarchy in the form of a rate difference (instead of a rate ratio) (Mackenbach and Kunst, 1997, page 762).

Three major considerations play a role in the selection of the measure or measures to be adopted. First, the size of the differentials in inequality can be measured in absolute or in relative terms. The two types of measures emphasize different aspects and which of the two should be used depends on the aims of the study to be carried out. From a public health perspective the absolute decrease in mortality differences is more important than the decrease in relative differences, because the aim of health programmes is to prevent as many premature deaths as possible. On the other hand, epidemiologists and demographers are in their analyses more interested in relative differences. Second, a distinction can be made between simple versus sophisticated measures whereby the former can be calculated by simple means (e.g., by hand or calculator) and the latter make use of computer-supported regression-based techniques. The sophisticated measures produce in general more precise results than the simple measures. Third, the distribution of the population by socio-economic categories differs by country and, in addition, usually changes over time within a country. An example of the latter is that in many European countries the level of education has improved over time (in a period of, say, 10 or 15 years) which means that the percentage of the lowest educated has decreased and the percentage of higher educated has increased. There are measures that do not take these differences between countries or changes within countries into account while others do. Especially when a study focuses on documenting changes over time within a country, it is relevant to choose a measure that corrects for changes over time in the composition of the population by socio-economic groups.

We make the following recommendations concerning use of measures in the analysis of data of statistical systems on mortality by socio-economic status in EU countries. First, it is in general advisable to use both absolute and relative measures, because they complement each other. Second, it is advisable to start the analysis by focusing on rate ratios and rate differences in mortality of the lowest versus the highest socio-economic groups. Care should be taken in comparisons to use the same cut-off points of the socio-economic groups. For example, if income is used as the socio-economic indicator in the comparisons, the rate ratios or rate differences should in all cases be calculated on the basis of the lowest versus the highest 10 or 20 percent. Third, when studying changes in the socio-economic-mortality relationships over time, it is advisable to apply measures that take into account of changes in the composition of the socio-economic groups. Examples of such measures are the Index of Dissimilarity and the Relative Index of Inequality. Fourth, it is important to be precise about the populations that are to be

compared in terms of age groups selected as well as by sex/gender. It has repeatedly been found that mortality rates not only vary by SES class, but that the strengths of these social class–mortality associations also differ in the various age groups and, in addition, are different for men and women. This means that conclusions vary depending on which groups (by age and sex/gender) are selected for purposes of comparison.

6. Data collection practices in EU Member States on mortality by socioeconomic status

All EU Member States collect mortality data and make it available for analyses and research but not all countries explicitly collect mortality data by socio-economic status. For instance, INSEE in France maintains a permanent statistical sample since the census of the late 1960s for social statistics purposes which enables INSEE to carry out studies on mortality differentials by SES. In Finland, population registers system enables Statistics Finland to provide mortality data by age, sex, SES and other variables e.g. cause of death. The Lithuanian Statistical Institute is following the practice of Finland. Similar data are collected and compiled by Statistics Denmark and Statistics Netherlands but legislation prevents their free dissemination. The United Kingdom has been producing cohort analysis for mortality by SES and Germany used SES characteristics in person records of pension databases to calculate life expectancy by SES. In the Netherlands, the Department of Public Health at Erasmus University Medical Center developed a methodology to link information from deaths and census data and carry out analysis on mortality by SES. Similar research projects are carried out by the Max-Planck Institute (EUTFLESEG, 2006).

To obtain a more complete picture about the state of affairs in Member States, we conducted a rapid appraisal survey by approaching national statistical institutes of EU Member States with a short questionnaire to assess their practices regarding collection of mortality and socioeconomic status data on the deceased and the living as well as the linking of the two types of data. National experts of 19 European countries[7] responded and we summarize results in table 6.1.

