

Supercentenarians – The Conquerors of Aging

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Abstract

Supercentenarians are people who have lived past their 110th birthday. While supercentenarians are not a recent phenomenon, the number of supercentenarians has increased over time. Previous research on supercentenarians has had a smaller scope which necessitated the present study. The aim of this study was to validate deceased supercentenarians and analyze them concerning number of supercentenarians, sex differences, regional differences, and seasonality. The results indicate that the number of supercentenarians has increased quickly over time, that 90% of validated supercentenarians are female and that most come from a limited number of regions, with most supercentenarians coming from the Northern hemisphere and either USA & Canada or Europe. About 56% of supercentenarians were born and died between the months of October to March. A mortality plateau of 50% might exist at ages up to 113, whereafter an acceleration towards 60% occurs. This study provides a better insight into supercentenarians than has previously been known but there are still gaps in the data which need to be addressed.

Keywords: Demography, Mortality Plateau, Seasonality, Supercentenarians

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Introduction

A supercentenarian is a person who has lived to at least 110 years of age. Based on a mortality plateau at 50% for centenarians aged 100 (Modig et al., 2017), approximately one in every 1,000 centenarians would be expected to reach 110 (Maier et al., 2010). With an estimated 575,000 and 700,000 living centenarians living worldwide (Gondo & Ishioka, 2021; United Nation, n.y.), it can be deduced that there are approximately 700 living supercentenarians in the world. Researchers have become increasingly interested in studying supercentenarians, due to their impressive ability to delay or escape age-related illnesses (e.g., dementia, cardiovascular diseases) when compared to people who die at younger ages (Andersen et al., 2012; Schoenhofen et al., 2006). Determining how genetic and environmental factors influence this characteristic is pivotal to understanding health outcomes associated with extreme longevity (Passarino et al., 2007). A validated supercentenarian database would provide information on sex disparities, country statistics, socioeconomic influences, and mortality rates.

Prior studies have found sex disparities among centenarians, with over 80% of reported centenarians being female (Poulain, 2010). Given the proportion of female centenarians, a prediction can be made that most supercentenarians are also female (Perls, 2017). Research has also indicated that which season a person is born in might influence their lifespan (Gavrilov & Gavrilova, 2011).

To validate data on supercentenarians, a rigorous set of guidelines must be established (Poulain, 2010). There are numerous supercentenarian claimants, but not all are accurate or verifiable due to a variety of factors such as lack of documentation, fraud (i.e., identity theft, pension fraud), misremembering age, or being unknown to researchers at study initiation (Poulain, 2010). Without a robust supercentenarian validation process, false claims remain undifferentiated from true claims, thus skewing the data and resulting in conclusions unrepresentative of real-world demographics. Previous research on supercentenarian age validation by other organizations, while commendable, has been demonstrated by us to contain inaccuracies, which necessitates a further review, especially given the increasing number of supercentenarians over time.

Aim

The aim of this study was to validate deceased supercentenarians and analyze them concerning number of supercentenarians, sex differences, regional differences, and seasonality.

Methods

Age Validation

The basis for the validation methodology originated from the established methodology of prior extreme-longevity researchers (Poulain, 2010; Gondo et al., 2017; Robine et al., 2019). Deceased supercentenarian claims born between 1788 and 1913 identified from sources such as media reports and death indexes, were included. Some of the included supercentenarians were previously verified by other groups researching supercentenarians but were re-checked to comply with our validation criteria and falsely validated supercentenarians were filtered out during review. Claims were examined by four reviewers. After evaluating a defined set of

biographical and documentation requirements, reviewers reached consensus on whether to accept or reject the claim as validated. Information collected included media reports, interviews, and photos. Family contact was initiated when necessary to obtain clarification of biographical details. For a supercentenarian to be considered “validated,” documentation dating from the period of birth until their time of death needed to exist. The documentation collected fell into three categories: early-life (i.e., original birth or baptismal certificate or equivalent), mid-life (i.e., marriage record, social security applications, or census records), and proof of death (death registration or extensive obituaries). Delayed birth registrations were not an acceptable substitute for original documentation. Name changes required documentation. Family tree reconstruction was performed, when possible, to decrease the possibility of identity swapping (i.e., sibling-sibling, parent-child). Claims were accepted once the review panel found that the documents corroborated life events from birth to present-day, thus supporting a lifespan of 110+ years.

