Estimating Mortality Differentials in Developed Populations from Survey Information on Maternal and Paternal Orphanhood

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Abstract

In general, the use of indirect methods is limited to developing countries. Developed countries are usually assumed to have no need to apply such methods as detailed demographic data exist. However, the possibilities of demographic analysis with direct methods are limited to the characteristics of available macro data on births, deaths and migrations. For instance, in many western countries official population statistics do not provide any data for estimating mortality by socioeconomic status or migration background, or for estimating the relationship between parity and mortality. In order to overcome these shortcomings we modify and extend the so-called 'orphanhood method' for indirect estimation of adult mortality from survey information on maternal and paternal survival to allow its application to populations of developed countries. The method is demonstrated and tested with data from two independent Italian cross-sectional surveys. We provide the tools necessary to apply the method to these specific data and compare the estimates with official population statistics and the traditional variants of the orphanhood method. The empirical applications reveal that the method can be used successfully for estimating levels and trends of mortality differentials in developed populations and thus offers new possibilities for the analysis of mortality.

European Demographic Research Papers are working papers that deal with all-European issues or with issues that are important to a large number of countries. All contributions have received limited review.

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1 INTRODUCTION

To what extent does life expectancy differ by education level and occupation status? Are there mortality differences between migrants and non-migrants? Does parity influence the survival of people, and if so, in what direction? Questions like these have recently received increasing interest from different sides. Although the political and societal importance of these aspects is obvious many countries cannot estimate the extent and trend of such mortality differentials for their population as they lack sufficiently detailed statistical data. In such cases one usually adopts experience from another country which seems comparable to the population of interest. Yet while such empirical experience usually reveals that the direction of socioeconomic, ethnic or parity-specific mortality differentials is the same, their extent and trend can vary considerably which is why it is hardly possible to transfer empirical findings from one population to another.

In the field of fertility research, similar constraints in the possibilities of demographic analysis have recently led to an increasing use of survey data and methods of event history analysis in order to study aspects that cannot be analysed with official population statistics. For mortality, however, the practicability of survey data is more limited since direct analysis of mortality requires longitudinal data as well as long observation times and large sample sizes in order to provide a sufficient number of deaths. Thus, mortality researchers in developed countries are often faced with the same problem as demographers in developing countries where demographic data are either nonexistent or of too bad quality to be usable. Therefore, indirect methods based on survey data are used in developing countries and have shown to provide reliable insights into demographic conditions and trends. In view of the shortcomings of the available information on mortality differentials for many developed countries the rare use of indirect methods outside the developing world is surprising. Exceptions, where indirect methods have been applied to analyse mortality in developed populations, are a study of mortality of Moroccans living in France (Courbage and Khlat 1996) and a study on alcohol-related mortality in the Russian Federation (Nicholson et al. 2005). Bobak et al. (2002) followed the same idea and showed, also for the Russian Federation, that indirect methods based on survey data might be a useful tool to study mortality not only in developing countries.

In order to improve the availability of information on specific mortality differentials in cases where no official data are available we will modify and extend the so-called 'orphanhood method' for indirect estimation of adult mortality from information on maternal and paternal survival to permit its application to populations of developed countries. Generally, the orphanhood method seems to be the most promising indirect method for estimating mortality differentials since the survival status of respondents' parents is included in many surveys. Beside the fact that indirect methods might allow to examine new research questions they have additional valuable characteristics. First, indirect methods like the orphanhood method allow the deriving of life tables and thus the estimation of life expectancy. In many cases and for most users of demographic data life expectancy is more important and more informative than relative risks which are usually calculated when surveys or linked census data are used for the analysis of mortality. Second, indirect methods typically provide trends of demographic conditions which are derived from a single cross-sectional survey.

The extension of the orphanhood method to its application to developed populations will be demonstrated with specific survey data from Italy, which is one of the countries with limited information about mortality by socioeconomic status (SES) from official statistics. Empirical tests of the proposed method suggest that it can be used successfully and that it provides several new possibilities for the analysis of mortality differentials, as will be shown at the end of this paper. The general method is, however, not restricted to the specific Italian data but can be transformed to any other survey data including information on parental survival. Above all the Gender and Generations Program (GGP)—with more than 20 participating countries and a survey including several questions on various characteristics of respondents' parents (like socioeconomic status, marital status, relationship of parents, place of residence) during the childhood of respondents—is an interesting data source for applying the orphanhood method. Furthermore, several other surveys also include information on the migration history of parents or their number of children as a basis for further interesting questions in mortality research which usually cannot be analysed with existing population statistics.

The paper is structured in the following way. The next section summarises the data used from two cross-sectional Italian surveys and the basic idea of the orphanhood method. Then we describe the derivation of the specific estimation tools for the extended orphanhood method followed by the empirical application to the survey data used. First, overall mortality of Italy is estimated by means of survey information on orphanhood and compared to official statistics in order to evaluate the general approach of the orphanhood method and the functionality of the proposed variant for its application to developed populations. Finally, the application to estimate education- and occupation-specific life expectancy is tested by comparing the results obtained from the two independent surveys.

2 ITALIAN MULTIPURPOSE SURVEY AND ORPHANHOOD METHOD

The data that the method derived in this paper refers to were taken from the Italian multipurpose survey "Family and social subjects" carried on by Istat (Italian National Statistical Institute) in the years 1998 and 2003 ("Istat, Famiglia, soggetti sociali e condizione dell'infanzia" 1998 and 2003). Both surveys belong to the system of cross-sectional surveys on Italian families and are representative for the Italian population at higher regional level. The first survey was carried out in June 1998 and includes a total of 59,050 individuals from about 20,000 interviewed families. The 2003 survey belongs to the international GGP project and includes 49,451 individuals. The data contain information about respondents' parents, e.g., if they are still alive, and if so, their current age. Additional questions on the parents' highest education level and about several characteristics of their job activities when the respondent was about 14 years old make the use of these surveys especially interesting for the study of socioeconomic mortality differences.

The estimation of adult mortality from information on the parents' survival with the orphanhood method is the dominating tool for the indirect estimation of adult mortality levels in developing countries with a lack of existing population statistics (see United Nations 2006; Bradshaw and Timæus 2006). Methodological descriptions can be found in the United Nation's "Manual X" (Hill et al. 1983) or in some more recent publications (Timæus 1991c; Hill et al. 2005; Hill 2006). The demographic relationship between the proportion of orphaned persons and the mortality experiences of their parents has been first described by Lotka (1939) who proposed to estimate the number of orphans from life table functions for adult survivorship. Later, Henry (1960) suggested to reverse this approach in order to estimate adult mortality from the number of orphaned children in cases where the underlying mortality and fertility schedules were known or assumptions could be drawn for applying specific mortality and fertility models. Brass and Hill (1973) further developed this idea, proposing methods to estimate life table survivorship probabilities from proportions of respondents of successive five-year age groups with mother or father alive based on a set of weighting factors (the so-called 'Brass method'). In the subsequent years, several scholars suggested successively improved and modified methods for estimating adult mortality from orphanhood data (Hill and Trussell 1977; Hill et al. 1983; Chackiel and Orellana 1985; Timæus 1991a; Timæus 1991b; Timæus 1992; Timæus and Nunn 1997) or for using two sets of orphanhood data to estimate adult mortality for the time between the surveys (Zlotnik and Hill 1981; Timæus 1986).

The basic idea of the orphanhood method is that the age group of respondents represents the survival time of the mother (or father). Consequently, the proportion of respondents of a given age group with mother (or father) alive approximates a survivorship ratio from an average

age at childbirth to that age plus the age of the respondents. The available methods model this relation using different patterns of fertility, mortality and age composition to allow the conversion of a proportion with parent surviving into a life table survivorship probability, controlling for the actual pattern of childbearing. Moreover, Brass and Bamgboye (1981) and Hill et al. (1983) developed general methods for estimating the reference date of estimates derived from data on the survival of parents. Chackiel and Orellana (1985) extended this approach for the case of known year of death of respondents' mothers.

Regarding the application of the orphanhood method in developing countries there is no clear consensus among demographers on its validity and it has been applied with mixed success (a conclusion arrived at by Hill 1984; Timæus and Graham 1989; Timæus 1991c). Typical problems are seen in a possible adoption effect (respondents whose parents have died are likely to be reared by another adult and may not even know that this person is not their biological parent), multi-reporting (the frequency of reporting about each parent depends on his or her number of surviving children and thus is connected to both, mortality and fertility levels of the family), selection effects (regarding fathers and mothers if there is a relationship between parity and mortality and regarding respondents if there is a relationship between parental and child mortality) and wrong age reports of the respondents. Another critical issue is the specific choice of theoretical fertility and mortality models underlying the different approaches to convert a proportion of not-orphaned respondents into life table estimates that do not necessarily reflect the real demographic conditions of the studied population in conjunction with the basic assumption of constant mortality.

In developing countries the use of such theoretical population models is necessary since no data exist about the basic fertility and mortality patterns. However, such basic data are well known for populations of developed countries. Consequently, there is no need to use uncertain demographic models or the assumption of constant demographic conditions in order to estimate overall levels and trends of fertility or mortality since the age-specific fertility and mortality patterns are available in detail for both, periods and cohorts. Similarly, an adoption effect and wrong age reporting are unlikely to bias orphanhood-based estimates in modern developed populations. Furthermore, the biases caused by multi-reporting and various kinds of selection are to some extent mutually offsetting and thus considered to be small and rather unimportant (Palloni et al. 1984). The net effect, however, might not be negligible in practice as already remarked by Brass (1975). This will be given further attention in Section 4 of this paper where the orphanhood-based estimates are compared to official data on mortality of the Italian population.

The Italian multipurpose surveys provide all information necessary to apply the approach of the orphanhood method with very nearly a maximum of possibilities, since in addition to the age of respondents and the information whether their fathers and mothers are still alive even the age of the still-living parents is included. Therefore also age at childbirth can be determined for all examined subgroups as will be shown below. Tables 1 and 2 summarise the corresponding numbers for the total population included in the 1998 and 2003 surveys, respectively, divided into five-year age groups. With the exception of maternal orphanhood in age group 20-24, the case numbers are sufficient to analyse mortality differentials by means of the orphanhood method.

3 Derivation of the specific estimation tools

Figure 1 shows the relationship between the proportion of respondents with mother/father alive and the demographic experiences of their parents from the moment of respondents' birth until the time of the interview. Here, the respondent age group 20-24 is chosen as an example. If the time of interview is denoted with 't' we know that respondents were born during the five calendar years t-25 to t-21. In these years, the mothers of the respondents lived at ages 15 to 49 as represented by the boldly outlined rect-

Table 1 Number of respondents aged (n, n+4) with mothers/fathers alive/dead and mean age at childbirth (A.C.B.) of still living mothers/fathers, Italian multipurpose survey 1998.

Age n	Maternal orphanhood			Paternal orphanhood		
	Mothers alive	Mothers dead	Mothers' A.C.B	Fathers alive	Fathers dead	Fathers' A.C.B
20	3,694	47	27.27	3,525	215	31.14
25	3,966	136	28.06	3,614	488	31.60
30	4,152	295	28.45	3,586	861	31.99
35	3,902	485	28.64	2,993	1,393	31.42
40	3,327	754	28.20	2,170	1,912	30.93
45	2,663	1,221	27.59	1,145	2,469	29.86
50	1,895	1,736	27.19	804	2,827	29.12
55	1,233	2,282	26.17	400	3,116	28.23
60	670	2,502	25.01	189	2,983	26.91

Table 2 Number of respondents aged (n, n+4) with mothers/fathers alive/dead and mean age at childbirth (A.C.B.) of still living mothers/fathers, Italian multipurpose survey 2003.

Age n	Maternal orphanhood			Paternal orphanhood		
	Mothers alive	Mothers dead	Mothers' A.C.B	Fathers alive	Fathers dead	Fathers' A.C.B
20	2,616	44	27.15	2,504	156	31.01
25	3,023	129	27.38	2,830	316	31.02
30	3,347	244	27.86	3,018	560	31.14
35	3,532	408	28.42	2,812	1,119	31.25
40	3,112	651	28.28	2,234	1,526	30.88
45	2,276	898	27.61	1,380	1,793	29.85
50	1,760	1,327	26.73	803	2,276	28.53
55	1,231	1,973	25.84	415	2,776	27.71
60	553	2,216	25.03	138	2,616	26.67

angle in Figure 1. (For the fathers we assume that the fertility rates are shifted along the age axes by four years to ages 19 to 53 as will be described below.) The grey shaded area in Figure 1 represents the survival experiences that are reflected in the proportion of respondents who were born in year t-23 with mother/father alive at time t. (For simplicity we assume that the survival of all parents who gave birth between t-25 and t-21 can be approximated by the cohort of parents who gave birth in the mid-year t-23.)[1] The proportion of respondents from an age group (n, n+4) with mother/father still alive is usually denoted with S(n), with n=20 for the age group 20-24, n=25 for the age group 25-29, and so forth.

As can be seen in Figure 1, S(n) represents an average survival experience of 35 cohorts over several calendar years. In the case of S(20) the survival time covers 23 (= n+2.5+time of interview in year t) calendar years. To what extent each of the 35 cohorts contributes to the value of S(n) depends on two factors: (i) the age distribution N(x) of the parents' cohorts at the time of respondents' birth, and (ii) the fertility schedule comprised by the age-specific fertility rates f(x) at this time. (For a more detailed and formal description of the relationship between the factual average age of mothers and the interplay of fertility function and population age structure see Brass 1975.) Furthermore, the reference period, i.e., the calendar year in which the deceased parents died on average, depends on d(t), the cumulated number of respondents' parents dying between the moment of respondents' birth and the time of the interview.

