Predictors of Longevity: Evidence From the Oldest Old in China

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Objectives. We investigated the characteristics of the oldest old in China and examined whether the factors associated with longevity varied with advanced age.

Methods. Drawing from the largest nationally representative longitudinal sample of oldest-old adults, we stratified descriptive statistics separately by gender and urban–rural residence and then used ordered logit models to examine the multivariate factors associated with increasing age-group membership.

Results. Differing combinations of demographic, social, physical, and behavioral factors were significantly related to surviving into later ages for men and women in urban and rural areas. With the exception of rural women, psychological disposition was not associated with increased longevity. Gender differences were generally smaller in urban areas than in rural areas, and urban–rural differences were more pronounced among women than among men.

Conclusions. Findings from the oldest-old population in China challenge many of the established relations in the health-inequality literature. Future research should examine why the oldest old are an exceptional group of physically, socially, and demographically heterogeneous individuals who exhibit healthy longevity beyond the average life span. (*Am J Public Health.* 2008;98:1203–1208. doi:10.2105/AJPH.2007.113886)

Human aging and longevity are of broad interest to health researchers, policymakers, and the general public. Consider that the number of persons 80 years and older is projected to increase worldwide from 86 million in 2005 to almost 400 million by 2050.[1] The reasons for such dramatic improvements in longevity are complex and involve changes in medical technology, public policy, and the major diseases that occur within evolving social, demographic, and economic contexts.[2] Although the literature on adult health disparities is sizeable, far less is known about the factors associated with surviving beyond the average life span.[3–5]

Persons who live into their 80s (octogenarians), 90s (nonagenarians), and over 100 (centenarians) are a testament to longevity and are among those typically considered *select survivors.* However, studies of the oldest old (defined here as persons 80 years and older) remain scarce because national surveys often lack sufficient representation of adults at advanced ages. The research that does exist is overwhelmingly from the United States and other Western nations and relies predominantly on descriptive information from census data.[6] In addition, many of these studies focused on the modeling implications of heterogeneity bias, age misreporting, and forecasting life expectancy.[7–11] More research is needed to examine the multifaceted characteristics of this unique population in developing nations.

In China, the annual growth rate of the oldest old is expected to increase on average by a staggering 4.4% (nearly double the US rate), making China the most populous nation of adults 80 years and older.[12] In fact, almost 20% of the world's oldest old live in China, and assuming a medium fertility rate (1.9 children), more than one quarter of the world's oldest old in 2050 will be from China.[13] Thus, the potential key to understanding successful aging and longevity may well rest in a greater understanding of this remarkably diverse and growing population. To date, only a limited amount of research has focused on the oldest old in China, and much of our knowledge is based on descriptive statistics.[14,15]

We used the Chinese Longitudinal Healthy Longevity Survey (CLHLS), the world's largest nationally representative longitudinal sample of oldest-old adults, to investigate the individual characteristics associated with advanced age. To our knowledge, our study is the first to use both descriptive and multivariate methods to examine the following research questions. First, what are the key sociodemographic, behavioral, physical, and psychological characteristics of adults 80 years and older in China? Second, do the factors associated with prolonged survival differ for octogenarians, nonagenarians, and centenarians? Finally, do the factors associated with advanced age-group membership vary by gender and urban–rural residence?

METHODS

Sample

Data from the 1998, 2000, and 2002 CLHLS were used for analysis. In-person interviews were conducted in one half of 22 randomly selected counties and cities throughout China. An initial sample of 8805 elderly persons aged 80 to 105 years was interviewed in 1998; of those, 4691 respondents (53%) were re-interviewed, 850 persons (9.6%) were lost to follow-up, and 3264 persons (37%) died before the second interview in 2000. An additional 6288 respondents aged 80 to 105 years were newly interviewed in 2000 to replenish the sample. Of the newly interviewed participants, 3632 (58%) were re-interviewed, 946 (15%) were lost to follow-up, and 1710 (27%) died before the 2002 survey. Although the original respondents in 1998 were re-interviewed in 2002, we excluded these cases to avoid the bias associated with overcounting the characteristics of individuals who were no longer representative of the oldest-old adults in the population. In all analyses, we used weights to produce population estimates that were adjusted for sampling. Further details of the CLHLS sampling design, response rates, questionnaire validity, and data quality are reported extensively elsewhere.[16,17]

