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Abstracts

The age pattern of mortality above age 105

Jesús-Adrián Alvarez, Francisco Villavicencio, Giancarlo Camarda

Some previous studies on the risk of death above age 105 suggest the existence of a mortality plateau among the oldest old. These findings are controversial due to the scarcity of reliable data, which generates high uncertainty around all statistical estimates. The use of the recently released new version of the International Longevity Database (IDL) seems to alleviate these limitations. The inclusion of individuals, both dead and alive, aged 105 years and above from more than 10 countries around the world has substantially risen the number of observations (~20,000) in comparison with previous versions of the database (less than 1,000 records).

By using data from this new version of the IDL and by implementing a non-parametric approach, free of functional assumptions about the underlying mortality hazard, we test out whether the mortality plateau is a regularity among human populations above age 105 years. In particular, we aim to determine (i) the age at which the mortality plateau begins and its starting level, (ii) the uncertainty around the statistical estimates, and (iii) if the data suggest a sex- and country-specific mortality plateau.

Plateaus and the Rate of Aging at Advanced Ages

James Vaupel, Jesus-Adrian Alvarez

The “plateau hypothesis” states that in a heterogeneous population, observed death rates level off (reach a plateau) at advanced ages even though the risk of death for all the individuals in the population is increasing with age. A more specific version of this hypothesis is the “ b hypothesis” that the risk of death for individuals increases according to a Gompertz curve with a rate of increase b , with the Gompertz parameter a varying across individuals according to a Gamma distribution with coefficient of variation γ .

In this paper we use these hypotheses to explore the links between rate of aging for individuals and the heterogeneity among individuals in their relative risks of death at advanced ages. We estimate values of b and γ after age 105 using data from the updated version of the IDL database and compare our results with those (using data for younger ages) obtained with HMD data. We also explore the implications for the level of the plateau, the age when the plateau is approached, and the age-specific risks of death for individuals at advanced ages.

Some biases that underestimate the level of mortality in the elderly.

Nicolas Brouard

After revisiting the mathematics of the Gompertz law of mortality, we will check some of the methods used in estimating the force of mortality at old ages like specific surveys on centenarians, probability of death, central mortality rates, extinct cohorts, pooling of data from different countries and see how most of them are creating an artificial plateau at old ages.

We will also show how the life expectancy index has created since the last 50 years an artificial bubble overestimating the proportion of older people and how the mean duration index, the CAL, could be a better predictor of the number of centenarians.

Combined with the belief in the new era opened by Calment’s 122 years, many demographers have overestimated the importance of supercentenarians and have suggested that mortality over one hundred years could drop dramatically as the maximum age at death reported yearly was increasing much rapidly during the last 30 years of the 20th century than during the previous 100 years. This was mainly due to the drop in mortality during the 20th century among children, young adults, and adults, and not to the decline in mortality at old ages.

Estimating the age-trajectory of mortality at ages 85 and above among French-Canadians birth cohorts

Nadine Ouellette and Robert Bourbeau

Detecting mortality deceleration from a statistical perspective is often a difficult task, notably because only few individuals survive to very old ages. In populations of (limited) size comparable to the French-Canadian cohorts born in Quebec during the late 19th century, the challenge is even greater. A recent study has shown however how valuable extending the age range, even to only slightly younger old ages, can be for assessing mortality deceleration in the circumstances. In this paper, we use a highly reliable set of individual-level data on French-Canadians centenarians born (1885-1898) and died (1970-2012) in the province of Quebec to compute new estimates of the age-trajectory of mortality at ages 85 and above. This is an expanded version of an earlier dataset, starting with age 85 rather than 90. We have also requested permission to obtain additional nominative lists of all deaths that occurred in Quebec during the period 2013-2016 from the Institut de la statistique du Québec to expand the coverage of our current data set of verified centenarians to the latest extinct birth cohorts. Our request is currently under review and should be completed by the time of the Supercentenarians international seminar in Paris.

Longevity extension in high-income countries through the lens of three metrics of old-age survival: The mean, the mode, and the age-of-mortality

Viorela Diaconu, Shiro Horiuchi, and Nadine Ouellette

This is the first study looking into the inverse of age-specific mortality, labeled the age-of-mortality (AoM) function, for providing possible longevity indicators. Here, we analyze trends and differentials in AoM functions at various levels of high adult mortality for both females and males in the G7 countries since 1970 using death counts and population exposures from the HMD. Our preliminary results show a sustained increase in AoM functions for all levels of old-age mortality studied, but paces of change differ greatly. Moreover, we find that trends in these AoM functions are systematically different from those in life expectancy at age 65 and in adult modal age at death. Our findings suggest that the use of the AoM function, in addition to current conventional lifespan indicators, is likely to provide a deeper insight on the longevity extension in countries exhibiting the lowest levels of mortality since 1970.

