

Chapter 10

Centenarians and Supercentenarians in Japan



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10.1 Introduction

The number of centenarians in Japan, or people who have reached their 100th birthday, increased from 25,353 on October 1, 2005, to 61,763 on October 1, 2015. While the number of centenarians increased 146% over this 10-year period, over the same time period, the number of supercentenarians (people who have reached their 110th birthday) grew from 22 to 146 – a 563.6% increase. There are two main sources of data that can be used to study centenarians and supercentenarians who were alive during this period in Japan.

The census is one of them. Unfortunately, in the censuses published in 2005 and 2010, the number of people older than age 100 is presented by single year of age; while in the censuses published before 2000, we can only see the aggregate number of people above age 100. Moreover, the 2015 census provides information on the number of people aged 109 or younger by single year of age, and the number of people aged 110 or older as an aggregate. Therefore, not much research on centenarians and supercentenarians can be done using the published census data.

The centenarian list published by the Japanese Ministry of Health, Labour and Welfare (MHLW) is another source of data. Since early September of 1963, the MHLW has compiled data on the number of centenarians from the resident registry (Jumin Kihon Daicho) of local municipalities. On Respect of the Aged Day, the

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MHLW publishes a nominative list of centenarians to be celebrated for their longevity. Until 2001, the list was published on September 15. Since then, however, the list has been published on the third Monday of September. From 153 centenarians in 1963, the number of centenarians included on the list has increased successively to 532 in 1973, 1354 in 1983, 4802 in 1993, 20,561 in 2003, 54,397 in 2013, and 61,568 in 2015. Unfortunately, the MHLW stopped publishing the number of centenarians by single year of age in 2007. Currently, only the number of centenarians by sex is available from this source.

Both the census and the list of centenarians are based on information from the resident registry system, which was established in 1915. This system differs from the family register (KOSEKI, see below) in that it is based on residence and not on family origin. Until the early 2000s in Japan, the growth in the number of centenarians was documented (Robine and Saito 2003; Robine et al. 2003; Saito 2010), but early 2010s the actual number of centenarians was questioned. This uncertainty arose because the family register showed that there were more than 200,000 living centenarians, even though the most of these individuals had died, and the information on their deaths had not been reported (Saito et al. 2012). In recent years, the incidence of such errors has been reduced as the computerization of the two registration systems has facilitated data linkage.

As we described above, the extent to which demographic studies of centenarians and semi- and supercentenarians have used these data over the last 10 years is very limited. An alternative source of data for studying the demography of centenarians and semi- and supercentenarians is Japan's vital statistics. This source provides information on the number of deaths by sex, age at death, and year of birth from 1899 to the present. Here, we seek to update the demography of the population aged 100 and above in Japan primarily by drawing upon vital statistics data from January 1951 to December 2015.

Regardless of where the research is conducted, age validation is always a big issue for studies on very old adults. In introducing the Japanese registration systems and the sources of data used in this article, we first describe how age is recorded in statistics in Japan. We then briefly introduce the demography of the population in Japan aged 100 and above using census data. Finally, we describe the same population using data from Japan's vital statistics.

10.2 Data Sources: Important Key Dates

1872: On April 4, 1871, a new law established a family register system that went into effect on February 1, 1872. Known as the Jinshin-KOSEKI, this registration system was composed of one sheet per family containing information on all family members, including each person's age (in years and months) at the time of registration. Since this form of registration was established, newborns have been added to the family sheet with their age (expressed in months) at the time of registration.

Dates of birth have been recorded since 1881. Thus, in theory, all new centenarians in Japan since 1972 have been registered from birth through the family register system, introduced in 1872. Japanese data are therefore unlikely to suffer from the well-known phenomenon of age exaggeration.

1886: The Family Registration Law was revised with the introduction of a standardized form for each family, which included the registration of the dates of birth for all family members. Penalties were introduced for those who failed to report births or deaths within a specified period of time after these events occurred. The *Jinshin-KOSEKI* of 1872 was then revised through a transcription of all of the family information added between 1872 and 1886.

1898: Another revision of the Family Registration Law established the Japanese family system. With this revision, each family became a unit of registration. A new column was added to the registration form indicating the household head.

1899: Since this year, vital statistics by sex and single year of age have been available on an annual basis. The volume for the 1899 vital statistics was published in 1902. Following the revision of the Family Registration Law a year before, the bureau of statistics – which at that time was under the cabinet office of the government of Japan – started enumerating demographic events. Each demographic event was recorded on a piece of paper and sent from local municipalities to the central office for enumeration.

1914: The Resident Registry Law established another civil registration system based on current residence to help maintain the registration system. “As the volume of migration increased within Japan, the Family Registration System was inadequate for tracking migrants” (Saito 2010). The resident registry system went into effect in 1915. It contains information about the members of a given household, and is linked to the family register system. Details of the registration systems in Japan are available in Saito (2010).

1947: The 1947 revision of the family register system established each conjugal union as a unit of registration. Since that time, each *KOSEKI* is limited to two-generation families made up of parents and their unmarried children.

1951: Although vital statistics tabulation methods have changed over time, the number of deaths by sex, age at death, month of death, and year of birth has been continuously available since 1951. The same information is also available, albeit sporadically, for earlier years.

1963: Since 1963, the Ministry of Health and Welfare (now the Ministry of Health, Labour and Welfare) has been compiling a nominative list of people who would be age 100 or older by September 30 of each year. The purpose of the list, “*Zenkoku Koureisha Meibo*,” is to celebrate centenarians on Respect of the Aged Day.

