Month of Birth Influences Survival up to Age 105+.
First results from the age validation study of German semi-supercentenarians.

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Introduction

Information about survival at the highest ages has only become recently available and we know little about why a person reaches age 105 and above. This study shows that among the many possible genetical and environmental factors also the very first period of life influences the chances of becoming a semi-supercentenarian. Since age reporting at the highest ages is notoriously unreliable we use age-validated information from a huge age validation project of German semi-supercentenarians aged 105+.

We use the month of birth as an exogenous indicator for seasonal changes in the environment around the time of birth. The effect of the month of birth on longevity and morbidity has recently been studied widely and it has been shown that the month of birth affects life expectancy at age 50 in various countries of the Northern and Southern Hemisphere (Doblhammer 2004). Using data from Germany, here we examine if month of birth also predisposes individuals to survive up to age 105. We compare the month-of-birth pattern in the survival risk of the German supercentenarians with the pattern that we previously found in the life expectancy of the Danish population aged 50 and above (Doblhammer 2004, Doblhammer & Vaupel 2000).

Data

The seasonal distribution of births in Germany at the end of the 19th century is given in the series of statistical yearbooks for the German Empire „Statistik des Deutschen Reiches“. For the time period 1881-1898, appr. 32,5 million births with a distinct seasonal pattern are reported.

The data about the semi-supercentenarians in Germany (ages 105+) come from the office of the German president. A total of 1.487 eligible semi-supercentenarians who survived up to the years 1989-2003 are registered in the office’s database; 1348 were born within the borders of the German Empire (Deutsches Reich). Up to date 787 of the latter have been age

validated by a special procedure, which in more detail is described later. The age validation process is still ongoing and we expect that by the time of the PAA all eligible semi-supercentenarians will be age validated. They are born between the years 1880 and 1900 (Table 1).

The Danish data consist of a mortality follow-up of all Danes who were at least 50 years old on 1 April 1968. This is a total of 1,371,003 people, who were followed up to week 32 of 1998. The study excludes 1,994 people who were lost to the registry during the observation period. Among those who are included in the study, 86% (1,176,383 individuals) died before week 32 of 1998; 14% (192,626 individuals) were still alive at the end of the follow-up.

Methods

The test whether the seasonal distribution of birth dates among the semi-supercentenarians departs from the seasonal distribution of births in 1881-1898 is based on the $\chi 2$-goodness-of-fit test.

To estimate differences in survival according to the month of birth a method called Survival-Attributes Assay (Christensen et al. 2001) is applied. Let N_0 be the number of births. Let p_0 be the proportion of births with the fixed attribute month of birth. Let p_{105} be the proportion at age 105. Let s be the survival probability from age 0 to age 105 for the individuals who have the fixed attribute. Let S be the survival probability from age 0 to 105 for the entire cohort.

Then, because

$$p_0 N_0 s = N_{105} S p_{105}, \qquad [1]$$

it follows that

$$s = S p_{105} / p_{0.} \qquad [2]$$

Thus, the relative risk of surviving from birth to age 105 for people born in a specific month is the ratio of their observed proportions at birth and at age 105.

Denmark both the risk population and the number of deaths are known, which means that it is possible to estimate remaining life expectancy at age 50 on the basis of life tables that were corrected for left truncation. This was achieved by calculating occurrence and exposure matrices that take into account an individual's age on 1 April 1968. For example, a person

who was 70 at the beginning of the study and who died at age 80 enters the exposures for ages 70 to 80 but is not included in the exposures for ages 50 to 69. The central age-specific death rate is based on the occurrence-exposure matrix. The corresponding life-table death rate is derived by means of the Greville Method (Greville 1943).

Age validation

The German age validation study is part of the International Database on Longevity project. Its aim is to obtain complete and validated lists of German semi-supercentenarians. The age validation follows a distinct procedure. In a first step, the office of the German president was asked for a list of all known persons aged 105 and older who ever received a congratulatory letter from the German president. This list is exhaustive because the local registries are required by law to report every person reaching the age of 105 in their municipality. In a second step, the local registry office at the place of residence was asked for information about the vital status of the person and for the person's place of birth. In a third step the local registry office at the place of birth is asked for a document certifying the date and place of birth. A person is considered age validated if both the local registries at the place of residence and at the place of birth verify the date and place of birth.

