# Age Differences in Mammography Screening Reconsidered: Life Course Trajectories in 13 European Countries

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## Abstract

**Background:** Breast cancer is the most common cause of cancer mortality among European women. To reduce mortality risk, early detection through mammography screening is recommended from the age of 50 onwards. Although timely initiation is crucial for cancer prognosis, the temporal dimension has largely been ignored in research. In cross-sectional research designs, it is not clear whether reported age differences reflect 'true' age effects and/or presumed period effects resulting from evolving knowledge and screening programs.

**Methods:** We use longitudinal data from the survey of Health, Ageing and Retirement (SHARELIFE, 2008), which enables to cast light on age differences by providing retrospective information on the age at which women commenced regular mammography screening. Moreover, the cross-national dimension of the SHARE permits framing the results within the context of nationally implemented screening programs. By means of the Kaplan-Meier procedure, we examine age trajectories for five 10-year birth cohorts in 13 European countries (N = 13 324).

**Results:** Birth cohorts show very similar age trajectories for each country. Along with the observation that large country differences and country-specific deviations coincide with screening program characteristics, this suggests strong period effects related to implemented national screening programs.

**Conclusion:** Age differences in mammography screening generally reflect the period effects of national screening policies. This leaves little room for economic theories about human health capital that leave out the institutional context of preventive health care provision.

# Introduction

Breast cancer is the most frequently diagnosed form of cancer among European women, accounting for 319 900 cases in 2006 (30.9% of all cancer diagnoses). It is the leading cause of death from cancer among women, with an estimated mortality rate of 16.7%. Breast cancer will remain an important public health issue, given that even more women are likely to be affected in the future due to the ageing population [1].

Research has predominantly focused on the role of national programs in reducing the well-documented socio-economic inequalities in mammography screening [e.g. 2, 3, 4]. In contrast, the timely initiation of screening has received much less attention [5], despite its crucial importance for cancer prognosis [6]. After all, the stage at diagnosis (or tumour size) is strongly linked to survival [7]. Since women aged 50-69 are at the highest risk for breast cancer, both the World Health Organization (WHO) and the Council of the European Union [8] recommend that national programs target these women for regular check-ups.

In general, age is regarded as a control or a confounding variable, or is used as a proxy for "need" for care, because "need" factors are not always apparent [e.g. 3, 9]. Occasionally, age differences are theoretically hypothesized based on the economic theory of human health capital [10]. Good health is treated as both a consumption commodity (i.e. sick days being a source of disutility) and an investment commodity (i.e. the total amount of time available for market and nonmarket activities). In the case of medical screening, early detection and intervention of the illness does not only improve the disease prognosis as previously mentioned, it can also reduce treatment costs [11]. As such, investments and the choice for mammography screening are made in order to optimize their utility [9]. During these cost-benefit considerations, women are likely to consider factors other than just financial costs such as the fear of false positives [12], pain [13] and overtreatment [14]. With regard to age, different hypotheses can be formulated. On the one hand, the returns on investment

from preventive screening are hypothesized as being reduced for older women, given that overall health deteriorates with increased age and the years that can potentially be saved also declines [15]. On the other hand, greater returns on investment can be hypothesized for older women, since they face a higher risk of breast cancer [1].

Empirical studies generally report lower engagement in screening among older women [9], but confusion remains high. One of the reasons for this is that studies still predominantly rely on cross-sectional designs, in which women are asked to report whether or not they engaged in screening during a prior period, usually two years. This design and question wording render it impossible to examine the extent to which age differences reflect 'true' age effects rather than age acting as a proxy for period effects, which are expected given the changing knowledge over time about breast cancer and screening programs. Moreover, this snapshot perspective does not allow study of the long-term use of mammography screening at the recommended regular intervals of two years [16]. The retrospective data from the Survey of Health, Ageing and Retirement (SHARE, 2008-2009, known as SHARELIFE), provides information about the age at which women commenced regular mammography screening. This allows to discern largely age effects from broader period effects and includes the notion of regularity.