Survival analysis at oldest ages on mortality data of longevity pioneers in France

Linh Hoang Khanh Dang, Carlo Giovanni Camarda, France Meslé, Nadine Ouellette, Jean-Marie Robine, Jacques Vallin

Studying mortality at extreme old ages has been very challenging, mostly because data of good quality are sparse. Decades of hard work of many research teams offered a new type of data on deaths at oldest ages where validated information at individual level are at disposal, which allows us to make use of methods that could not be of use otherwise. Following Barbi *et al.* (2018), we adopt herein the same analysis, using proportional hazard model on up-to-date French data on deaths at age 105 onwards, to study the evidence for the existence of a plateau of human mortality in France, as it was stated to be proven in Italy. As results, we find a statistically significant and positive Gompertz slope parameter, suggesting that mortality keeps increasing after age 105 instead of being constant. We also find significant effect of sex but no cohort effect on mortality of French semi-supercentenarians.

Data sources and criteria to identify a Blue Zone

A longevity Blue Zone (BZ) is a demographic concept introduced in 2000 to characterize a place where the population live longer. It results from the difference between individual longevity and population longevity. In my contribution, I intend to deal with the three following points:

1. Individual age validation of the oldest olds as this is an important prerequisite for identifying a BZ.
2. Data sources available to ensure the data collection on birth and deaths in the alleged BZ, exhaustively: all newborns a century ago and recent deaths of oldest olds should be collected with the possibility to link individually birth and death records.
3. The different indicators used to assess the level of longevity will be presented with pro's and con's.
4. The methodology for final identification and validation of the BZ including spatial smoothing methods and assessment of statistical signification of the exceptional level of longevity.

To support the presentation of this method, concrete examples will be shown from the different existing BZ.

Blue zones in a Western European population: The Netherlands birth cohorts 1872-1918

Lenny Stoeldraijer, Frans van Poppel, Ruben van Gaalen, Carel Harmsen

Poulain et al. (Poulain, Herm, & Pes, 2013) defined blue zones as ‘a rather limited and homogeneous geographical area where the population shares the same lifestyle and environment and its longevity has proved to be exceptionally high’ Blue zone populations have been identified mainly in geographically and/or historically isolated regions, characterized by a traditional lifestyle implying among other things intense physical activity, intensive family and community support for the oldest old and a relatively late epidemiological transition. The question whether such blue zones also exist in Northwest Europe has rarely been posed (exception made for a study by Klüsener and Scholtz (Klüsener & Scholz, 2013). Yet many countries in this part of Europe contained until far in the twentieth century regional entities characterized by a specific family ideology, family structure, and family relations (Terlouw, 2012). This suggests that in this part of Europe as well areas might be found that differ in the proportion of people reaching exceptionally high ages. In our paper we study whether in the Netherlands these blue zones can be identified. We use two datasets that together allow us to identify regional areas of exceptional longevity in cohorts born between 1872 and 1918.

The first database, containing information on some 19,000 centenarians who died in the period 1995-2018 and some 2,100 centenarians alive on January 1, 2019 is known as the BRP system, short for Basisregistratie Personen. This registration system is based on the digitized Municipal Personal Records Database. Since 1 January 1850, each municipality in the Netherlands was obliged to set up and keep a register of all residents who lived within the municipal boundaries. Among other things, their dates and places of birth and death had to be registered. In 1938, these registers were replaced with a paper card system, implying that for each inhabitant a separate personal card was made, on which all demographic events were registered, including date and place of birth and death. One of the fields that had to be filled in by the registration officer was whether the date of birth as given in the register had been compared with the date of birth as given in the birth certificate. After a person died, his or her card had to be sent for processing to Central Bureau of Statistics (CBS). The paper card system lasted until 1 October 1994, when the digitised population registers were put into use. From that time on, a central database was created in which copies of all personal data from the municipal registers were stored. This information is listed per individual inhabitant in a so-called personal record. It provides since 1995 information on among other things the exact dates of birth and dates of death (if applicable), and on the municipality of birth, of death and of residence of the whole population of the Netherlands (Prins, 2017).