2007: In response to concerns about privacy and the size of the list, it was decided in 2007 that the list of living centenarians would no longer be publically available. Since then, only the total numbers of male and female centenarians have been released each year. According to the list for 2016, 8167 male and 57,525 female centenarians were living in one or another of Japan’s municipalities in mid-September of that year.

Based on the history provided above, the following points are worth mentioning:

1. Age validation can only be done by using information from the family register in Japan. The family register was open to the public until 1976, but it has become highly restricted since then. Only family members of the target person of a study can request a copy of the relevant family register record.
2. As we mentioned above, newborns have been registered since February 1872, and the dates of birth have, in theory, been recorded since 1881. For age validation, we need to rely on records from the family register. This means that since February 1972, all Japanese people who reached age 100 should have been registered at birth in the family register; and that since 1981, the exact date of birth of all Japanese people who reached age 100 should have been recorded in the family register.
3. As explained by Saito (2010), the forms of the family register have been revised several times. The information for those who were registered at the time of the Jinshin-KOSEKI in 1872 has been transcribed several times. Even those who were born after the 1886 revision of the Family Registration Law have had their information in the family register transcribed a few times. This suggests that there may have been errors in the transcription of information from one form of family register to the next. However, as of today, there is no way of detecting mistakes in these transcriptions. It is, therefore, clear that we need to scrutinize the records in the family register of those who reached extremely high ages, as the cases presented in this book of Kimura and Okawa demonstrate.

10.3 The Number of Individuals in the Population Aged 100 and Above from the Censuses

Because we have very limited information on centenarians, we briefly present the number of surviving centenarians from the censuses conducted in 2005, 2010, and 2015. Looking at Table 10.1, we can see that over the 10-year period of 2005 and 2015, the total number of centenarians more than doubled from 25,353 to 61,763, while the number of semi-supercentenarians (people who reached age 105) also more than doubled from 1458 to 3770. Only 22 supercentenarians were alive in 2005, but that number had risen to 146 in 2015 – an almost seven-fold increase in 10 years. Considering that there were only 11 supercentenarians alive in 2000, and fewer than eight in most years prior to 1999 (based on the list of centenarians), the recent increase in the number of supercentenarians is quite surprising.

It is, however, important to keep in mind that the percent increase in the number of centenarians in almost all age groups between 2010 and 2015 is smaller than the percent increase between 2005 and 2010. We cannot predict whether the number of centenarians will continue to grow at the current pace. While the individuals who recently became centenarians were survivors of the Spanish Flu pandemic of 1918–1920, those who become centenarians after 2020 – and were thus born after 1920 – would not have been directly affected by the Spanish Flu. The parents of

Table 10.1 Total population and percent change in the number of individuals aged 100 and above by sex and 5-year age groups in 2005, 2010, and 2015

Age group	Sex	2005	2010	2015	%Increase 2005–2010	%Increase 2010–2015	%Increase 2005–2015
100	Males	3,760	5,851	8,383	55.6	43.3	123.0
	Females	21,593	38,031	53,380	76.1	40.4	147.2
	Total	25,353	43,882	61,763	73.1	40.7	143.6
100–104	Males	3,580	5,598	7,991	56.4	42.7	123.2
	Females	20,293	35,720	49,856	76.0	39.6	145.7
	Total	23,873	41,318	57,847	73.1	40.0	142.3
105–109	Males	178	250	383	40.4	53.2	115.2
	Females	1,280	2,236	3,387	74.7	51.5	164.6
	Total	1,458	2,486	3,770	70.5	51.6	158.6
110+	Males	2	3	9	50.0	200.0	350.0
	Females	20	75	137	275.0	82.7	585.0
	Total	22	78	146	254.5	87.2	563.6

these centenarians would, however, have been survivors of the 1918–1920 pandemic, which affected children and young adults in Japan (Ikeda et al. 2005; Richard et al. 2009). As Finch and Crimmins (2004) pointed out, “cohort levels of mortality during childhood are related to cohort mortality in old age.” The effect of the Spanish Flu on the number of centenarians requires further study.

10.4 The Number of Centenarian Deaths in Japan Between January 1, 1951, and December 31, 2015

According to Japan’s vital statistics, between January 1, 1951, and December 31, 2015, 260,220 Japanese died at age 100 or older, of whom 44,495 were males and 215,725 were females (82.9% of the total). These numbers include 592 people who died at age 110 or older, of whom 51 were males and 541 were females (91.4% of the total). This is the main dataset we will use to describe the demography of the population aged 100 or older in Japan between January 1951 and December 2015. The raw figures are displayed in Annex Table 10.5 by sex, single age from 100 to 120, and month of death.

Figures 10.1a and b provide a graphical view of this dataset. Figure 10.1a shows the age distribution of those who died between 1951 and 2015 by sex, while Fig. 10.1b shows the cumulative age distribution of the centenarians who died during the same period by sex. The latter figure displays the overall crude estimates of the mortality level above age 100 by sex and single year of age for those who died between 1951 and 2015. As we mentioned above, 215,725 females died at age 100 or older during the period. Therefore, 215,725 females reached the age of 100. Looking at Fig. 10.1b, we can see that out of this group of 100-year-olds, 36% (77,075/215,725) of females and 40% (17,983/44,495) of males died before reaching age 101. Mortality levels tended to increase after each successive

