Differences in life expectancy by education and occupation in Italy, 1980–94: Indirect estimates from maternal and paternal orphanhood

Marc Luy \(^a\), Paola Di Giulio \(^a\) & Graziella Caselli \(^b\)

\(^a\) Vienna Institute of Demography of the Austrian Academy of Sciences
\(^b\) University of Rome ‘La Sapienza’

Version of record first published: 27 May 2011

To cite this article: Marc Luy, Paola Di Giulio & Graziella Caselli (2011): Differences in life expectancy by education and occupation in Italy, 1980–94: Indirect estimates from maternal and paternal orphanhood, Population Studies: A Journal of Demography, 65:2, 137-155

To link to this article: http://dx.doi.org/10.1080/00324728.2011.568192

Population Studies: A Journal of Demography
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rpst20

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.tandfonline.com/page/terms-and-conditions

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
Differences in life expectancy by education and occupation in Italy, 1980–94: Indirect estimates from maternal and paternal orphanhood

Marc Luy\(^1\), Paola Di Giulio\(^1\) and Graziella Caselli\(^2\)

\(^1\)Vienna Institute of Demography of the Austrian Academy of Sciences; \(^2\)University of Rome ‘La Sapienza’

In the present study, we use the modified orphanhood method to analyse mortality differences by socio-economic status in Italy. This technique permits the indirect estimation of adult mortality from survey-based information on parents’ survival in developed populations and helps to overcome several limitations of conventional studies on mortality differences by social class. We estimate a time series of life tables by education and occupation and analyse the differences in life expectancy by socio-economic status along with their changes between 1980–84, 1985–89, and 1990–94. Whereas mortality differences between the highest social class and the other socio-economic status groups increased among men, they decreased among women. We speculate about the reasons for these sex-specific trends and evaluate the application of indirect estimation techniques to the populations of developed countries.

**Keywords:** differential mortality; education; occupation; socio-economic status; indirect estimation techniques; orphanhood method; smoking; Italy

[Submitted October 2009; final version accepted February 2011]

**Introduction**

The socio-economic-status gradient in mortality is a well-known phenomenon and has been extensively analysed. It can be found in all age segments of the adult population (Kitagawa and Hauser 1973; Kunst 1997; Kunst et al. 1998a; Huisman et al. 2004; Mishra et al. 2004; Cutler et al. 2006; Valkonen 2006). This and the occurrence of the gradient in mortality from a wide range of specific causes of death indicate a greater vulnerability among people with a lower socio-economic status (Marmot et al. 1984). Many studies show that the differences in people’s chances of survival are only partly due to specific health and mortality risks related to their occupation, the resources at their disposal, or to psychosocial or biological factors. Because individuals’ lifestyles and their socio-economic status are strongly interlinked, these differences in survival chances are primarily the result of health-related behaviours, particularly tobacco smoking (Liu et al. 1982; Marmot 1989; Williams 1990; Adler et al. 1994; Winkleby et al. 1994; Lynch et al. 1996; Cavelaars et al. 1997; Mackenbach et al. 1997, 2004; Kunst et al. 1998b; Lantz et al. 1998; Adler and Ostrove 1999; Jha et al. 2006). In view of the fact that women and men differ in all relevant respects—such as labour-force participation, type of occupation, and lifestyle characteristics related to health—it is not surprising that they too are dissimilar with respect to the relation between socio-economic status and mortality.

Generally, mortality differences by socio-economic status are larger (in absolute terms) and the mortality gradient is clearer among men than among women. This has been shown by many studies that have analysed the relationship between socio-economic status and mortality for national as well as subnational populations separately for males and females. It emerges whichever of the following measures is used: a multi-level indicator of socio-economic status (Turrell and Mathers 2001); education (Brajczewski and Rogucka 1993; Christenson and Johnson 1995; Preston and Elo 1995; Elo and Preston 1996; Valkonen et al. 1997; Dobhlammer and Kytir 1998; Shkolnikov et al. 1998, 2004; Borrell et al. 1999; Mackenbach et al. 1999, 2003; Kalediene and Petrauskiene 2000; Crimmins and Saito 2001; Leinsalu et al. 2003; Brønnum-Hansen et al. 2004;
Molla et al. 2004; Fawcett et al. 2005; Van Oyen et al. 2005); occupation (Carroll et al. 1993; Valkonen et al. 1993; Johnson et al. 1999; Brønnum-Hansen 2000; Detre et al. 2001; Burström et al. 2005; Dobhlammer et al. 2005); or income (Backlund et al. 1999; Gerdtham and Johannesson 2000; Claussen et al. 2003; Henriksson et al. 2006; Rognerud and Zahl 2006). Because mortality shows smaller variations among women, class-specific mortality levels of females in their lowest social group are often lower than those in the highest social group of males (Vallin 1995). Studies reporting mixed variations in mortality for the sexes or even a higher variability among women are rare and have focused on mortality at higher ages (Manton et al. 1997; Hattersley 1999; McDonough et al. 1999).

In his general overview of social inequalities in mortality Valkonen (2006) states four reasons for studying differences in mortality by socio-economic status. First, it is essential to take account of these differences in demographic research because socio-economic differences are often more discriminatory than other differences between subgroups of the population. Second, studies of mortality differences by socio-economic status contribute to a better understanding of the general determinants of mortality levels and trends. Third, for epidemiologists, social differences in mortality provide clues to the causes of disease. Last but not least, knowledge about mortality differences by socio-economic status is important from the perspective of social and health policy because they indicate inequalities in health and well-being (see also Allanson et al. 2010).

