

Age validation of Han Chinese centenarians

By

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Background

Age validation of centenarians and gathering data about the demographic patterns and health status of centenarians have become a research area of importance because populations in most countries are aging. China's population, in particular, is aging at an extraordinarily rapid rate (Banister, 1990; Ogawa, 1988; Zeng and Vaupel, 1989). Centenarians used to be exceedingly rare. They are still rare today, but the number of centenarians is now doubling approximately every decade (Kannisto 1994, Vaupel and Jeune 1995). The average annual growth rates in the 1970s and 1980s in the number attaining age 100 were, for example, 10.2%, 9.2%, and 9.1% in Japan, Switzerland, and West Germany respectively (Vaupel and Jeune, 1995, p. 112). If current rates of mortality improvement persist, then it will be as likely for a child born today to reach age 100 as it was for a child born eight decades ago to reach age 80 (Vaupel and Gowan, 1986).

Despite high mortality in the past, China has a large number of elderly people, because the Chinese population is so huge, currently totalling more than 1.25 billion people. The 1990 census reported 6,681 centenarians, 64,532 persons aged 95 or over, 416,134 persons aged 90 or over, and 2.32 million persons aged 85 or over. The annual growth rate of centenarians in China between 1982 and 1990 was 7.1%. The proportion of centenarians is much lower in China than in developed countries. For example, there were between 4 and 5 centenarians per million in China in 1990, while in Denmark there were 80 centenarians per million (Jeune and Kannisto 1997). Consequently, Chinese centenarian research may give us a better understanding of population ageing.

However, the fact that a large number of centenarians was recorded, whether in a census or in an official population register, does not necessarily mean that the country has a large population of centenarians, because elderly

people may tend to exaggerate how old they are. Any study on centenarians has to deal with this issue of the age inflation. How good is the data quality on centenarians in China? This paper attempts to answer this question by presenting a careful validation on age reporting of Han Chinese centenarians. The next section will give a brief review of the literature on age reporting among centenarians. We will then discuss data resources, methods and results of analysis, which involve comparing information as reported in the Chinese census of 1990 with survey interview data collected by Wang (1996). We will also look at the cultural background of the Chinese, with emphasis on the Han Chinese in particular. As will be shown, the cultural background of people can be an essential tool in the confirmation of age.

A brief review of the literature on age reporting among centenarians

Many researchers have indicated that elderly people tend to exaggerate their age. Thoms (1873, 2nd ed. 1878) found that the ages of about 90% of the centenarians reported in the newspapers during the period 1868-72 could not be validated. In the literature, age exaggeration by those claiming to be centenarians was often reported (see, for example, Bowerman, 1939). Among the 1756 reported centenarians in a census taken in Bulgaria at the beginning of this century, only 51 could be verified (Vischer 1945). This problem of overstatement of age by the extremely old has been found in the United States (Myers, 1966; Rosenwaike, 1968), and in the former Soviet Union (Medvedev, 1973, Myers, 1965). A carefully-validated census taken in Vilcabamba found that all the age claims made by those reporting their age to be over 100 years old, were either incorrect or unsubstantiated. Systematic age exaggeration was found from 70 years old onwards (Mazess & Forman, 1979). This is especially true of extremely old people who come from societies where illiteracy is high, accurate documentation showing date of birth does not exist, and even accurate oral information about birth dates is lacking (Mazess and Forman, 1979). A revaluation of actual ages among a sample of Abkhazians showed that the earlier reports of increased longevity in Abkhazia were erroneous. In fact, the study concluded that extreme old age was no more prevalent in Abkhazia than in the U.S.A. (Palmore, 1984). Age

exaggeration was, in fact, very common around 1900 in most of Europe. It is still common today in most other countries of the world, especially in countries with a high proportion of illiteracy (Jeune, 1995, p. 17).

Data from 31 countries (mostly European) were computerized at the University of Odense to form the Kannisto-Thatcher Oldest-Old Database within the Odense Archive of Population Data on Aging. The stored data begin at age 80 and start, for most countries, from the year 1950. Kannisto (1994, pp. 14-15) found that the data quality of the oldest old since 1950 can be categorized as follows:

Good : Austria, Belgium, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Iceland, Italy, Japan, Luxembourg, Netherlands, Norway, Scotland, Sweden, Switzerland and Wales;

Acceptable : Australia, New Zealand (*not including* the Maori population), Portugal and

Singapore (*only including* the Chinese population);

Conditionally acceptable: Estonia, Ireland, Latvia, Poland and Spain;

Poor : Canada, Chile, New Zealand (*only including* the Maori population), United States.