In addition, the cross-national dimension of the population-based data enables us to frame potential period effects within the context of nationally implemented screening programs. These programs can reduce or eliminate financial and other costs and therefore change age-eligible women's' cost-benefit analysis. Despite general guidelines [16], European countries differ greatly in screening strategies (left-hand columns, Table 1). Most have now organized national population-based programs, in which women are personally offered screening on a regular basis, mostly every two or three years from the age of 50 onwards. However, in Switzerland and Italy, programs of this nature have only been implemented in some regions [5, 8, 17], and other countries, such as Austria and Greece, still rely completely on opportunistic screening, where individuals request screening

themselves or are recommended to do so by health advisors [18]. Further, large differences exist in the organizational characteristics of programs, their implementation stage, the method of offering screening, and the participation rate [5, 8, 17].

By comparing different institutional contexts, we highlight the supply side, which influences preventive health care use along with frequently-cited individual factors such as socio-economic status [19]. To date, seven studies have addressed cross-national differences in mammography screening in Europe, using population-based data from the World Health Survey (2002) [20], the Eurobarometer (66.2, 2006) [21], the first two waves of the SHARE (2004/2006) [3, 9, 22], and SHARELIFE [23, 24]. Except for the last studies, all have focused on socio-economic inequalities using cross-sectional data, rendering the study of age differences in regular screening problematic. Also using data from SHARELIFE, Sirven and Or (27) very briefly mention age differences in the commencement of regular mammography screening for three large birth cohorts and four large European regions. This current paper aims to provide a more in-depth discussion, paying explicit attention to country differences and their associations with the characteristics of national screening policies.

## Data

SHARE is a multidisciplinary and cross-national panel database on health, socio-economic status, and social and family networks. Details about the sampling procedure can be found elsewhere [25], but in general it consists of probability samples, drawn from population registers or from multistage sampling. Respondents aged 50 or above together with their partner (and other household members in wave 1, aged at least 50) were interviewed face-to-face using structured computerized questionnaires. This study uses data from the third wave (SHARELIFE, 2008-2009), in which retrospective information was collected about preventive health care use during the life course, among other items. To improve recall of retrospective data, a life history calendar (LHC) was used. The respondent's life is represented graphically by a grid that is completed during the interview [26].

Special efforts were made to reduce attrition and attain high retention rates throughout the different waves. This has led to an overall retention rate of 71% [25] ((for details see [27]). The household response rate in the first wave was on average 62% and country variation reflected patterns from other international surveys [25]. Individual response rates amount to 85% on average (for country-specific figures see website: http://www.share-project.org/data-access-documentation/sample.html). Data was collected in six Western European countries (Belgium, France, The Netherlands, Germany, Switzerland, and Austria), two Northern European countries (Denmark and Sweden), three Southern European countries (Spain, Greece, and Italy) and two countries in Eastern Europe (Poland and The Czech Republic). Because of the focus on preventive mammography screening, a small number of women who were diagnosed with breast cancer during their lives are excluded from the sample (N = 285; 2.0%). This information was retrieved from wave 1 (2004) and wave 2 (2006). There is only a small amount of information missing for mammography screening practices (5.3%) and this is therefore deleted listwise.

## Measurements

*Regular mammography screening initiation*

Our dependent variable, the commencement of regular mammography screening, is retrieved from the question 'In which year did you start having mammograms regularly?' given to all women who answered yes to the question 'Have you ever had mammograms regularly over the course of several years?'

*Birth cohorts*

We construct five birth cohorts from 1910 to after 1949 in ten-year intervals. These cohorts act as proxy for period effects. Depending on their birth cohort, women were the recommended age for screening and/or the eligible age for population-based screening programs in different time periods.

