Trends in places and causes of death among centenarians in Japan from 2006 to 2016

Short title: Centenarians' death in Japan

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Author contributions: *Toshihiro Koyama contributed to the acquisition, statistical analysis, and interpretation of the data and drafting and revision of the manuscript. Hideharu Hagiya contributed to the conception and study design, interpretation of the data, and the revision of the manuscript. Tsukasa Higashionna, Akinori Maruo, Soichiro Ushio, Yoshito Zamami, and Ko Harada contributed to the interpretation of data and the critical review of the manuscript.*

Abstract

Aim: Amid the global aging, an establishment of healthcare policies for the aged population is a common issue to be addressed. However, few studies on centenarians have reported place and cause of death (PoD and CoD, respectively) as indicators of end-of-life care quality. This study aimed to analyze trends in PoD and CoD among centenarians in Japan.

Methods: Data from death certificates from Japanese vital statistics were analyzed; 205,513 deaths occurred among centenarians (aged ≥100 years) in Japan during the period from 2006 to 2016. PoD prevalence was calculated for each CoD. Trends in PoD prevalence were analyzed using the Joinpoint regression model. Changing points, annual percent changes (APCs), and average APCs (AAPCs) were calculated to examine trends.

Results: The number of deaths more than doubled from 10,340 in 2006 to 26,427 in 2016. PoDs were composed of hospitals (52.7%), nursing homes (31.4%), own homes (13.6%), and others (2.2%). Dementia and old age increased rapidly as CoD. Proportions of hospital and home deaths decreased, with AAPCs of -2.3% (95% confidence interval [CI], -2.6 to -1.9) and -2.3% (95% CI, -3.2 to -1.4), respectively. Conversely, the proportion of deaths in nursing homes rapidly increased, with an AAPC of 6.8% (95% CI, 6.0 to 7.7).

Conclusions: The results revealed changes in PoD among centenarians in Japan. Understanding these transitions is indispensable for health policy in aging societies.

Keywords: aging, centenarians, death, nursing home, trend.

INTRODUCTION

Centenarians, people aged ≥100 years, are celebrated in many societies. Because of multi-morbidity and frailty, a majority of centenarians depend on healthcare and social welfare systems. The global centenarian population has rapidly increased and gained attention in recent years, and is estimated to reach approximately 3.7 million in 2050, or approximately 8 times the population in 2015 (451,000).[1] In 2015, the United States had the largest number of centenarians (approximately 62,000), followed by Japan and China. When comparing 2015 and 2050 projections, the population growth rate of centenarians is expected to markedly exceed the total population growth rate in many countries. In developed countries, the number of centenarians per population is estimated to increase 3- to 5-fold. In some emerging countries, such as Brazil and China, the centenarian populations are estimated to increase at a rapid rate of more than 10-fold. By 2050, China is expected to have the largest centenarian population (approximately 500,000).[1] Thus, the rapid expansion in the centenarian population is a global issue; however, only few studies have focused on health policies for this population.

To improve end-of-life care (EoLC) for the increasing number of centenarians, an appropriate comprehension of places of death (PoD) and causes of death (CoD) is essential. Several previous studies have reported on patients' preferences regarding where they wish to die.[2-4] A study reported that 44% of Japanese subjects wished to die at home, although this study did not include centenarians.[3] Other studies have revealed that a home, or a home-like residential environment, such as a nursing home or care home, was preferable to a hospital.[4,5] So far, centenarians have not been well researched because of the relatively small population size.[6,7] By contrast, increasing numbers of studies have investigated the death locations of particular populations, such as relatively young older people, cancer patients, and patients with dementia.[2-5,8-11] However, a previous study of more than 30,000 centenarians in England

during 2001–2010 reported that 27.1% had died in a hospital, 26.7% in nursing care facilities, and 34.5% in care homes without nursing.[7] These findings may indicate a discrepancy between centenarians' wishes and actual PoD. Moreover, centenarians were more likely to die from pneumonia and frailty than from malignancy or ischemic diseases. [7] Thus, the difference in CoD suggests particular needs for care and support among centenarians.

In Japan, where the population is aging at a higher rate than in other countries, countermeasures to accommodate the increasing centenarian population are emerging issues. The number of centenarians relative to the total population in Japan is remarkably high when compared with the corresponding number in other countries; as of 2015, there were 46 centenarians per 100,000 residents.[1] This number will increase nearly 9-fold by 2050 and reach the world's highest level of approximately 400 per 100,000 residents.[1] Thus, a detailed investigation of Japanese centenarians will provide information on where and what medical resources should be invested to ensure a sufficient EoLC for the increasing older populations. Therefore, this study aimed to examine the trends in PoD and CoD among Japanese centenarians to better inform health service provisions for a global aging society.