A majority of Member States obtains mortality by SES statistics either by linking person records in census data files with person records in death registers (i.e. compiled death certificate information) *a posteriori*, or they rely on individual case studies to examine SES inequalities in mortality. *Czech Republic, Denmark, Romania and, Turkey* directly collect mortality by SES data, and link these to census data to produce mortality rates by SES. *Poland, Ireland, Estonia, and France* do not directly collect mortality by SES data but combine SES information stated on death certificates with SES information in other sources, using linked or unlinked methods. *Slovenia, Finland and the UK* also do not directly collect mortality by SES, but explicitly link death registration system to census data. *The Netherlands, Spain, and Sweden* also do not collect mortality by SES data and do or cannot link with SES information collected in a census and thus entirely rely on individual case studies (e.g. based on probability samples of the population) and decentralized data collection systems of socio-economic data on mortality.

Some countries do not collect mortality and socio-economic status at a national level but collect this at the municipal level. For example, Turin and Barcelona collect comprehensive data on all-cause mortality by socio-economic class for their population, in contrast to the relatively poor data available on national level (Borrell *et al.*, 2007; Kunst *et al.*, 2004).

[7] Austria, Bulgaria, Czech republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Romania, Slovenia, Spain, Sweden, Turkey, United Kingdom. Response was not received from national expert in Belgium.

Indicators and definitions of socio-economic status differ considerably across countries making cross-country comparisons difficult. No country compiles and publishes mortality by income group, whereas mortality by educational group or occupation-based social class (e.g. U.K.) is more common. If occupation is used as SES indicator it frequently applies only to men in the working ages (e.g. 18-64 years) (e.g. Kunst *et al.,* 2004).

In an attempt to standardize classifications, Eurostat sought collaboration with several key actors from around Europe to create a prototype harmonized European Socioeconomic Classification (ESeC), based on employment and occupation data. This endeavor contributes to comparability of mortality by SES statistics between EU Member States (see: http://www.iser.essex.ac.uk/esec/). UNESCO's International Standard Classification of Education (ISCED) is example of how educational attainment levels in different countries can be made comparable. ISCED is therefore used in several large scale EU surveys, such as the Survey of Health, Ageing and Retirement, though there are still problems to overcome, for instance in the way the ISCED is translated and applied in different countries.

Linking person records in mortality databases with concomitant ones in socioeconomic status databases is more precise and mostly done in Northern and Western Europe than in the rest of the EU (Kunst *et al.,* 2004). Therefore studies on mortality differences by SES in the EU are generally based on data compiled in the older EU Member States (E.g. Suurmond *et al.,* 2008; Kunst *et al*. 2004; 2005).

Based on our rapid appraisal and findings reported in several publications on the topic, we make the following recommendations. First, evidence of health inequalities are sensitive to both choice and quality of data, therefore initiatives should be taken for development of linked longitudinal mortality data by social class data (ESoC 2004). Second, a more in-depth inventory and understanding of various methodological approaches to derive mortality by SES statistics is needed in light of interpreting results of EU cross-national comparisons (Mustard et al 2003). For instance, in the Nordic countries (e.g. Finland, Sweden, Denmark), linkage of person records of population censuses and cause-of-death registers are important examples of how longitudinal data on socioeconomic inequalities by cause-of-death can be developed (Kunst *et al*., 2004). Data on mortality by socio-economic status is limited though in Member States in Central and Eastern Europe, with the possible exception of Bulgaria, so that efforts should thus be placed on developing other data linkage strategies in these countries.

Table 6.1. Current data collection practices by National Statistical Institutes (NSI) in EU Member States, reported by National Experts.