## Methods

We apply event history analysis, to model the time until women commenced regular mammography screening. The end of the risk period is defined either by the time the event occurred (i.e. the age of commencing regular mammography screening) or by the time the individual is censored (i.e. those who did not experience the event during the observation period) [28]. Here, women who did not engage in mammography screening are censored at the time of the retrospective data collection in SHARELIFE (2008 or 2009). Unlike standard statistical methods such as linear or logistic regression, event history analysis can adequately deal with censoring. The Nelson-Aalen method is used to calculate the cumulative hazard function, which assesses at each point in time the amount of accumulated risk between the beginning of the examined period and each observed event time. Exploring behavior graphically over time allows us to retrieve information about the shape of the underlying hazard function [28]. The graphs will thus show at each age, the accumulated risk factor for women of a specific birth cohort to commence regular screening. A log rank test is performed to assess whether these cumulative hazards differ significantly by birth cohorts. Also, simple descriptive statistics are calculated to give an overview of the proportion of women in each country that ever commenced regular screening. All analyses are carried out in Stata 11.

## Results

First, we focus on the age trajectories. Figure 1 shows that the cumulative hazard increases at a similar rate across age in all countries, except for a large increase at the age of 50, which reflects the generally recommended age for commencing screening. A notable exception is found for Sweden, where the likelihood of screening increases sharply among 40-year-old women. This is not that remarkable, as about 65% of Swedish counties start offering screening for women at the age of 40 [8].

(figure 1 around here)

To find out whether these age trajectories differ according to birth cohorts, we turn to the country-specific figures (Figure 2a-m). For all countries, women in younger birth cohorts have a higher cumulative hazard and are thus more likely to commence regular screening at some age (log-rank, $p<0.001$ for all countries). For the three youngest cohorts in particular, the hazard for screening increases at the same rate and a notable increase is observed at the age of 50, except for Austria, Greece, Germany, and Poland. This suggest that there are no 'true' age- effects, so that age is not a crucial factor that is taken into consideration when deciding about screening. Rather this points to broader period-effects, especially because features of national screening programs can again be linked to these exceptions and also to a great extent to the large country-variation in the overall take-up of screening.

(figure 2 a-m around here)

In Austria and Greece, an organized program is absent, while the implementation in Poland (2007) was too close to the data collection in 2008-2009 to be reflected in the figures. Similarly, in Germany, the roll-out of the national screening program started in 2005, but it was completed only in 2009 [29]. In Denmark, the national program only commenced in December 2007, but here an increase at the age of 50 is still notable. This can be explained by regional programs, which have covered 20% of Danish women aged between 50 and 69 since 1991 [30]. In Austria, a spontaneous screening program for women aged 35 years or above started in Tyrol in 1993. Here, screening is free of charge for women from the age of 40 [31]. The sharp increase in screening at the age of 40 for women born after 1949 in Austria is probably a reflection of this program or the example it has set. An increase at 45 years of age is found for Spanish and Czech women born after 1949. Some Spanish regions start offering screening to women aged 45 [32] and the national program in the Czech Republic includes women from the age of 45 onwards.

Next, countries differ largely in how high the cumulative hazards are across age (figure 1). This indicates that at all ages, the take-up of regular mammography screening differs strongly between

European countries, which is also reflected in the general figures in table 1. The lowest proportion is found in Denmark (29.3%), while Swedish women are the most likely to engage in regular screening (89.8%). It is remarkable that these extremes are both in the Northern European region, which is generally considered as universally the best performing with regard to health, due to relatively generous and universal welfare provision [33]. However, this is not so surprising given the long-term implementation of a national screening program in Sweden, in contrast to Denmark (see table 1)).

After Sweden, The Netherlands has the longest running program and the second-highest proportion of regular screeners (84.9%). On the other hand, the least regular screeners are found in Denmark (29.3%), Poland (40.1%), Germany (48.2%), Greece (47.5%) and Switzerland (48.9%). A national program was implemented too closely to the SHARELIFE data collection for reflection in the figures of Denmark and Poland, while it is absent in the two latter countries. However, the absence of a national program does not necessarily entail that many women forgo mammography screenings as for example in Austria a large volume of opportunistic screening is notable (64.7%). In Italy, regional programs have taken off since 1985 [17], so that in 2007 at least one pilot population-based program in all Italian regions has been realized [8]. Accordingly, the share of women with regular screenings in Italy (62.4%) is similar to its neighboring country Spain, where a national program was launched in 1990 (66.5%). Although Germany and France both had their national program only recently implemented in 2004, the number of regular screeners differs considerably (48.2% and 77.4% respectively). This could be associated with the long-standing practice since 1971 to offer yearly gynecological 'cancer early detection exams' to German women from the age of 30 onwards. Breasts are inspected and palpated by medical doctors who also give instructions for breast self-examination [34]. Czech women rank sixth, with 56.7% undergoing regular screenings.