Despite their broad relevance, most studies on mortality differences by socio-economic status contain major weaknesses. First, the analyses of mortality differences are based mainly on standardized mortality rates for limited age segments or on relative risks. However, for practical purposes such as policy-making, information on differences in life expectancy would be more informative. Years of life are the most easily understandable unit of measurement of mortality differentials. Variations in standardized death rates or relative risks are more difficult to assess—especially for laypersons—since large differences in these measures do not necessarily reflect large differences in actual length of life. Another weakness is that most studies on mortality differences by social class describe these differences by level of education. For men, this might be a good proxy for other socio-economic characteristics such as type of occupation or working sector. For women, this is not necessarily the case. Similarly, the other categories used to identify social classes and socio-professional conditions tend to be based on men’s working-life profiles. Since these might not be representative for women, the use of the same categories might excessively bias the analysis of the health effects of specific social-class categories (Menéndez et al. 2007). Further, most data used for examining mortality differences by occupation or working sector relate deaths to the current job of the deceased. However, theoretically, life conditions driven by socio-economic status in young adulthood might be more important determinants of mortality. There is also the problem that if people are already retired when they die, they are registered as retirees without any link to their previous job. This applies to most deaths in modern industrialized populations and thus many deceased persons cannot be linked with their former occupation. Finally, studies on mortality differences by socio-economic status typically lack information about institutionalized and economically inactive people. This shortcoming is described as potentially the largest problem with existing studies since it leads to a clear underestimation of mortality differences by occupational class (Kunst 1997; Mackenbach et al. 1997; Kunst et al. 1998b; Martikainen and Valkonen 1999; Valkonen 2006). Although this problem is discussed mainly in connection with mortality differences among men, it has also a major impact on the analysis of women’s mortality because housewives are usually registered as being economically inactive.

In Italy, several efforts have been made to study mortality differences by socio-economic status. Existing data based on the linkage of deaths with Italian census data for the years 1981–82 (Italian National Statistical Institute (Istat) 1990) and 1991–92 (Istat 2001) reveal unexpected changes in mortality differences by education among women. While the typical education gradient in mortality at ages 18–74 for men is reported to have remained constant (and differences have even grown) and was similar to that for women at the beginning of the 1980s, it no longer existed among women at the beginning of the 1990s. In the period 1991–92, the mortality of women with secondary education was approximately at the same level as the mortality of women with primary school education. Moreover, the advantages of women with a university degree over women with a high-school diploma had disappeared.

Since Istat stopped linking census data with the deaths that occurred in successive months by education and occupation after the census of 1991, the most promising source for tracking the levels and trends of mortality by socio-economic status in Italy no longer exists. It is therefore necessary to find
other ways to estimate mortality by social class for the Italian population. One possibility is to use the pension and retirement registers (Costa 2005; d’Errico et al. 2005), but d’Errico et al. report that these lack information about complete work histories and jobs held and therefore do not recommend using them. They are particularly unsuitable for studying those diseases of which only a low proportion can be attributed to a risk factor or which have a wide variability in exposure to risk in a specific sector. Moreover, access to these data is very restricted. For this reason, another project uses census-based linkage data from the Italian city of Turin (Rosso et al. 1997) and more recently the entire Piedmont region (Mamo et al. 2005b), but of course, the findings of these studies refer to the local population only. Other investigators attempt to correlate death rates with socio-economic and other indicators, either for the total Italian population (Caselli and Egidi 1981; Caselli and Reale 1999; Materia et al. 2005) or for the local population of Rome (Michelozzi et al. 1999). This method is inexpensive and easy to apply, but suffers from the weakness typical of so-called ‘ecologic analyses’, namely, that the aggregate-level relationship between socio-economic status and the mortality of populations in specific areas may be quite different from the individual-level association between these variables (see Valkonen 2006).

In the study reported in this paper we adopted another alternative: the use of the so-called ‘orphanhood method’ to estimate mortality differences by socio-economic status indirectly, using survey information about parents’ survival taken from Italian multipurpose surveys. This indirect approach is based on methods normally used in less developed countries where conventional demographic data are either non-existent or too deficient to be usable. So far, indirect methods have been applied only rarely to analyse mortality in developed populations. Indeed the only exception is a series of studies of the determinants of adult mortality in the Russian Federation based on data on spouses and siblings (Bobak et al. 2002, 2003; Nicholson et al. 2005; Murphy et al. 2006).

The method used in our study solves some of the problems encountered in analyses of mortality by socio-economic status outlined above and provides new insights into social-class mortality in Italy. The following features were particularly important: (i) the Italian surveys we used included information about the education of respondents’ parents as well as several job characteristics of the parents at the time the respondents were 14 years old; (ii) the analysed population (parents of respondents) included economically inactive and institutionalized people; (iii) the orphanhood method allowed us to estimate complete life tables by socio-economic status and thus enabled us to estimate differences in life expectancy; (iv) the orphanhood method permitted us to estimate time trends; (v) the multipurpose surveys were representative of the total population of Italy.

Our study addressed the following research questions: (i) Can the orphanhood method provide reliable estimates for mortality differences by socio-economic status and thus compensate for the lack of statistical data? (ii) If so, do mortality estimates based on socio-economic status in young adulthood reveal the same patterns and trends as the well-known patterns and trends of current socio-economic status, and what do these differences mean in terms of life expectancy? (iii) Do job-specific mortality differences among women show the same gradient and trend as the mortality differences by occupation for men? (iv) What should we expect about future trends in mortality differences by socio-economic status in Italy?

In the next section we describe the survey data, the method we used, and how we applied it to the specific data. Then we present our estimates of trends in life expectancy by socio-economic status in Italy from the early 1980s to the mid-1990s. In the last section, we discuss the functionality of this method and formulate hypotheses about the causes of what we discovered about variation in mortality by socio-economic status in Italy and about trends to be expected in the near future.

Data and methods

Italian multipurpose surveys

In our study, we used data from the multipurpose survey ‘Famiglia, soggetti sociali e condizione dell’infanzia’ (Family, welfare institutions, and childhood conditions) conducted by Istat in the years 1998 and 2003. Both of them are cross-sectional surveys of Italian families and representative of the Italian population at the subnational level (NUTS 1). In Italy, participation in Istat surveys is mandatory. For this reason, the non-response level is very low, that is, usually distinctly below 10 per cent. The first survey was carried out in June 1998 and included a total of 59,050 individuals from about 20,000 interviewed families. The 2003 survey was linked with the international ‘Generations and
Gender Programme’ (GGP) and included 49,451 individuals, who were interviewed at the end of 2003. The data contained information on the respondents’ parents, including whether they were still alive (and, if so, their ages), their highest educational attainment, and several characteristics of their occupation when the respondent was about 14 years old. The specific questions we used for our analysis were as follows: (i) ‘What is the highest educational qualification your mother and father obtained?’ and (ii) ‘Think back to when you were 14 years old. What were your mother’s and father’s employment?’