For the period 1972-1994 information is provided by the cause of death register (*Doodsoorzakenstatistiek*) from CBS, an electronic database that includes registered deaths in The Netherlands from January 1936 to the current date. Entries into the database are from the personal card

(*Persoonskaart*) that was held for each resident of The Netherlands in the local population register. For each death, reported to the local authorities a death certificate was completed, and information from this certificate was added to the individual's personal card and forwarded to CBS. Since 1972 the electronic database includes information on place and date of birth, date of death and city of residence at the time of death. Between 1936 and 1972 place of birth was not entered in the electronic database. Information is available for around 6200 centenarians dying in the years 1972-1994, giving a total number of more than 27000 centenarians in our study.

For each municipality we calculate the Extreme Longevity Index (ELI), the ratio between the number of centenarians born between 1872 and 1918 and the total number of births recorded during the same time interval. We apply spatial smoothing methods to outline the areas where ELI reached the maximum value. By comparing places of birth with places of death and residence we can find out whether substantial portions of the centenarians lived—at least in their final years—in the same geographic area they were born in. Finally, we will test whether contextual characteristics of the region mortality levels, family characteristics, geographic isolation, cultural characteristics such as voting for political parties stressing family solidarity might offer an explanation for observed regional patterns in longevity.

Centenarian Hotspots in Denmark

Anne Vinkel Hansen, Laust Hvas Mortensen, Rudi Westendorp

Background: The study of regions with high prevalence of centenarians is motivated by a desire to find determinants of healthy ageing. While existing research has focused on selected candidate geographical regions, we explore the existence of hotspots in the whole the Denmark, which is a small and homogeneous country.

Methods: We performed a Kulldorff spatial scan across the whole of Denmark, searching for regions of birth, and regions of residence at age 71, where a significantly increased percentage of the cohort born 1906-1915 became centenarians. Next we compared mortality hazards for the identified regions to the rest of the country by sex and residence at age 71.

Results: We found a birth hotspot of 222 centenarians, 1.37 times more than the expected number, centered on a group of fairly remote rural islands. Significantly lower mortality hazards from age 71 onwards were confined to those who were born within the hotspot and persisted over a period of at least 30 years. At age 71, we found two residence-based hotspots of 348 respectively 238 centenarians, equaling 1.46- and 1.44 times the expected number. One is located in the high-income suburbs of the Danish capital and here the lower mortality hazard was confined to those who moved into the hotspot. In the second residence-based hotspot, both those who were born, and those who moved into the hotspot, showed significant lower mortality hazards.

Conclusion: Within the whole of Denmark, we identified several centenarian hotspots that have different biological underpinnings. These outcomes point to complex gene-environmental interactions explaining a variety of longevity trajectories.

Prevalence and characteristics of Sardinian supercentenarians living inside and outside the Longevity Blue Zone

Gianni Pes, Alessandra Errigo

Background and aims. In the literature, humans who reach the age of 110 are defined as supercentenarians (SC) and are considered a vivid expression of the ability to age successfully. This ability appears to be the result of a unique combination of genetic (longevity alleles) and environmental (peculiar environment and lifestyle) factors. Supercentenarians have been reported throughout the developed world, with a prevalence reflecting the local variability of the phenomenon as well as the ability of measuring it accurately. Numerous cases of false supercentenarians are known. The likelihood of a false registration may be due to several causes (inaccurate recording, age exaggeration, vanity, deliberate fraud, etc.). In Italy SC are extremely rare and only 21 of them who died between 1969 and 2001 have been fully validated (Bruzzone et

al., 2010). However, the prevalence of SC in areas considered to be longevity hot spots, such as central Sardinia, has not been sufficiently investigated. In Sardinia, in historical literature or during the consultation of Civil State registers of the past, it is not unusual to come across on reports of exceptionally long-lived individuals (Pes and Poulain, 2014) but most of these cases have not been validated due to the lack of the necessary documents which have not survived the ravages of time.

Starting in 1996, with the launch of the AKEA study, a systematic search and validation of SC cases was carried out in Sardinia (Deiana et al., 1999). In this island an area characterized by an exceedingly high proportion of centenarians (Longevity Blue Zone, LBZ) was identified in 1999 (Pes et al., 1999), whose extension and features have later been better outlined (Poulain et al., 2004). In this population the sex ratio at age 100 years is virtually 1.0. It is therefore interesting to investigate whether this spatial clustering of longevity, and its male-biased M/F ratio, can also be observed for the most extreme age phenotype as well.