(table 1 around here)

## Discussion

The aim of this paper is to move the debate on age differences in mammography screening forward using data from SHARELIFE. This dataset contains unique information for 13 European countries, which is both longitudinal and population based. Several meaningful observations strongly suggest that age differences as reported in cross-sectional surveys are no 'true' effects of age but reflect period effects. Neither hypothesis with regard to age as a component of cost-benefit considerations of mammography screening seem to hold.

Overall, older birth cohorts engage less in screening in all the countries. However, when they do, they do not initiate screening at an considerably older age than younger cohorts. It is rather clear that the fewer uptake of mammography screening by older women over the course of their lives is inextricably bound up with the evolution in knowledge about breast cancer [see e.g. 35] and the discussion and implementation of screening policies. The crucial role of screening policies is also reflected in the large country variation in screening as well in the observation that exceptions can be linked to features of national screening programs.

Even within the same European region, large country differences are notable in the take up of mammography screening. The World Health Survey (WHS) 2002 revealed similar results [20], although the ranking of prevalence rates shows some differences. For five countries (Belgium, Denmark, Sweden, Greece, and the Czech Republic) proportions are lower in the WHS than in SHARELIFE, while for the other five countries with available data (France, Germany, Austria, Spain, and Italy), higher proportions are noted. For France, this might be related to the introduction of a national program (2004) between the data collections of the two surveys. However, in other countries such as Spain this might not be the case, given the early implementation of the program there in 1990. Instead, as suggested by Braillon [36], cross-sectional data might overestimate the quality of the programs. The one other cross-national study that did not use data from SHARE [21], only scrutinized determinants of screening for a dichotomous grouping of countries based on

opportunistic versus nationally organized programs. Our results suggest that important country-specific characteristics are thereby overlooked.

The SHARELIFE also questioned the reasons for not taking up mammography. These reasons differ strongly between countries [for numbers see 24, 37] and can again been linked to screening policies. Respondents stated that information was lacking and that screening was not affordable or available in countries without a national program (Austria and Greece) or only a recently implemented program (Germany and Poland). In countries with only regional coverage (Italy and Switzerland), respondents stated that they did not engage in screening because of a lack of information and financial means. In the Netherlands and Sweden, the two countries with the highest screening rates, none of the aforementioned perceived barriers were indicated. Instead, only the belief that screening is not necessary was found to be significantly related to not participating [37].

The fact that age trajectories in screening appear relatively universal for all countries, despite the varying perceived 'costs' of screening, corroborates the contention that age differences are largely attributable to the period effects of national policies. These period effects are mirrored in cross-sectional studies that have reported lower screening rates above the age of 60 [2] or 65 [3, 9]. Similarly, longitudinal studies such as that of Puddu and colleagues [4], report important period effects in terms of an increase in screening over a three-year period among women aged 60 to 69.

Before turning to the conclusion, two limitations should be acknowledged. First, retrospective data may raise some concerns regarding recall bias. However, SHARE took this concern seriously. In addition to the measures to minimize bias at the time of data collection, quality checks were conducted on the respective data. Although more research is needed, strong consistency has already been found for personal events [38]. The second limitation concerns the question wordings regarding mammography screening. It is impossible to discern fully whether women started mammography screening for preventive purposes only or for other reasons. Data limitations hinder us from discerning the motivations of women to commence screening. A family history of breast cancer is

related to perceived risk of the disease, which in turn impacts on the commencement of mammography screening [39]. However, the information on health history enables us to exclude women diagnosed with breast cancer.