According to Kannisto, the age-reporting data quality of the oldest old in most European countries has been good since 1950. For the most part, European people know their birth dates and are educated. Also advanced statistical approaches are used in Europe to help monitor and evaluate data quality.

Data quality at advanced ages was investigated by Coale and Li (1991) based on the 1982 Chinese Census data through a detailed analysis of the Han Chinese population with the Han and minority populations combined. For their data on advanced ages, they had to look at the combined data for ages 100 and older, because the detailed tabulations by exact age for the Han Chinese and minority populations were not available at the time of their study. They discovered that the elderly from the minority populations seriously overstated their ages. This finding became clear mainly through their analysis of comparative data from Xinjiang province where the Weiwuer and other ethnic groups make up about 60% of the total population. In 1982, the

reported number of centenarians in Xinjiang was 22.5% of the total number of centenarians in China as a whole, while the population of Xinjiang was only 1.3% of the total population of China. According to the census, there were 144 males listed as over 110 years of age in China in 1982. Of these, 121 were living in Xinjiang. Another 15 were living in four Chinese provinces with high proportions of minority populations having cultural backgrounds very different from that of the Han Chinese. In all, the five provinces (Xinjiang, Guanxi, Qinghai, Ningxia, and Yunnan) with the highest proportion of these minorities were reported to have 94.4% of all males over 110 years old while containing less than 9% of the population of China. Both the number of centenarians in China as of 1982, and the death rate for 1982, become seriously distorted when the Chinese census data from all of China's provinces, including Xinjiang, are used as the basis of calculation. These two figures, however, become immediately more plausible when the data from Xinjiang are omitted (Coale and Li, 1991, pp. 298-300).

Data resources and methods

The 1990 census Data

With assistance from State Statistical Bureau, we have obtained the 1990 Chinese Census data on detailed single-year age-specific and ethnic-group-specific information for centenarians. Again, the census reports that minority ethnic populations account for nearly 24% of all centenarians in China, even though they represent slightly less than 8% of the total population. For males over age 110, 85.4% belong to minority groups. Using the approach discovered by Cole and Li (1991), which involved the calculation of special demographic indices for measuring mistakes in age reporting, our analysis of the 1990 census data clearly shows that the ethnic minority Chinese counted as centenarians were mostly not true at all. Therefore, the ethnic minority groups - about 8% of the total population - are excluded from our analysis. Based on the Han Chinese 1990 census data, various demographic indices for measuring centenarians' age reporting accuracy will be computed and discussed in the next section of this paper.

The surveys in Hangzhou, Beijing and Chengdu

Wang (1996) conducted surveys of Chinese centenarians in Hangzhou, Beijing and Chengdu areas in late 1995 and early 1996. In total, 319 centenarians, as listed by the relevant aging committees, lived in these three areas. In order to obtain survey data, Wang interviewed 208 centenarians. Of the total interviewed, there were 40 males and 168 females. The following procedures were used to validate the age reporting of these centenarians during the surveys:

(1) *Each elderly person was asked to answer, in a face-face interview, the question about their date of birth, by giving the Chinese animal year of their birth, the Gan Zhi year of their birth, or their date of birth according to the Western calendar.*

The Chinese calendar consists of a simple cycle of 12 animal years, such as the year of the rooster, dragon, or tiger. The Chinese calendar also follows a more complicated cycle of 60 years, called the Gan Zhi year system. We had user-friendly information sheets produced for the survey which converted Chinese calendar years into Western-calendar years. We found that it was important to ask for a person's date of birth and then to compute the person's age immediately afterwards by subtracting it from the date of the survey. We did not ask our interviewees about their age because the Chinese system for reckoning nominal age may make the response ambiguous. According to the Chinese nominal age system, a person is counted as one year old on the day of birth, and becomes one year older, each year, on the day Chinese New Year is celebrated. This means that, in China, nominal age is usually exaggerated by one to two years as compared with actual age. If one simply asks for age, some may respond with their nominal age, and others may provide their actual age, which will result inaccurate data.

(2) *We checked both the household registration booklet and the certificate of old age held by each elderly person.*

The household registration system in China started in the early 1950s. A certificate of old age is issued for anyone reaching the age of 65. Using their certificates, elderly people get benefits when travelling, visiting parks,

visiting museums and so on. The certificates are issued by the local aging committee or by the local aging association, as these committees are now called. The household registration booklet is a unique certificate issued to each household by the government to confirm the age of the members of the household. For example, people have to show their household registration booklets when they apply to a school or take a new job.