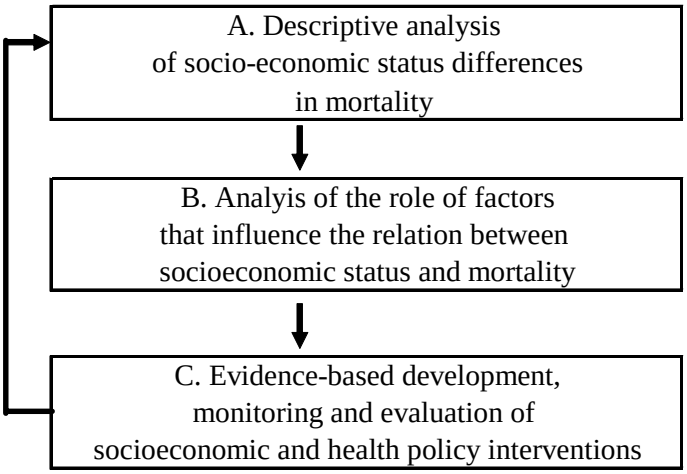
Country	NSI compiles mortality by SES?	How are mortality data tabulated and published?	Mortality data linked to SES?	SES indicator: Education	SES indicator: Occupation	SES indicator: Income	Websites
Austria	no	by age, sex	no	no	no	no	http://www.statistik-austria.at/web_en/statistics/health/causes_of_death/index.html
Bulgaria	no	by age, sex, and region	no	no	no	no	http://www.nsi.bg/SocialActivities/Health.htm http://www.nchi.government.bg
Czech Republic	yes	by age, sex and other categories	yes	yes	no	no	http://www.czso.cz/csu/2007edicniplan.nsf/engpubl/4019-07-2006
Denmark	yes	by age, sex , occupation	yes	no	yes	no	http://www.dst.dk/ http://www.si-folkesundhed.dk/Om%20instituttet.aspx?lang=en
Estonia	no	by age, sex, region	yes, using 'unlinked' cross-sectional mortality studies	yes	yes	no	http://www.sm.ee/est/HtmlPages/kunstII/$file/kunstII.pdf
Finland	no	by age, sex, occupation	yes, linked with census	no	yes	no	http://www.stat.fi/meta/til/kuol_en.html
France	no	by age, sex, occupation	yes, by death certificate	no	yes	no	http://www.insee.fr/fr/ppp/ir/accueil.asp?page=sd20063/accueil.htm
Germany	no	by age, sex	No	no	no	no	
Hungary	no	by age, sex	No	no	no	no	
Ireland	no	By age, sex, occupation	Yes, death certificate	no	yes	w/ infants	http://www.cso.ie/releasespublications/documents/vitalstats/current/vsta www.publichealth.ie http://www.esri.ie/health_information/nprs/

							nprs_reports/Report_on_Perina
Italy	no	By age, sex	No	no	no	no	www.istat.it
Lithuania	no	By age, sex, education	Yes, 1988-2004 only	yes	no	no	
Netherlands	no	By age, sex, education, postal code	Yes, by individual studies	yes	no	no	www.nationaalzorgkompas.nl www.nationaalkompas.nl
Poland	no	By age, sex,	possibly, by death certificate	yes	yes	no	www.infozdrowie.org.pl
Romania	yes	By age, sex, education, occupation	yes, education, occupation	yes	yes	no	http://www.insse.ro/cms/rw/pages/index.en.do http://www.ms.ro/pagina.php?id=127
Slovenia	no	By age, sex	Yes, census-linked	yes	no	no	
Spain	no	By age, sex	Yes, individual studies	yes	no	no	http://www.msc.es/estadEstudios/estadisticas/estadisticas/estMinisterio/mortalidad/home.htm
Sweden	no	By age, sex	yes, individual studies	yes	no	no	http://www.scb.se/statistik/_publikationer/BE0701_1986I03_BR_04_BE51ST0404.pdf
Turkey	yes	By age, sex occupation	Yes	no	yes	no	http://www.turkstat.gov.tr/VeriBilgi.do?tb_id=37&ust_id=11
United Kingdom	no	By age, sex region	yes, through the census, using occupation-based social classes	no	yes	no	http://www.statistics.gov.uk/CCI/nugget.asp?ID=1899&Pos=5&ColRank=2&Rank=224

7. Future directions in data collection: pathways of influence

Comparable statistics on EU country populations help EU policy makers to identify where the need for social, economic and health reform is needed most. However, additional data collection and analyses are required to identify and develop effective policy interventions. On the one hand, data must be collected and analyzed on factors influencing the *strength* of the relationship between SES and mortality. On the other hand, data must be collected and analysed on indicators measuring the impact of policy interventions. The interdependence of these three systems of data collection and analysis is illustrated in figure 7.1.