This study illustrates the potential of applying a longitudinal perspective in cross-national comparative research on health. For both policy makers and researchers, timeliness deserves further attention, even more so for preventive services that require already starting routine check-ups in childhood, such as dental care [40]. In sum, cross-sectional age differences in mammography screening generally reflect the period effects of national screening policies. This leaves little room for economic theories about human health capital that ignore the institutional context of preventive health care provision.

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## Conflict of Interest

None declared

## Keypoints

*What is already known on this subject?*

1. The uptake of mammography screenings differs largely between countries and socio-economic groups.

2. Little is known about the age of commencement of regular screenings. In a cross-sectional design it is impossible to discern age effects from period effects related to evolving knowledge and the implementation of national screening programs.

*What this study adds?*

1. By means of retrospective information of the SHARELIFE on the age of screening initiation, age trajectories are calculated for different birth cohorts in 13 European countries.

2. In all 13 European countries, age trajectories seem very similar for all birth cohorts, which suggests strong period effects rather than 'true' age effects.

3. Besides, strong period-effects are reflected in the large between-country variation in screening uptake as well as in country-specific deviations.

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# Tables

Table 1: Mammography screening in 13 European countries

| Characteristics of breast cancer screening policies | | | | Number and % of regular screeners, based on SHARELIFE data | |
|---|---|---|---|---|---|
| | National/ regional program | Year of implementation of national program | Target age group | N | % regular screeners |
| Sweden | National | 1986 | 40/50-69/74 | 748 | 89.8% |
| The Netherlands | National | 1989 | 50-75 | 1066 | 84.9% |
| Spain | National | 1990 | 45/50-64/69 | 1020 | 66.5% |
| Belgium | National | 2001 | 50-69 | 1425 | 71.6% |
| The Czech Republic | National | 2002 | 45-69 | 997 | 56.7% |
| France | National | 2004 | 50-74 | 1216 | 77.4% |
| Germany | National | 2005 | 50-69 | 920 | 48.2% |
| Poland | National | 2007 | 50-69 | 944 | 40.1% |
| Denmark | National | 2008 | 50-69 | 1068 | 29.3% |
| Italy | Regional | n.a. | 45/50-69 | 1292 | 62.4% |
| Switzerland | Regional | n.a. | 50-70 | 665 | 48.9% |
| Austria | No | n.a. | n.a. | 425 | 64.7% |
| Greece | No | n.a. | n.a. | 1538 | 47.5% |

# Legends for illustrations

**Figure 1:** Cumulative hazard function for mammography screening initiation per country (Nelson-Aalen estimates)

**Figure 2 (a-m):** Country-specific cumulative hazard function for mammography screening initiation per 10-year birth cohort (Nelson-Aalen estimates)