Results

A distinct seasonal pattern exists in the seasonal birth distribution of the years 1881-1898 of the German Empire (Table 2). Births peak in March (+8,74%), reach a trough in June (7,91%) and a secondary peak in September (8,61%).

The seasonal distribution of birth dates changes with age and the seasonal fluctuations in the birth dates of semi-supercentenarians are more pronounced than at the time of their births (Figure1). The distribution of birth dates of semi-supercentenarians departs from the seasonal distribution of births in their birth years (eligible: χ^2 test statistic=18.98, df=11, p=0.06; validated: χ^2 test statistic=11.48, df=11, p=0.40).

Among the December-born validated semi-supercentenarians the relative risk of survival from birth to age 105+ is 17 per cent higher than the average, among the June-born, 23 per cent lower (Figure 2). The month-of-birth pattern in the survival risks of the semi-supercentenarians in Germany is highly correlated with the respective pattern for Denmark, which shows the deviation in remaining life expectancy at age 50 by month of birth from the average life expectancy.

Conclusion

The study suggests that the environment early in life influences the chances of an individual to survive up to the highest ages. We use month of birth as an exogenous indicator for seasonal changes in the environment at the time of birth. These seasonal changes most probably are related to nutrition of the mother during pregnancy and to infectious disease. The seasonal pattern we observe is in line with the pattern observed in younger age groups in Denmark (and in other countries).

References

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Table 1: Year of birth and number of German Semi-supercentenarians who attained age 105+ in the years…

Year of birth	Total		Born in the German Empire		Born in the German Empire and age validated	
	Number	Percent	Number	Percent	Number	Percent
1880	1	0.1	1	0.1		
1881	2	0.1	2	0.1	1	0.1
1882	4	0.3	4	0.3	2	0.3
1883	16	1.1	14	1.0	12	1.5
1884	31	2.1	27	2.0	18	2.3
1885	59	4.0	54	4.0	27	3.4
1886	68	4.6	61	4.5	30	3.8
1887	66	4.4	60	4.5	38	4.8
1888	84	5.6	73	5.4	42	5.3
1889	87	5.9	75	5.6	46	5.8
1890	84	5.6	74	5.5	49	6.2
1891	112	7.5	102	7.6	59	7.5
1892	115	7.7	109	8.1	55	7.0
1893	115	7.7	103	7.6	55	7.0
1894	126	8.5	112	8.3	70	8.9
1895	165	11.1	151	11.2	84	10.7
1896	158	10.6	148	11.0	99	12.6
1897	191	12.8	175	13.0	99	12.6
1898	2	0.1	2	0.1	1	0.1
1900	1	0.1	1	0.1		
Total	1487	100.0	1348	100.0	787	100

Table 2: Seasonal distribution of births in the German Empire for the years 1881 to 1898 and seasonal distribution of birth dates among semi-supercentenarians born in the German Empire.

	Births German Empire 1881-1898		Birth Months of age validated Semi-supercentenarians (ages 105+) born in the German Empire		Birth Months of eligible Semi-supercentenarians (ages 105+) born in the German Empire	
	Number	Percent	Number	Percent	Number	Percent
Jan	2826175	8.69	60	7.62	110	8.27
Feb	2622762	8.06	71	9.02	113	8.54
Mar	2843700	8.74	70	8.89	121	9.28
Apr	2674474	8.22	59	7.50	98	7.13
May	2702507	8.31	60	7.62	96	7.13
Jun	2573261	7.91	48	6.10	86	6.52
Jul	2672654	8.21	63	8.01	105	7.33
Aug	2733265	8.40	60	7.62	117	8.20
Sep	2800130	8.61	78	9.91	136	10.15
Oct	2720225	8.36	75	9.53	114	8.41
Nov	2632740	8.09	66	8.39	112	8.47
Dec	2732161	8.40	77	9.78	140	10.56
Total	32534054	100.00	787	100	1348	100

Sources: Statistische Jahrbücher. Deutsches Reich

Figure1: Distribution of birth dates of the 1348 eligible and the 787 age validated semi-supercentenarians born in the German Empire and seasonal distribution of births 1881-1898 in the German Empire.