Figure 7.1: Interdependency between different types of data collection and analysis systems (adapted from Kunst, 2007)



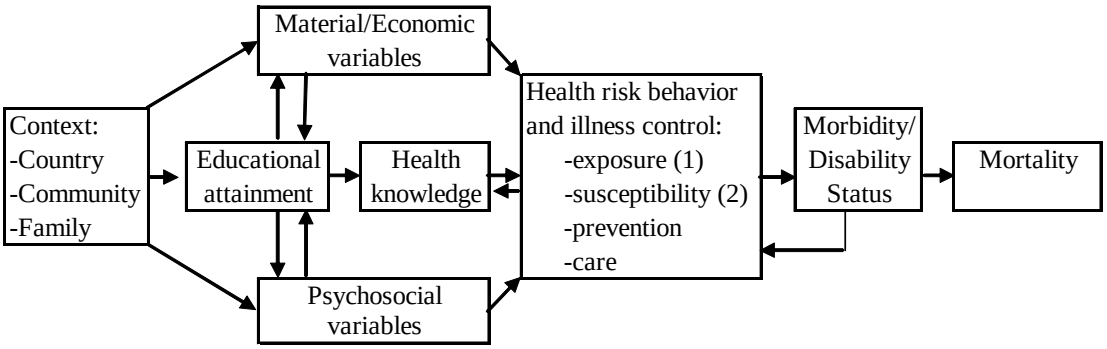
The previous sections were mainly devoted to the area of work subsumed under A. in figure 7.1. The other two areas of research involve exploratory and explanatory analyses (B) and evidence-based policy impact analyses (C) with feedbacks to future basic data collection and production of descriptive analyses.

Accomplishments in the form of new insights in research area B provide information to identify domains of variables for future data collection, because the focus is in that research area is on factors and pathways of influence between SES and mortality. Based on conceptualization work done by others (e.g. Cleland and Van Ginneken, 2008; Doorslaer and Koolman, 2004; Lynch *et al.* 2000; Oort *et al.*, 2005; Schrijvers *et al.* 1999) figure 7.2 was composed. It is a general framework and it identifies main domains of variables, areas of interactions and pathways of influence. Indicators of economic status such as income, material wealth status, as well as occupational status are captured under the heading of 'Material/Economic' variables. Though not explicitly incorporated in the model, age and sex are of course important control variables, notably when inter-country comparisons are made on SES differentials in mortality.

Regarding figure 7.2., we already elaborated in previous sections on the role of education, occupation, income and wealth status in the explanation of health risk behaviour, illness control, morbidity and mortality, including the different pathways of influence.

Three areas remained somewhat underexposed: the role of context, psychosocial variables, and health risk and illness control factors.

Figure 7.2. Major variable domains for explanatory analysis of socioeconomic status differentials in mortality, as well as areas of impact of policy responses



(1) includes voluntary, compulsive, involuntary exposure to adverse health behavior (e.g. smoking, drinking, excess food consumption, hazards in the working place or at home)

(2) expresses differences between persons in the physiological reaction of being exposed to a particular health risk