If the birth date printed on the household registration booklet or the certificate of old age is not consistent with the reported birth date, it is very likely that something is wrong. Whenever dates did not match, we tried to find out which age was correct; was it the reported age, or the age as recorded in either the household registration booklet or on the certificate of old age. On the other hand, if there was the consistency with their age reporting and their certificate of elderly and household record, we still can not exclude that some age-exaggeration already could happen at age 65 or before age 65. Therefore, we need to do the further validation on their age reporting.

(3) We asked how old people were when an important historical event took place at the beginning of this century.

We felt that if a centenarian could reasonably report how old he or she was when a very important historical event occurred at the beginning of this century, such as the coronation of the last emperor, it would be further evidence to support that person's reported age. This additional information could only be used as a reference point. We did not use it to determine the accuracy of a person's age since the historical event may not have been known at all to the interviewee.

(4) We asked for the birth dates of interviewees' surviving and deceased children, and calculated the children's ages. These questions about the birth date and/or age of the interviewees' children were addressed to both interviewees and their neighbours.

We felt that if the age difference between a female interviewee and her child was more than 50 years, we then had evidence that the interviewee could not be a true centenarian. For both men and women, the evidence became ever stronger if we could confirm that his or her child was over 85 years old at the time of our survey.

(5) *We asked for information on the number of surviving generations in the interviewee's family;*

If the interviewee had more than four surviving generations in his or her family, it would help support the claimed age, but could not be used to determine the exact age of the interviewee.

(6) *We visited the centenarian's neighbours and interviewed them.*

In the Chinese cultural context, neighbours know each other very well, especially in the rural areas. The neighbours of centenarians and other extremely old persons generally know, at least roughly, the age of such a very special person as well as some of their family history. In some areas, centenarians receive substantial extra benefits from local government. It would not be regarded as proper, from a neighbour's point-of-view, if someone were to receive a benefit by exaggerating his or her age.

If the neighbours told us that the interviewee's age, as reported, was not correct, we would pay serious attention to that allegation, and most likely reject the interviewee's claimed centenarian status.

The answers and information, collected by following the six procedures above, were recorded in detail; and a final conclusion as to the accuracy of the age reported by each respondent was reached. If an elderly passes all of the six age validation procedures, we conclude that his or her age reporting is accurate without doubt. If answer(s) in one or two of the procedures is not consistent with the others, we will further investigate whether it is truly wrong or it is due to careless (e.g. typing error in a certificate or so), and then make a conclusion. For those who can not pass more than two procedures, and no careless mistakes such as typing errors etc. can be identified, we will conclude that their age reporting are wrong, and exclude them from our further substantive analysis on centenarians health and longevity.

We found that it was very helpful to use the Chinese animal year and Gan Zhi year systems to validate the interviewees' age reporting. We shall discuss how these Chinese year systems were used in more detail here.

Centenarians in Hangzhou and Beijing reported their animal year at birth, but the centenarians in Chengdu reported their Gan Zhi year at birth. There are 12 animal years at birth: Mouse, Pig, Dog, Rooster, Monkey,

Sheep, Horse, Snake, Dragon, Rabbit, Tiger and Cow. Each of these 12 animals represents one year and the cycle is 12 years. Table 3 gives examples for the year 1995, showing how Chinese animal years correspond to Western calendar years and to a person's actual age.

Table 1. The table of animal year, calendar year and age at the year 1995

In Hangzhou and Beijing, most centenarians could remember, and were able to report, their animal year at birth clearly (as long as they weren't handicapped by hearing, speaking or mental problems). We also asked centenarians to tell us his or her birthdays according to the Western calendar to double check our data. However, not many of the interviewees were able to tell us their birth year according to the Western calendar, since they were mostly uneducated people. In such cases, we had to use the birth date according to the Chinese calendar (animal year or Gan Zhi year) to validate the reported age. The process went like this - if a centenarian reported that her animal year at birth was the year of the sheep, we then knew that her year of birth was either 1907 or 1895 or 1883 from Table 1. In other words, she was probably 88 or 100 or 112 years old. How could we determine her exact age? We looked for additional clues. We soon found out that her household registration booklet gave her year of birth as 1895; and that her daughter was 80 years old at the survey time. Probably, she was a centenarian, aged 100 years old. Her year of birth was 1895.