As described in the introduction, the application of indirect methods for populations of developed countries becomes interesting when the mortality of specific subgroups can be analysed. Examples are the analysis of mortality differences by education, occupation, migration, fertility, or

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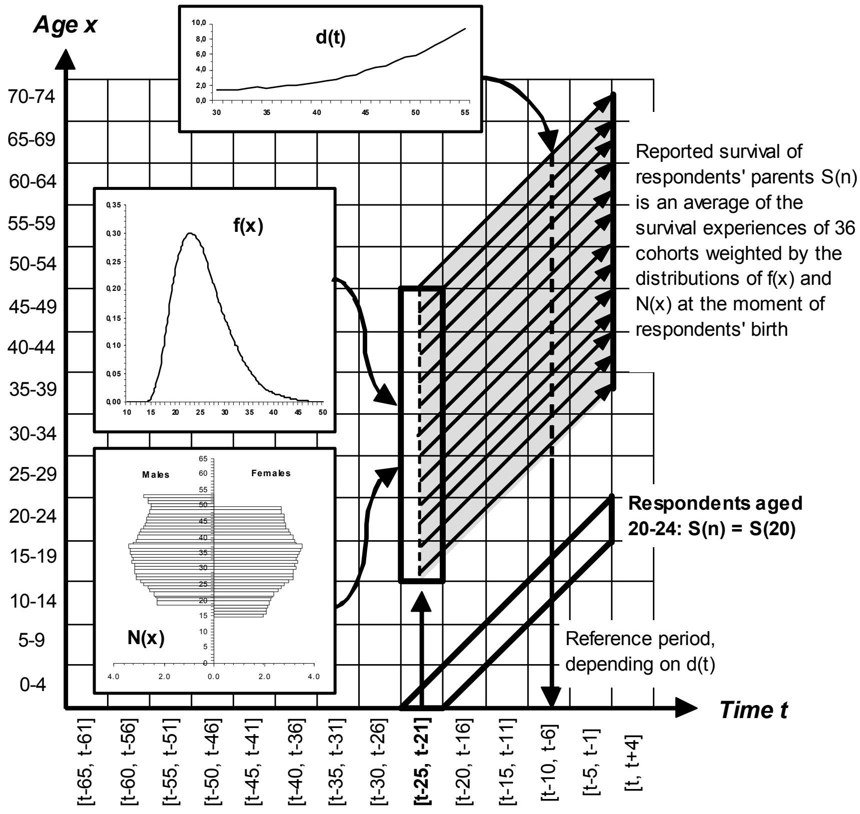
[1] Technically it is possible to include the cohorts of parents for all five birth years of respondents. However, this makes the calculations considerably more complicated. All but four of all cohorts of parents are included in the mid-year of the five birth years of respondents. Therefore, the reduction to the mid-year is justified.

Figure 1 Relationship between the proportion of respondents with father or mother alive and the demographic experiences of their parents from the time of respondents' birth until the time of the interview.



marital status. Thus, in the practical application of the orphanhood method respondents will be divided into subgroups by characteristics of their parents. These subgroups differ regarding the reported mortality and the reported average age at childbirth of the parents. These preconditions require an analytic model that is flexible for both, fertility and mortality. In the following, we will show how to provide the tools necessary to estimate group-specific life tables from the Italian multipurpose survey data by means of the orphanhood method. These tools are (i) a set of values to derive the average age at childbirth of all parents from the information about age at childbirth of still-living parents only,[2] (ii) a set of weighting factors W(n) to convert the empirical values for S(n) into survivorship probabilities l(33+n)/l(30) and (iii) a set of parameters for determining the corresponding reference periods (thus, the calendar years to which the survivorship estimates refer to). Each tool is presented in tabulated form for five-year age groups of respondents and variable ages at childbirth. Either set is based on the real cohort survival experiences of respondents' parents and modelled for different age-specific fertility schedules representing average ages at childbirth from 22.0 to 35.0 for mothers and 24.0 to 37.0 for fathers, respectively. By using the Brass' logit life table model (Brass 1971; Brass 1975) with an appropriate Italian life table as standard, the derived survivorship probabilities can then be transferred into complete life tables from age 30 depending on the proportion of mothers/fathers alive and the corresponding age at childbirth as given from the analysed survey data.

The derivation of these tools for estimating male and female survivorship probabilities from specific survey data consists of five major steps:

(i) Modelling of theoretical age-specific fertility schedules leading to specific ages at childbirth, given the real age composition of the living population and based on the real age-specific fertility schedule at the time of respondents' birth;

(ii) Reconstruction of the survival experiences of respondents' parents for each theoretical age at childbirth, given the modelled fertility schedules from Step (i) and the real cohort mortality trends;

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[2] Note that this step is not necessary for most other survey data since usually all respondents are asked the birth year of parents, not only those whose parents are still alive. It is a specific feature of the Italian multipurpose surveys to include this information for still-living parents only.

(iii) Derivation of reference periods for the reconstructed survival experiences of Step (ii) in order to determine the period life tables for deriving the weighting factors W(n);

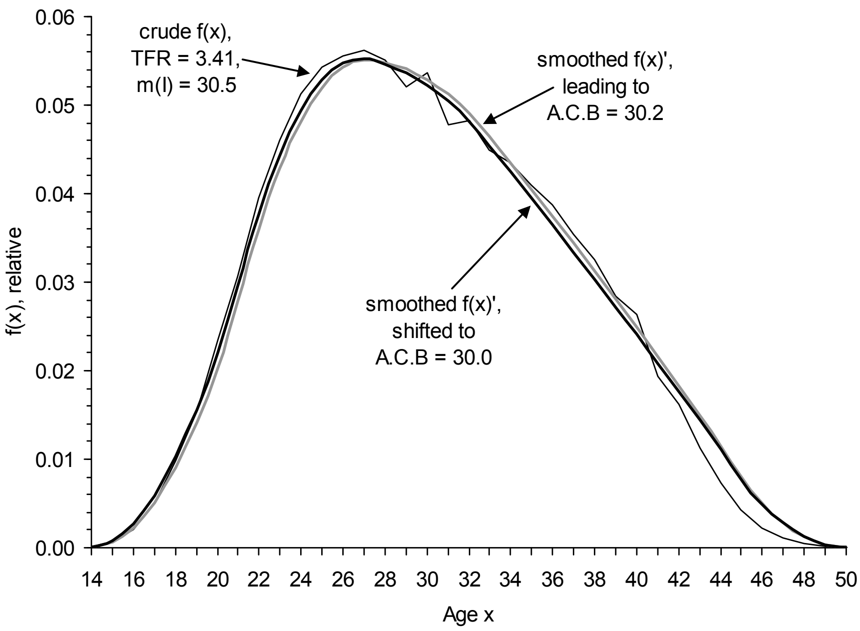
(iv) Derivation of weighting factors W(n) to convert the empirical survey values for S(n) into survivorship probabilities referring to the unique age 30 [l(33+n)/l(30)], based on Steps (i), (ii) and (iii);

(v) Derivation of a mathematical model to determine the reference period of the survivorship estimates from empirical survey data depending on the level of mortality and the average age at childbirth of the analysed population subgroup.

Step (i) constitutes the most sophisticated task. Our models are based on the Italian age-specific fertility rates f(x) from official population statistics for single calendar years from 1933 to 1982 (i.e. the birth years of survey respondents), averaged for the five calendar years in which the respondents of a specific five-year age group were born. Figure 2 shows such a fertility pattern for the example of calendar years 1933-1937 which are the birth years of the 60-64 years old respondents of the 1998 survey (thin black line). (This example was chosen in order to demonstrate the procedure used here because it provides the most suitable properties for graphical display. Note that in all other periods the age-specific fertility schedules do not show similar irregularities.) Using the fertility model proposed by Schmertmann (2003) we smoothed this pattern of age-specific fertility rates leading to the fertility pattern represented by the bold grey line in Figure 2.

Given the age composition of the female Italian population during the years 1933-1937, this smoothed fertility schedule leads to an average age at childbirth of 30.2 years. This age at childbirth is different from the mean age of age-specific fertility rates—in demographic textbooks usually denoted with m(I)—since the rates are weighted with the age composition of the population. This weighting is necessary since the survey information on average age at childbirth of respondents' parents depends on both the age composition N(x) of the population at the time of respondents' birth and the

Figure 2 Female fertility patterns (relative values) representing the real Italian age-specific fertility rates f(x) of the years 1933-1937 (time of birth of 1998 survey respondents aged 60-64) and the corresponding smoothed f(x)' leading to ages at childbirth of 30.2 and 30.0 years.



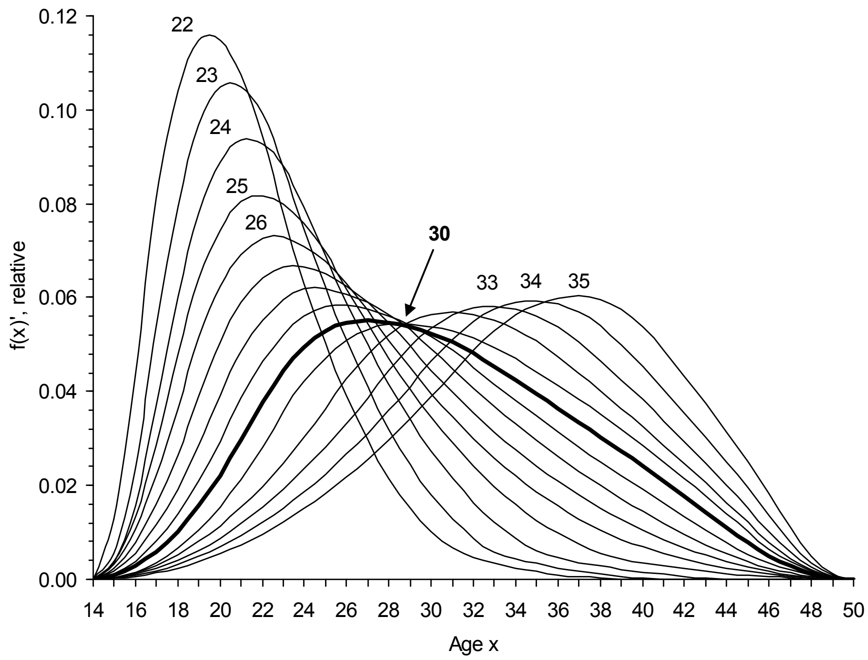
Notes: A.C.B. = average age at childbirth given the real age composition of Italian women aged 14 to 50 of the calendar years 1933-1937; m(I) = mean age of the unweighted age-specific fertility rates.

corresponding age-specific fertility rates f(x) (see Fig. 1). By using the relational Gompertz fertility model of Brass (1981), keeping parameter β=1 constant and varying parameter α, the smoothed fertility pattern was then shifted along the age axes to provide a fertility schedule with the closest exact average age at childbirth, thus in the presented example to age 30.0 (bold black line in Fig. 2).

This smoothed and adjusted fertility schedule f(x)' represents the basis for modelling the theoretical fertility patterns for alternative ages at childbirth. For that purpose, Schmertmann's fertility model was used to shift and model the basic distribution of age-specific fertility rates in both directions along the age axes by systematic changes of parameters P (the age at which fertility reaches its peak level) and H (the youngest age above P at which fertility falls to half of its peak level). The other two parameters of the Schmertmann model were always kept constant with $\alpha=14$ (the youngest age at which fertility rises above age zero) and f(P) (fertility rate at age P) as given by the real fertility schedule of the Italian population. In the case of the basic fertility pattern of the years 1933-1937 the corresponding Schmertmann parameters are P=27, f(27)=0.172 and H=39.18. As already described for the basic fertility schedule, Brass' Gompertz fertility model was then used to further shift the resulting fertility patterns to exact ages at childbirth from 22.0, 23.0, 24.0, … to 35.0 given the real age composition of Italian women in the years 1933-1937. This led to the final theoretical fertility schedules as shown in Figure 3.

The same procedure was used for all age groups of respondents with information on maternal and paternal orphanhood and for which the application of the method was at all possible (thus, age groups 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64). As already mentioned, for the estimation of theoretical fertility schedules for males we assumed the female fertility rates to be shifted by four years to ages 19-53. For the case of France, Caselli and Vallin (2006) have shown that this assumption fits empirical reality very well for the former past and approximately well for more recent years. Accordingly, the assumed fertility rates for men were then applied to the corresponding age composition of the Italian male population in order to derive male fertility schedules for exact ages at childbirth from 24.0 to 37.0. The parameters used for modelling the specific fertility patterns for different ages at childbirth can be found in Tables A.1 and A.2 in the appendix of this paper for different cohorts of respondents' mothers and fathers, respectively.

Figure 3 Modeled female fertility patterns f(x)' (relative values) leading to average ages at childbirth from 22.0 to 35.0 given the real age composition of the Italian population of the years 1933-1937 (time of birth of 1998 survey respondents aged 60-64).



Note: bold printed fertility pattern (average age at childbirth 30.0) represents the basis for the derivation of the other fertility schedules as described in the text.

Step (ii) consists of combing these theoretical fertility patterns with the real cohort survival experiences of the Italian population, reconstructed from official Italian mortality statistics. As mentioned at the beginning of this section, we assumed that the survival of the parents of respondents of a specific five year age group (n, n+4) can be approximated by the cohorts of parents being alive at the mid-year of the five calendar years in which the respondents were born (see Fig. 1). Thus, the information on parental survival obtained by respondents of a specific age group reflects a mixture of survival experiences of 35 cohorts, i.e., the cohorts aged 15-49 (mothers) respective 19-53 (fathers) at the mid-year of respondents' birth years. Assuming that the interviews of the two surveys took place on average near the middle of the survey years the reported proportions of mothers and fathers alive reflect survival experiences of approximately n+3 years.[3] In principle, the survival time of fathers should be calculated 0.75 years longer to account for the gestation period. While mothers can die only during or after childbirth, fathers can die at any time since conception. Although the incorporation of such a prolonged survival time of fathers is technically possible we refrained from adjusting for the gestation period. The gestation period causes two opposing effects for the interpretation of the proportion of not-orphaned respondents as the survivorship ratio of their parents: (i) an increase of the survival time by 0.75 years, and (ii) a decrease of the age in the denominator of the survivorship ratio by 0.75 years since the survival time does not refer to the father's age at childbirth but to the age at conception. While the first effect leads to an increase of mortality, the latter causes the risk of dying to decrease. Consequently, both effects cancel each other out to some extent and thus can be expected to count as negligible. The omission of an adjustment of the gestation period is further justified by the fact that the method is not developed for estimating life expectancy as precise as possible but for analysing levels and trends of mortality differences between population subgroups which are all equally affected by the described effects.

[3] This assumption is fulfilled quite well in the 1998 survey where the majority of interviews took place in June and July. Since the majority of interviews of the 2003 survey were carried out in November, there is a slight underestimation of survival time in the corresponding survivorship estimates. This underestimation, however, occurs equally in all analysed population subgroups and is of minor extent so that the final results for mortality differentials are not affected by this simplification.