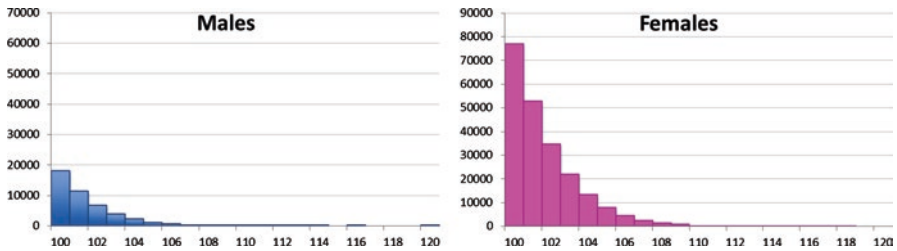


Fig. 10.1a Number of centenarian deaths in Japan between January 1, 1951, and December 31, 2015, by age at death and sex

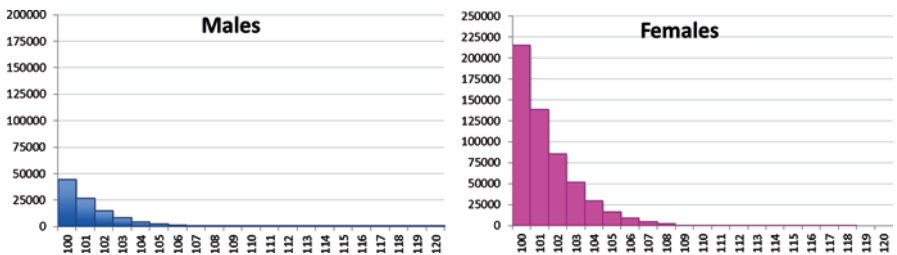


Fig. 10.1b Cumulative age distribution of centenarians who died in Japan between January 1, 1951, and December 31, 2015, by sex

birthday, reaching 59% for females between the 114th and the 115th birthday and 55% for males between the 107th and the 108th birthday. Only nine Japanese females died after reaching age 115. No more trends can be seen at higher ages. We observe that 229 Japanese males died after reaching age 108, and that a kind of mortality plateau is reached for four or five consecutive ages up to age 111/112. Only 10 males died after reaching age 112. No more trends can be seen at higher ages.

Our sample covers 65 calendar years, but in 1951, the number of those who died at age 100 or older was very low in Japan, and this number increased very slowly prior to the 1970s and even prior to the 1980s. Thus, Table 10.2 provides the raw number of centenarian deaths by sex and three age groups (100–104, 105–109, and 110+) for the period 1951–1975 and for the four 10-year periods 1976–1985, 1986–1995, 1996–2005, and 2006–2015.

Between 1951 and 1975, 3,331 deaths at age 100 or older were recorded in Japan, but the number of deaths recorded at age 110 or older for females may be too high, as suggested by the proportion represented by these deaths (0.4% of the total). All Japanese citizens who reached age 100 between 1951 and 1972 had been registered for the first time in 1872, when the family register system was introduced. At that time, the age of each person registered was expressed in years and months. In 1872, the ages of these future centenarians ranged from 1 year to about 25 years, leaving some room for mistakes in age reporting.

Table 10.2 Number of deaths at age 100 and above by broad age groups, period of time, and sex; Japan 1951–2015

	100–104	105–109	110+	Total	% 100–104	% 105–109	% 110+	% Total
1951–1975								
Females	2,472	96	11	2,579	95.9	3.7	0.4	100.0
Males	712	39	1	752	94.7	5.2	0.1	100.0
Sex-ratio	3.5	2.5	11.0	3.4	–	–	–	–
1976–1985								
Females	3,977	176	4	4,157	95.7	4.2	0.1	100.0
Males	1,033	41	1	1,075	96.1	3.8	0.1	100.0
Sex-ratio	3.8	43	4.0	3.9	–	–	–	–
1986–1995								
Females	11,838	612	23	12,473	94.9	4.9	0.2	100.0
Males	3,509	137	3	3,649	96.2	3.8	0.1	100.0
Sex-ratio	3.4	4.5	7.7	3.4	–	–	–	–
1996–2005								
Females	42,344	2,939	78	45,361	93.3	6.5	0.2	100.0
Males	10,552	522	14	11,088	95.2	4.7	0.1	100.0
Sex-ratio	4.0	5.6	5.6	4.1	–	–	–	–
2006–2015								
Females	1,38,658	12,072	425	1,51,155	91.7	8.0	0.3	100.0
Males	26,437	1,462	32	27,931	94.7	5.2	0.1	100.0
Sex-ratio	5.2	8.3	13.3	5.4	–	–	–	–
1951–2015								
Females	1,99,289	15,895	541	2,15,725	92.4	7.4	0.3	100.0
Males	42,243	2,201	51	44,495	94.9	4.9	0.1	100.0
Sex-ratio	4.7	7.2	10.6	4.8	–	–	–	–
Total	2,41,532	18,096	592	2,60,220	92.8	7.0	0.2	100.0

However, since 1963, all living centenarians have been enumerated each year by the Ministry of Health, Labour and Welfare through the compilation of the resident registry system of the Japanese municipalities. This administrative check may have indirectly improved the quality of age reporting at death. Thus, “extreme” cases of longevity, which were reported quite frequently between 1925 and 1955, almost disappeared after 1963 (Robine and Saito 2003; Saito 2010).

During the next decade, between 1976 and 1985, 5,232 deaths at age 100 or older were recorded in Japan. The births of almost all of these people should have been registered, with their current age at the time of the registration expressed in years and months. For those who died between 1951 and 1985, the information on their birth included in the KOSEKI may have been transcribed four times from one KOSEKI to another, with the last one being the KOSEKI of 1947, known as the current KOSEKI.