Based on the answers to question (i) we classified education by the highest level of completed education according to OECD guidelines (see, e.g., Cavelaars et al. 2000) into (1) no education completed or first-level education (primary school); (2) lower secondary level; (3) upper secondary level; and (4) tertiary level, which includes university and other forms of post-secondary education. The information obtained from the answers to question (ii) enabled us to link the mortality of the respondents’ parents with their jobs irrespective of the parents’ current age. Hence, our analysis of mortality by occupation was based on the socio-economic characteristics of parents belonging to different cohorts, that is, representing different periods of time, when, on average, they were around 45 years old. From replies to question (ii) we divided the parents’ occupations into the following groups: (1) economically inactive; (2) manual workers; (3) non-manual workers; (4) self-employed; and (5) professionals (see the Appendix for more details).

Because the analysis was based on the socio-economic status of the respondents’ parents, there were also additional categories for cases with unknown occupation and unknown education. For reasons discussed below we kept these as separate categories. Our analyses included parents of male and female respondents born in Italy aged 20–64 at the time of the interview. Tables 1 and 2 show the numbers of respondents who reported the socio-economic characteristics of their parents in the two surveys.

### The modified orphanhood method

The orphanhood method, which estimates adult mortality from information about parents’ survival, is the main tool for the indirect estimation of adult mortality levels in less developed countries that lack population statistics (see Bradshaw and Timeus 2006; United Nations 2006; Luy 2010a). The basic idea of the method is that the age of respondents represents the period of the mother’s (or father’s) survival. Consequently, the proportion of respondents of a given age group whose mother (or father) is still alive approximates a survivorship ratio from

| Table 1 | Number of respondents aged 20–64 whose mother/father is alive/dead and mean age at childbirth (ACB) of mothers/fathers who are still alive by educational level and occupation status of parents, weighted data, Italy 1998 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | Maternal orphanhood | Paternal orphanhood |                |                |                |
| Educational level | Mother alive | Mother dead | Mothers’ ACB | Father alive | Father dead | Fathers’ ACB |
| Primary         | 18,019         | 10,259         | 28.10         | 11,278         | 14,903         | 31.37         |
| Lower secondary | 4,123          | 661             | 26.43         | 3,539          | 1,596          | 30.24         |
| Upper secondary | 2,549          | 505             | 27.45         | 2,749          | 1,232          | 30.52         |
| Tertiary        | 537            | 81              | 29.18         | 811            | 418            | 33.01         |
| Unknown         | 546            | 945             | 27.55         | 372            | 1,328          | 31.02         |
| Occupation status |                |                |                |                |                |                |
| Econ. inactive  | 16,369         | 8,137           | 27.97         | 199            | 421            | 31.95         |
| Manual workers  | 3,771          | 1,545           | 27.90         | 8,594          | 8,697          | 30.88         |
| Non-manual workers | 1,996        | 267             | 27.68         | 3,382          | 1,942          | 31.09         |
| Self-employed   | 2,616          | 1,337           | 27.57         | 3,845          | 4,465          | 31.28         |
| Professionals   | 383            | 86              | 27.59         | 2,072          | 1,181          | 31.57         |
| Unknown         | 641            | 527             | 27.20         | 658            | 1,191          | 30.98         |
| Dead before age 14 | 2,616    | 1,337           | 27.57         | 3,845          | 4,465          | 31.28         |
| Total           | 25,775         | 12,452          | 27.46         | 18,750         | 19,477         | 31.09         |

1Figures represent ‘normalized’ (or rescaled) weights, that is, weighted and unweighted totals are identical.
2Including primary education and no completed education.
3Parents deceased before respondents reached age 14.
4Source: Italian multipurpose survey 1998.
an average age at childbearing to that age plus the average age of the respective respondents. The available methods model this relation using different theoretical patterns of fertility, mortality, and age composition in order to convert the share of those with a surviving parent into a life table survivorship probability, controlling for the actual pattern of childbearing (Brass and Hill 1973; Hill and Trussell 1977; Zlotnik and Hill 1981; Hill et al. 1983; Chackiel and Orellana 1985; Timæus 1986, 1991a, b, 1992; Timæus and Nunn 1997).

In less developed countries, theoretical population models have to be used for this conversion because there are no data on basic fertility and mortality patterns. These theoretical models have given rise to serious concern about the reliability of results obtained by the orphanhood method (Hill 1984; Timæus and Graham 1989; Timæus 1991c). However, for most populations of developed countries, detailed age-specific fertility and mortality rates are available for both periods and cohorts. There is no need to use uncertain demographic models or make assumptions about constant demographic conditions in order to estimate overall levels and trends of fertility or mortality. To address this issue, Luy (forthcoming) suggests converting the proportion of respondents of a 5-year age group \( (n, n + 4) \) with mother/father still alive, denoted by \( S(n) \), into period survivorship probabilities from age 30 to age 33 + n. This is done by multiplying \( S(n) \) with a factor that relates the period life table for a specific reference time \( \tau(n) \) to the cohort survival of respondents’ parents reconstructed from official statistics and transfers all estimates to the unique baseline age of 30 years. Thus

\[
\left( \frac{l_{33+n}}{l_{30}} \right)_{\tau(n)} = \hat{S}(n) \cdot \frac{\left( \frac{l_{33+n}}{l_{30}} \right)_{\tau(n)}}{\sum_s \hat{w}_x \cdot \left( \frac{p_{x+n}}{p_x} \right)}
\]

where \( x \) represents the single ages at childbearing of respondents’ mothers/fathers, \( p_x \) the corresponding cohort life table survival probability to age \( x \), \( z \) and \( \beta \) the minimum and maximum ages at childbearing, \( \bar{n} \) the average age of respondents aged \( (n, n + 4) \), \( l_{30} \) and \( l_{33+n} \) the period life table survival probabilities to age 30 and 33 + n, respectively. The weights \( \hat{w}_x \) are the proportions of \( x \)-year-old mothers/fathers at the time of the respondents’ birth. Variables with hats refer directly to the survey data or to estimates about the parents of survey respondents whereas variables without hats refer to the total Italian population. The reference period \( \tau(n) \) is the average date at which deceased parents died. For more details see Luy (forthcoming).