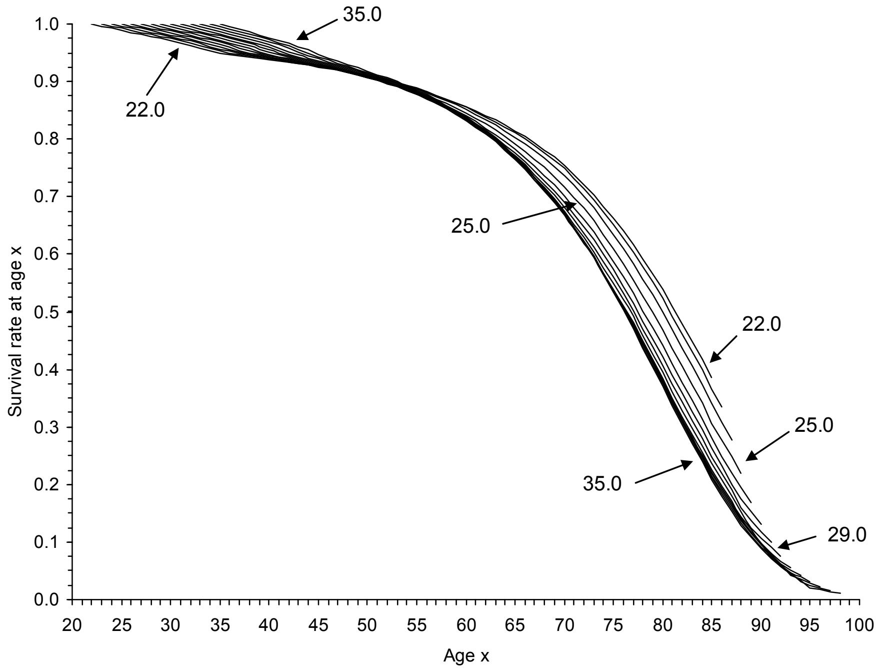
For reconstructing the total survival experience of a specific group of respondents' parents, the fertility schedules modelled in Step (i) served as weights for the 35 series of cohort survivals of respondents' parents from the time of respondents' birth to the time of the interview. This was done by multiplying the age- and cohort-specific probabilities of dying q(x) with the modelled relative fertility rates f(x)'. For each age group of respondents, this leads to 14 different survivorship functions referring to the theoretical ages at childbirth from 22.0 to 35.0 (mothers) or 24.0 to 37.0 (fathers), respectively (see Fig. 4).

Due to the continuous improvement of survival conditions, the reconstructed survivorship functions are the more rectangular the younger the underlying average age at childbirth since younger parents represent younger cohorts. In Step (iii) we calculated the average survival time from these survivorship functions in order to derive the calendar year in which the deceased members of the reconstructed cohorts of respondents' parents died on average, using as time of interview 1998.5 for the first and 2003.9 for the second survey. The resulting calendar years were used as reference dates for deriving the weighting factors W(n) to convert the proportions of respondents with mother/father alive S(n) into period survivorship probabilities l(33+n)/l(30) [Step (iv)]. This was done by relating the reconstructed mixed cohort survival [Step (ii)] to the determined period life table [Step (iii)] and by transferring all estimates to the unique baseline age of 30 years. The weighting factors W(n) can be used to derive the survivorship probabilities l(33+n)/l(30) from empirical survey data by

$$l(33+n)/l(30) = S(n) \cdot W(n). \quad (1)$$

The set of weighting factors for female and male survivorship estimates and for the two surveys can be found in Tables A.7-A.10 in the appendix of this paper. The exact weighting factors for specific ages at childbirth can be derived by linear interpolation of the given weighting factors for exact ages at childbirth surrounding the specific childbearing age.

Figure 4 Reconstructed survivorship functions for the mothers of 1998 survey respondents aged 60-64 with average ages at childbirth from 22.0 to 35.0.



The estimated survivorship probabilities must finally be related to the corresponding reference period. As already described for Step (iii) we defined the reference period as that calendar year in which deceased parents died on average. This approach differs from the traditional method for the determination of reference periods where the reference time is defined as the time point in which the cohort survivorship equals the survivorship of a period life table given certain assumptions regarding the pattern of mortality and the nature of mortality changes (Brass and Bamgboye 1981). Our approach is driven by the idea that the best time point represented by the mortality of respondents' parents is the calendar year that centres the deaths occurred (which can be determined empirically since our estimates are based on the real cohort survival of the Italian population), as also suggested by Chackiel and Orellana (1985). By modelling several scenarios of higher and lower mortality levels than those resulting from empirical Italian mortality data we found that the relationship between the level of mortality and the number of years t(n) before the survey when deaths occurred on average can be approximated for each age group n by the logarithmic equation

$$t(n) = a(n) \cdot \mathit{ln}[S(n)] + b(n) \qquad (2)$$

with parameters a(n) and b(n) depending on the age of respondents and the average age at childbirth. For each age group of respondents and for both surveys these parameters can be found in Tables A.11-A.18 in the appendix of this paper. As with the weighting factors, the exact parameters for specific ages at childbirth can be derived by linear interpolation of the given parameters for exact ages at childbirth surrounding the specific childbearing age. In order to derive the reference period the reference time t(n) calculated from Formula (2) must be subtracted from the survey time, i.e., 1998.5 for the first and 2003.9 for the second survey. These reference periods determine the period life table to be used as standard life table for the Brass logit life table model in order derive the life table for the analysed population subgroup. By applying the determined survivorship probability from Formula (1) the standard life table is then shifted upwards or downwards depending on the estimated survivorship ratio being higher or lower than the corresponding survivorship of the reference life table. Consequently, the parameter α of the Brass logit life table model is determined by the estimated survivorship probability l(33+n)/l(n). If specific information about the pattern of mortality of the analysed population subgroup is available then this information can be used to determine the corresponding parameter β of the Brass logit life table model (for such an empirical determination of β see, e.g. Stewart 2004 or Ngom and Bawah 2004). If no information about the specific mortality pattern is available then β should be set to 1.0, thus assuming the mortality pattern to equal that of the total population.

In principle, the proposed extension of the orphanhood method can be applied after deriving the weighting factors W(n) for converting the values for S(n) into survivorship probabilities and the parameters a(n) and b(n) for determining the corresponding reference periods. However, one specific feature of the Italian multipurpose surveys requires an additional analytical step. As already mentioned, the age at childbirth of respondents' mothers and fathers can only be derived from information about parents still alive. From the fact that mortality rises with age follows that the average age at childbirth of still-living parents must be lower than that of all respondents' parents to whom the basic information about survival refers to. To correct for this effect it is necessary to estimate the age at childbirth for all parents before determining W(n), a(n) and b(n). Therefore, the reconstructed survivorship functions of Step (ii) were used to derive the average ages at childbirth of all parents, given that the baseline ages 22.0, 23.0, …, 35.0 for mothers and 24.0, 25.0, …, 37.0 for fathers refer to survivors at the end of observation time (time of interview) only. Tables A.3-A.6 in the annex give for both surveys the corresponding estimates for the average ages at childbirth of all mothers and fathers, respectively. These tables show that the higher the age at childbirth and the age of respondents, the larger the deviation between the ages at childbirth of surviving and all parents.

To sum up, in order to use the presented tools for estimating adult mortality from Italian multipurpose data, three analytical steps are necessary:

(i) Determining the ages at childbirth of all parents from the survey information on the average ages at childbirth of parents still alive using Tables A.3-A.6;

(ii) Determining the weighting factors W(n) from the ages at childbirth calculated from Step (i) using Tables A.7-A.10 and Formula (1) to derive the corresponding survivorship probabilities l(33+n)/l(30);

(iii) Determining the corresponding reference period by using Tables A.11-A.18 and Formula (2) in order to choose the reference life table for transferring the estimated survivorship probabilities from Step (ii) into complete life tables from age 30 by using the Brass logit life table model.

4 APPLICATION OF THE EXTENDED ORPHANHOOD METHOD TO THE 1998 AND 2003 SURVEY DATA

In contrast to the situation in developing countries, the functionality and efficiency of the proposed method can be tested by its application to a developed country like Italy. In this section, we apply the extended orphanhood method (EOM) as well as the most common traditional methods introduced by Brass and Hill (1973) ('Brass method') and Timæus (1992) to the data of the Italian multipurpose surveys of 1998 and 2003 and compare the results to the life tables for Italy from the Human Mortality Database (HMD) which are reconstructed from official Italian population statistics. The reference periods for the traditional estimates were derived using the method of Brass and Bamgboye (1981) with the adjusted ages at childbirth from Tables A.3-A.6.

Before comparing the orphanhood-based estimates to the HMD life table data we have to think about how orphanhood-based estimates of life expectancy should look like compared to results from life tables for the total population. By its pure nature, orphanhood-based estimates exclusively refer to parous women and men (with surviving children). Several studies have shown that women with children have significantly lower mortality than nulliparous women, although among parous women mortality seems to increase at higher parities (Kitagawa and Hauser 1973; Green et al. 1988; Lund et al. 1990; Kvåle et al. 1994; Doblhammer 2000; Grundy and Tomassini 2005; Hurt et al. 2006; Le Bourg 2007; Butt et al. 2009; Spence and Eberstein 2009).[4] However, since parities of four and more children are the minority among the parous Italian population we can assume that the

[4] Only Friedlander (1996) reported the opposite effect with a poorer survivorship of parous women in her analysis of the cohorts 1880-1929 from Southern California. Among men she found no relationship between reproduction and survivorship.

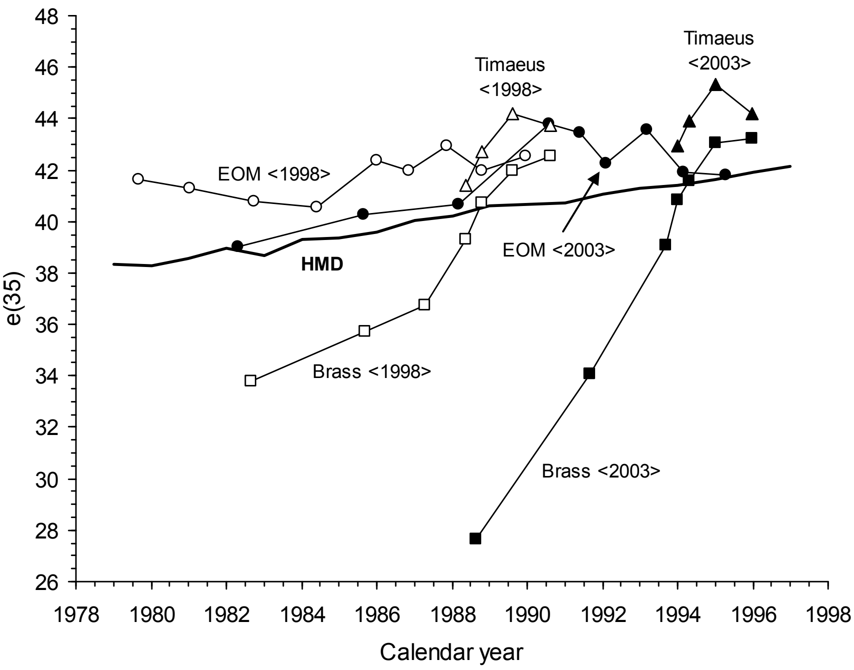
positive effect of having children dominates the negative effect of higher parities. Furthermore, in Italy childbearing occurs almost exclusively among married women and men whose lower mortality as compared to unmarried persons has been shown in many studies and for many populations (e.g. Hu and Goldman 1990; Goldman and Hu 1993; Rogers 1995).

Aside from these causal effects there is also a structural effect leading to a better survival of women and men with children. Regarding the survivorship curve, and thus life expectancy, deaths at younger ages have a stronger impact on overall mortality than deaths at older ages. The closer deaths occur to the beginning of the reproductive life span the more likely they affect childless individuals. Thus, the population of parents necessarily experiences better longitudinal survival than all individuals aged 15-49 (19-53) at the beginning of the observation. Consequently, both the causal effects and the structural effect should entail a higher life expectancy for the population of parents as compared to the life expectancy of the total population including nulliparous women and men. This holds independently from the aspect of multi-reporting and has already been demonstrated empirically. Using Austrian micro-census data and official death statistics, Festy (1995) has shown that the proportion of maternal orphans is in fact lower than the corresponding survival ratios reconstructed from official mortality statistics for the total population.

Figure 5 illustrates the comparison of the orphanhood-based estimates for life expectancy at age 35 in men.[5] The basic results and conclusions are the same for the applications to both surveys. In more recent years, i.e., with estimates referring to younger respondents and consequently based on the survival experiences of younger cohorts of parents, the Brass method performs well in the sense that it provides life expectancy estimatesabove the level for the total population as reflected by the life tables from the HMD. The same holds for the Timæus method. However, the

[5] Life expectancy at age 35 has been chosen because this is the youngest age for which all methods are able to provide the necessary survivorship estimates.

Figure 5 Estimates for male life expectancy at age 35 by applying the extended orphanhood method (EOM) and the methods of Brass and Timæus, Italian 1998 and 2003 multipurpose surveys.



Notes: reference periods for the Brass/Hill and the Timæus method are estimated by using the method of Brass and Bamgboye (1981); HMD = values for e(35) derived from life tables from the Human Mortality Database for the total Italian male population.

estimates obtained with the Timæus method are higher above the HMD level as compared to the Brass method. For estimates referring to the three most recent periods of both survey data (based on respondents aged 25-29, 30-34 and 35-39), the Brass method provides results close to the EOM. On the other side, the life expectancy estimates derived from the Timæus method are closer to those derived from the EOM for the estimates based on respondents aged 35-39 and 40-44 with the 1998 survey and for the estimates based on respondents aged 40-44 with the 2003 survey.[6] That both traditional methods perform quite well for younger parents is due to the fact that the mortality pattern in younger ages does not differ considerably between the Italian population and the mortality models used for these variants of the orphanhood method. However, the higher the age groups of respondents and thus the longer the survival time of parents the more the results obtained by the Brass method deviate from the real trend in life expectancy providing life expectancy estimates distinctly below the level of the total Italian population. These deviations are a consequence of the larger differences between the Brass general standard (which is the mortality pattern underlying the Brass method) and the mortality of the Italian population in higher ages.