METHODS

Data sources

This was a population-based observational study in Japan conducted during an 11-year period. Data on the number of centenarian deaths by PoD and CoD during 2006–2016 were obtained from the vital statistics based on death certificates collected by the Japanese Ministry of Health, Labor, and Welfare according to international coding rules of the World Health Organization.[12] The PoD was determined from the death certificate as a hospital (hospital or physician's office), nursing home (care home or nursing care home), or own home. Underlying CoDs were defined using the following *International Classification of*

Diseases Tenth Revision (ICD-10) codes:[13] pneumonia (ICD-10: J12–J18), cerebrovascular disease (I60–I69), ischemic heart disease (I20–I25), dementia (F01–F03 and G30), cancer (C), old age (R54), circulatory others (I [others]), and respiratory others (J [others]) based on a previous study.[7] In the Japanese manual on completing a death certificate, old age is defined as a death of an old person from natural causes, without an apparent describable CoD.

Statistical analysis

The proportions of PoD, expressed as percentages, were obtained by dividing the number of deaths at each hospital, nursing home, or home by the number of all deaths in that year. To estimate the trends in the proportions for each PoD, the Joinpoint regression model was applied using the Joinpoint Regression Program version 4.7.0.0 (February 2019; National Cancer Institute).[14] The annual percentage change (APC) between trend-change points was determined with its confidence intervals (CI). To compare differences in the trends among PoD, we estimated the average APC (AAPC) over the entire period. A two-tailed *p*-value of <0.05 was considered significant. Data processing and aggregation were performed using Microsoft Access® 2013 (Microsoft Corporation, Redmond, WA, USA).

Ethics approval

This study used data provided by the Japanese Ministry of Health, Labor, and Welfare and the Statistics Bureau of the Ministry of Internal Affairs and Communications. Ethics approval was obtained by the institutional review board at Okayama University Hospital (No. 2007-011). The requirement for informed consent was waived because the study was a retrospective analysis of routinely collected data.

RESULTS

In this study, we analyzed data on 205,513 deaths among all Japanese centenarians. The number of deaths was 10,340 in 2006 and more than doubled to 26,427 in 2016. At the end of the study period, 52.7% (95% CI, 52.1 to 53.3) died in hospitals, 31.4% (95% CI, 30.9 to 32.0) in nursing homes, 13.6% (95% CI, 13.2 to 14.0) at home, and 2.2% (95% CI, 2.1 to 2.4) in other locations (**Table 1 and Fig. 1**). As the total number of deaths increased more than 2.5 times, the number of deaths in all PoD categories increased. However, when analyzing the proportion of PoD over the long term, the proportion of hospital deaths decreased from 65.8% (95% CI, 64.9 to 66.7) in 2006 to 52.7% (95% CI, 52.1 to 53.3) in 2016. The proportion of nursing home deaths increased from 16.7% (95% CI, 16.0 to 175) to 31.4% (95% CI, 30.9 to 32.0) and that of home deaths decreased from 16.8% (95% CI, 16.1 to 17.5) to 13.6% (95% CI, 13.2 to 14.0) (Table 1). Furthermore, in 2006, the death rate at medical facilities was high, the death rates in nursing homes and own homes were comparable, and the death rate in nursing homes increased sharply in 2016 and exceeded the percentage of home deaths. Although the hospital death rate decreased over time, it continued to exceed 50% of the total deaths.

Table 2 shows the results of the trend analysis of PoD. The proportion of hospital deaths declined at an APC of 1.4% (95% CI, -2.7 to -0.1) from 2006 to 2009 and 2.7% (95% CI, -3.0 to -2.4) from 2009 to 2016. The prevalence of hospitals as PoD decreased by 2.3% (95% CI, -2.6 to -1.9) of the AAPC in the entire period. Similarly, the prevalence of homes as PoD also decreased by 4.0% (95% CI, -6.2 to -1.7) from 2006 to 2010 and -1.2% thereafter (95% CI, -2.2 to -0.2) and decreased by 2.3% (95% CI, -3.2 to -1.4) of the AAPC throughout the period. By contrast, the prevalence of nursing homes as PoD increased consistently at 8.0% (95% CI, 6.9 to 9.1) of APC from 2006 to 2013 and 4.2% (95% CI, 1.9 to 6.5) from 2013 to 2016 and increased with an AAPC of 6.8% (95% CI, 6.0 to 7.7) throughout the period.