Statistical Analysis

Linear regression was performed to investigate potential increases in the number of supercentenarians. Chi²-test was used to compare sexes regarding seasonality and a log-rank-test was used to compare sexes regarding survival.

Results

Number of Supercentenarians

3,011 deceased supercentenarians born between 1788-1913 were validated as of December 31st, 2023. Of these, 2,740 (90%) were female and 271 (10%) male. It was observed that the number of supercentenarians increased over time with close to zero being born prior to the 1850s and the number steadily increasing thereafter (Figure 1) ($p < 0.001$).



Figure 1. Number of validated supercentenarians per decade

Supercentenarians came from a limited number of regions, with the region USA & Canada (1,247), as well as Europe (1,092) representing over three quarters of all validated supercentenarians. Asia (456), with almost exclusively Japanese representation, was the third-largest region. Few supercentenarians came from the rest of the Americas (166), Oceania (51) and only one validated supercentenarian came from Africa.

<i>Age</i>	<i>Female SC</i>	<i>Male SC</i>	<i>Total SC</i>	<i>One-Year-Mortality (%) *</i>
110	2174	209	2383	45.0
111	1208	103	1311	47.3
112	651	40	691	49.2
113	333	18	351	52.1
114	162	6	168	63.1
115	59	3	62	56.5
116	26	1	27	63.0
117	10	0	10	60.0
118	4	0	4	25.0
119	3	0	3	66.7
120	1	0	1	0.0
121	1	0	1	0.0
122	1	0	1	100.0

* Table 1 describes the mortality rate at each age for supercentenarians (SC). For Age 110 row: 1,311 of the 2,383 validated supercentenarians born between 1788-1906 that reached age 110 survived until age 111 or higher.

Table 1. Supercentenarian mortality

Due to not all cohorts for validated supercentenarians being extinct at the time of the study, a mortality table was only constructed for the deceased cohorts (1788-1906). It was observed that the one-year-mortality-rate increased with age, especially after age 113. A low proportion of supercentenarians survived past their 117th birthday, indicating that the one-year-mortality-rate could be less accurate past this age. Female supercentenarians had a lower mortality-rate than male supercentenarians up to age 114, after which the number of remaining male supercentenarians was extremely low.

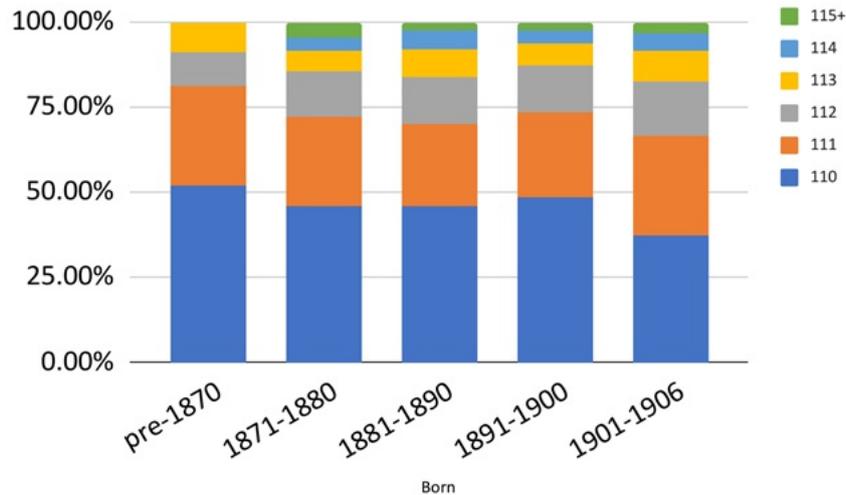


Figure 2. Age distribution of supercentenarians over time

It was noted that the age distribution of supercentenarians changed over time (Figure 2). Prior to 1870, no supercentenarian achieved an age of over 114 years, which was first achieved by a person born in 1871. The proportion of supercentenarians who lived to be 110-111 years decreased over time, with more supercentenarians reaching higher ages. Only a small proportion lived past their 115th birthday.