The EOM, however, provides estimates as expected according to the theoretical considerations at the beginning of this section. All estimates are lying above the level for the total Italian population and differ to a reasonable extent of max. three years in life expectancy at age 35. Regarding the results obtained from the 1998 survey, the estimates based on information from respondents aged 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49 (i.e. the estimates referring to the six most recent periods) even reflect the basic degree of life expectancy increase which occurred among Italian men according to the official mortality statistics (HMD data). The deviations of the EOM estimates from the HMD life tables data become larger for estimates based on information from respondents aged 50-54, 55-59 and 60-64. This might be due to the fact that the older the respondents and thus the older the cohorts of parents, the stronger the structural effects discussed above. In the case of these three age groups, respondents were born between

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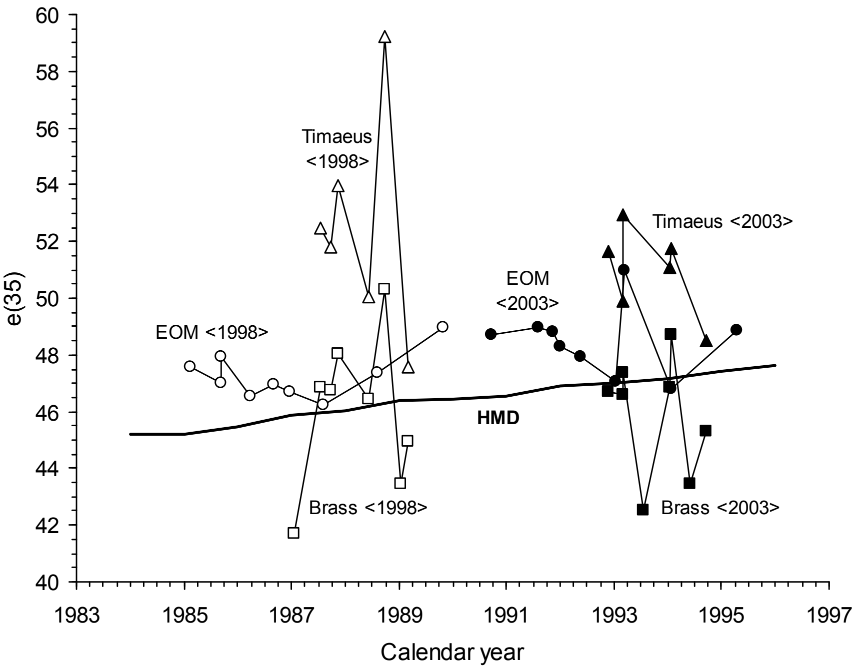
[6] The parameters published for applying the Timæus method only allow four survivorship estimates for men and six survivorship estimates for women (compared to seven male and eight female estimates with the Brass method and nine male and nine female estimates with the EOM).

1933 and 1947, which means that the first years of the reported survival of their parents were in wartime and other periods with high mortality conditions. However, this effect cannot be seen in the results obtained from the 2003 survey data. Nevertheless, here as well the basic trend of increasing life expectancy as pictured by the HMD data is visible. In contrast to the 1998 data, the EOM estimates based on information from younger respondents deviate stronger from this trend than the EOM estimates based on information from older ones. This might be explained by the fact that among younger age groups the number of respondents with deceased fathers is lower in the 2003 survey (see Tables 1 and 2), making the estimates more sensible to arbitrary bias due to low case numbers.

Basically, the estimates for female life expectancy confirm what has just been said for the male estimates regarding the results obtained by the EOM, forming a U-shaped pattern similar to what was observed for men with the 1998 data (see Fig. 6). The two traditional approaches, however, perform considerably worse than they did in the application to data on male mortality. This holds above all for the Timæus method and the method of Brass and Bamgboye (1981) for the derivation of reference years. The latter causes the biggest problems here since it does not provide a systematic set of reference periods. Regarding the estimates based on the 1998 survey, the three life table estimates with the Brass method lying below the HMD level are those derived from the orphanhood information of the three oldest age groups of respondents 50-54, 55-59 and 60-64. Thus, according to the reference date estimates obtained by applying the Brass/Bamgboye method the three oldest age groups provide mortality estimates for the oldest as well as for the youngest period. Similar problems occur with the 2003 data where the three most recent estimates refer to information from age groups 50-54, 55-59 and 25-29. The reason for the failure of the traditional methods when applied to Italian women is that they are unable to process the low levels of female mortality in developed countries, where the difference to the mortality levels in developing countries is bigger than among males.

Figure 6 Estimates for female life expectancy at age 35 by applying the extended orphanhood method (EOM) and the methods of Brass and Timæus, Italian 1998 and 2003 multipurpose surveys.



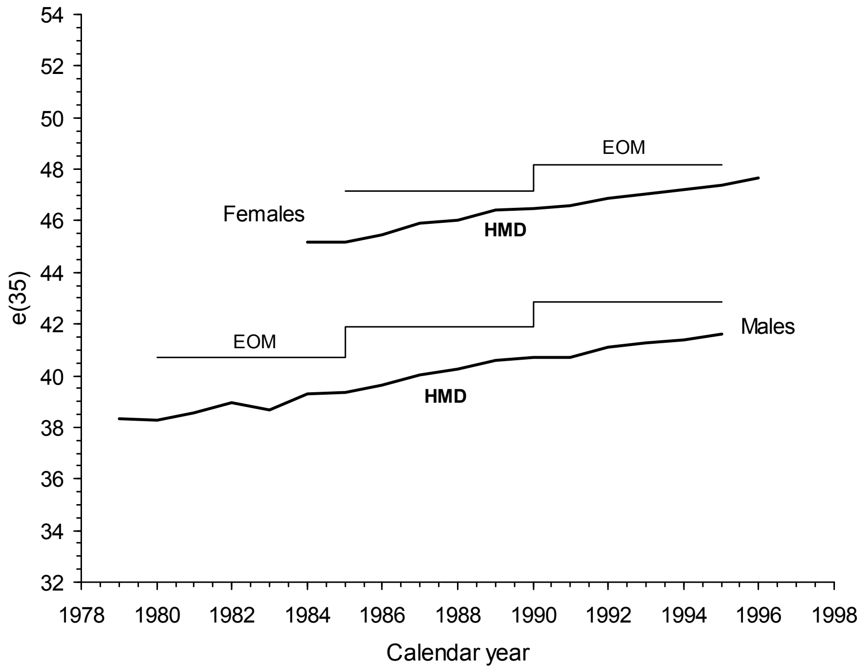
Notes: reference periods for the Brass/Hill and the Timæus method are estimated by using the method of Brass and Bamgboye (1981); HMD = values for e(35) derived from life tables from the Human Mortality Database for the total Italian female population.

Among the results for female life expectancy obtained by the EOM there is only one problematic estimate for each of the surveys. In the 1998 data this is the estimate referring to the time 1985.7 [e(35) = 47.95 years] and in the 2003 data the one referring to 1993.2 [e(35) = 50.96 years]. These estimates are based on information from respondents aged 55-59 (1998) and

60-64 (2003), respectively. Both estimates are striking because of their extreme low mortality levels, affecting not only the estimates for life expectancy but also the derived reference periods. Interestingly, both these outliers refer to the same birth cohorts of respondents, i.e., those being born during the years 1938-1942. So this obvious cohort effect is possibly due to the wartime years in which these respondents lived their early childhood and might reflect a specific adoption effect. However, this is just a hypothesis which needs further investigation. Nevertheless, since the bias in information about maternal survival of respondents born between 1938 and 1942 is obvious it seems better to exclude them from more detailed analysis of mortality differentials.

Although the case numbers of the Italian multipurpose surveys are comparatively high Figures 5 and 6 reveal that the orphanhood-based estimates for life expectancy are subject to irregular fluctuations. This could become a severe problem when population subgroups with lower case numbers are analysed. In order to better control for this possible bias when analysing mortality differentials we summarised the estimates for the five-year periods 1980-1984, 1985-1989 and 1990-1994 by calculating weighted averages for these periods (with the weights being the case numbers underlying the different estimates for life expectancy) and excluding the information on maternal orphanhood from respondents born between 1938 and 1942. Figure 7 shows the estimates obtained using the EOM averaged for these quinquennials in comparison to the HMD estimates. The graph elucidates the functionality of the proposed method. Both aspects required for reliable mortality estimates are reflected accordingly: the higher level of life expectancy and the trends of rising life expectancy as depicted by the HMD estimates.

Figure 7 Estimates for female and male life expectancy at age 35 by applying the extended orphanhood method (EOM) averaged for the calendar years 1980-1984, 1985-1989 and 1990-1994 from the Italian 1998 and 2003 multipurpose surveys.



Note: HMD = values for e(35) derived from life tables from the Human Mortality Database for the total Italian population.

The data on paternal orphanhood of the two surveys further allow to test if the proposed method can provide reliable results for analysing the mortality of subgroups since estimates for the period 1985-1989 can be obtained from both the 1998 and the 2003 survey (see Fig. 5). Figure 8 displays the corresponding estimates for life expectancy at age 30 by education level and occupation status.[7] As we could already see in Figure 5, the 2003 survey provides lower estimates for life expectancy than the 1998 survey for the years 1985-1989, which also holds for every population subgroup. This is, however, no problem for the application of the method. First, as we have just seen, all population subgroups are affected similarly by this effect. Second, since—as discussed in the previous section—the values for life expectancy obtained by the orphanhood method are difficult to assess by its pure nature, it is preferable to use the differences in life expectancy to a specific reference group instead of analysing and comparing the total values. Since we can assume that both the causal effects and the structural effect affect all population subgroups similarly, the interpretation of differences in life expectancy in relation to a reference group seems the best way to interpret such orphanhood-based estimates.

Concerning the applicability of the EOM it is much more important whether the two surveys provide similar results regarding the patterns of education- and occupation-specific differences in life expectancy for the period 1985-1989. Figure 8 shows that this holds very well for the occupation groups analysed. The data from both surveys provide the same order from the lowest to the highest level of life expectancy, i.e., economically inactive men, manual workers, non-manual workers, self-employed men and professionals. Even the relative differences between the

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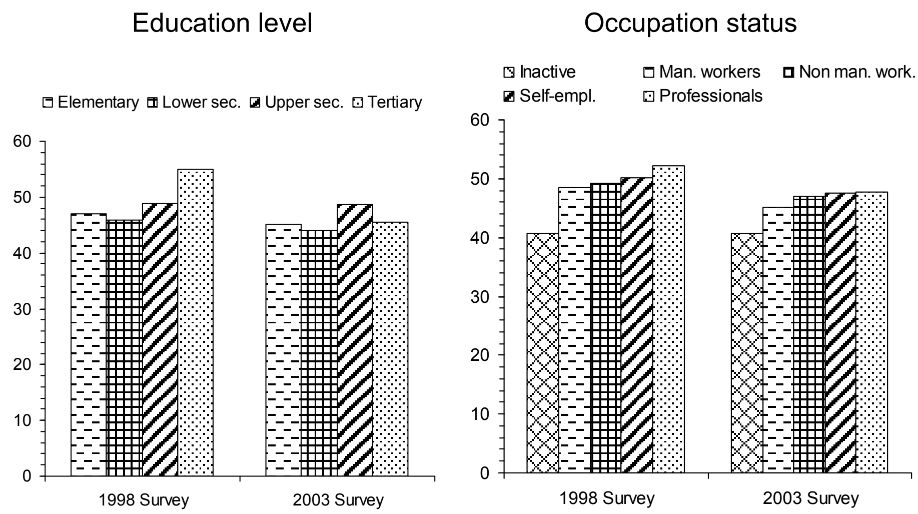
[7] The estimates were derived with the EOM transferring the resulting survivorship probabilities into complete life tables from age 30 with the Brass logit life table model. Values for the Brass parameter β were estimated from education- and occupation-specific death rates for age groups 18-29, 30-44, 45-54, 55-64 and 65-74 published by Istat (2001) for the years 1991-1992. The corresponding β's are: elementary education 0.84187, lower secondary education 0.85633, upper secondary education 0.95302, tertiary education 1.07845, manual workers 1.17250, non manual workers 1.09398 and professionals 0.94072. For economically inactive and self-employed men β has been set to 1.0 because the death rates available from Istat are not fully comparable due to different compositions of the occupation groups as compared to the multipurpose survey.

Figure 8 EOM estimates for male life expectancy at age 30 by education level and occupation status for the period 1985-1989 according to the Italian 1998 and 2003 multipurpose surveys.



groups are comparable. The same holds for the education groups elementary, lower secondary and upper secondary, with lower secondary education showing the lowest and upper secondary education the highest life expectancy of these three groups. Men with tertiary education are the only subgroup for which the results based on the two surveys differ. According to the 1998 survey men with tertiary education have the highest life expectancy, whereas according to the 2003 survey men with tertiary education fall in between men with lower and men with upper secondary education, being close to the level of elementary education. These differing results for tertiary education are probably due to the low case numbers for this education group (only one estimate based on 58 deaths of the 2003 survey falls into the years 1985-1989). Nevertheless, all other results indicate that the EOM provides stable results even for the analysis of population subgroups.

5 SUMMARY AND DISCUSSION

In this paper we extend the orphanhood method, which was originally designed to be applied in the populations of developing countries, for estimating mortality differentials in developed populations. In detail, we provide three tools to estimate group-specific life tables from Italian multipurpose survey data: (i) a set of values to derive the average age at childbirth of all parents from the information about age at childbirth of still-living parents only, (ii) a set of weighting factors W(n) to convert the empirical values for S(n) into survivorship probabilities l(33+n)/l(30) and (iii) a set of parameters a(n) and b(n) for determining the corresponding reference periods. Each of these tools is provided in tabulated form for nine age groups of respondents and 14 variable ages at childbirth for the surveys of 1998 and 2003. The tools can be used to reconstruct a time series of male and female survivorship estimates and thus to analyse time trends of mortality differentials from survey information on the proportion of respondents of different ages with mother/father still alive. Italy was chosen for demonstrating the proposed method for two reasons: First, Italy is one of those developed countries where data and knowledge on socioeconomic mortality differences are limited. Second, Italy already provides two large comparable and nationally representative surveys with the necessary information to test the applicability of the method.