Between 1986 and 1995, 16,122 deaths at age 100 or older were recorded. Since 1986, most centenarians should have been registered according to the 1886 Family Registration Law, which standardized the registration form, including the registration of the date of birth for all family members. Since that time, the date of birth for each newborn should have been recorded at the time of birth within a specified period of time. For those who were registered for the first time after 1886, information on their birth may have been transcribed three times, from one family register to another.

During the next decade, between 1996 and 2005, 56,449 deaths at age 100 or older were recorded in Japan. In 1996–2005, the number of semi-supercenarians who died was almost five times higher and the number of supercentenarians who died was 3.5 times higher than in the preceding decade. The centenarians who died in 1996–2005 had been born well after the family register was established in 1872 and standardized in 1886.

Over the last decade of our study period, between 2006 and 2015, 179,086 deaths at age 100 or older were recorded. Almost 50 supercentenarian deaths per year were reported in this period, compared to around nine per year in the previous decade. The birth information of those centenarians who died between 1996 and 2015 may have been transcribed at least twice, once from the third form of the family register, and again to the current form of the family register.

As Table 10.2 shows, the sex ratio and the distribution among the three age groups, 100–104, 105–109, and 110+, vary little from one period to the next. Over the whole study period, from 1951 to 2015, the sex ratio was 4.8 female deaths for each male death among centenarians; and the total distribution of the deaths among the three age groups was 92.8% in the age group 100–104, 7.2% in the age group 105–109, and 0.2% in the age group 110+.

10.5 The Highest Reported Age at Death in Japan Between 1963 and 2015

Figure 10.2 displays the 10 highest reported ages at death (HRAD), for each sex, recorded in Japan between 1963 and 2015. Although this information is available from 1899 onward, we purposefully limited the series to the period covered by the centenarian list. We did so because, as we mentioned above, the centenarian list is based on the compilation of information from the resident registry system, and thus excludes incredible and unverifiable old cases. It appears, however, that most implausible age reports disappeared after 1963. On the male side, we note that a death was reported at age 120 in 1986. This is the well-known case of Shigechiyo Izumi, whose age seems to have been mistakenly reported. We also note that a death was reported at age 116 in 2013. This case, of a man named Jiroemon Kimura, has been thoroughly studied by Gondo et al. (2017), and appears to be rigorously documented. On the female side, we note that several deaths at very high ages have been reported, including one at age 118 in 1964, one at age 116 in 1970, and one at age 113 in 1976. These three old cases look like outliers. The first case, of a woman named Yasu Kobayashi, seems to be false. The second case, of a woman named Ito



Fig. 10.2 The 10 highest reported ages at death (HRAD) and their mean in Japan since 1963, by sex
 Note: The top solid line is the HRAD and the bottom solid line is the 10th HRAD. The bold line is the mean

Morimoto, has not been documented. But the third case, of a woman named Niwa Kawamoto,¹ may be true. The most recent cases of deaths reported at ages 114, 115, or even 116 have been examined by Saito (2010). The case of Hide Ohira, who reportedly died at the age of 114, seems to be true, but has not been documented with information from the KOSEKI (only press reports are available). The case of Tane Ikai, who was reported dead at the age of 116, has been verified (Inagaki et al. 1997). The spike in 2003 reflects the case of Kamato Hongo, who died at the age of 116. The case of Misao Okawa, who was reported dead at the age of 117 in 2015, seems to be true (see Chap. 21). Because these extreme cases are very rare and hard to verify, we prefer to focus on two alternative indicators of the highest reported ages at death (HRAD): the 10th HRAD and the mean of the first 10 HRADs. The two indicators provide similar information. Figure 10.2 shows the 10th HRAD and the mean of the 10 highest ages at death.

Looking at the 10th HRAD, we see that the figures increase from 101 in 1963 to 109 in 2015 for males, or by 8 years over 53 calendar years; and from 103 in 1963 to 112 in 2015 for women, or by 9 years over this period. When we examine the mean of the 10 HRADs, we find that the figures increase from 101.8 in 1963 to 109.7 in 2015 for males, or by 7.9 years over 53 calendar years; and from 105.3 in 1963 to 113.3 in 2013 for females, or by 8 years over the period (the bold lines on Fig. 10.2). On average, from 1963 to 2015, the 10th HRAD ages are 2.4 years higher for females than for males.

¹She is listed by the Gerontological Research Group. See <http://www.grg.org/Adams/OldestCentYear.HTM>

10.6 Mortality Estimates by Using the Extinct Cohort Method

To provide another crude mortality estimate, we assembled the number of deaths by birth cohort. If we assume that the last member of a birth cohort died at a certain age – say, 115 – and that international migration above age 100 is negligible, we can reconstruct the centenarian cohort population between 100 and 115 years old by adding the number of deaths backward from 115 to 100. This is the same method we used for creating data for Fig. 10.1b above, but here we only create data by cohort. We grouped five cohorts to create data for mortality estimates by birth cohorts, starting with the 1874 cohort: i.e., 1874–1878, 1879–1883, 1884–1888, 1889–1893, and 1894–1898. In addition, we grouped two cohorts, 1899 and 1900, for the analysis.