Since orphanhood-based estimates are derived exclusively from a population of parents, they yield higher life expectancies than estimates for the total population. The differences are particularly large in Italy due to the high proportion of childless marriages and births after age 30, which are more common in the parents of respondents than in the total population. To illustrate this, Table 2 provides data on the number of respondents aged 20–64 whose mother/father is alive/dead and the mean age at childbirth (ACB) of mothers/fathers who are still alive by educational level and occupation status of the parents, weighted data, Italy 2003.

<table>
<thead>
<tr>
<th>Educational level</th>
<th>Mother alive</th>
<th>Mother dead</th>
<th>Mothers’ ACB</th>
<th>Father alive</th>
<th>Father dead</th>
<th>Fathers’ ACB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>13,338</td>
<td>8,561</td>
<td>27.89</td>
<td>8,324</td>
<td>12,033</td>
<td>31.00</td>
</tr>
<tr>
<td>Lower secondary</td>
<td>4,431</td>
<td>693</td>
<td>26.23</td>
<td>3,904</td>
<td>1,594</td>
<td>29.79</td>
</tr>
<tr>
<td>Upper secondary</td>
<td>2,974</td>
<td>536</td>
<td>27.32</td>
<td>2,836</td>
<td>1,181</td>
<td>30.57</td>
</tr>
<tr>
<td>Tertiary</td>
<td>604</td>
<td>101</td>
<td>29.28</td>
<td>829</td>
<td>417</td>
<td>32.48</td>
</tr>
<tr>
<td>Unknown</td>
<td>354</td>
<td>571</td>
<td>27.50</td>
<td>261</td>
<td>783</td>
<td>30.14</td>
</tr>
<tr>
<td>Occupation status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ. inactive</td>
<td>12,988</td>
<td>6,851</td>
<td>27.58</td>
<td>131</td>
<td>288</td>
<td>31.40</td>
</tr>
<tr>
<td>Manual workers</td>
<td>3,032</td>
<td>1,250</td>
<td>26.84</td>
<td>6,900</td>
<td>6,962</td>
<td>30.47</td>
</tr>
<tr>
<td>Non-manual workers</td>
<td>2,216</td>
<td>285</td>
<td>27.93</td>
<td>3,033</td>
<td>1,593</td>
<td>30.69</td>
</tr>
<tr>
<td>Self-employed</td>
<td>2,360</td>
<td>1,165</td>
<td>27.58</td>
<td>3,482</td>
<td>3,934</td>
<td>30.87</td>
</tr>
<tr>
<td>Professionals</td>
<td>477</td>
<td>112</td>
<td>27.86</td>
<td>2,074</td>
<td>1,219</td>
<td>31.32</td>
</tr>
<tr>
<td>Unknown</td>
<td>627</td>
<td>454</td>
<td>27.25</td>
<td>534</td>
<td>883</td>
<td>29.98</td>
</tr>
<tr>
<td>Dead before age</td>
<td>143</td>
<td>346</td>
<td></td>
<td>1,129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21,700</td>
<td>10,462</td>
<td>27.51</td>
<td>16,154</td>
<td>16,008</td>
<td>30.70</td>
</tr>
</tbody>
</table>

1, 2, 3 See Table 1.

population; for empirical evidence see Festy (1995) and Luy (forthcoming). However, the lower mortality level of a population of parents compared with that of the total population does not restrict the application of the orphanhood method when differences in life expectancy between subpopulations are analysed. All subpopulations contain only parous individuals and are thus equally affected by this mortality bias (see Luy forthcoming). Moreover, the proportions childless do not differ remarkably in the subgroups we analysed. Among the respondents aged 45–79 in the 1998 and 2003 Italian multipurpose surveys, the share of men without children is around 13 per cent and hardly varies across the categories of education and occupation. It was only among women that we found some differences. About 20 per cent of those with tertiary education or a professional or non-manual occupation are childless, whereas the corresponding shares among economically inactive women and women with primary education only are 12 and 11 per cent, respectively. Given the generally lower level of mortality differences among women, these differences are, however, unlikely to cause significant biases in the orphanhood-based mortality estimates.

**Applying the modified orphanhood method to Italian multipurpose survey data**

In surveys with complete information on all required data, weights $\hat{w}_x$ can be directly derived from the survey data. However, the Italian multipurpose surveys contain only the ages of parents who are still alive. Hence, the required data on age at childbearing of all respondents’ mothers and fathers had to be derived from the available information on parents who were still alive. In order to facilitate the procedure for users of the modified orphanhood method, Luy (2009, 2010b) produced a toolkit for estimating period survivorship probabilities from age 30 to $33+n$ from the Italian multipurpose survey data. The toolkit included (i) a set of values to deduce the average age at childbearing of all parents from the age of only those parents who were still alive; (ii) a set of weighting factors to convert a proportion of respondents from 5-year age groups with father or mother still alive into survivorship probabilities $l_{33+n}/l_{30}$; and (iii) a set of parameters to determine the corresponding reference periods. We used the updated version of the toolkit, which can be found in tabulated form for respondents’ age groups 20–24 to 60–64 and variable ages at childbearing from 22.0 to 35.0 for mothers and 24.0 to 37.0 for fathers in Luy (2010b). To ensure that the data were representative of the total Italian population, we calculated the basic proportions of respondents with mother or father still alive by weighting the respondents with their individual weighting factors taken from the multipurpose survey data. We used the ‘normalized’ (or rescaled) weights, so that the weighted and unweighted totals would be identical.