The main conceptual difference between the EOM and the traditional methods is that the weighting factors and regression coefficients of the traditional methods are exclusively based on theoretical population models, independent from the period to which the estimates refer. In contrast, the necessary tools for the application of the proposed EOM are specifically derived from, or based on, real empirical data for the population analysed and the survey used. Only the fertility schedules for different ages at childbirth (and thus the weights for the reconstructed survival experience of respondents' parents) are based on theoretical models but they are derived from the real age-specific fertility pattern prevailing at the time of respondents' birth. The traditional methods for reference period estimation use the theoretical time lag between period- and cohort-type life tables to display the same specific survivorship ratio. The basis of the weighting factors of the EOM for deriving the survivorship probabilities is the reference periods derived from the average date of death of the reconstructed cohorts. The period life table of that time is used as a reference for deriving the weighting factors. On the basis of this life table, the weighting factors contain two different components: (i) the transformation from a specific average age at childbirth to the unique starting age of 30 years, and (ii) the transformation of a complex mixed cohort survival into a period survivorship probability. Another option to derive the reference period might be to calculate the date of the parents' death directly from respondents' reports in surveys where the parents' time or age of death is asked explicitly, as suggested by Chackiel and Orellana (1985). The main limitation of this approach is that it requires respondents to remember accurately when their parents died, however. This might be an increasing problem the older the respondents are and therefore the longer ago their parents died.

Although the reported survival of respondents' parents is cohort survival we followed the approach of the traditional variants of the orphanhood method to estimate past period mortality. In order to get estimates for life expectancy (differentials) it seems more logical to connect the reported deaths which occurred in the past to the corresponding complete and known period mortality than to incomplete and unknown (projected future) cohort mortality. Due to the differences between period- and cohort-type mortality schedules, the reported cohort survival of respondents' parents has a different age pattern than the finally estimated period life table. This difference becomes stronger in ages when the survivorship curve turns downward. Consequently, estimates based on younger ages of respondents are more robust than estimates based on older respondents. According to our empirical applications, age group 60-64 should be the highest to apply the orphanhood method.

The weighting factors derived from empirical data are slightly irregular as compared to weighting factors derived from theoretical population models. Generally, ages at childbirth below 30.0 should lead to weighting factors below 1.0, and ages at childbirth above age 30.0 should lead to weighting factors above 1.0. In many cases around the average age at childbirth of 30.0, the weighting factors derived from empirical data diverge from this expected pattern (see Tab. A.7-A.10). The weighting factors relate the survivorship probabilities from age 30 of the reference period life table to the reconstructed cohort survival from flexible ages at childbirth. Mainly in the 1950s and 1960s the trend of steadily increasing life expectancy in Italy was interrupted by short decreases in life expectancy of up to one year. The reference periods for the derivation of the weighting factors, however, lie between 1970 and 1996. During these years no such decreases occurred anymore. Thus, if the cohorts of respondents' parents went through a phase of decreasing life expectancy (increasing mortality) it could happen that, for instance, l(61)/l(28) of the cohorts is lower than l(63)/l(30) of the corresponding period life table and thus, the weighting factor W(28) rises above 1.0. This example demonstrates why we call for using as many empirical data for applying the orphanhood method as possible: When we know that the cohorts of respondents' parents went through years of increased mortality than we should take this knowledge into account.

While testing the proposed method we also compared the reported proportions of respondents with father/mother alive to the corresponding survival functions reconstructed from the empirical mortality data of the cohorts of respondents' parents. It turned out that the reported survival of the parents differs slightly from the reconstructed survival (as finally reflected by the differences between the orphanhood-based estimates for period life expectancy and the HMD data as presented in Section 4). These deviations might be caused by five different factors: (i) orphanhood-based survivorship estimates refer exclusively to people with children, (ii) people with more children have a slightly higher weighting than people with fewer children, (iii) the simplification of using only the survival of the cohorts alive at the mid-year of the five births years of respondents of a specific age group (instead of using all five calendar years), (iv) the modelled fertility schedules do not give the correct weights to each cohort of parents, and (v) the sample error of the multipurpose surveys. Consequently, the orphanhood method can hardly be used for estimating the life expectancy of the total population. However, since the mentioned effects can be assumed to affect population subgroups equally, orphanhood-based estimates can be used to analyse differences in life expectancy between subgroups and changes of these differences over time. Caution is needed when comparing the results of orphanhood-based estimates with direct estimates of mortality differentials for the total population. The mortality of a population of parents is lower than the mortality of the total population and consequently, the variability between subgroups must be lower as well.

The lower mortality level of a population of parents compared to the total population as necessarily obtained by orphanhood-based estimates does not, however, reduce or qualify the applicability of the proposed method. It is important to note that the goal of the EOM is not to provide a new or alternative estimate for the life expectancy of the population. The goal is to provide a tool for estimating differentials in life expectancy that cannot be analysed otherwise due to the lack of statistical data. Thus, the EOM should not be seen as an alternative to direct life table estimation, but as an alternative to having no data for specific research questions. The results obtained from applying the EOM to the empirical survey data suggest that the method can in fact provide important insights into trends and levels of mortality differentials when official data on the characteristics of interest are not available.

Nevertheless, as Timæus (1991c) has outlined in detail, indirect methods like the orphanhood method always entail several drawbacks. First, indirect methods can provide only broad measures of the overall level and trend in adult mortality. They are inherently unable to detect short-term trends or abnormal age patterns of mortality within adulthood. A further limitation of the orphanhood method is that it yields estimates of mortality that refer to dates well before the survey was conducted. Deaths of parents occur over a period extending back to when respondents were born in the case of mothers and about nine months earlier for fathers. The younger the respondents the more recent are the derived mortality estimates. But even the estimates based on the reports of respondents aged 20-24 refer to a period about eight years prior to the survey. On the other side, the orphanhood method and other indirect methods have some advantages over direct methods of estimating mortality. One is that the information used is based on respondents' lifetime experience and thus, fairly precise estimates of the proportions of respondents with living parents (or other relatives) can be obtained even from surveys of moderate size, such as those conducted by the Gender and Generations Program (GGP). Furthermore, knowing the general functionality of this method, information on interesting aspects of mortality can be collected quite easily and at a moderate cost by including a few simple questions into existing or planned survey programs. Information about the level and trend of mortality differentials is often sufficient to provide a basis for forecasting and the allocation of resources.

Using the described techniques of modelling theoretical fertility schedules for variable ages at childbirth and of reconstructing the corresponding survival experiences, the EOM can be transformed to any other survey data including information on parental survival. The paper demonstrates how empirical data can be used to adjust the orphanhood method accordingly. The question is if it is possible to improve the estimates by combining the orphanhood information of two neighbouring age groups as done by most of the traditional approaches. This could make the estimates more stable and less susceptible to fluctuations resulting from low case numbers in the survey data. We decided to restrict the weighting factors to single five-year age groups for two reasons. First, such an extension of the method would make its replication more difficult. The empirical applications carried out so far did not provide fluctuations of an extent that would justify a further complication of the method. Second, we have to point out once more that the major objective of this method is not to estimate precisely the level of life expectancy of the total population. Thus, we concluded that the losses caused by a further complication of the method would be higher than the gains. For the same reason we refrained from adjusting the male weighting factors and reference year parameters for the gestation period. However, when replicating the method to any survey this adjustment can be incorporated if deemed necessary.

Finally, the empirical applications of the proposed extension of the orphanhood method provide important information for its traditional variants. The fact that the traditional approaches of Brass and Hill (1973) and Timæus (1992) and the method of reference date estimation by Brass and Bamgboye (1981) do not perform well in the application to Italian survey data does not mean that they do not work for populations of developing countries. The results presented in this paper reveal that the underlying mortality models of these methods are too different from the mortality of a developed population to be useful here. In developing countries with high mortality levels they should be more appropriate. Our empirical analysis provided a similar U-shaped pattern of the orphanhood-based estimates as observed in developing countries. Thus, this shape seems to be a typical characteristic of results obtained by the orphanhood method rather than being unrealistic as described by Hill (1984). This observation and the theoretical considerations and empirical outcomes regarding the lower mortality levels of parous women and men suggest that these relations hold in every population, regardless of being from a developed or a developing country. The comparison between EOM estimates and HMD data clearly shows that the mortality difference between a population of parents and the total population caused by these factors is bigger in practice than described by Palloni et al. (1984). According to our knowledge, this effect is not adjusted for in the traditional methods which were developed to obtain estimates of adult mortality for the total population. A further adjustment of the traditional methods to overcome this underestimation of the overall mortality level might be useful.

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Appendix

Table A.1 Parameters of the modeled female fertility patterns for different ages at childbirth, ages 22-28.

Cohort	Parameter	Average age at childbirth						
		22	**23**	**24**	**25**	**26**	**27**	**28**
1933-1937	Schmertm. P	19.75	20.25	21.00	22.00	23.00	24.00	25.00
	Schmertm. f(P)	0.172	0.172	0.172	0.172	0.172	0.172	0.172
	Schmertm. H	24.68	25.68	27.18	29.18	31.18	33.18	35.18
	Brass α	0.081	-0.038	-0.041	0.044	0.091	0.093	0.077
1938-1942	Schmertm. P	18.75	19.25	20.00	21.00	22.00	23.00	24.00
	Schmertm. f(P)	0.168	0.168	0.168	0.168	0.168	0.168	0.168
	Schmertm. H	24.49	25.49	26.99	28.99	30.99	32.99	34.99
	Brass α	-0.065	-0.124	-0.083	0.027	0.074	0.085	0.077
1943-1947	Schmertm. P	19.25	19.75	20.25	21.00	22.00	23.00	24.00
	Schmertm. f(P)	0.155	0.155	0.155	0.155	0.155	0.155	0.155
	Schmertm. H	23.63	24.63	25.63	27.13	29.13	31.13	33.13
	Brass α	-0.362	-0.442	-0.497	-0.414	-0.248	-0.138	-0.092
1948-1952	Schmertm. P	19.25	19.75	20.25	21.00	22.00	23.00	24.00
	Schmertm. f(P)	0.158	0.158	0.158	0.158	0.158	0.158	0.158
	Schmertm. H	23.89	24.89	25.89	27.39	29.39	31.39	33.39
	Brass α	-0.210	-0.300	-0.379	-0.338	-0.202	-0.123	-0.093
1953-1957	Schmertm. P	19.75	20.25	21.00	22.00	23.00	24.00	25.00
	Schmertm. f(P)	0.147	0.147	0.147	0.147	0.147	0.147	0.147
	Schmertm. H	23.80	24.80	26.30	28.30	30.30	32.30	34.30
	Brass α	-0.232	-0.308	-0.250	-0.109	-0.003	0.043	0.052
1958-1962	Schmertm. P	20.25	20.75	21.25	22.00	23.00	24.00	25.00
	Schmertm. f(P)	0.160	0.160	0.160	0.160	0.160	0.160	0.160
	Schmertm. H	23.52	24.52	25.52	27.02	29.02	31.02	33.02
	Brass α	-0.360	-0.432	-0.486	-0.391	-0.215	-0.082	-0.019
1963-1967	Schmertm. P	20.25	20.75	21.25	22.00	23.00	24.00	25.00
	Schmertm. f(P)	0.175	0.175	0.175	0.175	0.175	0.175	0.175
	Schmertm. H	23.11	24.11	25.11	26.61	28.61	30.61	32.61
	Brass α	-0.543	-0.584	-0.618	-0.499	-0.291	-0.139	-0.038

Table A.1 continued on the next page

Table A.1 (continued)

Cohort	Parameter	Average age at childbirth						
		22	**23**	**24**	**25**	**26**	**27**	**28**
1968-1972	Schmertm. P	20.25	20.75	21.25	22.00	23.00	24.00	**25.00**
	Schmertm. f(P)	0.169	0.169	0.169	0.169	0.169	0.169	**0.169**
	Schmertm. H	24.09	25.09	26.09	27.59	29.59	31.59	**33.59**
	Brass α	-0.173	-0.260	-0.326	-0.256	-0.102	0.013	**0.058**
1973-1977	Schmertm. P	20.25	20.75	21.25	22.00	23.00	24.00	**25.00**
	Schmertm. f(P)	0.153	0.153	0.153	0.153	0.153	0.153	**0.153**
	Schmertm. H	23.22	24.22	25.22	26.72	28.72	30.72	**32.72**
	Brass α	-0.488	-0.541	-0.586	-0.480	-0.284	-0.131	**-0.038**
1978-1982	Schmertm. P	20.50	21.00	21.50	22.25	23.00	24.00	**25.00**
	Schmertm. f(P)	0.125	0.125	0.125	0.125	0.125	0.125	**0.125**
	Schmertm. H	23.43	24.43	25.43	26.93	28.43	30.43	**32.43**
	Brass α	-0.461	-0.521	-0.566	-0.457	-0.372	-0.211	**-0.093**

Notes: Schmertmann's α is constantly kept at 14.0 years; resulting fertility patterns lead to average ages at childbirth given the real age composition of the Italian population at the time of respondents' birth; cohort 1933-37 reflects respondents aged 60-64 of the 1998 survey, cohort 1938-42 reflects respondents aged 55-59 of the 1998 survey and respondents aged 60-64 of the 2003 survey, etc.; bold printed values represent the baseline fertility schedule.

Table A.2 Parameters of the modeled female fertility patterns for different ages at childbirth, ages 29-35.