Note that among the total of 260,220 deaths recorded at age 100 or older from 1951 to 2015 used in this study, only nine cases were reported to have died after the age of 115: five at the age of 116, one at the age of 117, two at the age of 118, and one at the age of 120. This last case, of Shigechiyo Izumi, is known to be misreported. As both cases of deaths at age 118 are old, (reported in 1951 and 1964), it is likely that they were also misreported, and are therefore excluded from our analysis. Our examination of the data by cohort is thus restricted to the cohorts who reached the age of 100 starting in 1974. The case of Misao Okawa, who reportedly died at the age of 117, may be true (see Chap. 21). This case should be added to our study as a survivor at her 117th birthday in order to eliminate any age censorship for the 1898 birth cohort. Among the five cases of individuals who reportedly died at age 116, two are old. These two cases, who were reported dead in 1951 and 1970, may be incorrect, but do not interfere with our cohort study. Another two of these cases are of individuals whose deaths at the age of 116 were reported more recently: one of a woman, Kamato Hongo, who died in 2003; and one of a man, Jiroemon Kimura, who died in 2013 (Gondo et al. 2017). Although Poulain (2010) investigated Hongo's case and questioned her reported age, we included her case here because there is currently no consensus about her age. The last case, of an individual named Tane Ikai who was reported dead at the age of 116 in 1995, has been verified (Inagaki et al. 1997). These three cases should be included in our study as survivors at their 116th birthdays to eliminate any age censorship in their respective birth cohorts: 1879 for Tane Ikai, 1887 for Kamato Hongo, and 1897 for Jiroemon Kimura. There may also be some missing cases of supercentenarians who belong to the studied cohorts and survived to 2015. We therefore looked carefully at the public lists of Japanese supercentenarians who died in 2016 or 2017 at the age of 116 or older, as well as at the list of Japanese supercentenarians who were known to be alive on August 5, 2017.² Of these living supercentenarians, two are older than 115 years old: Chiyo Miyako (116 years old on August, 5, 2017; see Chap. 21) and Nabi Tajima (117 years old on August, 5, 2017). Chiyo Miyako was born in 1901, and therefore is not part of the present cohort study; but Nabi Tajima was born in 1900, and should be added to our study as having survived to her 117th birthday in August 2017.

²https://en.wikipedia.org/wiki/List_of_Japanese_supercentenarians, accessed on August fifth 2015.

By adding these five cases to their respective cohorts, we reconstructed cohort populations from age 100 to age 117, as shown in Table 10.3. Of these five added cases, four were female and one was male. To the best of our knowledge, our information on the Japanese centenarians belonging to the 1874–1900 birth cohorts is complete. Only two of these individuals reached the age of 117, one of whom was still alive on August 5, 2015. We used this information to study empirically the mortality trajectories in Japan above the age of 100.

In total, this part of our study comprises 53,533 centenarians – 42,547 females and 10,986 males – belonging to the cohorts born in 1874–1900. For each group of birth cohorts, the number of survivors was followed from the age of 100 to extinction at age 117, without any age censorship, except for two females who survived to age 117. The survival curves are plotted on Fig. 10.3, with a radix of 10,000 survivors at age 100 for each group of cohorts. We chose 10,000 as a radix for life table construction and for computing the standardized number of survivors (l_x) and the probability of dying (q_x) for the study. Figure 10.3 shows shifts in the survival curve to the right (higher ages) from one group of cohorts to the other. Obviously, each successive group of centenarians, comprising five birth cohorts, is surviving to higher ages than the previous group. This shift to the right is observed for both the male and the female cohorts.

Table 10.4 shows the computed life table probabilities of dying (q_x) by birth cohort from 1874 to 1900 and by sex. When looking at the table, it is very important to note that the actual size of the cohorts is increasing quickly for later cohorts, and that the size of the female cohorts is much larger than the size of the male cohorts. The table also shows that q_x is generally lower for later cohorts for both females and males. q_x steadily increases with age, and then starts fluctuating.

Figure 10.4 provides a graphical presentation of q_x , as shown in Table 10.4. The general trend observed from this figure is that the smaller the studied group of cohorts (earlier group of cohorts and/or male group of cohorts), the sooner fluctuations appear to prevent these cohorts from following the mortality trajectories associated with higher ages.

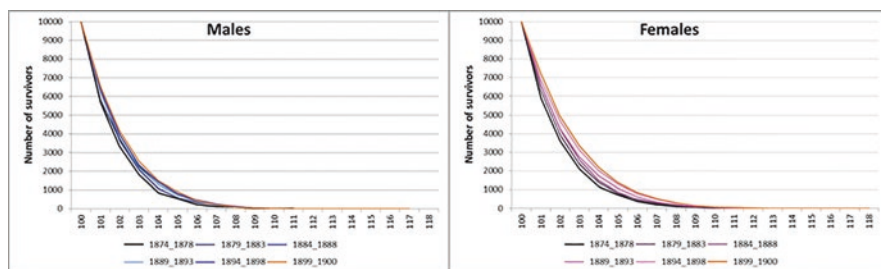


Fig. 10.3 Survival curves from age 100 for the extinct Japanese birth cohorts born between 1874 and 1900 by sex and by group of 5 consecutive cohorts, except for the last two cohorts 1899 and 1900

Table 10.4 Computed life table probability of dying (q_x) by single year of age and birth cohort from 1874 to 1900 by sex