Centenarians in Chengdu reported their Gan Zhi year at birth. The Gan Zhi year system is more complicated, but more precise in identifying the year of birth than the animal year system. The Gan Zhi year system consists of two sets of characters. The first set includes 10 characters representing 10 different stars in the sky, named: Zia, Yi, Bing, Ding, Wu, Ji, Geng, Xin, Ren and Kui. The second set includes the 12 animals representing the earth. The animal names are: Zi (mouse), Hi (pig), Xu (dog), You (rooster), Shen (monkey), Wei (sheep), Wu (horse), Si (snake), Chen (dragon), Mao (rabbit), Yin (tiger) and Chou (cow). A Gan Zhi year is taken as a combination of one character from the Sky (10 characters), which becomes the first sign; and another character from the earth (12 characters), which becomes the second sign. The cycle of the Gan Zhi year system is 60 years.

Results and discussion

Based on 1990 census data

The population sizes and sex ratios at advanced ages for Han Chinese appear reasonable, as compared with Sweden (see Table 2). According to the 1990 census, nearly 60% of Han Chinese centenarians, were either 100 or 101 years old. The per cent share sharply declines after age 101, due to high mortality rates at extremely high ages. About 21% of the centenarian population was male, or about one male Han Chinese centenarian per five female Han Chinese centenarians. The sex ratio (of males to females) at ages 105-109 for the Han Chinese was 20.64; while for the Swedish, it was 19.34.

Table 2. Male and female centenarians population, sex ratio at advanced ages for Han Chinese 1990 and Swedish 1984-1993

Table 3 presents an index for measuring the degree of digit preference at ages divisible by ten or five, mainly for centenarians. The index was proposed by Coale and Li (1991) for ages between 65 and 100; and it is computed as a mean of the ratios of the number at each age to a two-stage moving average (the five-term average of a five-term average). We computed this index for the Han Chinese in China as well as for the populations of: Sweden, Japan, France, Italy and Germany. For each population, we computed the indices from ages 85 to 105, from ages 95 to 105, and from ages 100 to 105 respectively. Sweden is considered to be the country with the best demographic data accuracy in the world, so that the more accurate a country's age-reporting is, the closer its mean indices will be to those of Sweden. Table 3 shows a reasonably close match between the Han Chinese indices to those of Sweden. The closeness of this match can be put into perspective by a further comparison of the Swedish data to the other countries having centenarian data of high quality, such as Japan, France, Italy and Germany.

The Whipple's index is a classic measurement for evaluating the age heaping². Table 4 lists a comparison of the Whipple's indexes for elderly survivors and deaths over ages 95 between Han Chinese and Swedish populations. As stated in the endnote 2, the United Nations recommend that a relative deviation of less than 5 percent, 5-9.99 percent, 10-24.99 percent, 25-74.99 percent, and equal or greater than 75 percent from the perfect standard is considered as very accurate, relatively accurate, OK, bad, and very bad data quality respectively. If one takes the Swedish population as a perfect standard and the criteria of relative derivation for evaluating data quality recommended by the United Nations, the Whipple's indexes of Han Chinese centenarians survivors and deaths indicate "relatively accurate" or "very accurate".

Table 4. A comparison of the Whipple's Index for centenarians, China 1990 and Sweden 1985-1994

The above analysis of census data indicates that there is no serious age heaping. However, the absence of significant digit preference at ages divisible by ten or five is not necessarily proof of data accuracy, since other age-reporting errors, such as the tendency to exaggerate old age, may also distort the data. If the age exaggeration at very old ages is more serious than at younger ages, which is the case in many countries with poor data, then the reported total number of very old persons will tend to be relatively large when compared with the reported population size at younger ages. As shown by Coale and Kisker (1986), the ratios of those aged 95 years or over, to those aged 70 or over, in the 23 countries with accurate data quality, were all less than 6 per thousand. On the other hand, the ratios for the 28 countries with poor data quality, which ranged from 1% to 10% (Coale and Kisker, 1986, p.398), clearly showed age exaggeration for persons aged 95 and over. These ratios for male and female Han Chinese in 1990 were 0.76 per thousand and 2.18 per thousand respectively, which closely match the ratios for Sweden during the period of 1985-1994. The male and female ratios of those aged 100 years old or over, to those aged 75 or over, among Han Chinese in 1990 were 0.128 and 0.388 per thousand; the corresponding ratios among the Swedish population in 1985-1994 were 0.127 and 0.386 per thousand respectively.