Using Brass’s two-parameter relational logit model life table system (1971, 1975) we transformed the derived survivorship probabilities into complete life tables at age 30 by using the reference life tables for all of Italy as standard. We adjusted these life tables for each educational/occupational subgroup by varying the beta parameter of the Brass model to fit the education-specific and occupation-specific death rates for the age groups 18–29, 30–44, 45–54, 55–64, and 65–74 published by Istat (2001) for the years 1991–92. The standard life table with a fixed beta defines a one-parameter family of models that varies solely in the level of mortality defined by the alpha parameter of the two-parameter relational logit model life tables. An estimated survivorship probability from age 30 to age $33+n$ identifies a unique life table within this set and allowed us to calculate life expectancy at age 30.

We excluded estimates for the mortality of mothers from respondents aged 20–24 because the numbers of deceased mothers was too low for further subgrouping. Because no parents in some socio-economic categories had died, there were no estimates available from the 2003 survey for fathers with unknown education of respondents aged 20–24, for self-employed mothers of respondents aged 25–29, and for mothers in the occupation group ‘professionals’ of respondents aged 25–29 and 40–44. We also excluded estimates based on fewer than five surviving parents. This situation arose in connection with the estimates for economically inactive fathers of respondents aged 55–59 and 60–64 from both surveys, fathers with tertiary education of respondents aged 60–64 from the 2003 survey, mothers with tertiary education of respondents aged 60–64 from both surveys, and mothers belonging to the occupation group ‘professionals’ of respondents aged 60–64 from the 1998 survey.

For the estimates of occupation-specific mortality, we had to exclude deaths of parents that occurred before the respondents had reached age 14 since the information about occupation referred
to that age. There is no reason to suppose that their exclusion caused any bias in the mortality estimates since the proportion of parents who had died before the respondents turned 14 was only slightly higher in the lowest education groups than in all the other groups. We also excluded all information on the mortality of mothers from respondents born between 1938 and 1942, that is, respondents aged 55–59 and 60–64 in the 1998 and 2003 survey, respectively, since we could observe a significant adoption effect in these age groups (see Luy 2009). The final number of estimates from the two Italian multipurpose surveys ranged between 10 and 18 for the specific socio-economic subgroups.

Results

Figures 1(a)–(d) show the orphanhood-based estimates of life expectancy at age 30 by education and occupation for males and females derived from the Italian multipurpose surveys of 1998 and 2003. Each dot indicates an estimate derived from a specific 5-year age group of respondents. Estimates for the most recent periods refer to the youngest age group of the 2003 multipurpose survey respondents (age 20–24 for men and 25–29 for women) and estimates for the earliest periods refer to the oldest age groups of the 1998 multipurpose survey respondents (most of them aged 60–64). The observation time covered by the estimated reference periods ranges from 1973

![Figure 1](image-url)

**Figure 1** Estimates of life expectancy at age 30 by education and occupation in Italy based on the modified orphanhood method, 1970–95.

**Notes:** The betas for the two-parameter relational logit life table model for males/females (estimated on the basis of education-specific and occupation-specific death rates for the age groups 18–29, 30–44, 45–54, 55–64, and 65–74 published by Istat (2001) for the years 1991–92) are: elementary education 0.84187/0.90674, lower secondary education 0.85633/0.96559, upper secondary education 0.95302/0.94881, tertiary education 1.07845/1.03771, manual workers 1.17250/1.00811, non-manual workers 1.09398/1.00786, and professionals 0.94072/0.96267; for economically inactive and self-employed women and men, beta was set to 1.0, because, owing to different compositions of the occupation groups, the death rates available from Istat are not fully comparable to the multipurpose surveys.

**Source:** Italian 1998 and 2003 multipurpose surveys for respondents aged 20–64.
to 1995 for men and from 1981 to 1995 for women. The graph shows that although the case numbers of the Italian multipurpose surveys are comparatively high, the orphanhood-based estimates for life expectancy are subject to irregular fluctuations when smaller population subgroups are analysed. The results presented provide selected information only, such as the higher life expectancy of those with tertiary education and of professionals among men in the second half of the observation period (Figures 1(a) and (c)), the lower life expectancy of economically inactive men (Figure 1(c)), and the generally low life expectancy of parents whose education and occupation are unknown (both sexes).

To get a better basis for analysing mortality differences by socio-economic status we combined the estimates for life expectancy at age 30 within the 5-year periods 1980–84, 1985–89, and 1990–94 by calculating weighted averages for these quinquennials (using the case numbers of the analysed subgroups of respondents’ parents in the corresponding age groups of respondents as weights). Figures 2 and 3 summarize the corresponding results obtained for life expectancy at age 30 by education and occupation for men and women. Owing to the lower mortality of women and the resulting more recent reference periods than those of men, estimates for the period 1980–84 could be obtained for men only. Note that results derived from survey data by means of indirect methods have to be interpreted with more caution than results from complete official statistics for the total population. Thus, results like those shown in Figures 2 and 3 should not be evaluated and interpreted by means of the exact values of the estimates but rather on the basis of the differences between the subgroups.

As already mentioned, the first striking result is that the fathers and mothers whose educational level is unknown to the respondents have the lowest life expectancy of all the education groups we analysed. Of the several factors that might be responsible for this result, some would be the effects of a causal relationship between unknown parents’ education and high mortality in this population group and thus these factors would lead to an overestimation of life expectancy for those with primary education. First, the group for which education is ‘unknown’ might comprise mainly women and men with unreported low or non-existent education. Second, respondents might infer the education of their parents from the latter’s occupation, which might make it easier for them to assess parents’ education if the occupation is one for which a higher education is a prerequisite, for example, that of a school teacher. Third, there might be a link between the education of the respondents and the quality of their answers: the less-educated respondents might simply not know anything about the education of their parents. Because of the high likelihood that parents with low education also have children with low education, we may conclude that fathers and mothers with unknown education mainly belong to the lowest socio-economic group. In fact, the proportion of parents with unknown education is higher among respondents with the lowest level of education. The percentage of respondents with upper secondary and higher education who lack information about their parents’ education is below 2 per cent, whereas the corresponding percentage of respondents with primary and lower secondary education ranges between 6 and 9 per cent.