Regarding the CoD, the highest number of deaths was attributed to old age (64,533), followed by circulatory others (35,295), pneumonia (29,119), cerebrovascular diseases (17,967), other respiratory diseases (12,274), cancer (10,160), ischemic heart disease (6,498), and dementia (5,572) (**Fig. 2**). The total number of all CoD among centenarians also increased in 2006–2016. Particularly, the rates of death from dementia and old age increased rapidly. Dementia as a CoD increased 5-fold from 172 deaths in 2006 to 941 deaths in 2016, and old age as a CoD increased 4-fold from 2,412 to 9,907 deaths during that period.

More than half of centenarians whose CoD was pneumonia, cerebrovascular disease, ischemic heart disease, cancer, or other circulatory diseases died in hospitals (**Table 3**). Dementia and old age were associated with prevalence rates of 43.6% and 28.3%, respectively, for nursing homes as PoD; these rates increased rapidly to 59.2% and 45.0%, respectively, in 2016. Ischemic heart disease and old age accounted for the largest proportion of home deaths, at 20.6%, while pneumonia accounted for the smallest proportion of home deaths, at 6.8%.

DISCUSSION

To the best of our knowledge, this study was the first study to investigate trend changes in PoD and CoD among centenarians in a super-aged country with the highest centenarian population density. Moreover, this study included the largest number of centenarians reported to date worldwide. Hospitals were the most frequent PoD for the Japanese centenarians, although this proportion decreased consistently throughout the study period. Conversely, the proportion of nursing homes as the PoD continued to increase, approaching one-third of the total deaths by 2016. The proportion of homes as the PoD remained at a low level of approximately 10% during the study period.

Our analysis uncovered the increasing trend of Japanese centenarians who died in

177 nursing homes; the AAPC of nursing homes was 6.8% from 2006 to 2016, while the
178 prevalence of hospital and home as PoD both decreased by 2.3%. The trend change points
179 differed among the three categories, for which we cannot account a plausible reason.
180 However, we consider the point to pay attention to is the trend itself; in brief, more
181 centenarians decease in Japanese nursing homes. Although the present data did not include
182 those of under centenarians, such as octogenarians or nonagenarians, our recent study based
183 on a population-based observational analysis has revealed that the Japanese older population
184 aged ≥65 years showed almost the same tendency.[15] That is, the APCs of nursing homes in
185 the same period were 12.4% during 2006–2013 and 7.8% during 2013–2017, whereas the
186 prevalence of hospital and home as PoD significantly decreased by 0.3% and 1.7%,
187 respectively. Another study has revealed that the Japanese older patients with dementia have
188 also followed a similar trend;[16] the APCs of nursing homes in the same period were 6.5%
189 during 2004–2011 and 3.3% during 2011–2016, while the prevalence of hospital and home as
190 PoD significantly decreased by 2.5% (2005–2016) and 5.8% (1998–2016), respectively. In
191 this way, not only the centenarians, we assume the increasing numbers of Japanese older
192 people generally die in nursing homes in recent years.
193 The proportions of PoD of aged people differ between countries. A 10-year study of
194 35,876 centenarians in England reported that the proportions of deaths in hospitals, nursing
195 and residential homes, and own homes were approximately 25%, 60%, and 10%,
196 respectively.[7] In other European countries, such as the Netherlands and Finland, people aged
197 ≥90 years died mostly in nursing homes.[11,17] In the US, more than half (57.6%) of people
198 aged ≥95 years died in nursing homes, followed by hospitals (28.0%) and homes (14.5%).[18]
199 In Taiwan, 63.8% of the centenarians died at their own homes, followed by hospitals (30.5%)
200 and hospice home (0.3%).[19] Compared with the results of these previous studies, a high
201 proportion (52.7%) of Japanese centenarians died in hospitals even in 2016. Moreover, the