Coale and Kisker calculated the relative ratios of T_{100}/T_{70} for various countries as compared to T_{100}/T_{70} for Sweden in 1980 (T_{100}/T_{70} is the ratio of total person-years above age 100 to the total person-years above age 70). The relative ratios for the countries with accurate data were mostly below 1.0, with the lowest value being 0.04 for Finland in 1950. Of the few accurate data countries which had relative ratios over 1.0, the highest ratio value was 1.28. The relative ratios in the countries with poor data ranged in value from 7.92 (Mauritius) to 82.1 (Dominican Republic). Such high values clearly show the overstatement of age over 100 years old in these countries. The relative ratio of T_{100}/T_{70} for Han Chinese in 1990 as compared to T_{100}/T_{70} for Sweden in 1980 is 0.13, which seems to support our hypothesis that the Han Chinese are one of the populations with good data quality for centenarians.

The fact that the T_{100}/T_{70} ratio of persons aged 70+ to persons aged 100+ among Han Chinese is extremely close in value to the T_{100}/T_{70} for Sweden is strong evidence of the generally high quality of age reporting among Han Chinese centenarians.

Based on the centenarians survey

Table 5 Age reporting of centenarians: A survey in Hangzhou, Beijing and Chengdu

Table 5 summarises our findings on the degree of accuracy of age reporting of centenarians in our Hangzhou, Beijing and Chengdu surveys, based on our careful field work of age validation. The age-reporting of 86.5% of the 208 interviewees is considered to be accurate. The reported ages (mostly based on their reported animal year or Gan Zhi year at birth) of this group were consistent with all other related aspects and verified by all of our six age validation procedures. They are true centenarians. 8.7% of the interviewees accurately reported their birth date (animal year or Gan Zhi year at birth) and passed the six age validation procedures, and although they are only 99 or 98 years old, they were classified incorrectly as centenarians by their local aging committee. This is due to the traditional recognition of Chinese nominal age, as discussed earlier in this paper. In our surveys, we found that some local aging committees are careful to record both a person's nominal age and actual age, but the others do not. For example, in Xiao Shan city in Hangzhou, the officer of the aging committee told us that there were five people whose nominal age was 100 years old, meaning their actual ages were under 100. Consequently, we decided not to visit them. But the aging committees in some other areas did not know how many persons were listed as being 100-years-old based on their nominal ages. It is therefore extremely important when taking a survey or census in China to ask for a person's birth date (as it appears in either a Chinese calendar or a Western calendar) instead of asking directly for age, because some people will provide the nominal age.

We also found that it is important to check all official records, including birth and marriage dates, carefully. In one case, a 98 year-old woman in Hangzhou reported her animal year at birth correctly and passed our age validation procedures. Although she was definitely 98, she was listed as being 104 years old in her household registration booklet. The mistake was due to a handwriting error; her birth year, 1897, was written down as 1891.

In another case, a female interviewee in Beijing was listed as 107 years

old by the local aging committee. Her birth year was recorded as 1889 in her household registration booklet. She reported her animal year at birth as the year of the ox. We found that, at the time of the survey, her oldest child was 72 years old, and her youngest child was 53 years old. The interviewee married when she was 18 years old. Putting all these facts together, we determined that, if she had been born in 1889, she would have been 35 years old when she gave birth to her first child, and 52 years old when she gave birth to her last child. In China, it is highly improbable for a woman to have her first child in her 17th year of marriage, and equally improbable for a woman to have her last child at the age of 52. We concluded that her listed age (107) was wrong, while acknowledging that her reported animal year at birth (the year of the Ox) might well be correct. If so, she was born in 1901 rather than 1889. We feel that the official records concerning the age of this woman were incorrect.

Similarly, three interviewees in Chengdu who reported their birth dates correctly, were less than 100 years old, but all three were mistakenly listed as centenarians by their local aging association due to careless errors. In all, we found errors either in the records of the aging committee or in the household registration booklet for about 2.4% of our total sample.