		Average age at childbirth						
Cohort	**Parameter**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
1933-1937	Schmertm. P	26.00	**27.00**	29.00	31.00	33.00	35.00	37.00
	Schmertm. f(P)	0.172	**0.172**	0.172	0.172	0.172	0.172	0.172
	Schmertm. H	37.18	**39.18**	40.18	41.18	42.18	43.18	44.18
	Brass α	0.057	**0.037**	-0.031	0.027	0.029	0.020	-0.002
1938-1942	Schmertm. P	25.00	**26.00**	28.00	30.00	32.00	34.00	36.00
	Schmertm. f(P)	0.168	**0.168**	0.168	0.168	0.168	0.168	0.168
	Schmertm. H	36.99	**38.99**	39.99	40.99	41.99	42.99	43.99
	Brass α	0.060	**0.040**	0.022	0.007	-0.001	-0.004	-0.030
1943-1947	Schmertm. P	25.00	26.00	**27.00**	29.00	31.00	33.00	35.00
	Schmertm. f(P)	0.155	0.155	**0.155**	0.155	0.155	0.155	0.155
	Schmertm. H	35.13	37.13	**39.13**	40.13	41.13	42.13	43.13
	Brass α	-0.074	-0.069	**-0.070**	-0.068	-0.067	-0.070	-0.085
1948-1952	Schmertm. P	25.00	**26.00**	28.00	30.00	32.00	34.00	36.00
	Schmertm. f(P)	0.158	**0.158**	0.158	0.158	0.158	0.158	0.158
	Schmertm. H	35.39	**37.39**	38.39	39.39	40.39	41.39	42.39
	Brass α	-0.084	**-0.082**	-0.085	-0.081	-0.071	-0.059	-0.075
1953-1957	Schmertm. P	**26.00**	28.00	30.00	32.00	34.00	36.00	38.00
	Schmertm. f(P)	**0.147**	0.147	0.147	0.147	0.147	0.147	0.147
	Schmertm. H	**36.30**	37.30	38.30	39.30	40.30	41.30	42.30
	Brass α	**0.045**	0.028	0.016	0.008	0.004	-0.023	-0.046
1958-1962	Schmertm. P	**26.00**	28.00	30.00	32.00	34.00	36.00	38.00
	Schmertm. f(P)	**0.160**	0.160	0.160	0.160	0.160	0.160	0.160
	Schmertm. H	**35.02**	36.02	37.02	38.02	39.02	40.02	41.02
	Brass α	**-0.002**	-0.022	-0.039	-0.054	-0.070	-0.120	-0.185
1963-1967	Schmertm. P	**26.00**	28.00	30.00	32.00	34.00	36.00	38.00
	Schmertm. f(P)	**0.175**	0.175	0.175	0.175	0.175	0.175	0.175
	Schmertm. H	**34.61**	35.61	36.61	37.61	38.61	39.61	40.61
	Brass α	**-0.002**	-0.025	-0.044	-0.060	-0.077	-0.130	-0.184
1968-1972	Schmertm. P	27.00	29.00	31.00	33.00	35.00	36.50	37.50
	Schmertm. f(P)	0.169	0.169	0.169	0.169	0.169	0.169	0.169
	Schmertm. H	34.59	35.59	36.59	37.59	38.59	39.34	40.09
	Brass α	0.036	0.016	-0.005	-0.032	-0.080	-0.176	-0.271

Table A.2 continued on the next page

Table A.2 (continued)

Cohort	Parameter	Average age at childbirth						
		29	**30**	**31**	**32**	**33**	**34**	**35**
1973-1977	Schmertm. P	27.00	29.00	31.00	33.00	35.00	36.50	37.50
	Schmertm. f(P)	0.153	0.153	0.153	0.153	0.153	0.153	0.153
	Schmertm. H	33.72	34.72	35.72	36.72	37.72	38.47	39.22
	Brass α	-0.076	-0.115	-0.160	-0.192	-0.235	-0.340	-0.443
1978-1982	Schmertm. P	27.00	29.00	31.00	32.50	34.00	35.00	36.00
	Schmertm. f(P)	0.125	0.125	0.125	0.125	0.125	0.125	0.125
	Schmertm. H	33.43	34.43	35.43	36.18	36.93	37.68	38.43
	Brass α	-0.131	-0.175	-0.223	-0.315	-0.412	-0.523	-0.633

Notes: Schmertmann's α is constantly kept at 14.0 years; resulting fertility patterns lead to average ages at childbirth given the real age composition of the Italian population at the time of respondents' birth; cohort 1933-37 reflects respondents aged 60-64 of the 1998 survey, cohort 1938-42 reflects respondents aged 55-59 of the 1998 survey and respondents aged 60-64 of the 2003 survey, etc.; bold printed values represent the baseline fertility schedule.

Table A.3 Parameters of the modeled male fertility patterns for different ages at childbirth, ages 24-30.

		Average age at childbirth						
Cohort	**Parameter**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1933-1937	Schmertm. P	23.25	23.75	24.25	24.75	25.25	26.00	27.00
	Schmertm. f(P)	0.172	0.172	0.172	0.172	0.172	0.172	0.172
	Schmertm. H	27.68	28.68	29.68	30.68	31.68	33.18	35.18
	Brass α	0.470	0.298	0.155	0.037	-0.064	-0.064	-0.008
1938-1942	Schmertm. P	22.25	22.75	23.25	23.75	24.25	25.00	26.00
	Schmertm. f(P)	0.168	0.168	0.168	0.168	0.168	0.168	0.168
	Schmertm. H	27.49	28.49	29.49	30.49	31.49	32.99	34.99
	Brass α	0.459	0.332	0.221	0.119	0.023	0.018	0.042
1943-1947	Schmertm. P	23.25	23.75	24.25	24.75	25.25	26.00	27.00
	Schmertm. f(P)	0.155	0.155	0.155	0.155	0.155	0.155	0.155
	Schmertm. H	27.63	28.63	29.63	30.63	31.63	33.13	35.13
	Brass α	0.360	0.227	0.129	0.053	-0.009	0.018	0.094
1948-1952	Schmertm. P	22.25	22.75	23.25	23.75	24.25	25.00	26.00
	Schmertm. f(P)	0.158	0.158	0.158	0.158	0.158	0.158	0.158
	Schmertm. H	25.89	26.89	27.89	28.89	29.89	31.39	33.39
	Brass α	-0.042	-0.184	-0.297	-0.383	-0.445	-0.377	-0.219
1953-1957	Schmertm. P	23.25	23.75	24.25	24.75	25.25	26.00	27.00
	Schmertm. f(P)	0.147	0.147	0.147	0.147	0.147	0.147	0.147
	Schmertm. H	26.80	27.80	28.80	29.80	30.80	32.30	34.30
	Brass α	0.289	0.136	0.007	-0.102	-0.196	-0.178	-0.066
1958-1962	Schmertm. P	23.25	23.75	24.25	24.75	25.25	26.00	27.00
	Schmertm. f(P)	0.160	0.160	0.160	0.160	0.160	0.160	0.160
	Schmertm. H	25.52	26.52	27.52	28.52	29.52	31.02	33.02
	Brass α	-0.182	-0.290	-0.370	-0.432	-0.484	-0.401	-0.238
1963-1967	Schmertm. P	23.75	24.25	24.75	25.25	25.75	26.25	27.00
	Schmertm. f(P)	0.175	0.175	0.175	0.175	0.175	0.175	0.175
	Schmertm. H	26.11	27.11	28.11	29.11	30.11	31.11	32.61
	Brass α	0.090	-0.054	-0.169	-0.258	-0.329	-0.386	-0.316
1968-1972	Schmertm. P	23.75	24.25	24.75	25.25	25.75	26.25	27.00
	Schmertm. f(P)	0.169	0.169	0.169	0.169	0.169	0.169	0.169
	Schmertm. H	27.09	28.09	29.09	30.09	31.09	32.09	33.59
	Brass α	0.324	0.184	0.078	-0.006	-0.077	-0.137	-0.097

Table A.3 continued on the next page

Table A.3 (continued)

		Average age at childbirth						
Cohort	**Parameter**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
1973-1977	Schmertm. P	23.75	24.25	24.75	25.25	25.75	26.25	27.00
	Schmertm. f(P)	0.153	0.153	0.153	0.153	0.153	0.153	0.153
	Schmertm. H	26.22	27.22	28.22	29.22	30.22	31.22	32.72
	Brass α	0.123	-0.029	-0.151	-0.247	-0.321	-0.379	-0.307
1978-1982	Schmertm. P	23.75	24.25	24.75	25.25	25.75	26.25	27.00
	Schmertm. f(P)	0.125	0.125	0.125	0.125	0.125	0.125	0.125
	Schmertm. H	25.93	26.93	27.93	28.93	29.93	30.93	32.43
	Brass α	-0.030	-0.157	-0.250	-0.324	-0.386	-0.439	-0.365

Notes: Schmertmann's α is constantly kept at 18.0 years; resulting fertility patterns lead to average ages at childbirth given the real age composition of the Italian population at the time of respondents' birth; cohort 1933-37 reflects respondents aged 60-64 of the 1998 survey, cohort 1938-42 reflects respondents aged 55-59 of the 1998 survey and respondents aged 60-64 of the 2003 survey, etc.; bold printed values represent the baseline fertility schedule.

Table A.4 Parameters of the modeled male fertility patterns for different ages at childbirth, ages 31-37.

Cohort	Parameter	Average age at childbirth						
		31	32	33	34	35	36	37
1933-1937	Schmertm. P	28.00	29.00	30.00	**31.00**	33.00	35.00	37.00
	Schmertm. f(P)	0.172	0.172	0.172	**0.172**	0.172	0.172	0.172
	Schmertm. H	37.18	39.18	41.18	**43.18**	44.18	45.18	46.18
	Brass α	0.003	-0.002	-0.014	**-0.026**	-0.026	-0.022	-0.015
1938-1942	Schmertm. P	27.00	28.00	29.00	**30.00**	32.00	34.00	36.00
	Schmertm. f(P)	0.168	0.168	0.168	**0.168**	0.168	0.168	0.168
	Schmertm. H	36.99	38.99	40.99	**42.99**	43.99	44.99	45.99
	Brass α	0.033	0.009	-0.020	**-0.047**	-0.064	-0.072	-0.075
1943-1947	Schmertm. P	28.00	29.00	30.00	**31.00**	33.00	35.00	37.00
	Schmertm. f(P)	0.155	0.155	0.155	**0.155**	0.155	0.155	0.155
	Schmertm. H	37.13	39.13	41.13	**43.13**	44.13	45.13	46.13
	Brass α	0.118	0.118	0.105	**0.087**	0.074	0.062	0.052
1948-1952	Schmertm. P	27.00	28.00	29.00	**30.00**	32.00	34.00	36.00
	Schmertm. f(P)	0.158	0.158	0.158	**0.158**	0.158	0.158	0.158
	Schmertm. H	35.39	37.39	39.39	**41.39**	42.39	43.39	44.39
	Brass α	-0.127	-0.087	-0.070	**-0.064**	-0.060	-0.054	-0.051
1953-1957	Schmertm. P	28.00	29.00	**30.00**	32.00	34.00	36.00	38.00
	Schmertm. f(P)	0.147	0.147	**0.147**	0.147	0.147	0.147	0.147
	Schmertm. H	36.30	38.30	**40.30**	41.30	42.30	43.30	44.30
	Brass α	-0.009	0.010	**0.014**	0.007	0.007	0.014	0.025
1958-1962	Schmertm. P	28.00	29.00	**30.00**	32.00	34.00	36.00	38.00
	Schmertm. f(P)	0.160	0.160	**0.160**	0.160	0.160	0.160	0.160
	Schmertm. H	35.02	37.02	**39.02**	40.02	41.02	42.02	43.02
	Brass α	-0.118	-0.062	**-0.047**	-0.070	-0.089	-0.105	-0.122
1963-1967	Schmertm. P	28.00	29.00	**30.00**	32.00	34.00	36.00	38.00
	Schmertm. f(P)	0.175	0.175	**0.175**	0.175	0.175	0.175	0.175
	Schmertm. H	34.61	36.61	**38.61**	39.61	40.61	41.61	42.61
	Brass α	-0.168	-0.075	**-0.045**	-0.066	-0.084	-0.102	-0.122
1968-1972	Schmertm. P	28.00	**29.00**	31.00	33.00	35.00	37.00	39.00
	Schmertm. f(P)	0.169	**0.169**	0.169	0.169	0.169	0.169	0.169
	Schmertm. H	35.59	**37.59**	38.59	39.59	40.59	41.59	42.59
	Brass α	0.012	**0.052**	0.028	0.004	-0.019	-0.044	-0.089

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Table A.4 (continued)

Cohort	**Parameter**	**Average age at childbirth**						
		31	**32**	**33**	**34**	**35**	**36**	**37**
1973-1977	Schmertm. P	28.00	**29.00**	31.00	33.00	35.00	37.00	39.00
	Schmertm. f(P)	0.153	**0.153**	0.153	0.153	0.153	0.153	0.153
	Schmertm. H	34.72	**36.72**	37.72	38.72	39.72	40.72	41.72
	Brass α	-0.149	**-0.053**	-0.085	-0.118	-0.159	-0.195	-0.243
1978-1982	Schmertm. P	28.00	**29.00**	31.00	33.00	35.00	37.00	39.00
	Schmertm. f(P)	0.125	**0.125**	0.125	0.125	0.125	0.125	0.125
	Schmertm. H	34.43	**36.43**	37.43	38.43	39.43	40.43	41.43
	Brass α	-0.208	**-0.094**	-0.137	-0.186	-0.232	-0.268	-0.312

Notes: Schmertmann's α is constantly kept at 18.0 years; resulting fertility patterns lead to average ages at childbirth given the real age composition of the Italian population at the time of respondents' birth; cohort 1933-37 reflects respondents aged 60-64 of the 1998 survey, cohort 1938-42 reflects respondents aged 55-59 of the 1998 survey and respondents aged 60-64 of the 2003 survey, etc.; bold printed values represent the baseline fertility schedule.

Table A.5 Estimated age at childbirth of all mothers of 1998 survey respondents by information on age at childbirth of surviving mothers only.

Age at child-birth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	22.01	22.02	22.02	22.04	22.10	22.24	22.40	23.00	22.93
23	23.01	23.03	23.03	23.06	23.15	23.34	23.56	24.28	24.32
24	24.01	24.04	24.04	24.09	24.23	24.47	24.75	25.81	25.98
25	25.02	25.06	25.06	25.14	25.41	25.73	26.09	27.65	28.00
26	26.04	26.10	26.11	26.24	26.67	27.18	27.72	29.19	29.84
27	27.07	27.15	27.19	27.39	27.88	28.53	29.26	30.57	31.34
28	28.09	28.18	28.27	28.51	29.05	29.78	30.60	31.88	32.68
29	29.09	29.18	29.33	29.61	30.21	30.99	31.87	33.14	33.90
30	30.08	30.17	30.33	30.61	31.23	32.18	33.09	34.38	35.06
31	31.08	31.17	31.32	31.61	32.25	33.17	34.30	35.31	35.96
32	32.07	32.16	32.32	32.62	33.28	34.15	35.23	36.24	36.66
33	33.06	33.15	33.31	33.62	34.31	35.13	36.18	37.15	37.47
34	34.06	34.14	34.29	34.62	35.34	36.12	37.16	38.06	38.31
35	35.06	35.14	35.27	35.60	36.37	37.13	38.15	38.98	39.18

Note: age at childbirth in the left column refers to surviving mothers only, representing the available information from the multipurpose survey.