Females						
Age	1874_1878 (n = 1648)	1879_1883 (n = 2513)	1884_1888 (n = 4413)	1889_1893 (n = 8079)	1894_1898 (n = 16,036)	1899_1900 (n = 9858)
100	0.40837	0.36490	0.33809	0.33457	0.31111	0.28069
101	0.38769	0.38158	0.36186	0.35900	0.32226	0.31335
102	0.42211	0.39514	0.38144	0.35287	0.33031	0.32368
103	0.44638	0.41206	0.42585	0.37085	0.35341	0.35226
104	0.36649	0.43875	0.42447	0.39059	0.35719	0.36381
105	0.47107	0.38071	0.44882	0.42105	0.38388	0.38394
106	0.46875	0.39344	0.42857	0.44646	0.39720	0.37679
107	0.52941	0.44595	0.45000	0.44526	0.44057	0.42994
108	0.25000	0.26829	0.40909	0.45395	0.41801	0.43771
109	0.50000	0.43333	0.46154	0.40964	0.48413	0.44910
110	0.33333	0.41176	0.28571	0.46939	0.46923	0.48913
111	0.25000	0.70000	0.26667	0.42308	0.57971	0.53191
112	0.33333	0.33333	0.27273	0.66667	0.48276	0.59091
113	0.50000	0.00000	0.50000	0.40000	0.53333	0.77778
114	1.00000	0.50000	0.75000	1.00000	0.57143	0.00000
115		0.00000	0.00000		0.66667	0.50000
116		1.00000	1.00000		0.00000	0.00000
117					1.00000	1.00000
Males						
Age	1874_1878 (n = 363)	1879_1883 (n = 670)	1884_1888 (n = 1270)	1889_1893 (n = 2252)	1894_1898 (n = 4170)	1899_1900 (n = 2261)
100	0.42975	0.41493	0.36772	0.37567	0.35827	0.34719
101	0.41546	0.36990	0.42217	0.39403	0.38079	0.36043
102	0.45455	0.38057	0.42241	0.41901	0.41038	0.39407
103	0.53030	0.43137	0.48134	0.40606	0.39406	0.41259
104	0.35484	0.43678	0.46043	0.44218	0.43581	0.38690
105	0.60000	0.40816	0.41333	0.47561	0.40419	0.51456
106	0.37500	0.48276	0.40909	0.51163	0.45729	0.48000
107	0.20000	0.46667	0.50000	0.40476	0.45370	0.57692
108	0.75000	0.62500	0.46154	0.48000	0.49153	0.40909
109	0.00000	0.66667	0.42857	0.38462	0.63333	0.46154
110	0.00000	1.00000	0.25000	0.37500	0.54545	0.85714
111	1.00000		0.33333	0.40000	0.60000	1.00000
112			1.00000	0.66667	0.00000	
113				0.00000	0.50000	
114				1.00000	0.00000	
115					0.00000	
116					1.00000	

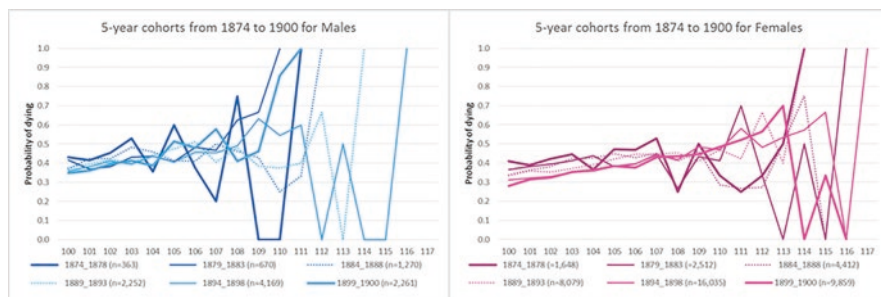


Fig. 10.4 Probability of dying from age 100 onward by single year of age for the extinct Japanese cohorts born between 1874 and 1900, by sex and by group of 5 consecutive cohorts, except for the last two cohorts 1899 and 1900

When we look at individual mortality trajectories by birth cohort, some interesting features appear. The 1874–1878 male cohort displays fluctuations from age 103 onward; while the 1894–1898 female cohort and the 1899–1900 cohort seem to show a steady increase in mortality until age 115 or age 113, respectively. In between, we can see that the age at which the cohorts become extinct tends to shift over time to higher ages, and that the fluctuations tend to decrease with the increase in the number of centenarians in the studied cohorts. More importantly, we can see that the probabilities of dying tend to plateau with age for the cohorts in the middle (1879–1883 female cohorts, 1884–1888 male and female cohorts, and 1889–1893 male and female cohorts). Fluctuations can be observed among the earlier groups of cohorts, especially the 1874–1878 group of cohorts. By contrast, among the most recent 1894–1898 group of cohorts, a regular increase in mortality can be seen up to age 111 for the male cohorts and up to age 115 for the female cohorts. The two most recent extinct cohorts, 1899–1900, display a monotonic increase in mortality until age 107 for males and age 113 for females. This observation suggests that a plateau of mortality occurred among the cohorts born between 1879 and 1893. Among the preceding cohorts, the oldest-old are too rare to allow us to observe anything other than fluctuations in mortality above age 100. Among the cohorts born after 1894, when the numbers of centenarians start to be consequential, the mortality trajectories seem to keep increasing with age, even if the rate of increase is not large.

As a kind of sensitivity analysis, we grouped the cohorts born after 1893 differently. The two female cohorts 1899–1900 seem to follow a lower mortality trajectory than the five previous birth cohorts born in 1894–1898, but they represent only two cohorts of centenarians ($n = 9859$) versus five cohorts ($n = 16,035$). The two male cohorts comprise only 2261 centenarians, and suffer from large fluctuations. Therefore, it is tempting to add the two cohorts of 1899–1900 to the previous 1894–1898 cohorts, especially because Fig. 10.4 suggests that the survival patterns of these two groups of cohorts are quite similar. We took this opportunity to perform some sensitivity analyses, proposing alternative groupings (see Fig. 10.5).