The ecological setting or context in which individuals and families live influences exposure to health and mortality risks. For instance, community-level indicators of economic development, environmental quality and living conditions, and health infrastructure could be included to assess, with multi-level analysis methods, what the contribution of community-level factors is in the explanation of SES differentials in mortality across countries (e.g. Steenland *et al.* 2004). For instance, Kravdal (2008) shows that when municipality level characteristics are explicitly included in the analysis, the assumed harmful health effects of income inequality disappear. Mackenbach (et al, 2008, pp. 2479) though found little evidence in their comparative study of 22 European countries that variation in social and economic policies contribute to the explanation of variation between countries in SES gradients of health and mortality. However, considering contextual variables in analyses is also important for another reason. They help policy makers to decide whether to opt for SES-mortality interventions directed towards 'vulnerable' groups of individuals (subsidies, educational programs) or to communities as a whole (e.g. health infrastructure). The implication is that contextual variables, such as those pertaining to the wider community, which can be expected to affect health and mortality risk must be included in person records that are used to examine SES-mortality relations. Some person characteristics of household members are 'context' characteristics of other household members, such as the educational attainment and health status of parents, and their influence must be adequately accounted for in studies on health risks and illness control of children.

Data on psychosocial variables such as self-efficacy (the extent that one perceives to be in control and is successful in overcoming difficulties), health perceptions, and sense of emotional and social support can be collect in large-scale health surveys. This is, for example, done in the periodic Local and National Population Health Monitor, a periodic nationally representative survey in The Netherlands, collecting data on most of the variable domains included in figure 7.2. (e.g. see: Brinck *et al.* 2005).

Main aspects of health risk and illness control behavior are 'exposure' to unhealthy life style behavior, including smoking, poor diet, lack of physical exercise and excessive alcohol consumption, and access to medical treatment. However, 'susceptibility' of people may differ as

demonstrated by time-lag differences in physiological reactions to different types of unhealthy behavior (e.g. smoking). Furthermore, the number and kind of preventive measures that people take against exposure to unhealthy behavior differs as well as health care measures that people apply to overcome consequences of unhealthy behavior (i.e. personal illness control). Susceptibility, exposure, prevention and care vary according to socioeconomic status so that data are needed covering these aspects. Furthermore, it is noted that spatial differences in SES differentials in self-assessed health may not indiscriminately be extrapolated to SES differentials in mortality. This is partly due to the fact that health status may be defined and measured in many different ways. This is illustrated by the findings of Mackenbach (et al. 2008) when, among others, geographical patterns in mortality differentials by SES are compared to self-assessed health status differentials by SES.

It is recommended, that appropriate indicators and measures of context and psychosocial conditions are identified and measured. Similarly, data and measures of health risks (e.g. occupation-related health hazards) and personal illness control could be collected and integrated in studies on the analysis of SES-mortality differentials.

8. Conclusion and recommendations

Empirical studies in EU countries reveal that, in spite of general declines in mortality in EU countries, inequalities by SES remained or even increased. Representatives of policy groups (EU Social Protection Committee) and departments (EMPL, ECFIN) expressed the need to address with appropriate and effective policy measures the prevailing inequalities in EU Member States. The design, implementation, monitoring and evaluation of such EU policy measures requires the presence in all Member States of comparable and high quality systems of data collection and compilation that cover, among others, indicators and measures of SES and mortality. Although some Member States maintain high quality and comprehensive data collection systems, privacy protection legislation and other reasons may prevent linkage of data compiled in different data sources, such as the matching and linkage of person records in vital statistics databases with records in censuses, tax-offices, and school enrolment databases.

In this methodological note we reviewed various aspects of indicators and measures of SES and mortality, and we examined the data infrastructure in EU countries in light of the feasibility to produce comparable statistics on SES differentials in mortality.

As regards their comparability, we conclude the following. NSIs in Member States use different indicators and measures of SES and mortality. Most frequently used is education, occupation or income, and less so wealth status. Another problem for comparative analysis is that indicators of SES are not defined and measured in the same way, and the quality, completeness and coverage of data sources differ. This is less of a problem regarding indicators and measures of mortality. Furthermore, we noted that not all NSIs produce mortality statistics by SES, and those who do compile them frequently use different approaches and measures to generate these statistics.