One interviewee obviously exaggerated her age in the survey. She lived in a nursing home for the elderly in Beijing. At the beginning of last year she said she was 103 years old, and asked the leader of the nursing house to celebrate her 103rd birthday. At the end of last year, she said she was 108 years old. We checked her household registration booklet, visited the nursing home, and called the work unit where the interviewee worked before her retirement. We concluded that her age, as reported, was wrong. She came from a cultural background where old age is highly regarded. She was a Chinese Tai Ji; and her husband was a famous Tai Ji master. Tai Ji people, who believe that their Tai Ji inheritance gives them health and long life, have been known to exaggerate their ages to show they have good “Gong Fu”

Age-reporting among super-centenarians and semi-super-centenarians

We found, from our investigation, that age reporting among super-centenarians (age 110+) and semi-super-centenarians (age 105-109) is questionable. The sex ratio of males to females at age 110 and over, is 0.328, which is substantially higher than those at the lower ages. Ages of 110+ are probably reported incorrectly for males more often than for females. The reported number of Han Chinese in 1990, who were aged 105 to 109, was 10.97% of the total number of centenarians aged 100 to 109. This proportion in Sweden in 1984-1993 was 4.39%. Jeune and Kannisto (1997) found that the proportion of reported deaths at ages 105 years or older, among all reported centenarian deaths in the period 1644-1899 in Denmark, was 15%, almost 4-fold higher than its corresponding value of 3.9% in the period 1970-1993. Similar results were also found in some other European countries with good current data. We think that the high proportion of people reported to be above age 105 in China today, and in Europe historically, is probably largely attributable to age misreporting. It is also possible that mortality selection plays some role, because the proportion of a cohort attaining age 105 is much lower in China and in Europe historically than it is in Europe today. However, we are not sure whether the mortality selection hypothesis is true or not in this special case and further research is needed.

Is the questionable quality of age-reporting among the super-centenarians and semi-super-centenarians contradictory with our previous conclusion on the general accuracy of the age-reporting of Han Chinese centenarians? Our answer is: no. The number of super-centenarians and semi-super-centenarians is small, and age misreporting for even a small number of persons can seriously distort the data at these exceptional ages. Let's illustrate this point with a hypothetical example. Suppose that among 1000 reported centenarians age 100 to 104, 950 (95%) report their ages accurately, 25 persons (2.5%) exaggerate their age by 5 years - meaning they are actually 95 to 99 years old, and 25 persons (2.5%) exaggerate their age by 10 years - meaning they are actually 90 to 94 years old. It is estimated that the annual probability of death after age 100 is, on average, 50%, so that five years later only about 30 of those 950 centenarians who reported their ages accurately will survive to age 105-109. Based on the 1990 census data, the probability of

a Han Chinese surviving from age 95-99 to 100-104 is 0.1506, and, from age 90-94 to 95-99, 0.2196, so that five years later 9 of the 50 persons who exaggerated their ages, will survive and report themselves as 105-109 years old. The rate of age misreporting becomes 23% at age group 105-109, as compared to 5% at age group 100-104. Therefore, the questionable age validity of super-centenarians and semi-super-centenarians is not inconsistent with our conclusion that age reporting for Han Chinese centenarians appears generally to be of good.

As in some European countries with generally accurate population data, the Han Chinese data after age 105 and especially after 110 must be used with great caution. In most of our analyses, we will probably exclude those people who report their age as over 105, but in some analyses we will focus on these people and try, judiciously and sceptically, to see if we can learn anything from the data.

In our survey, four interviewees reported their age as 110 or above, but we could not validate any of the four ages given. A man in Chengdu, rather well-known because of his declared super-centenarian status, reported that he was 122 years old. He not only lives in a temple which is far away from any town, but he is the manager of the temple. When we arrived at the temple, he was in the tea house drinking tea and chatting with people. During the interview, he gave us his birth date and answered the question on his age when the last emperor took power. His reported age was the same as that listed in his household registration booklet. We visited a man who corroborated the age in question as being 122 years old. We also visited several of the super-centenarian's neighbours. They said he moved into the area in 1933, 63 years ago. They could not tell how old he was then, but they did say he was already an old man. On a daily basis, he is still very active, sometimes travelling over 1000 km to another province or city to pray. He manages his own life, plays a leading role at the temple, and even takes care of temple finances. During our visit, he showed us around the temple, pointing out how he planned to develop it by having walls reconstructed and building new rooms. He does Qi Gong, a set of Chinese exercises, everyday. He had no relatives living close by, he never married, and has no children.

Although we have not found any evidence to prove that his age, as reported, is wrong, his health status was so good and he was so active, it was hard to believe that he could be 122 years old. Somehow we would like to confirm his age, but how? One possibility is to go to his birth place and follow the path he migrated to investigate his likely age in connection to his activities and related records in different places he lived. However, we are unfortunately not able to do so due to fund and time limitation.