Methods. In this study we searched through the demographic databases of Sardinian municipalities for those individuals born between 1/1/1880 and 12/31/1900 who attained the age of 110, dividing them into those residing inside or outside the LBZ. This search was facilitated by the fact that centenarians in Sardinia have been the object of intense interest, and newspaper articles often report each subsequent birthday of a centenarian. The geographical boundaries of the LBZ have been defined in previous articles (Poulain et al. 2004; Pes et al., 2013).

Results. The analysis of the death registers of Sardinian municipalities from 1980 on revealed the existence of 16 potential individuals who died after age 110. Seven of them were excluded because their date of birth, verified directly in the original Civil Status document, was posterior to 12/31/1900; three other alleged SC were excluded because comparing the date of birth and death it turned out that they were younger than 110 years (one women was only 3 days short to her hundred and tenth birthday). The age of the 6 remaining individuals was validated by double-checking the civil status registers and baptism registers (*Quinque Libri*) of the diocesan archives of the Catholic Church.

The number of SC born inside or outside the LBZ was 2 and 4, respectively, (8 cases/ 1M births in the LBZ; 14 cases/ 1M births outside the LBZ) a difference not statistically evaluable due to the small number of cases. The calculated prevalence was clearly superior than that of continental Italy. The M/F ratio was equal to 1.0 (3M / 3F) matching the ratio documented previously in LBZ centenarians (Poulain et al. 2004) and clearly outweighing the value of 1:10 among SC reported by the International Database on Longevity (IDL) (Robine et al., 2004).

As for the phenotypic and genotypic characteristics, two SC out of 6 (33%) had at least one sibling aged ≥ 90 years, the MMSE score was ≥ 24 only in one SC out of 3 males and in none of 3 females, all 3 male SC were functionally independent or required minimal assistance, while female SC were dependent on a family member for the basic activities of daily life. Nutritional status was excellent, revealed by albumin levels higher than 5.0 g/L in 4 out of 6 individuals. The only remarkable genetic finding was the presence of a heterozygous Q39X mutation in the β -globin gene (OMIM 141900) in 2 out of 3 male SC. This variant, common (about 8%) in the general Sardinian population, is frequently associated with a healthy lipid profile and might decrease the likelihood of atherosclerotic plaque formation (Hashemi et al., 2007). A SC from the LBZ was carrier of the M26 variant on the Y chromosome. None of SC showed glucose-6-phosphate dehydrogenase deficiency, another inherited condition common in Sardinia.

Discussion. At least 6 individuals born in Sardinia between 1880 and 1900 became age-validated SC, indicating a proportion well above the estimated prevalence in developed nations of approximately one SC per five million people (Young et al., 2010). The lack of a marked superiority of the number of SC in the Longevity Blue Zone over the rest of Sardinia (however difficult to compare due to the extremely small number of SC) suggests that the this extreme longevity phenotype could be rather attributable to general factors (including genetics) acting in the Sardinian population rather than to those specific for the LBZ and invoked to explain a less extreme longevity (≥ 100 years). In any case, our findings underline the need of investigating in greater depth the genetic and lifestyle background of future Sardinian SC, possibly extending the study to the semi-supercentenarians (aged between 105 and 109 years old) with the ultimate aim of gaining better understanding of potential mechanisms underlying the longevity of the population living on this island.

Longevity hotspot in Sicily. The exploration of a new possible Blue Zone.

Anna Aiello, Giulia Accardi, Giuseppina Candore, Michel Poulain, Calogero Caruso

We are conducting a survey in some mountainous Sicilian populations, particularly in villages sited in the Palermo province, part of the Madonie Park. To ascertain the true longevity rate, we checked the born and death registers, analyzing about 37,000 newborns between 1881 and 1917 in a sample of five small municipalities located in Madonie. About 1,700 individuals died at the age of 90 years and over, and about one hundred were centenarians. Therefore, the probability to reach 90 and 100 years old was of 4.6% and 0.22% respectively. Accordingly, we observed significant lower mortality rates for all causes of death when compared to those measured in Palermo town. Therefore, the population of these municipalities is experiencing a higher longevity as compared to other places in Sicily and in Italy.

Considering the healthy conditions of the population and the low rate of mortality, a total of 42 (14 males and 28 females) long-living individuals (LLIs) (≥ 90 years, mean age 97) were recruited between Madonie municipalities and Palermo city. A group of trained nutritionists administered a questionnaire to collect demographic data, cognitive and health status, clinical anamnesis, eating habits, and drug use, and the history of major age-related diseases were accurately reported.