Table A.6 Estimated age at childbirth of all fathers of 1998 survey respondents by information on age at childbirth of surviving fathers only.

Age at child-birth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	24.01	24.05	24.04	24.07	24.23	24.33	24.78	24.95	25.11
25	25.02	25.07	25.06	25.11	25.32	25.47	26.00	26.23	26.46
26	26.03	26.09	26.10	26.15	26.43	26.65	27.24	27.57	27.84
27	27.05	27.13	27.14	27.21	27.58	27.87	28.51	28.99	29.24
28	28.07	28.17	28.20	28.28	28.76	29.11	29.82	30.47	30.66
29	29.09	29.23	29.27	29.43	30.10	30.53	31.42	32.19	32.36
30	30.14	30.34	30.40	30.71	31.66	32.22	33.07	33.76	34.04
31	31.24	31.49	31.64	32.10	33.05	33.70	34.46	35.13	35.38
32	32.32	32.60	32.87	33.40	34.32	34.99	35.74	36.38	36.56
33	33.31	33.59	34.03	34.62	35.54	36.19	36.96	37.56	37.66
34	34.29	34.58	35.01	35.59	36.49	37.35	38.15	38.69	38.71
35	35.25	35.57	35.99	36.56	37.44	38.20	39.05	39.50	39.45
36	36.23	36.54	36.96	37.53	38.38	39.06	39.95	40.30	40.21
37	37.21	37.50	37.92	38.51	39.33	39.96	40.88	41.11	41.01

Note: age at childbirth in the left column refers to surviving fathers only, representing the available information from the multipurpose survey.

Table A.7 Estimated age at childbirth of all mothers of 2003 survey respondents by information on age at childbirth of surviving mothers only.

Age at child-birth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	22.01	22.01	22.03	22.03	22.06	22.16	22.37	22.61	23.42
23	23.01	23.02	23.05	23.04	23.09	23.22	23.52	23.84	24.81
24	24.01	24.02	24.06	24.06	24.13	24.36	24.73	25.11	26.57
25	25.02	25.04	25.09	25.10	25.21	25.64	26.11	26.58	28.73
26	26.04	26.07	26.15	26.17	26.37	27.05	27.77	28.49	30.39
27	27.06	27.11	27.22	27.30	27.61	28.37	29.27	30.21	31.80
28	28.08	28.15	28.27	28.42	28.80	29.62	30.60	31.62	33.07
29	29.08	29.14	29.27	29.51	29.96	30.85	31.87	32.91	34.28
30	30.07	30.13	30.26	30.50	30.96	31.87	33.10	34.14	35.43
31	31.06	31.11	31.25	31.50	31.96	32.90	34.04	35.34	36.21
32	32.06	32.10	32.24	32.49	32.96	33.92	34.97	36.18	36.99
33	33.05	33.09	33.22	33.48	33.96	34.95	35.90	37.03	37.77
34	34.05	34.08	34.21	34.45	34.95	35.98	36.84	37.93	38.57
35	35.05	35.08	35.21	35.42	35.93	37.00	37.80	38.83	39.38

Note: age at childbirth in the left column refers to surviving mothers only, representing the available information from the multipurpose survey.

Table A.8 Estimated age at childbirth of all fathers of 2003 survey respondents by information on age at childbirth of surviving fathers only.

Age at child-birth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	24.01	24.02	24.08	24.06	24.11	24.31	24.45	25.01	25.14
25	25.01	25.03	25.11	25.09	25.15	25.44	25.63	26.27	26.44
26	26.02	26.05	26.14	26.14	26.21	26.59	26.87	27.54	27.80
27	27.03	27.07	27.19	27.20	27.29	27.79	28.14	28.84	29.24
28	28.04	28.10	28.26	28.28	28.39	29.04	29.44	30.18	30.75
29	29.06	29.14	29.34	29.38	29.60	30.49	30.95	31.83	32.49
30	30.10	30.22	30.49	30.57	30.99	32.20	32.76	33.52	34.05
31	31.17	31.36	31.72	31.91	32.52	33.68	34.29	34.89	35.38
32	32.26	32.48	32.87	33.23	33.91	35.00	35.58	36.13	36.59
33	33.24	33.46	33.86	34.45	35.19	36.24	36.76	37.31	37.74
34	34.22	34.43	34.84	35.42	36.14	37.15	37.88	38.46	38.84
35	35.19	35.38	35.81	36.37	37.08	38.04	38.66	39.29	39.61
36	36.17	36.34	36.77	37.33	38.03	38.93	39.46	40.15	40.38
37	37.15	37.31	37.71	38.27	38.98	39.84	40.29	41.03	41.17

Note: age at childbirth in the left column refers to surviving fathers only, representing the available information from the multipurpose survey.

Table A.9 Weighting factors W(n) for conversion of proportions of 1998 survey respondents aged (n, n+4) with mother alive into female survivorship probabilities l(33+n)/l(30).

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	0.98567	0.97569	0.95792	0.92670	0.87537	0.78479	0.59822	0.41730	0.19416
23	0.98703	0.97826	0.96163	0.93326	0.88668	0.80341	0.63582	0.44311	0.22649
24	0.98859	0.98109	0.96583	0.94068	0.90150	0.82606	0.67891	0.48430	0.26801
25	0.99057	0.98451	0.97110	0.94999	0.92209	0.85822	0.73569	0.55359	0.32277
26	0.99305	0.98889	0.97794	0.96261	0.94906	0.90604	0.81209	0.63587	0.40553
27	0.99599	0.99384	0.98660	0.97872	0.97669	0.95477	0.89000	0.73701	0.51801
28	0.99902	0.99864	0.99587	0.99505	1.00541	1.00468	0.97191	0.86893	0.69640
29	1.00109	1.00230	1.00507	1.01196	1.03686	1.05980	1.06631	1.04142	0.88803
30	1.00332	1.00631	1.01235	1.02530	1.06363	1.12239	1.17988	1.22732	1.11175
31	1.00562	1.01070	1.02040	1.04036	1.09437	1.17781	1.31931	1.43061	1.37102
32	1.00816	1.01552	1.02925	1.05743	1.13002	1.24232	1.44310	1.70699	1.76860
33	1.01107	1.02068	1.03899	1.07694	1.17149	1.31861	1.59995	2.09732	2.33314
34	1.01430	1.02645	1.04944	1.09913	1.21912	1.41160	1.80487	2.65982	3.25115
35	1.01812	1.03345	1.06109	1.12412	1.27353	1.52740	2.06888	3.53043	4.97225

Note: l(33+n)/l(30) = S(n)·W(n).

Table A.10 Weighting factors W(n) for conversion of proportions of 1998 survey respondents aged (n, n+4) with father alive into male survivorship probabilities l(33+n)/l(30).

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	0.97656	0.95509	0.91333	0.85884	0.79717	0.69034	0.50661	0.31885	0.16749
25	0.97883	0.96131	0.92346	0.87603	0.82466	0.72693	0.54902	0.36106	0.20630
26	0.98181	0.96832	0.93534	0.89547	0.85636	0.77061	0.60449	0.41605	0.25082
27	0.98553	0.97634	0.94913	0.91756	0.89309	0.82225	0.67380	0.48885	0.31198
28	0.99003	0.98564	0.96501	0.94286	0.93622	0.88319	0.76221	0.60162	0.41274
29	0.99540	0.99642	0.98326	0.97476	0.99266	0.96421	0.89695	0.78304	0.61082
30	1.00257	1.01070	1.00646	1.01623	1.06822	1.07916	1.05001	0.98920	0.88771
31	1.01257	1.02877	1.03720	1.06844	1.14719	1.19972	1.21544	1.25336	1.41533
32	1.02314	1.04656	1.07081	1.12282	1.23162	1.32066	1.42518	1.61601	2.21189
33	1.02954	1.05999	1.10490	1.17997	1.32612	1.45939	1.70108	2.13136	3.10198
34	1.03648	1.07536	1.13278	1.22940	1.41240	1.62923	2.10847	2.88384	4.49205
35	1.04394	1.09266	1.16420	1.28520	1.51307	1.82438	2.59995	4.18968	6.13744
36	1.05307	1.11192	1.19971	1.34841	1.63024	2.07167	3.22367	5.57768	7.67791
37	1.06408	1.13321	1.23927	1.42112	1.76996	2.39980	4.07716	7.80446	13.04529

Note: l(33+n)/l(30) = S(n)·W(n).

Table A.11 Weighting factors W(n) for conversion of proportions of 2003 survey respondents aged (n,n+4) with mother alive into female survivorship probabilities l(33+n)/l(30).

Age at childbirth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	0.98585	0.97720	0.96366	0.93730	0.89023	0.81333	0.68289	0.48641	0.26632
23	0.98683	0.97928	0.96736	0.94262	0.89947	0.82933	0.71056	0.52797	0.30359
24	0.98805	0.98165	0.97145	0.94876	0.91028	0.85097	0.74510	0.57702	0.36447
25	0.98973	0.98460	0.97645	0.95668	0.92448	0.88204	0.79397	0.63977	0.47096
26	0.99168	0.98831	0.98303	0.96726	0.94437	0.92438	0.86540	0.74199	0.60278
27	0.99425	0.99273	0.99058	0.98083	0.97041	0.96909	0.94151	0.86740	0.74718
28	0.99706	0.99731	0.99792	0.99543	0.99702	1.01610	1.02266	0.99999	0.94519
29	0.99876	1.00044	1.00343	1.01001	1.02488	1.06877	1.11565	1.15783	1.27622
30	1.00060	1.00379	1.00948	1.02137	1.04666	1.11441	1.22519	1.35906	1.86436
31	1.00267	1.00724	1.01616	1.03404	1.07164	1.16808	1.32685	1.62986	2.75831
32	1.00508	1.01106	1.02352	1.04812	1.10043	1.23193	1.44952	1.93388	3.68134
33	1.00778	1.01547	1.03145	1.06381	1.13398	1.30837	1.60060	2.36615	5.92530
34	1.01091	1.02041	1.04042	1.08083	1.17287	1.39898	1.79315	2.98539	11.31010
35	1.01424	1.02633	1.05153	1.10011	1.21744	1.50600	2.04380	3.84968	21.40042

Note: l(33+n)/l(30) = S(n)·W(n).

Table A.12 Weighting factors W(n) for conversion of proportions of 2003 survey respondents aged (n, n+4) with father alive into male survivorship probabilities l(33+n)/l(30).

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	0.97597	0.95665	0.92786	0.87229	0.80155	0.72247	0.59930	0.40523	0.19869
25	0.97778	0.96084	0.93743	0.88649	0.82458	0.75911	0.64756	0.45411	0.24700
26	0.98006	0.96604	0.94801	0.90318	0.85091	0.80266	0.70673	0.50703	0.26375
27	0.98293	0.97229	0.95990	0.92263	0.88129	0.85471	0.77441	0.57074	0.30537
28	0.98646	0.97978	0.97350	0.94521	0.91673	0.91778	0.85495	0.65490	0.49091
29	0.99090	0.98854	0.98940	0.97141	0.96249	1.00359	0.96373	0.79734	0.61830
30	0.99697	0.99980	1.01068	1.00518	1.02392	1.12336	1.12525	1.02825	0.84684
31	1.00522	1.01515	1.03787	1.05093	1.10553	1.25388	1.32059	1.30417	1.38444
32	1.01452	1.03142	1.06476	1.10191	1.19323	1.39910	1.53789	1.52326	2.13981
33	1.01980	1.04164	1.08524	1.15447	1.28819	1.56324	1.77875	2.09983	3.22601
34	1.02553	1.05264	1.10873	1.19774	1.37188	1.71461	2.08442	2.84922	5.48772
35	1.03179	1.06440	1.13528	1.24715	1.46909	1.89548	2.41409	3.64810	9.11659
36	1.03912	1.07871	1.16496	1.30390	1.58266	2.11373	2.84764	5.00311	17.51528
37	1.04750	1.09590	1.19795	1.36831	1.71659	2.39038	3.51176	7.51683	30.72635

Note: l(33+n)/l(30) = S(n)·W(n).

Table A.13 Parameters a(n) for the calculation of the time reference for female survivorship estimates from data on maternal orphanhood of the Italian 1998 multipurpose survey.

Age at childbirth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	-3.8842	-4.6669	-5.3222	-5.9339	-6.4772	-7.0401	-7.9610	-8.4826	-8.7452
23	-3.8562	-4.6220	-5.2791	-5.8771	-6.4106	-6.9387	-7.7832	-8.3077	-8.5427
24	-3.8278	-4.5810	-5.2296	-5.8362	-6.3525	-6.8386	-7.5836	-8.1087	-8.3801
25	-3.7985	-4.5436	-5.1924	-5.7947	-6.2660	-6.7048	-7.4221	-7.9112	-8.2798
26	-3.7713	-4.5100	-5.1580	-5.7364	-6.1584	-6.5332	-7.2391	-7.7803	-8.1730
27	-3.7435	-4.4821	-5.1258	-5.6766	-6.0861	-6.3974	-7.1007	-7.6855	-8.1145
28	-3.7248	-4.4599	-5.0894	-5.6411	-6.0264	-6.3042	-7.0069	-7.6115	-8.0679
29	-3.7106	-4.4349	-5.0689	-5.5997	-5.9578	-6.2556	-6.9348	-7.5531	-8.0256
30	-3.6981	-4.4197	-5.0543	-5.5707	-5.9229	-6.2146	-6.8781	-7.5073	-7.9821
31	-3.6881	-4.4066	-5.0316	-5.5561	-5.8751	-6.1954	-6.8336	-7.4723	-7.9390
32	-3.6800	-4.3954	-5.0211	-5.5302	-5.8295	-6.1774	-6.8086	-7.4461	-7.8956
33	-3.6737	-4.3861	-5.0023	-5.5062	-5.7854	-6.1600	-6.7851	-7.4257	-7.8401
34	-3.6685	-4.3708	-4.9955	-5.4842	-5.7545	-6.1426	-6.7657	-7.4054	-7.7753
35	-3.6628	-4.3641	-4.9807	-5.4646	-5.7359	-6.1264	-6.7551	-7.3814	-7.7021

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 1998.5.