Seasonality

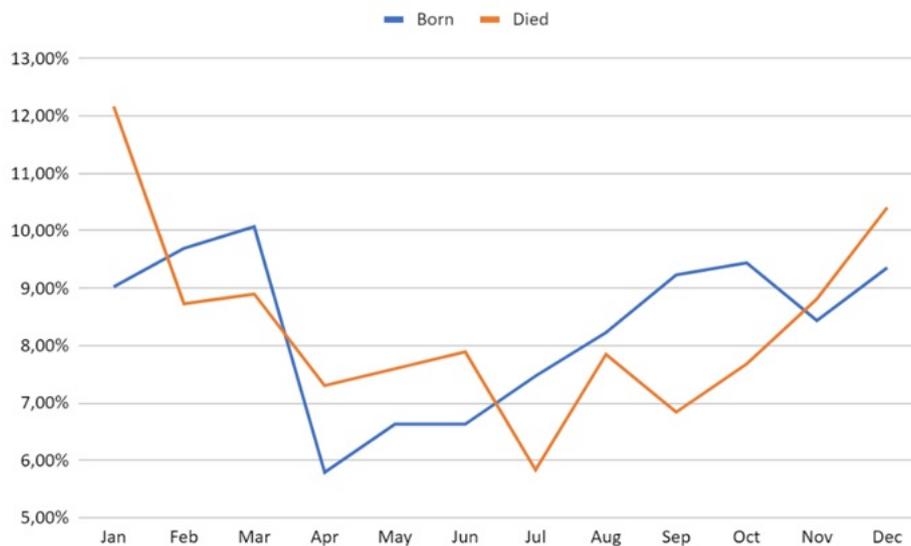


Figure 3. Supercentenarian seasonality (%) based on how many were born and died each month

The study found that a significant majority of supercentenarians, 56.4%, were born during the colder months of the year (October to March), with the highest birth rate occurring in March at 10.1% (Figure 3, Table 2). No significant differences were observed between female and male supercentenarians regarding their season of birth ($p = 0.675$). Similarly, mortality patterns for supercentenarians followed a comparable trend, with 55.8% dying during

October-March, peaking in January at 12.2%. There were no significant differences in the season of death between female and male supercentenarians ($p = 0.777$).

It was observed that seasonality varied by region (Table 2). Four out of five regions with more than one supercentenarian had most supercentenarians being born between October-March, the exception being The Americas except the USA & Canada. Likewise, three out of five regions with more than one supercentenarian had most supercentenarians dying between October-March, with the exceptions being The Americas except the USA & Canada (equal amount) and Oceania (majority died April-September).

	<i>Born</i>			<i>Died</i>		
	Oct-Mar N (%)	Apr-Sep N (%)	p *	Oct-Mar N (%)	Apr-Sep N (%)	p *
Total	1697 (56.4)	1314 (43.6)		1680 (55.8)	1431 (44.2)	
Sex			0.675			0.777
<i>Female</i>	1541 (56.2)	1199 (43.8)		1531 (55.9)	1209 (44.1)	
<i>Male</i>	156 (57.6)	115 (42.4)		149 (55.0)	122 (45.0)	
Region						
<i>Europe</i>	610 (55.9)	482 (44.1)		621 (56.9)	471 (43.1)	
<i>USA & Canada</i>	694 (55.7)	553 (44.3)		717 (57.5)	530 (42.5)	
<i>Asia</i>	285 (62.5)	171 (37.5)		240 (52.6)	216 (47.4)	
<i>Rest of America</i>	73 (44.5)	91 (55.5)		82 (50.0)	82 (50.0)	
<i>Oceania</i>	35 (68.6)	16 (31.4)		19 (37.3)	32 (62.7)	
<i>Africa</i>	0 (0.0)	1 (100.0)		1 (100.0)	0 (0.0)	

* Seasonality in birth divided by sex and continent. Chi²-test was used on dichotomous variables.

Table 2. Supercentenarian season of birth

Survival

Survival past age 110 for the supercentenarians was plotted and it was noted that 50% of the supercentenarians were deceased by 111.17 years. 25% were alive at 112.15 years and 10% at 113.42 years. Female supercentenarians were noted to have a higher survival rate past age 110 than male supercentenarians ($p < 0.001$).

Discussion

Apart from it being the first time such a large set of supercentenarians has been researched, the main findings of this study are also that the majority (90%) of all supercentenarians is female, that the number of supercentenarians born each year has increased over time, and that there appears to be a seasonal aspect to when supercentenarians are born and when they die. Given this, certain findings need to be discussed.