![Figure 2](https://example.com/figure2.png)

**Figure 2** Estimates of life expectancy at age 30 by education and occupation for Italian men based on the modified orphanhood method, periods 1980–84, 1985–89, and 1990–94.

*Source: As for Figure 1.*
However, children might also lack information about the education of their parents because their parent(s) died very early and the respondents simply do not know much about their deceased fathers and mothers. To the extent that this is the reason, the results are affected by a form of mortality bias that probably affects all subgroups similarly. If so, the major consequence of this would have been an additional overestimation of life expectancy at all educational levels, which would have only minor effects on the interpretation of the differences between subgroups. We assume such a mortality bias to be the main reason for the low life expectancy of women and men with unknown education since the difference in life expectancy between fathers or mothers with unknown occupation and the other occupational groups, in which the deaths of parents when the respondent’s age was below 14 are excluded, are somewhat smaller. This assumption is also supported by the fact that lacking knowledge of parents’ education increases with the respondent’s age. Combining both surveys, 14 to 339 persons from the youngest to the highest age group were unable to give information about the education of their mother, that is, 0.3 to 10.7 per cent, and 32 to 343 persons from the youngest to the highest age group, that is, 0.8 to 10.8 per cent were unable to report their father’s educational level. The situation is similar with regard to occupation status. A total of 85 to 179 persons from the youngest to the highest age group did not provide information about the occupation of their mother (i.e., 2.1 to 5.6 per cent). The corresponding figures for fathers were 132 to 278 persons from the youngest to the highest age group (i.e., 3.2 to 8.8 per cent). In light of this information, we kept parents with unknown education level and occupation status as separate categories and excluded them from our interpretation of results.

Among men, all education groups show a continuous increase of life expectancy over the three observation periods. The only exception is the group whose education level is unknown (see Figure 2(a)). The largest increase between 1980–84 and 1990–94 is found among men with tertiary education (8.0 years), followed by those with upper secondary education (3.5 years), lower secondary education (2.7 years), and primary/no education (2.1 years). With regard to the differences between the education groups we find evidence to support three conclusions. First, there is a clear and stable pattern of differences in life expectancy between men with tertiary education, upper secondary education, and lower secondary education. Second, men with primary education or no completed education are basically not different, or only slightly different from men with lower secondary education. A comparison of the two groups shows that the life expectancy of men with primary or no completed education is around 0.1 and 0.7 years lower in the periods 1980–84 and 1990–94, and 0.6 years higher in the period 1985–89. Third, the advantage in life expectancy of men with tertiary education increases with time. The differences to men with upper secondary education grew from 1.9 years in 1980–84 to 3.6 years in 1985–89 and 6.3 years in 1990–94. The differences between upper secondary education and lower secondary education also increases between 1980–84 and 1985–89, from 1.2 to 3.0 years, but then decreases to 2.0 years in 1990–94.

Some of the characteristics of mortality differences by occupation are similar to those found in
mortality differences by education (see Figure 2(b)). Note that information about the type of occupation does not refer to the current or last occupation of the respondents’ parents but to the time the respondents were 14 years old. For men, we can once more draw three conclusions. First, economically inactive men exhibit the lowest life expectancy; it is even lower than that of men with unknown occupation. The differences with the other occupation groups seem to increase over time and their life expectancy is around 9 and 10 years less than that of non-manual workers and professionals in 1990–94. Second, manual workers have a lower life expectancy than self-employed men, non-manual workers, and professionals. However, the differences from self-employed men and non-manual workers decrease over time. Finally, the differences in life expectancy between the active working subgroups increase over time and become about 3 years between manual workers and professionals in the periods 1985–89 and 1990–94. In the years 1980–84, the differences in life expectancy between self-employed men, non-manual workers, and professionals are negligible.

The education gradient in life expectancy among women in the period 1985–89 is similar to that found for men, although the differences are less (Figure 3(a)). This fits with the results of studies for other developed countries, which also show education-specific differences in life expectancy to be less pronounced among women than among men (see, e.g., Koskinen and Martelin 1994; Shkolnikov et al. 2006; Deboosere et al. 2009). The difference in life expectancy between those with completed primary education and no education on the one hand, and with lower secondary education on the other hand, increases from 0.5 years in 1985–89 to 1.1 years in 1990–94, while the differences between upper and lower secondary education increase only marginally, from 0.1 to 0.3 years. Women with tertiary education have the highest life expectancy in 1985–89, with an advantage of 1.9 years over women with upper secondary education. However, in 1990–94, women with the highest education fall below the life expectancy level of women with lower and upper secondary education.

Women’s mortality differences by occupation in the period 1985–89 are also comparable to those of men. The biggest difference is that economically inactive women have a higher life expectancy than women with unknown occupation (Figure 3(b)). This is plausible since most economically inactive women are housewives, whereas the group of economically inactive men usually comprises, predominantly, ill persons and individuals of very low socio-economic status (see, for example, Hemström 1999). In 1985–89, female professionals have the highest life expectancy, with an advantage of 3.2 years over non-manual employees. In the period 1990–94, the differences between manual workers, self-employed women, and non-manual workers increase slightly above the level they were in the period 1985–89. In more detail, the differences between, on the one hand, women who are manual workers and self-employed, and on the other, those who are non-manual workers increases from 0.8/0.9 years in 1985–89 to 2.3/1.9 years in 1990–94. The most striking result is that the life expectancy of female professionals drops below that of non-manual workers, owing to a decrease of 3.2 years between 1985–89 and 1990–94. This is in line with the findings for education-specific mortality differences (see Figure 3(a)).

Discussion

Functionality of the modified orphanhood method

The tests of the modified orphanhood method for the indirect estimation of adult mortality in developed populations by Luy (forthcoming) and the empirical application presented in this paper indicate that the method provides reliable estimates of differences in life expectancy by educational level and occupation status. This is important because many developed countries lack official population data to investigate mortality differences by socio-economic status. Using results from other countries is unsatisfactory since specific national circumstances can strongly influence the magnitude, pattern, and causes of socio-economic inequalities in health (see Kunst 1997; Mackenbach et al. 1997; Kunst et al. 1998b). Data of high quality from an increasing number of surveys, such as the Generations and Gender Programme (GGP), contain the required information about survival and socio-economic status of respondents’ parents.