Regarding the social and psychological aspects, 35 of 42 analysed subjects lived with their offspring or with spouse. Only 4 lived in retirement home and 3 with in-home nurse. The Geriatric Depression Scale was administered to 27/42 subjects with medium score of 5.44 (not depressed). The Mini Mental State was administered to 33/39 LLIs with medium score of 19.26 (cognitive impairment from moderate to mild). Most of LLIs attended few years of primary school and 6 had a high school (and University) education.

About the life-style, the ex-smokers were 9/42 and the alcohol consumption was limited, in few cases, to red/white wine. Concerning the eating habits, nobody consumed red meat more than once a week, whereas almost all consumed plant foods several times a week.

This study represents a picture of longevity in Sicily with the limitation of the small sample size. So, further recruitment and demographic studies are needed to validate the Blue Zone and the possible explanation of the extreme longevity.

Validating supercentenarian deaths in England and Wales

Ngairé Coombs, Rose Giddings

The number of centenarians in the UK is projected to increase faster than any other age group. One in ten girls born 50 years ago could expect to see their 100th birthday compared to three in ten girls born today, and half of girls born 50 years from now. Similar (slightly lower) levels are seen for males. And among centenarians, the number reaching 110 has increased rapidly in recent years. But how do we know how many centenarians (including supercentenarians) there are? Reporting of age in traditional methods of estimation, such as censuses and household surveys, is unreliable and prone to bias at advanced ages. To estimate the age distribution of the population at the top of the pyramid (ages 90 and over), we start with death records and work backwards. But even age recorded on death registrations can be prone to error at the very highest ages. We will be presenting our results on the validation of supercentenarian deaths in England and Wales between 1968 and 2017 and examining the number and characteristics of those who reach this age over time.

Why supercentenarians are so frequent in French DOM?

The case of Guadeloupe

With regard to the total population, much more cases of supercentenarians are observed in the French *Département d'Outre Mer* (DOM) than in the metropole, about 3 times more. And this remains true after applying the same validation protocol that, in France, consist in a strict comparison of the common pieces of information given by death and birth original certificates. Such fact appeared too much questionable to keep any DOM data when writing the French chapter for the Second collective international book on Supercentenarians. But that prudent decision did not prevent to try to get further explanation of this strange phenomenon.

A first possible explanation was that, the general French protocol of validation, although quite strict, was not enough for DOM population, as it is for cases of extreme longevity everywhere. But, if additional checks tend to confirm that the fact is real it becomes important and quite interesting to make explanatory hypotheses. Thanks to some INED research fund, I started to investigate in the two DOM where the phenomenon is the most acute: Guadeloupe and Martinique. I am about at the mid-term of that project and I would like to summarise here my first returns on the case of Guadeloupe. They will show that combining several additional checks does not let serious room for really suspecting further the ages of validated supercentenarians. They also will give some arguments in favour of one main possible explanation: the genetic selection by the extreme severity of the mortality due to the slavery.

Geography of Italian centenarians semi-supercentenarians: statistical evidences in territorial longevity differences

Graziella Caselli, Marco Battaglini, Giorgia Capacci, Rosa Maria Lipsi,

Following the IDL protocol, the Italian National Institute of Statistics (Istat) has been collecting and validating data about living and dead semi-supercentenarians since 2009, as a first stage of the SemiSuperCentenarian (SSC) survey. On January 1st 2018, ten years after the survey began, 5,171 living and dead individuals aged 105 and over were collected and validated for the cohorts born between 1896 and 1912. Each individual validated was classified by data of birth and place of the last residence. In this way, the complete information allows to know the trajectory of the last transition of each individual from one municipality to another and/or one province to another, and/or one region to other, depending on what territorial area is to be examined.

The aim of this work is to focus on the geography of the semi-supercentenarians in the SSC survey for the whole period of observation 2009-2018. The region will be the territorial unit studied. Particular attention will be given to some characteristics in which the semi-supercentenarians were born and/or live, to see if there is a relation between these characteristics and the differences that can be observed in longevity levels and gender gaps.

In particular, two specific aspects will be analysed. In the first part, analysing the trajectories that have led the individuals born in one region to live or die semi-supercentenarians in another, will indicate each individual region's capacity to expel or attract. In this part, we shall be trying to identify the main directions of these movements.