Whatever the grouping used starting with the cohort born between 1894 and 1900, mortality seems to increase, at least up to age 107 among males and up to age

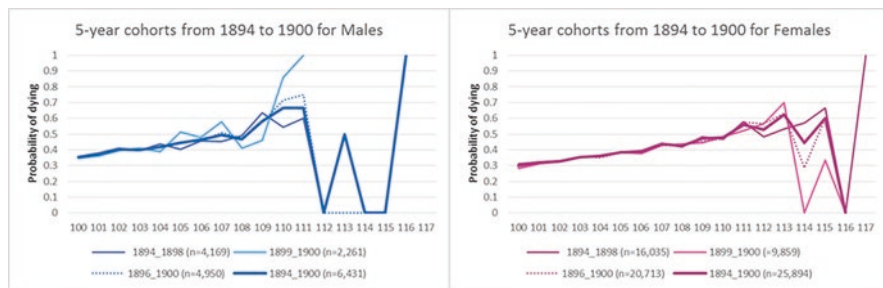


Fig. 10.5 Mortality trajectories (annual probability of dying) from age 100 onward for the extinct Japanese cohorts born between 1894 and 1900 by sex, according to 4 different groupings, 1894–1898, 1898–1900, 1896–1900, and 1894–1900

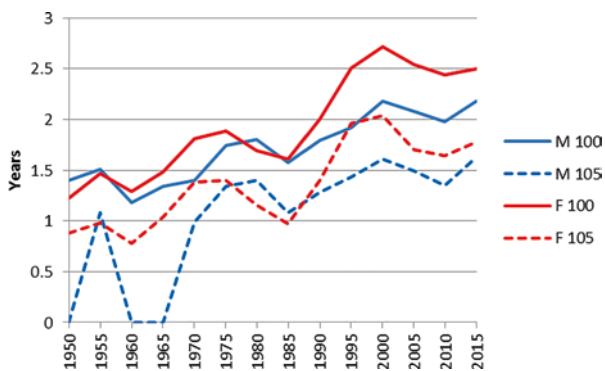


Fig. 10.6 Trends in life expectancy at ages 100 and 105 by sex: 1950–2015 Japan

111 among females. Then, for the following 2 or 3 years, to age 110 for males and age 113 for females, the trend seems to keep increasing, but with some noise. After these ages, the series only show fluctuations due to the small numbers of Japanese males and females reaching the ages of 111 and 114, respectively.

10.7 Trends in Life Expectancy at Ages 100 and 105

Finally, we would like to introduce trends in life expectancy at ages 100 and 105 by sex from complete life tables published by the Ministry of Health, Labour and Welfare. As Fig. 10.6 shows, for both males and females, life expectancy at age 100 and at age 105 increased over time from 1950 to 2015, albeit with some fluctuations. We will have to wait another 10–15 years to determine whether the trend in life expectancies at ages 100 and 105 over the last 15 years represents stagnation, or is merely a fluctuation. Moreover, we have to study further the effect of the Spanish Flu Pandemic of 1918–1920 on mortality among centenarians.

10.8 Conclusion

The aim of this chapter has been to carefully present the data that are available in Japan to study the demography of centenarians, which include population estimates, number of deaths, mortality levels, and maximum reported ages at death (MRAD) or highest reported ages at death (HRAD). Japan leads the adult longevity revolution among the low-mortality countries, and many studies use Japanese data to discuss various longevity issues, such as the yearly pace of increases in life expectancy and the possible limits to human longevity (Oeppen and Vaupel 2002; Ouelette and Bourbeau 2011; Hanayama and Sibuya 2016; Dong et al. 2016). The strengths and limits of the Japanese data are not always well understood. Among the strengths are the quality of the data on centenarians since at least 1963 (Saito et al. 2012) and the size of the centenarian population. Currently, there are more centenarians living in Japan than in the United States, and more than in all of the western European countries taken together. Among the limits of the data is the absence of a long chronological series starting during the nineteenth or the eighteenth century, like those in France and Sweden (Wilmoth et al. 2000). It is important that these strengths and weaknesses are understood, because one of the most important criticisms of the Dong et al. study (2016) about the limits of the human life span is the asynchronous addition of several countries/datasets that the authors undertook because of small sample sizes at the country level (Hughes and Hekimi 2017; Lenart and Vaupel 2017). For example, the Japanese dataset used by Dong et al. comprises 78 Japanese individuals who died between 1996 and 2005. By comparison, our Japanese dataset comprises 541 female and 51 male supercentenarians who died between 1951 and 2015, including 315 female and 32 male supercentenarians belonging to the extinct birth cohorts of 1874–1900.

If we are not using the same dataset when proposing and testing a hypothesis (Rozing et al. 2017; Brown et al. 2017), it is important that we have a large, independent hypothesis-generating sample, such as the Japanese dataset. Western European samples and/or American samples can then be used as hypothesis-testing samples, while avoiding asynchronous addition, or vice-versa.

Traditionally, demographers distinguish between the period and the cohort approach (i.e., cross-sectional vs. longitudinal framework). The available Japanese dataset can be used to test various hypotheses about the mortality trajectory with age, central death rate (m_x), and/or probability of dying (q_x) in both frameworks. In a longitudinal framework, survivors to the next age can benefit from annual progress, offsetting in part the negative impact of their increased aging. The dataset can also be used to explore the limits of lifespans.