The fact that the information on mortality and socio-economic status is based on indirect reports seems unproblematic since the estimates obtained are in line with the results from other studies based on other types of data. It is true that a limitation of this approach is the fact that we encounter mothers and fathers with unknown education and occupation whose mortality is higher than that of parents of known socio-economic status. However, this seems to be much less of a problem for the analysis of
mortality differences by occupation than the exclusion of economically inactive persons, which is the common practice of previous studies. Moreover, a high proportion of cases of unknown education and occupation are also found in official death certificates (see O’Shea 1997).

The indirect approach used in this paper offers an interesting alternative to, and even has some advantages over, other research strategies such as data linkage or the ecologic approach: it provides estimates and time trends for differences in life expectancy; is neither restricted to active working-age groups nor to the current occupation; and includes economically inactive as well as institutionalized people. On the other hand, indirect methods like the orphanhood method have their drawbacks: they can provide only gross measures of the overall level and trend in adult mortality and yield estimates of mortality that refer to dates well before the survey was conducted (for a more detailed discussion see Luy forthcoming).

As a rule, results like those obtained in this paper need to be shown with confidence intervals. Theoretically, there are several possibilities. One is to derive confidence intervals for the proportions of respondents whose mother or father is alive by means of bootstrapping or formulae based on asymptotic distributions. The resulting proportions, representing the upper and lower limits of the confidence interval, can then be used to derive the corresponding survivorship probabilities and estimates for life expectancy. Another alternative is to derive confidence bands for the estimated survivorship function, for example, the ‘Kolmogoroff–Smirnov’ band (based on Kolmogoroff 1941 and Smirnov 1948) or the ‘equal precision band’ (Nair 1984). Originally, these procedures were developed to test the statistical significance of differences between complete survival functions (see, for example, Klein and Moeschberger 2005). Nevertheless, the upper and lower bands might also be used to derive the corresponding life expectancies. In our analysis, however, we refrained from constructing confidence intervals. The objective of the analysis was not to estimate the precise levels of life expectancy for a specific socio-economic status group but to obtain information about levels and trends of the differences in life expectancy by socio-economic status. For the purposes of our study, it was less important whether each difference was statistically significant, especially since our results were consistent with those obtained from other populations with better data.

Socio-economic mortality differences in Italy: towards an explanation of specific patterns by sex

For lower secondary, upper secondary, and tertiary education, the results obtained from using the modified orphanhood method show basically the same education gradient in mortality among men as that shown by an analysis of the age group 18–74 using linked census data for the years 1981–82 (Istat 1990) and 1991–92 (Istat 2001). For the last observation period of our analysis, that is, 1990–94, this also holds true for primary education. The orphanhood-based estimates permit us to translate the differences in education-specific mortality into life expectancy. In the period 1990–94, the life expectancy of men with primary or no completed education is 0.7 years lower than that of men with lower secondary education, 2.7 years lower than that of men with upper secondary education, and 9 years lower than that of men with tertiary education. Our estimates imply that the advantage of men with tertiary education increased markedly during the 1980s and 1990s. This is also reflected in the results of Istat (1990, 2001). For women, the results obtained by applying the modified orphanhood method also confirm the results obtained by Istat. In the second half of the 1980s, women with tertiary education had a life expectancy around 2.0–2.5 years higher than that of other education groups, but they lost this advantage during the first half of the 1990s. This finding is in line with the results for women with a university degree based on the linked census data (Istat 1990, 2001). In most cases, the differences between the other education groups are negligible and range between 0.1 and 1.4 years in life expectancy at young adult ages.

Our estimates for mortality differences by occupation status reflect the results obtained for mortality differences by education. This indicates that socio-economic status in young adulthood is associated with mortality differences similar to those of current or last socio-economic status. In particular, in the two latest observation periods, that is, 1985–89 and 1990–94, we find the expected socio-economic status gradient among men, with professionals having the highest and manual workers the lowest life expectancy. Nevertheless, with a maximum difference of around 3 years, the differences seem quite moderate. Kunst et al. (1998b) also report comparatively small mortality differences by occupation in Mediterranean countries. They conclude that differences were mitigated by dietary habits and drinking patterns that were especially protective of men from
lower classes against ischaemic heart diseases, and that this explained their advantage in life expectancy over their peers in other countries.

Among women, we find decreasing mortality differences between professionals and the other occupation groups (in the case of non-manual workers even a reversal), which is consistent with the loss of the survival advantage of women with tertiary education. Our findings seem to confirm that, as is the case for men, occupation-specific mortality differences among women have the same pattern as education-specific mortality differences. However, this might be due to the broad occupation categories we used. Unfortunately, the case numbers did not permit a more detailed categorization. Even the linkage data from Istat for the years 1981–82 and 1991–92 proved insufficient for a detailed analysis of specific occupations, especially among women (see Costa 2005; Mamo et al. 2005a).

In sum, our results indicate that the mortality gradient by socio-economic status in Italy is basically the same for women and men. However, our estimates point to one notable difference. Whereas mortality differences between the highest socio-economic status group and the others increased among men, they decreased among women. The increase among men might be explained by an increasing variability of the social-class-specific composition of the population and a stronger selection of individuals with low socio-economic status. The proportion of Italian men aged 18–74 with the lowest educational attainment dropped from 52.6 per cent in 1981 (Istat 1990) to 35.4 per cent in 1991 (Istat 2001). Among women, these effects might be overlaid by the consequences of smoking habits. Several Italian studies show that during the 1980s and 1990s the prevalence of smoking and smoking-related diseases were inversely related to education among men but directly related to education among women (La Vecchia et al. 1990, 1991; Faggiano et al. 1994, 2001; La Vecchia 2002). This sex difference is typical of populations in the earlier stages of the so-called ‘smoking epidemic’ (Lopez et al. 1994; Ramström 1997), which seems to have spread later in southern Europe than in the north (Graham 1996). International comparative studies documented a positive link between educational level and smoking prevalence among women of different southern European populations during the 1990s, whereas the opposite relationship was found in countries of northern Europe (Cavelaars et al. 1997, 2000; Giskes et al. 2005; Huisman et al. 2005a, b).