First, while recent research included more than double the number of SCs recognized by longstanding organizations such as the International Database on Longevity, IDL, (1,161 validated supercentenarians as of April 2022) (Ined, n.y.), the results are in no way exhaustive. We at LongeviQuest are aware of a substantial number of known, partially documented supercentenarians (as of December 2023 over 1,000 supercentenarians) and

validation efforts are ongoing. Even considering this, it is likely that there is some degree of selection bias in the data. For supercentenarians to be researched and validated, researchers must know of them. Given that the researchers that participated in the validation of supercentenarians come from a limited number of areas it is possible that some supercentenarians from other regions go unnoticed. Further, not all supercentenarians are reported on in the media, meaning that if they do not have any proof of death, they cannot be fully validated, or potentially even known by researchers.

Second, most deceased validated supercentenarians resided in a handful of developed, wealthy countries. A clear Western bias existed, with certain countries (e.g., USA, France, United Kingdom, and Italy) being well-represented. Japan, with one of the highest life expectancies in the world (Tsugane, 2021), was the Asian country with most validated supercentenarians. Notably, several regions and countries with a significant proportion of the global population had little or no representation. China and India, the two most populous countries with a combined 2.8 billion people as of 2023 (~35% of the global population) (Hertog et al., 2023), had only two validated deceased supercentenarians in total. While these two countries have many supercentenarian claims, the lack of validated cases may be due to a combination of several factors: poor record keeping, language barriers, poor socioeconomic conditions for many non-metropolitan residents, and a lack of knowledge about longevity research organizations, thus limiting participation. There was only one validated deceased supercentenarian from Africa, which has a population of approximately 1.4 billion people (Abramova, 2022). This finding can potentially be attributed to insufficient record-keeping for most African countries, as well as poor media coverage for potential claimants.

Third, approximately 90% of the validated supercentenarians are female, in line with previous findings that 85 - 90% of centenarians are female (Andersen et al., 2012; Kestenbaum, 2021). This can partially be explained by the differences in life expectancy, with females on average living for 2 to 3 years longer than males (Thorslund et al., 2013; Ginter & Simko, 2013). Notably, the ages of the individuals from age 111 and upward indicate an annual mortality rate of approximately 50%, which remains consistent with the theory of a mortality plateau (Barbi et al., 2018). The limited number of individuals validated at age 110 that could result in a lower mortality rate in this dataset may be attributed to several factors, most likely selection bias of which supercentenarians the researchers devoted their time to validating and a potential bias in media reports to emphasize longer-lived individuals. There appears to be an acceleration in mortality towards 60% after age 113. After age 116 or 117 there is insufficient data for any conclusions to be drawn.

Finally, that there was a seasonal component to when supercentenarians were born and died is tangentially related to previous research, which has found that centenarians are born to a higher extent in the Fall and Winter months (Gavrilov & Gavrilova, 2011; Doblhammer et al., 2005). Access to nutrition for expectant and nursing mothers has been put forward as a potential explanation for their children living longer (this period follows the harvest in several areas of the world). Research from 1936 found that in New York and Belgium, children born in the Spring and Summer had a higher mortality following the first year of their birth (Huntington, 1936). For season of death the colder months have been linked to a higher risk of death from infection and environmental exposure (Rau, 2007). Since the exceptionally old are likely to be frail towards the end of their lives it is possible that the cold weather affects their mortality. Specific diseases such as chronic obstructive pulmonary disease and the flu are both associated with excess mortality during the winter months (McCormack et al., 2018; Pebody et al., 2018), both of which are known as causes of death

among the oldest old. In the present study, it was noted that the pattern in seasonality for birth and death was most apparent for people born in the Northern hemisphere, potentially indicating that previous explanations on this phenomenon are accurate.

Conclusion

The number of supercentenarians has increased over time and the majorities are female. A potential mortality plateau might exist at younger ages, but a potential acceleration occurs after age 113. There also appears to be a seasonal aspect to longevity, with most supercentenarians, especially from the Northern hemisphere, being born and dying between October to March. While this study helps provide a better understanding on the number of supercentenarians there are still gaps in certain areas of the world that need to be addressed to provide a full picture about mortality and seasonality patterns of supercentenarians.

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Data Availability

Data used in this study (and other, more recent, validations) are continuously being added and available at <https://longeviquest.com>.

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