In the second part, the strength of the phenomenon will be examined, referring to the two indicators: the ratio of the number of semi-supercentenarians to the number in the birth cohort by gender (N_{105}/B per 100,000) and the ratio of the number of semi-supercentenarians to the number of survivors at the age of 65 (N_{105}/N_{65} per 100,000 as in Robine et al., 2006). In this way, we can examine the geography of the phenomenon from two different points of view: that of place of birth and that of place of residence. The geography of the gender gap will also be presented. Geographical differences and gender differences will also be analysed taking into account differential mortality in old age, referring to the cohort life tables available for a group of regions.

Three pieces of discussion about Polish supercentenarians

Waclaw Jan Kroczek

The emergence of Polish semi-supercentenarians and supercentenarians has been confirmed. The rapid increase of the number of semi-supercentenarians in Poland follows the observation in the Western developed countries; namely, it tends to double with every decade. The paper includes the examination of semi-supercentenarians by health parameters, including the Katz ADL Index and the Geriatric Depression Scale among others. The paper also includes the latest revelations on the study of Polish supercentenarians that were made since the last update (13th Supercentenarian Workshop; Rostock, Germany, May 2017), including the newly validated supercentenarian cases and reported unvalidated supercentenarian claims. In the paper, I also include the validation effort of the case of Polish supercentenarian emigrant to the UK, Jerzy Pajączkowski-Dydyński (1894-2005), the former oldest man in the UK and Europe, using early-, middle- and late-life evidence obtained with the help of the GRG-UK Correspondents.

Health profiles among nonagenarians from Mugello district (Tuscany, Italy) and their socio-economic characteristics

Cosmo Strozza, Patrizio Pasqualetti, Viviana Egidi, Claudia Loreti, Federica Vannetti, Claudio Macchi and Luca Padua

Objectives

Nowadays, studying the health conditions in which people reach the very old ages is one of the major public health challenges. According to the WHO definition, health is a multidimensional concept that includes different aspects. The aims of this study are to investigate whether (1) it is possible to identify health profiles, taking into account physical, emotional and psychological information about health, among the oldest-old; (2) there are demographic and socio-economic differences among the health profiles.

Methods

Using data from the Mugello Study, we applied Latent Class Analysis with covariates - for identifying health profiles among the 504 nonagenarians residing in Mugello district (Tuscany, Italy) and evaluating the association between socio-economic characteristics and the resulting health profiles.

Results

Four groups have been identified and labeled according to posterior probabilities of finding a certain health characteristic into them: (1) "healthy", (2) "non-testable", (3) "unhealthy", (4) "semi-autonomous senile". Some demographic and socio-economic characteristics were found to be associated with belonging to the final groups: older nonagenarians are more likely to be in worse health conditions; men are in general healthier than women; more educated individuals are less likely to be in extremely bad health conditions while the lowest educated are more likely to be cognitively impaired; past-office-workers are less likely to be in bad health conditions compared to farmers.

Conclusions

Considering health as a multidimensional concept by finding health profiles, according to different health aspects, could help to choose for the right care needed by the oldest-old.

A comparison of medical expenditures between centenarians and non-centenarians using big data in medical claims

Yasuhiro Nakanishi, Yukio Tsugihashi, Tatsuya Noda, Tomoya Myojin, Shinichiro Kubo, Yuichi Nishioka, Manabu Akahane, Tomoaki Imamura

Background

Recently, the number of centenarians, semi-supercentenarians (105–109 years), and supercentenarians (110 years and over) has been increasing in advanced industrialized nations including Japan. Studies on centenarians have been mainly conducted in the USA, France, Sweden, and Japan, and have indicated that a shorter period of serious illness may be a characteristic of centenarians compared to other generations. However, only a few studies have focused on medical expenses of centenarians with serious illness. The purpose of the present study is to compare the medical expenses between centenarian and non-centenarian patients for the last five years using big data of medical claims.

Methods

The data used in this study were from the Latter-stage Elderly Medical Care System in Nara Prefecture, Japan (Nara Prefectural Kokuho Database (KDB)). Adults 75 years and older were enrolled in the KDB. Information such as the number of unique inpatients and outpatients, medical expenses for hospitalization and outpatient from April 2013 to March 2018 was extracted, and subsequently analyzed by age group (5-year categories).