More recent studies on cigarette smoking indicate that Italy reached the last stage of the smoking epidemic at the beginning of the twenty-first century (Ferketic et al. 2008; Mathis 2008; Federico et al. 2009; Mereu et al. 2009; Tramacere et al. 2009). Hence, if our hypothesis about why women of higher social classes lost their survival advantage during the 1990s is correct, we can expect mortality differences by socio-economic status among Italian women to rise again and show the typical pattern. Similar trends of decreasing mortality differences by social class among females and a re-widening of the gap thereafter have been observed in other countries that passed the stages of the smoking epidemic earlier. For instance, in the UK, women showed the typical social class gradient in mortality during the early 1960s. This gradient had vanished by the early 1970s (Townsend and Davidson 1982) but reoccurred thereafter (Hattersley 1997). Valkonen (2006) reports comparable trends for Finland.

The findings of the studies summarized in this section suggest that our indirect analysis does show the prevailing mortality conditions by socio-economic status of Italian women and men during the 1980s and 1990s, or at least the basic trends for broad education and occupation groups. Note, however, that our conclusions for women are based on two 5-year periods only and thus are educated guesses rather than empirically well-established facts. Indirect estimates cannot be a substitute for directly obtained empirical data. Nevertheless, combined with the evidence from other studies on smoking behaviour and mortality differences by socio-economic status in Italy, the overall pattern yielded by our orphanhood-based estimates seems coherent. Future research could address the effect of the husband’s and wife’s education on each other’s mortality. This might provide valuable additional information that would improve understanding of mortality differences by socio-economic status, especially among women. Since the Italian multipurpose surveys are repeated regularly, the modified orphanhood method offers a promising way of tracing all the trends we have discussed with representative and comparable data for the total population of Italy.

Notes

1 Marc Luy and Paola Di Giulio are at the Vienna Institute of Demography of the Austrian Academy of Sciences, Wittgenstein Centre for Demography and
Human Capital, Wohllebengasse 12–14, Floor 6, 1040 Vienna, Austria. E-mail: marc.luy@oeaw.ac.at. Graziella Caselli is at the University of Rome ‘La Sapienza’.

2 The authors thank three anonymous referees for their constructive comments and Sylvia Trnka for language editing.

References


Costa, G. 2005. Differenze nella salute tra le professioni: spunti epidemiologici per le politiche del lavoro e della previdenza [Health differences in professions: epidemiologic suggestions for work and social security policies], *La Medicina Del Lavoro* 96(Suppl.): s7–s27.


Henriksson, Göran, Peter Allebeck, Gunilla Ringbäck Weitoft, and Dag Thelle. 2006. Income distribution and mortality: implications from a comparison of


Liu, Kiang, Lucila B. Cedres, Jeremiah Stamler, Alan Dyer, Rose Stamler, Serafin Nanas, David M. Berksen, Paul Oglesby, Mark Lepper, Howard A. Lindberg, John Marquardt, Stevens Elizabeth, James A. Schoenberger,


Luy, Marc. Forthcoming. Estimating mortality differentials in developed countries from survey information on maternal and paternal orphanhood, *Demography*.


Appendix

The classification of occupations in the Italian multi-purpose surveys differs from the categorizations commonly used in international statistics. Istat groups the professions into (1) employed (lavoratori dipendenti) and (2) self-employed people (lavoratori autonomi o indipendenti). These main groups are subdivided into specific categories based on their level of autonomy and/or responsibility in the local working unit. The Istat classification of occupations comprises the following categories:

(1) Employed:
   (a) Manager (Dirigente)
   (b) Executive (Direttivo, quadro)
   (c) Lower and upper secondary school teacher (Insegnante di scuola media inferiore o superiore)
   (d) Kindergarten and primary school teacher (Insegnante di scuola materna o elementare)
   (e) Clerk, skilled worker (Impiegato, intermedio)
   (f) Supervisor, unskilled worker, and similar (Capo operaio, operaio subalterno e assimilati)
   (g) Trainee (Apprendista)
   (h) Home worker (Lavorante a domicilio per conto di imprese).

(2) Self-employed:
   (i) Entrepreneur (Imprenditore)
   (j) Freelancer (Libero professionista)
   (k) Self-employed (Lavoratore in proprio)
   (l) Partner in a goods production and/or service co-operative (Socio di cooperativa di produzione di beni e/o prestazioni di servizio)
   (m) Assistant (Coadiuvante).

In this paper we grouped professions of comparable socio-economic status because they are expected to have similar levels of mortality. Moreover, we tried to keep the number of groups as small as possible to ensure that we would have a sufficient number of cases for our analysis in each group. We therefore created the following categories:

(1) Professionals (categories a, b, i, j): This category includes both employed and self-employed people who have full responsibility for an organization (private or public) or a very important part of it and take decisions autonomously. This category also includes self-employed people who work as freelancers, for example, lawyers and engineers.

(2) Non-manual workers (categories c, d, e): This category includes employees who work as clerks and skilled workers, administrators, and non-manual workers, as well as assistants of managers and teachers (up to upper secondary level).

(3) Manual workers (categories f, g, h): This category includes employees involved in the production of goods (including home workers) as well as trainees.

(4) Self-employed (categories k, l, m): This category includes self-employed people whose activity cannot be clearly allocated to any of the previous categories.
Our categorization produces a clear social class gradient between professionals, non-manual workers, and manual workers. It is difficult to assess where the ‘self-employed’ belong in relation to the gradient because they have only their employment status in common. Unfortunately, the Istat classification does not permit the use of more comparable classifications such as the ISCO (International Standard Classification of Occupations) or the Erickson–Goldthorpe class scheme.