Table A.14 Parameters a(n) for the calculation of the time reference for male survivorship estimates from data on paternal orphanhood of the Italian 1998 multipurpose survey.

Age at childbirth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	-3.9126	-4.6674	-5.2373	-5.6577	-5.8966	-6.1756	-7.1521	-8.0142	-8.2446
25	-3.8771	-4.6013	-5.1419	-5.5604	-5.8242	-6.1422	-7.1044	-7.9263	-8.2573
26	-3.8383	-4.5399	-5.0654	-5.4780	-5.7402	-6.1236	-7.0663	-7.8500	-8.2690
27	-3.7996	-4.4763	-4.9895	-5.3978	-5.6842	-6.1170	-7.0373	-7.7896	-8.2730
28	-3.7638	-4.4274	-4.9258	-5.3435	-5.6536	-6.1196	-7.0183	-7.7455	-8.2642
29	-3.7276	-4.3783	-4.8742	-5.2915	-5.6481	-6.1342	-7.0130	-7.7227	-8.2301
30	-3.7016	-4.3443	-4.8354	-5.2551	-5.6571	-6.1645	-7.0205	-7.7038	-8.1691
31	-3.6816	-4.3118	-4.8100	-5.2222	-5.6694	-6.1954	-7.0290	-7.6812	-8.0985
32	-3.6617	-4.2864	-4.7840	-5.2058	-5.6839	-6.2246	-7.0384	-7.6543	-8.0184
33	-3.6487	-4.2702	-4.7625	-5.2123	-5.7012	-6.2543	-7.0475	-7.6201	-7.9291
34	-3.6380	-4.2501	-4.7480	-5.2152	-5.7144	-6.2854	-7.0541	-7.5763	-7.8318
35	-3.6241	-4.2334	-4.7378	-5.2221	-5.7306	-6.3074	-7.0502	-7.5301	-7.7474
36	-3.6171	-4.2196	-4.7238	-5.2326	-5.7492	-6.3303	-7.0452	-7.4775	-7.6539
37	-3.6070	-4.2090	-4.7138	-5.2468	-5.7699	-6.3544	-7.0360	-7.4164	-7.5538

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 1998.5.

Table A.15 Parameters a(n) for the calculation of the time reference for female survivorship estimates from data on maternal orphanhood of the Italian 2003 multipurpose survey.

Age at childbirth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	-3.7883	-4.5922	-5.2812	-5.8522	-6.3933	-6.8154	-7.1910	-7.8923	-8.4796
23	-3.7729	-4.5509	-5.2307	-5.8114	-6.3316	-6.7402	-7.0623	-7.7658	-8.3478
24	-3.7557	-4.5041	-5.1878	-5.7740	-6.2880	-6.6544	-6.9182	-7.6450	-8.2045
25	-3.7369	-4.4686	-5.1406	-5.7242	-6.2254	-6.5332	-6.7638	-7.5124	-8.0784
26	-3.7197	-4.4405	-5.1085	-5.6878	-6.1545	-6.3902	-6.6538	-7.3770	-8.0107
27	-3.7043	-4.4186	-5.0812	-5.6370	-6.0787	-6.2932	-6.5829	-7.2894	-7.9690
28	-3.6880	-4.4014	-5.0598	-5.6063	-6.0035	-6.1987	-6.5391	-7.2401	-7.9396
29	-3.6780	-4.3859	-5.0334	-5.5695	-5.9542	-6.1310	-6.5096	-7.2100	-7.9155
30	-3.6682	-4.3660	-5.0205	-5.5430	-5.9238	-6.1167	-6.4899	-7.1938	-7.8912
31	-3.6588	-4.3577	-5.0100	-5.5313	-5.8951	-6.1044	-6.4878	-7.1884	-7.8617
32	-3.6511	-4.3524	-4.9910	-5.5084	-5.8537	-6.0941	-6.4879	-7.1895	-7.8290
33	-3.6454	-4.3493	-4.9840	-5.4876	-5.8289	-6.0853	-6.4896	-7.1904	-7.7897
34	-3.6433	-4.3471	-4.9775	-5.4819	-5.7921	-6.0769	-6.4927	-7.1922	-7.7391
35	-3.6433	-4.3448	-4.9606	-5.4654	-5.7589	-6.0689	-6.4983	-7.1964	-7.6751

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 2003.9.

Table A.16 Parameters a(n) for the calculation of the time reference for male survivorship estimates from data on paternal orphanhood of the Italian 2003 multipurpose survey.

Age at childbirth	Age n								
	20	25	30	35	40	45	50	55	60
24	-3.8228	-4.6505	-5.2639	-5.7086	-6.0259	-6.2122	-6.6013	-7.5466	-8.4206
25	-3.8183	-4.5904	-5.1856	-5.6136	-5.9319	-6.1773	-6.5893	-7.5233	-8.3543
26	-3.8053	-4.5312	-5.1072	-5.5316	-5.8681	-6.1542	-6.5901	-7.5081	-8.2940
27	-3.7860	-4.4771	-5.0505	-5.4644	-5.8058	-6.1427	-6.6012	-7.5000	-8.2418
28	-3.7630	-4.4233	-4.9938	-5.4116	-5.7572	-6.1421	-6.6204	-7.4989	-8.1955
29	-3.7389	-4.3865	-4.9478	-5.3605	-5.7121	-6.1546	-6.6515	-7.5101	-8.1572
30	-3.7101	-4.3597	-4.9131	-5.3357	-5.7164	-6.1818	-6.6992	-7.5247	-8.1087
31	-3.6906	-4.3360	-4.8899	-5.3042	-5.7316	-6.2095	-6.7418	-7.5301	-8.0477
32	-3.6766	-4.3180	-4.8716	-5.2809	-5.7494	-6.2375	-6.7781	-7.5277	-7.9762
33	-3.6584	-4.3045	-4.8516	-5.2705	-5.7689	-6.2664	-6.8106	-7.5165	-7.8947
34	-3.6464	-4.2868	-4.8359	-5.2744	-5.7828	-6.2882	-6.8402	-7.4948	-7.8038
35	-3.6362	-4.2789	-4.8159	-5.2825	-5.8002	-6.3116	-6.8573	-7.4592	-7.7172
36	-3.6292	-4.2671	-4.8080	-5.2945	-5.8206	-6.3357	-6.8714	-7.4163	-7.6278
37	-3.6197	-4.2592	-4.7957	-5.3097	-5.8437	-6.3601	-6.8813	-7.3645	-7.5337

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 2003.9.

Table A.17 Parameters b(n) for the calculation of the time reference for female survivorship estimates from data on maternal orphanhood of the Italian 1998 multipurpose survey.

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	9.1059	10.3230	11.2802	12.0865	12.5385	12.7265	12.9860	11.5556	8.8254
23	8.9739	10.1946	11.1820	11.9596	12.3507	12.4045	12.4549	10.7838	7.7023
24	8.8578	10.0890	11.0921	11.8239	12.1076	12.0595	11.9242	9.8852	6.4620
25	8.7612	10.0007	10.9906	11.6662	11.7961	11.6371	11.2596	8.8719	5.0620
26	8.6917	9.9159	10.8750	11.4712	11.4461	11.1256	10.4853	7.9770	3.6812
27	8.6393	9.8369	10.7396	11.2436	11.1549	10.7119	9.7851	7.1260	2.2904
28	8.5953	9.7718	10.6243	11.0517	10.9034	10.3558	9.1924	6.2547	0.8701
29	8.5530	9.7307	10.5242	10.8905	10.6715	9.9967	8.6236	5.3334	-0.5869
30	8.5210	9.6920	10.4636	10.7973	10.5089	9.6394	8.0479	4.3431	-2.0901
31	8.5009	9.6574	10.4081	10.6919	10.3429	9.3668	7.4439	3.4190	-3.5586
32	8.4887	9.6250	10.3465	10.5876	10.1613	9.0732	6.9291	2.3944	-5.0135
33	8.4796	9.5947	10.2900	10.4755	9.9621	8.7534	6.3467	1.2835	-6.6105
34	8.4714	9.5639	10.2318	10.3550	9.7367	8.3975	5.6769	0.0752	-8.2938
35	8.4602	9.5195	10.1769	10.2290	9.4857	7.9991	4.9272	-1.2248	-10.0297

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 1998.5.

Table A.18 Parameters b(n) for the calculation of the time reference for male survivorship estimates from data on paternal orphanhood of the Italian 1998 multipurpose survey.

Age at childbirth	**Age n**								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	9.2997	10.1736	10.7076	10.9752	10.9507	10.6214	9.9081	7.8520	3.5502
25	9.0831	9.9580	10.5049	10.7945	10.7575	10.3633	9.4392	7.0864	2.2280
26	8.8878	9.7766	10.3242	10.6344	10.5846	10.0906	8.9500	6.2524	0.7917
27	8.7206	9.6286	10.1776	10.4971	10.4030	9.7993	8.4326	5.3426	-0.7407
28	8.5840	9.5025	10.0548	10.3628	10.2068	9.4882	7.8767	4.3496	-2.3826
29	8.4780	9.4025	9.9507	10.2334	9.9687	9.1197	7.1943	3.1580	-4.1764
30	8.3977	9.3164	9.8583	10.0895	9.6843	8.6688	6.4104	1.8832	-6.0364
31	8.3434	9.2492	9.7652	9.9316	9.4126	8.2209	5.6428	0.5825	-7.8414
32	8.3024	9.1893	9.6790	9.7740	9.1456	7.7813	4.8403	-0.7731	-9.6154
33	8.2524	9.1296	9.5955	9.6068	8.8698	7.3226	3.9734	-2.1856	-11.3944
34	8.2097	9.0787	9.5217	9.4705	8.6363	6.8297	3.0295	-3.6435	-13.1803
35	8.1750	9.0323	9.4476	9.3263	8.3832	6.3996	2.1372	-5.0075	-14.8972
36	8.1441	8.9886	9.3767	9.1715	8.1080	5.9162	1.1436	-6.4166	-16.6689
37	8.1233	8.9475	9.3036	9.0016	7.8036	5.3577	0.0516	-7.8907	-18.4978

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 1998.5.

Table A.19 Parameters b(n) for the calculation of the time reference for female survivorship estimates from data on maternal orphanhood of the Italian 2003 multipurpose survey.

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
22	9.0302	10.1171	11.0625	11.8814	12.4385	12.4954	12.1083	11.4288	8.7201
23	8.9030	9.9796	10.9601	11.7929	12.2837	12.2450	11.7031	10.7597	7.7145
24	8.7905	9.8719	10.8752	11.6975	12.1097	11.9220	11.2856	10.0769	6.3966
25	8.6941	9.7895	10.8023	11.5826	11.9007	11.5076	10.7733	9.2938	4.6783
26	8.6199	9.7350	10.7058	11.4218	11.6175	11.0562	10.1202	8.2591	3.0568
27	8.5671	9.6855	10.6058	11.2268	11.2852	10.6777	9.5626	7.2966	1.3987
28	8.5340	9.6422	10.5238	11.0431	11.0243	10.3599	9.0685	6.4209	-0.4311
29	8.4874	9.6051	10.4848	10.8981	10.7891	10.0441	8.5833	5.5228	-2.5172
30	8.4471	9.5843	10.4433	10.8210	10.6527	9.8001	8.0879	4.5465	-4.9452
31	8.4166	9.5738	10.4022	10.7326	10.5048	9.5339	7.6798	3.4383	-7.1414
32	8.3993	9.5693	10.3650	10.6465	10.3530	9.2416	7.2340	2.4821	-9.7273
33	8.3910	9.5610	10.3235	10.5556	10.1770	8.9194	6.7430	1.3615	-12.7438
34	8.3926	9.5511	10.2730	10.4572	9.9957	8.5682	6.1914	0.0158	-16.3447
35	8.4012	9.5292	10.2048	10.3570	9.8050	8.1902	5.5688	-1.5785	-20.7307

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 2003.9.

Table A.20 Parameters b(n) for the calculation of the time reference for male survivorship estimates from data on paternal orphanhood of the Italian 2003 multipurpose survey.

Age at childbirth	Age n								
	20	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
24	9.5794	10.3011	10.7501	11.1092	11.2299	10.9904	10.0794	8.1240	4.2435
25	9.3396	10.0389	10.5578	10.9378	11.0695	10.7421	9.6897	7.4204	3.1125
26	9.1316	9.8159	10.4071	10.7874	10.9095	10.4762	9.2606	6.6737	1.8422
27	8.9375	9.6364	10.2779	10.6571	10.7595	10.1886	8.7893	5.8731	0.3907
28	8.7641	9.5020	10.1752	10.5403	10.6036	9.8732	8.2761	5.0024	-1.2717
29	8.6152	9.3975	10.0880	10.4377	10.4280	9.4849	7.6618	3.8959	-3.3318
30	8.4982	9.3266	10.0087	10.3221	10.1783	9.0052	6.9083	2.6345	-5.5448
31	8.4148	9.2841	9.9327	10.1916	9.8796	8.5423	6.1571	1.3949	-7.8370
32	8.3537	9.2462	9.8595	10.0533	9.5873	8.0842	5.4172	0.0981	-10.3052
33	8.2855	9.1926	9.7963	9.9123	9.2975	7.6083	4.6459	-1.3022	-13.0080
34	8.2251	9.1513	9.7344	9.7932	9.0667	7.2024	3.8215	-2.8316	-15.9933
35	8.1776	9.1117	9.6788	9.6656	8.8145	6.7590	3.0976	-4.2710	-18.6948
36	8.1437	9.0812	9.6176	9.5266	8.5375	6.2742	2.2896	-5.8744	-21.6436
37	8.1209	9.0548	9.5612	9.3758	8.2294	5.7374	1.3660	-7.6475	-24.9562

Notes: reference year = survey year – t(n); t(n) = a(n)·ln[S(n)]+b(n); survey year: 2003.9.