proportion of deaths in nursing homes (31.4%) was relatively low. The proportion of home deaths was as low as approximately 10%, similar to that reported in previous studies. As healthcare systems differ between these countries, the possible reasons for these discrepancies are difficult to determine. However, in Japan, the patient's preferred PoD may not be shared by their family members, caregivers, and healthcare professionals. A nationwide questionnaire survey regarding the perspective on EoLC was conducted by the Japanese Ministry of Health, Labor, and Welfare in 2017, which targeted randomly selected adults aged ≥20 years. The survey reported that 55.1% had never discussed death with their families or caregivers. Moreover, 66.0% agreed to share their own preferences on terminal care with family members or caregivers, but only 8.1% of them actually documented their wishes regarding EoLC.[20] Based on the current situation, there may be room to promote advanced care planning and achieve centenarians' preferences regarding EoLC.[21,22] A similar situation was reported in a population-based study through in-person interviews in Germany, which described a misunderstanding between the centenarians and their primary contacts (proxy informants) regarding their thoughts and plans for EoLC. [23]

The pattern of CoD among centenarians changed drastically in Japan over the 11-year study period, which has implications regarding the need for policies on the future transition of EoLC. Although the proportion of hospital deaths due to pneumonia, cancer, and other circulatory conditions has decreased, the actual number of deaths due to each disease has increased as the total number of deaths has increased. This may explain the high reliance on hospitals as PoD in Japan. The number of deaths due to dementia and old age, though still relatively small, had increased 5- and 4-fold, respectively. Moreover, the proportions of dementia and old age as CoD were high in nursing homes (54.2% and 39.4%, respectively). In addition to these figures supporting the increasing social demand for nursing care facilities as PoD, we need to consider centenarians' wishes to ensure that aged people are treated with

dignity and respect. Approximately half of the Japanese people reportedly wish to die at home;[3] however, the proportion of home deaths has remained low (<20%) during the study period. Thus, there may be a wide gap between the hopes of centenarians and their actual PoD, and social systems must be prepared to support comfortable lives, including deaths outside of hospital settings. Our findings highlight the need for healthcare provisions and policies to enhance support for EoLC at preferred PoD, which include homes and home-like environments, such as nursing homes. Among the centenarians, reluctant factors for living longer are reportedly annoyance, uselessness, loss of meaning, disconnection, and loneliness.[24] Willingness of PoD should be considered in terms of these views. Moreover, to avoid unwanted transportation to the hospital, advanced care planning would also be necessary for healthcare providers and care givers.[22,25]

Strengths and limitations

As strength, this study analyzed all Japanese centenarian deaths. This is the largest population of centenarians reported to date, and the analysis has captured significant changes in the trends of PoD. However, this study has several limitations. First, this study used data on PoD from death certificates, which do not necessarily reflect the place of terminal care. A person may receive care in a nursing home or their own home before being transferred to the hospital or another place during the last moments of their life. Second, we could not evaluate whether PoD were the locations where the centenarians had hoped to die. Therefore, the findings may not reflect the appropriateness of each PoD. Third, lack of the evaluation for and comparison with octogenarians or nonagenarians should be pointed out. However, compiled with the results of previous literature, [15,16] a similar tendency would be observed in such populations. Finally, death at home may include the centenarians who could enjoy a satisfactory EoLC by home medical care and those who died in loneliness on the other hand.

Our data was lack of these in-detailed backgrounds to be discussed. Despite these limitations, the present findings increase our comprehensive understanding of the current trends of PoD among centenarians in Japan, prompting the development of social platform to fulfill the wishes of the older population. To achieve that, as have done in Netherlands,[26,27] a well-organized cohort study would provide us valuable insights.

CONCLUSION

This large-scale study revealed that more than half of Japanese centenarians died in hospitals in 2006–2016, while deaths in nursing homes increased up to one-third of the total deaths during this period. The increases in old age and dementia as CoD in this population will likely emphasize the role of nursing homes as PoD for centenarians. In the times of accelerated population aging, larger numbers of people will die at age ≥100 years with multiple comorbidities and frailty. The observed drastic changes in the CoD imply the need for health policies that would ensure sufficient EoLC for centenarians. Further demographic analyses of the PoD and CoD among the oldest populations worldwide are warranted.

Acknowledgments

We would like to thank Editage (www.editage.jp) for English language editing. This study was supported by Japan Society for the Promotion of Science KAKENHI (19K10533) (Tokyo, Japan).

Disclosure

The author(s) declare no competing interests.

Data Sharing and Data Accessibility

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figure legends

Fig 1. Number of deaths among centenarians by place of death, 2006–2016.

Fig 2. Number of centenarian deaths by cause of death, 2006–2016.