Results

Average numbers of unique inpatients per month by age group were as follows, 5,700, 1,900, and 80 in the categories of 80–89, 90–99 and 100–109 years, respectively. Average numbers of unique outpatients per month by age group were as follows, 70,700, 14,700, and 500 in the categories of 80–89, 90–99 and 100–109 years, respectively. Average hospitalization expenses per inpatient and month were as follows, 590,000 JPY (5,364 USD), 570,000 JPY (5,182 USD), 540,000 JPY (4,909 USD), 520,000 JPY (4,727 USD), 490,000 JPY (4,455 USD), and 440,000 JPY (4,000 USD) in the categories of 80–84, 85–89, 90–94, 95–99, 100–104, and 105–109 years, respectively. As the numbers show, the average hospitalization expenses per patient and month decreased gradually in subsequent age groups, varying by 150,000 JPY (1,364 USD) between the 80–84 age group and the 105–109 age group. Average outpatient's expenses per outpatient and month were as follows, 44,000 JPY (400 USD), 43,000 JPY (391 USD), 39,000 JPY (355 USD), 35,000 JPY (318 USD), 33,000 JPY (300 USD), and 39,000 JPY (355 USD) in the categories of 80–84, 85–89, 90–94, 95–99, 100–104, and 105–109 years, respectively. The data indicate that the average outpatient's expenses per patient and month peaked in the 80–84 age group and slightly declined until the 100–104 age group, but increased a little in the 105–109 age group.

Discussion

This study clearly indicated that centenarians and semi-supercentenarians tended to have lower average medical expenses per patient compared with patients aged 99 years and under. We did not analyze them statistically in this study. In a future study, we will report data such as the difference in medical expenses incurred 1 year prior to exitus between those under 100 years and those 100 years and over. It may be possible to evaluate the premortem periods of serious illness in centenarians and semi-supercentenarians. One further task is to include long-term care costs to more accurately assess their health expenditures.

ContreQui: Countering the Jeanne Calment Investigation with a Counter- Investigation

Robert Young

The Jeanne Calment case is of utmost importance to scientific researchers in more ways than one. Not only is Jeanne's age, at 122 years 164 days, the official Guinness World Records and scientific organization (IDL, GRG, MPIDR, etc) record, her case also represents the best-validated case of all time, to this point. It is thus imperative that we "get this right". For this proposal, I plan to review two major areas concerning the recent Jeanne Calment controversies: first, a history of the "Jeanne-debunk" investigation, followed by recently discovered research favorable to Jeanne Calment's

casearising in “contre” to the “Jeanne-debunk” investigation. Given my historical involvement in this subject over many years, including the latest, I will be able to provide primary-source insights (including documentation) that will impact the Jeanne Calment case (strengthening it at this point).

Is the age attained by Jeanne Calment really that implausible?

Anthony Medford, James W. Vaupel

Has the maximum human lifespan been reached? The current record stands at 122 years, 164 days and has held for over 20 years and is more than four and three quarter years higher than the previous record. The value and persistence of this record have surprised some researchers, with some even questioning its veracity. There have been previous attempts in the literature to answer questions about how long this record might stand and whether it is truly exceptional but the focus has been mainly on the record ages, using *ad hoc* tools. This article contributes in two new ways. First we study lifespan records via the (inter-) record times and second we make use of specific tools from statistical Records Theory. We find that the occurrence of the present record was not surprising. We estimate around a 25% chance that the record would have survived until now and around a one in five chance that it will survive until 2050, demonstrating remarkable persistence.

The case Jeanne Calment – can fake news change the truth?

Jean-Marie Robine and Bernard Jeune

Background: In December 2018 Jeanne Calment (JC)’s record of longevity (122 years) was rejected by two Russians, the gerontologist Valery Novoselev in an interview published at a Russian internet site, and the mathematician Nikolay Zak in a report on the internet medium ResearchGate. They concluded that JC’s daughter usurped her mother’s identity after her death in 1934 in order to avoid paying inheritance tax. Nikolay Zak’s report was later published in a revised form in *Rejuvenation Research* (RR) with the same conclusion based on approximately the same arguments and results.

Methods: Analysis of the effects of first the internet documents in the social medias and the press worldwide, since the boosting effects of the article in RR. Discussion of the authors arguments and results, and our finding of new evidences of JC’s record.

Results: The whole affair went on from 4 December 2018 (interview with Novoselov) to the 30 January 2019 (publication of Zak’s article). In that period not only the family was seriously accused as frauds and liars in world-wide medias, but also the French researchers who documented JC’s longevity record and the city of Arles. We will demonstrate how all the authors arguments can either be refuted or at least strongly questioned. We will stress the unacceptability of publishing an article with such an unfounded accusation, and the unethical demand of exhumations based on what can indeed be called “fake news”.