Another man in Chengdu reported that he was born in 1884, or in the year of “Jia Shen” using the Gan Zhi year system and was 112 years old. He became blind at 3 years old, but had excellent hearing acuity throughout his life. By developing a talent for music, he made a living singing stories from his early life, and playing various musical instruments. When we asked about his family, he told us he had no biological children and no living relatives. Once again, we had very little evidence to support his age-reporting.

A woman in Chengdu who reported that she was born in 1882; making her 114 years, had a child aged 63 years old at the time of our survey. Since it is so unlikely for a woman to bear a child at age 51, we decided that her age was overstated.

Another Chengdu woman, who could not confirm her age in an interview with us, due to a mental problem, was listed as being 110 years old by the local aging committee. In our investigation of her age, we found that she married at 16, and gave birth to her first child at 21. But her first child was only 78 years old at the time of our visit with her. Since the age of her child would make her 99 years old, and this was not consistent with her reported age, we knew her age, as listed, was incorrect.

Conclusion

Based on our analysis of the Chinese census data set for centenarians, and the age validation procedures conducted in our Hangzhou, Beijing and Chengdu surveys, we conclude that the age reporting of Han Chinese centenarians below age 105 is generally good. From a cultural perspective, Han Chinese people believe that it is important to remember their birth dates. Han Chinese, whatever of their education level, know precisely their birth

date. The young and the educated people can supply birth date according to the Western calendar, and the old and the illiterate people can supply birth date according to the traditional Chinese calendar. The Chinese calendar consists of a simple version of cycle of 12 animal years such as rooster, dragon, tiger etc., as well as a more complicate version of cycle of 60 years, with 12 animals and each animal has five different qualities. The precise date of birth is significant in making decision on important life events such as marriage matching, date of marriage, date to start to build a house, and date of travelling etc., according to the Han Chinese tradition. We also found that some persons aged 99 or 98 years old may be mistakenly listed as being 100 years old. A researcher has to check birth dates carefully due to the confusion caused by the Chinese nominal age.

Age reporting of both super-centenarians (110+ years old) and semi-super-centenarians (105-109 years old) is questionable. The super-centenarians and semi-super-centenarians are so rare that should even a small number exaggerate their ages, this can result in a large distortion of the data quality. Due to the small number of oldest-old in our sample size, we are not yet in a position to identify either the degree or causes of age overstatement by super-centenarians and semi-super-centenarians. Further research is needed in this area.

Given that the Han Chinese are not only a large population in a developing country, but also somewhat unique in their ability to provide accurate data about their birth dates, further studies on Han Chinese centenarians will provide researchers with an invaluable opportunity to better understand both population aging and human longevity.

References

- Banister, J. 1990. Implications of ageing of China's population. in: Zeng Yi, ZHANG Chunyuan and Peng Shongjian (eds.), CHanging Family Structure and Population Ageing in China: A Comparative Approach. Peking University Press, 1990. Beijing. And in Dudley L. Poston, Jr. and David Yaukey (eds.), The Population of Modern China, New York: Plenum Press, 1992.
- Bowerman, W. G. 1939. Centenarians. Transactions of Actuarial Society of America, Vol. 40, 361-378.
- Coale A. and E. E. Kisker. 1986. Mortality Crossovers: Reality or Bad Data? Population Studies, 40(1986), 389-401.
- Coale, Ansley and Shaomin Li. 1991. The effect of age misreporting in China on the calculation of mortality rates at very high ages. Demography. Vol. 28, No. 2.
- Coale, A. J. 1984. Rapid Population CHanges in China, 1952-1982. Committee on Population and Demography, National Research Council, Report No. 27. Washington, D.C.: National Academy Press.
- Ernest, M. 1938. The longer life. Adam & Co., London.
- Jeune B. 1995. In Search of the First Centenarians. In: Jeune B. and J. Vaupel (eds.). Exceptional Longevity: From Prehistory to the Present. Odense University Press, pp. 11-24.
- Jeune B and Kannisto V 1997. Emergence of Centenarians and Supercentenarians. In: J.-M. Robine et al. (Eds.) Longevity: To the Limits and Beyond. Springer -Verlag Berlin Heidelberg New York .PP.77-89.
- Kannisto, V. 1994. Development of Oldest-Old Mortality, 1950-1990: Evidence from 28 Developed Countries. Odense Monographs on Population Aging 1, Odense University Press, Odense.
- Mazess, R.B., and S. Forman. 1979. Longevity and age exaggeration in Vilcabamba. Journal of Gerontology 34:94-98.
- Medvedev, Z.A. 1973. Caucasus and Altay longevity: A biological or social problem? Gerontologist, Vol. 14, pp. 381-387.
- Myers, R. J. 1965. Analysis of mortality in the Soviet Union according to 1958-59 life tables. Transactions of Society of Actuaries, Vol. 16, pp.