Annex

Table 10.5 Death counts for Japanese who died at the age of 100 years or above from 1951 to 2015, by sex, single age at death, and month of death

Females		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
100		7,641	6,787	6,982	6,604	5,995	5,426	5,770	5,852	5,699	6,101	6,694	7,524	77,075
101		5,299	4,656	4,737	4,294	4,155	3,774	3,871	3,909	3,889	4,412	4,592	5,164	52,752
102		3,317	3,107	3,102	2,803	2,693	2,403	2,558	2,591	2,584	2,875	3,030	3,393	34,456
103		2,144	1,950	1,991	1,827	1,819	1,529	1,585	1,577	1,617	1,759	1,842	2,150	21,790
104		1,314	1,133	1,191	1,079	994	903	950	992	984	1,093	1,190	1,393	13,216
105		740	679	680	609	619	557	574	568	573	593	652	745	7,589
106		436	374	369	320	364	331	295	338	340	320	385	424	4,296
107		237	176	217	193	182	148	164	190	184	182	202	215	2,290
108		116	94	102	91	96	91	80	87	93	92	103	93	1,138
109		60	61	34	51	38	41	50	39	39	48	69	52	582
110		26	21	27	24	21	20	20	22	22	22	25	24	274
111		11	12	14	10	14	12	11	17	16	11	16	8	152
112		7	7	4	2	7	6	3	2	4	7	5	11	65
113		4	7	1	2	1	1	3	2	1	5	1	0	28
114		0	0	1	1	2	2	1	1	1	0	3	1	13
115		1	0	0	0	0	0	0	0	1	0	0	1	3
116		0	0	0	0	0	1	1	0	0	1	0	0	3
117		0	0	0	1	0	0	0	0	0	0	0	0	1
118		0	0	0	0	2	0	0	0	0	0	0	0	2
119		0	0	0	0	0	0	0	0	0	0	0	0	0
120		0	0	0	0	0	0	0	0	0	0	0	0	0
Total		21,353	19,064	19,452	17,911	17,002	15,245	15,936	16,187	16,047	17,521	18,809	21,198	2,15,725

(continued)

Table 10.5 (continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Males													
100	1,933	1,681	1,673	1,436	1,366	1,189	1,256	1,305	1,280	1,438	1,545	1,881	17,983
101	1,196	1,054	1,077	953	890	769	813	803	811	887	995	1,135	11,383
102	674	674	615	540	511	483	463	526	499	568	607	630	6,790
103	407	351	350	291	289	287	301	265	272	308	368	385	3,874
104	206	189	207	201	174	151	164	156	154	190	193	228	2,213
105	119	80	97	96	86	78	78	95	85	90	126	110	1,140
106	64	52	52	42	44	30	53	45	48	56	55	57	598
107	24	38	30	23	19	22	15	27	21	21	17	28	285
108	18	9	12	9	11	12	8	7	8	7	9	9	119
109	13	7	2	3	4	4	7	2	6	2	7	2	59
110	6	1	2	0	2	0	3	4	1	4	2	4	29
111	2	3	1	0	0	3	1	1	1	0	0	0	12
112	1	0	0	1	2	0	1	0	0	0	0	0	5
113	0	0	0	0	0	1	0	0	0	0	0	0	1
114	0	0	0	0	0	0	0	0	1	0	0	0	1
115	0	0	0	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	1	1	0	0	0	0	0	0	2
117	0	0	0	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	4,663	4,140	4,118	3,595	3,399	3,030	3,163	3,236	3,187	3,571	3,924	4,469	44,495

Both sexes		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
100	9,574	8,468	8,655	8,040	7,361	6,615	7,026	7,157	6,979	7,539	7,539	8,239	9,405	95,058
101	6,495	5,710	5,814	5,247	5,045	4,543	4,684	4,712	4,700	5,299	5,299	5,587	6,299	64,135
102	3,991	3,781	3,717	3,343	3,204	2,886	3,021	3,117	3,083	3,443	3,443	3,637	4,023	41,246
103	2,551	2,301	2,341	2,118	2,108	1,816	1,886	1,842	1,889	2,067	2,067	2,210	2,535	25,664
104	1,520	1,322	1,398	1,280	1,168	1,054	1,114	1,148	1,138	1,283	1,283	1,383	1,621	15,429
105	859	759	777	705	705	635	652	663	658	683	683	778	855	8,729
106	500	426	421	362	408	361	348	383	388	376	376	440	481	4,894
107	261	214	247	216	201	170	179	217	205	203	203	219	243	2,575
108	134	103	114	100	107	103	88	94	101	99	99	112	102	1,257
109	73	68	36	54	42	45	57	41	45	50	50	76	54	641
110	32	22	29	24	23	20	23	26	23	26	26	27	28	303
111	13	15	15	10	14	15	12	18	17	11	11	16	8	164
112	8	7	4	3	9	6	4	2	4	7	7	5	11	70
113	4	7	1	2	1	2	3	2	2	1	5	1	0	29
114	0	0	1	1	2	2	1	1	2	0	0	3	1	14
115	1	0	0	0	0	0	0	0	1	1	0	0	1	3
116	0	0	0	0	1	2	1	0	0	1	1	0	0	5
117	0	0	0	1	0	0	0	0	0	0	0	0	0	1
118	0	0	0	0	2	0	0	0	0	0	0	0	0	2
119	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Total	26,016	23,204	23,570	21,506	20,401	18,275	19,099	19,423	19,234	21,092	21,092	22,733	25,667	2,60,220

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