The end of Life Trajectory of the Longest-lived Man in the World

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Longevity is often considered as one of factors to increase the national medical expenses. However, researchers, who closely looking into care and medical costs across different age groups of older people, suggest that the medical expenses tend to rapidly increase one year before the death. Stated differently, longevity itself does not impact the national medical expenses. In addition, based on the theory of compression mobility, longevity in fact may help to decrease the medical expenses since our health status rapidly decline as we age. In this study, we introduce the end of life trajectory of

Jiroemon Kimura who is the longest-lived man in the world. He passed away on June 12, 2013 at the age of 116 years and 54 days. We calculated his care and medical expenses five years before he passed away. In total, he spent 2,418,467 yen between 2009 and 2013. In 2009, he spent 975,823 yen which is the largest amount of care/medical related payment among five years; however, it was mostly used to rebuild his house for barrier-free. In 2010 and 2011, his care/medical expenses were less than 100,000 yen. He spent 562,779 yen in 2012 and 774,634 yen in 2013 that are mostly to cover hospitalization. Although there is a possibility that healthy people can live long, we may be able to say that longevity is not necessarily cost much.

The cases of Violet Brown and Louisa Thiers

Robert Young

Violet Brown of Jamaica, recognized by Guinness World Records as the ‘oldest living person’ in 2017, attained the Guinness-authenticated age of 117 years, 189 days which places her among some all-time recordholders, including: 1. Oldest validated black person on record (assuming the withdrawal of the Lucy Hannah case) 2. Oldest British Empire subject (she was born in the British West Indies, now Jamaica) 3. Third-oldest validated person with a birth certificate, all-time 4. Fourth-oldest validated person, all-time. In addition, the age of her oldest child (97) may have set a new record for the oldest verified child who had a parent living. Nonetheless, we understand that, though Guinness World Records may have made their decision, the scientific community would like to see the actual documents and research context. As the case began as a GRG-validated case, and as I have personally visited with Violet Brown (at age 115) and her family, I am in a position to share a lot about this case. It may not be validated to the level of the Jeanne Calment case but is, in my view, stronger than some other similar cases. In addition, there is the issue that Violet Brown’s health status (at her 117th birthday, Violet Brown lived at home, could still walk with assistance, and had a clear mind and could talk lucidly) and unfortunate demise in 2017 (different parts of the family battled for custody and she was forcefully removed from her home just six days from her death...could she have lived longer without this upsetting event)? means that this case is important in the comparison to Jeanne Calment at age 117, to debunk the assertion that Jeanne Calment at 117 was in “too good of shape” to be the age claimed.

Examining limit of human longevity using Japanese individual data

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Using individual level data in Japan from 1972 to 2017, including information on the exact date of birth and death, place of death, causes of death, marital status, work status, etc. we plan to investigate a limit of human longevity and the impact of available variables on the probability of dying.

We first plan on conducting a survival analysis. Instead of using approximations, we could conduct a precise survival analysis in continuous time. Using Kaplan Meyer estimates, as well as Cox proportional hazard methods, we will estimate age and sex specific survival rates. We will model the age at death distribution, using non parametric statistical analyses by fitting a P-spline model. Thanks to this technique, we will be able to calculate a set of statistics including the mode, the upper standard deviation of the distribution, the C50 (smallest interval around the mode gathering 50% of the distribution) and apprehend their evolution and variability in time. In this study, a non-parametric model would be fitted on a individual-based data to apprehend as best as possible the age at death distribution at the level of a country. This study is the first such study and could greatly advance our knowledge of the shape of the distribution for old ages, and how it has changed over time. Such results could shed light on the potential existence or not of a limit to human longevity.

To identify the variables impacting survival rates and explaining inter-individual variability, we will test for the effect of different variables provided in the database. In particular, we will include

in the model an effect of year, place of death, marital status and occupation. Indeed, we expect age-specific survival rates to increase with time for both sexes, given the actual increase in life expectancy observed since several years. We will also investigate finer inter-annual variations that could be due to various environmental variables especially at advanced ages (for example climate). Previous analyses in other countries, for example France, have shown an influence of occupation and marital status on survival at old ages. We know for example that during flue epidemics, old people living in nursing homes tend to be more vulnerable than those living in their own place. Hence, we will include these information (occupation, marital status at death and place of death) as covariates in the survival model in order to estimate their relative contribution in the probability of dying at different ages for females and for males.