309-317.

- Myers, R. J. 1966. Validity of centenarians data in the 1960 census. Demography. Vol. 3, pp. 470-476.
- Ogawa, Naohiro. 1988. Aging in China: demographic alternatives. Asian-Pacific Population Journal, No. 1.
- Palmore EB. 1984. Longevity in Abkhazia: a reevaluation. The Gerontologist 24:95-6.
- Rosenwaike, I. 1968. On measuring the extreme aged in the population. Journal of American Statistical Association, Vol. 63, pp. 29-40.
- Thoms, W.J. 1873. Human Longevity. Its Facts and Its Fictions. *John Murray*, London
- Vaupel, W.J. and Gowan A. 1986. Passage to Methuselah: Some Demographic Consequences of Continued Progress against Mortality. American Journal of Public Health. Vol. 76, No. 4.
- Vaupel, W.J. & Jeune B. 1995. The Emergence and Proliferation of Centenarians. In. Jeune B. and j. Vaupel (eds.). Exceptional Longevity: From Prehistory to the present. Odense University Press, pp. 109-116.
- Vischer, A.L. 1945. Medizinische Betrachtungen bei einem Hundertjhrigen. Schweizerische Medizinische Wochenschrift 75:747-748.
- Wang, Zenglian, 1996. Report of the centenarians Surveys in Hangzhou, Beijing and Chengdu. Unpublished manuscript.
- Zeng, Y. & Vaupel, W.J. 1989. Impact of urbanisation and delayed childbearing on population growth and ageing in China. Population and Development Review, Vol. 15, No. 3.

1 . The authors are very grateful to State Statistical Bureau of China for providing the data set. Support from the National Centre for Aging Research of China, the National Natural Science Foundation of China, the Aging Research Unit at the Medical School of Odense University and the Max Planck Institute for Demographic Research was highly appreciated. We are very grateful to Professor Xiao Zhengyu at the National Centre of Aging Research, and the Aging Committees in Hangzhou and Beijing for their effective help. The Authors are very grateful to Ms. Nancy Vaupel for her thoughtful comments and suggestions. Wang Zhenglian is affiliated with Odense University, the Max Planck Institute for Demographic Research. Zeng Yi is affiliated with Institute of Population Research of Peking University and the Max Planck Institute for Demographic Research. Bernard Jeune is affiliated with Odense University. James W. Vaupel is affiliated with the Max

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2. The Whipple's Index for evaluating the general degree of age heaping in a population of all ages is usually calculated as:

The Whipple's Index =

$$\frac{(\text{sum of numbers at ages } 25,30,35, \dots,60) \times 100 \times 5}{\text{total number between ages } 23 \text{ and } 62}$$

The value of the Whipple's Index in a population with perfect age reporting as well as no any large changes in fertility, mortality and migration for a long time would be 100. The United Nations recommended a standard for measuring the age heaping as follows:

Whipple's Index quality of data Deviation from perfect

<105	very accurate	< 5%
105-110	relatively accurate	5-9.99%
110-125	OK	10-24.99%
125-175	bad	25-74.99%
>175	very bad	>= 75%

The choice of 23 and 62 as the limits of age band to be examined in the classic Whipple's Index calculation is arbitrary but has been found most suitable for practical purpose of measuring age heaping in general in a population of all ages (United Nations, 1955, pp. 39-45). However, this age band can not be used for the centenarians since it excludes persons above age 62. We, therefore, define that the Whipple's Index for the centenarians survivors or deaths of age x and over as follows:

The Whipple's Index for centenarians =

$$\frac{(\text{sum of numbers at ages } 95,100,105) \times 100 \times 5}{\text{total number between ages } 93 \text{ and } 107}$$

The lower limit (x) is 95. The reason why 100 is not chosen as the lower limit here is that too small sample size and too quick decrease of the numbers after age 100 may not produce meaningful result of Whipple's Index. As shown in Table 4, the values of the Whipple's Index for centenarians population are less than 100, due to the quick decline of the numbers of survivors and deaths at very old ages. We evaluate Han Chinese age reporting by comparing it with the Swedish counterparts, which has the best data quality in the world.