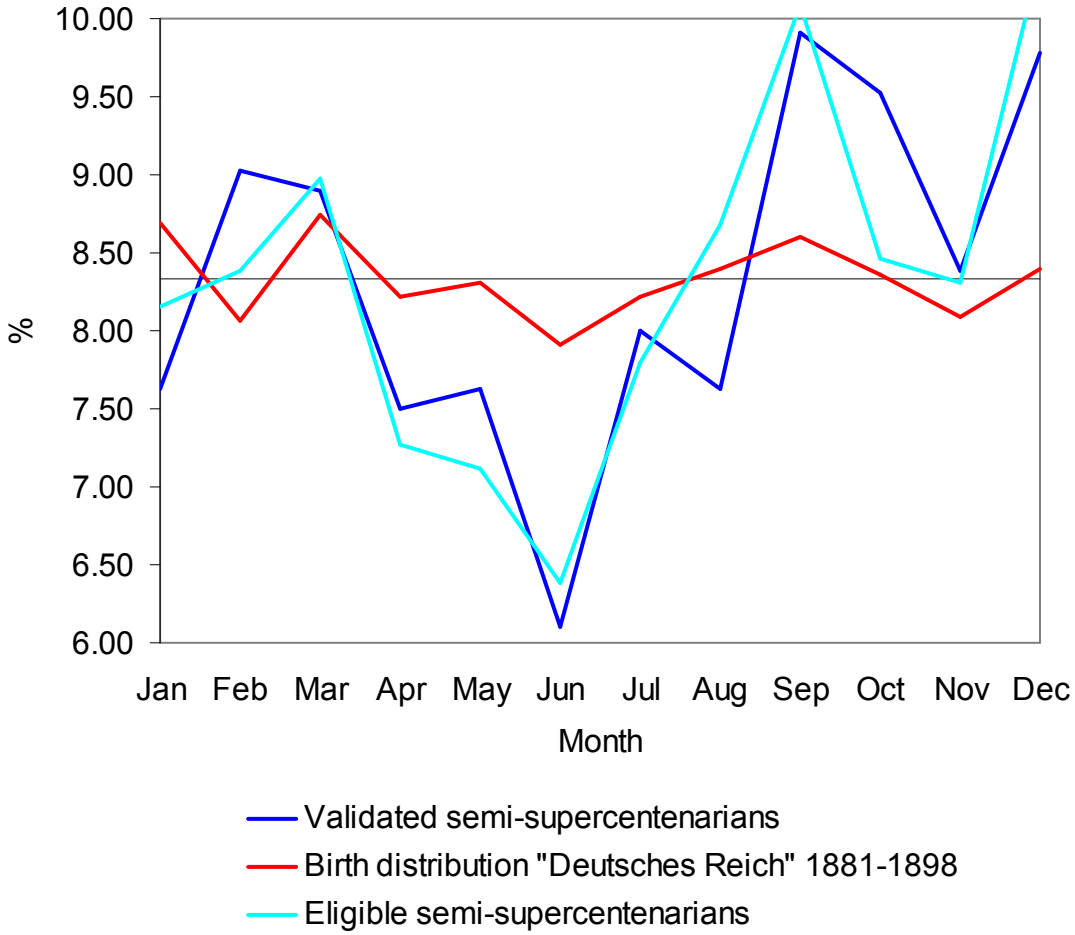

Figure 2: Relative risks of survival from birth to age 105+ by month of birth for the 1348 eligible and the 787 age validated semi-supercentanarians born in the German Empire and deviation in remaining life expectancy at age 50 by month of birth in Denmark.