We recommend the following. First, Member States should preferably work towards adopting a prospective, linked approach in the development and harmonization of nationally representative health and mortality statistics by SES. In such an approach, person records in the most recent census are matched and linked by means of a common and unique person identification number to records in death registers. This prospective approach thus reveals the number of people who died (i.e. in terms of age, sex, SES characteristics), say 6 months, one year or several years after they

were recorded in the census. If a common and unique person identifier is lacking in both databases, deterministic and probabilistic linkage methods should be explored, using a set of common variables in both databases (e.g. place of birth, date of birth, sex).

Second, irrespective of whether a prospective linked approach is feasible or not, we also recommend that the following is explored:

- incorporation of educational attainment and last occupation on death certificates, using a classification terminology compatible with the one used in the most recent census questionnaires;
- coverage of conventional SES indicators (i.e. educational attainment, occupational status and economic status) in the forthcoming 2011 round of censuses within the EU. For the measurement of economic status, two general questions could be included, one requesting respondents to position themselves in predefined income classes, another recording ownership of durable assets, quality of housing, and access to certain amenities;
- collecting in the census information on SES of recently deceased household members. This allows estimation of death rates by SES using a retrospective approach;
- coverage of issues raised in (b) and (c) by means of a sample survey built into the census (e.g. every k-th household), should the anticipated costs of covering them in the census be too high.

Third, we recommend that both *absolute and relative measures* are used in analyses and publications. In a first stage, analyses of SES differentials in mortality should employ rate ratios and rate differences in mortality of the lowest versus the highest socio-economic groups. Furthermore, the same cut-off points of socio-economic classes should be used in different data sources. When changes in socioeconomic-mortality relations over time are studied, in a later stage, measures that account for changes in the composition of socio-economic groups should also be used, such as the Relative Index of Inequality and Slope Index of Inequality. Last, it is important to be precise about the populations to be compared in terms of age and sex.

Fourth, we recommend, in the spirit of the EU collaborative "Open Method of Co-ordination (OMC)"-framework, that a two-phase *technical cooperation and assistance* project is developed and implemented.

In the first phase, NSIs should produce country-specific assessment reports. More specifically, reports should address the following themes: (a) organisational and technical details of existing health, mortality and SES data collection and compilation sources, including indicators and definitions used; (b) legislative, logistical, financial, technical arrangements and procedures, as well as availability and characteristics of human resources at NSIs, including training needs; (c) identification of realistic strategies to overcome observed constraint. On the basis of the content of draft assessment reports, Member State NSIs are then grouped by a project coordination team into one of three regional working groups. In three consecutive regional workshops NSI representatives will present their assessment reports. The outcome of workshop discussions should be a series of country-specific *tentative* work plans, to be implemented in the main phase of the project. All work plans should be shared among participating NSIs, as well as the results of project monitoring and evaluation reports produced by the project coordination team.

The main phase of the project starts with a plenary workshop where the tentative country strategies and work plans are discussed and finalized. To allow NSIs to learn from each others experience and to further collaboration between them, the work plans will be implemented only in countries belonging to the first regional working group. Their progress will be monitored by the

project coordination team, who will also act as technical resource persons and trainers. During the period that the first group of countries implement their work plans, one or two regional project-progress workshops are envisaged. After the first group has produced most of the deliverables, a plenary workshop will be organised in which representatives present their experience with the implementation of work plans. The outcome discussions in this plenary workshop should be that strategies and work plans of NSIs in the other two regional working groups be updated. While the first group finalize outstanding issues in their work plans, the second and third groups start implementing their work plans. They will be supported by the project coordination team, complemented with NSI staff in the first group. By the end of the main phase of the project, NSIs in Member States should have a system of data collection, compilation and analysis in place capable of routinely producing periodic and timely health and mortality statistics according to SES. One indicator of success of the main phase may be the delivery of a set of country-reports in which recent health and mortality conditions by socioeconomic status are analysed, using comparable measures, methods of analysis, and formats of presentation.

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