# Figures

**Figure 1**

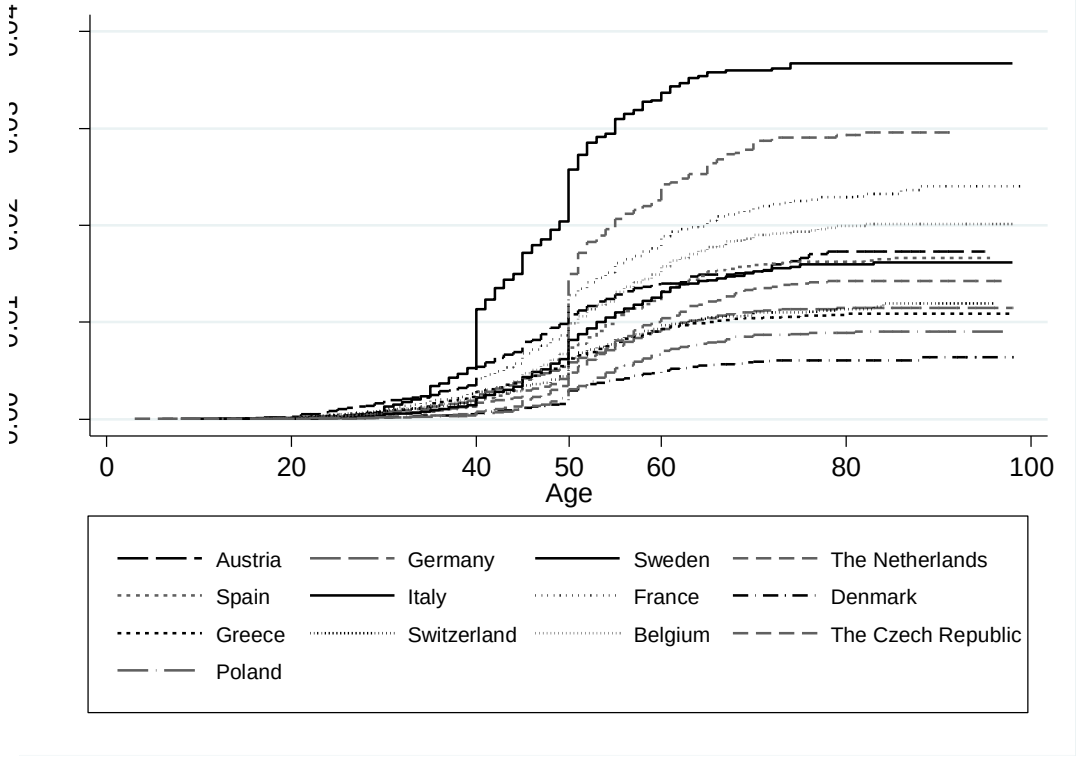
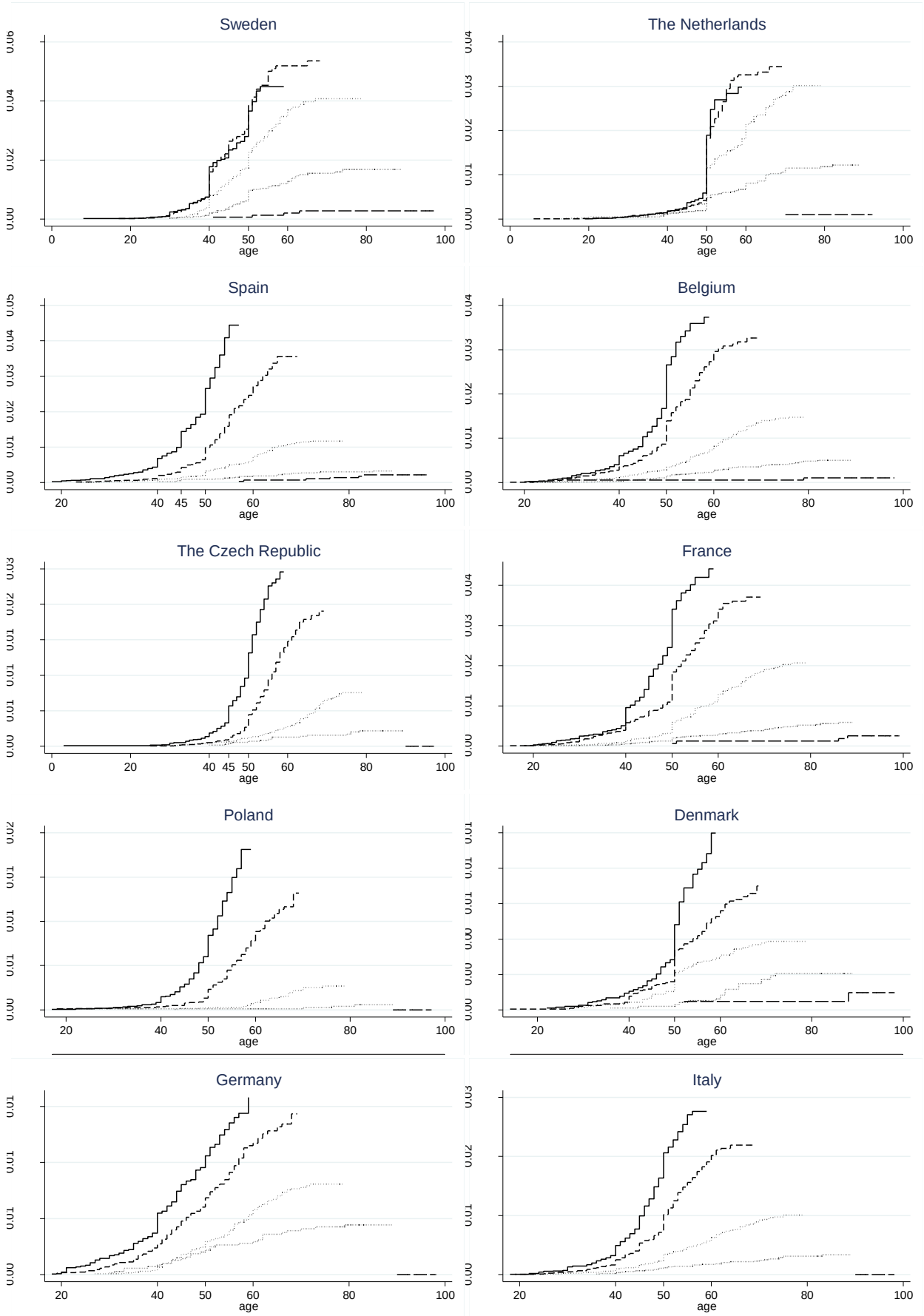


**Figure 2 (a-m)**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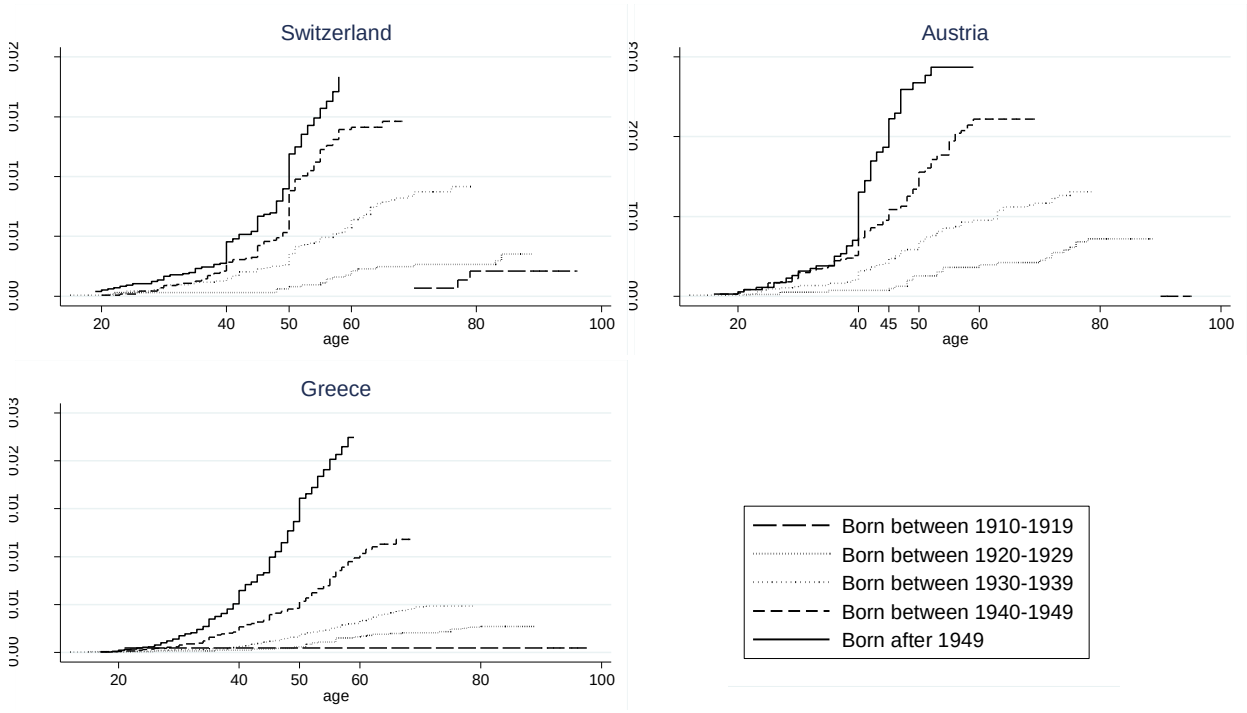
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