Dependent Variable

The main dependent variable was an age categorization of longevity for octogenarians, nonagenarians, and centenarians. We measured longevity by using an ordinal variable that classified the oldest old according to their age in the following ranges: 80 to 89, 90 to 99, and 100 years and older (coded 0, 1, and 2, respectively). From an analytic standpoint, this allowed us to examine whether the profile of the oldest-old population varied with advanced age. The assumption was that persons in each of the successive age groups would be selectively different in terms of their individual characteristics.

We recognized that the validity of age reports is crucial for studying the oldest old, and we made great efforts to minimize age misreporting in the CLHLS sample. Information was collected and validated on the basis of the respondents' self-reported age, month and year of birth (from both Western and Chinese calendars), animal year of birth, and age reported on various forms of identification. Previous studies have shown that age reporting in China is of relatively high quality because of the longstanding astrological significance attributed to one's date of birth, particularly among the Han majority.[18,19] It has further been shown that the quality of age reports in the CLHLS is much better than that of reports obtained from the Chinese census and, among centenarians, nearly identical to that of reports from Sweden and other developed countries.[17,20] Moreover, our analyses were based on broad age categories that are less affected by imprecise age reports. Therefore, we were confident that our findings were not simply an artifact of age inaccuracies in the data (or sampling, as noted earlier).

Independent Variables

Independent variables included the respondents' background characteristics, socioeconomic status (SES), social contact and support, health behaviors and diet, health status, and psychological characteristics. Background characteristics included ethnicity (Han or a variety of non-Han minorities), childhood SES score ranged from 0 to 5 (1 point each if respondent was born in an urban area, got adequate medication, went to bed without hunger, both parents were alive at age 10 years, and father's occupation was white collar), and 2 dichotomous variables indicating whether the respondent's mother or father survived to age 80 years or older. Measures of SES included education (any formal education), primary lifetime occupation (agricultural or nonagricultural), and economic independence (i.e., primary financial source was from own work or pension).

Social contact and support measures included current marital status (married), household size (from 1 to 6), high proximity to offspring (coded 1 if co-residing with biological or adopted children, including a spouse's child, or having 1 or more biological children living in the same village or street block), and religious activity (almost every day, sometimes, or never). We also included 3 dichotomous indicators of health behaviors and diet, including smoking (never, current, or past smokers), alcohol consumption (never, current, or past drinkers), and consumption of vegetables (almost every day, except winter, occasionally, or rarely or never).

Health status was indicated by impairments in activities of daily living (ADL), cognitive functioning, and the presence of a major chronic disease. The ADL measure was based on the Katz index scale, and respondents were categorized as ADL disabled if they needed help in 1 or more activities.[21] Cognitive functioning was ascertained by using the Mini-Mental State Examination, which measured orientation, registration, attention, calculation, recall, and language.[22] Persons scoring less than 24 were categorized as being cognitively impaired.[22,23] Individuals were classified as having a chronic disease (coded 1) if they reported hypertension, a pulmonary disorder, heart attack, or cerebrovascular disease. Finally, psychological characteristics were measured by using 3 dummy variables to categorize respondents who felt "anxious," "lonely," or always "looked on the bright side of things" (i.e., had a positive outlook).

Data Analyses

We use weighted descriptive statistics to demonstrate the characteristics of the oldest old separately for men and women and by urban and rural residence. We then used weighted, ordered logit models to examine how the sociodemographic, behavioral, physical, and psychological makeup of the oldest old changed across age categories. Supplemental analyses were used to evaluate the proportional odds assumption that the slope coefficients were the same in the single-equation model of the ordered dependent variable. Results from both Wald and approximated likelihood-ratio tests for each of the subgroup analyses were consistent and provided strong evidence to support the proportional odds assumption. Therefore, the odds ratios were constant for all age categories and were interpreted as the odds of being in an age group that was greater than k compared with those less than or equal to k, where k was the cumulative level of age.

All analyses used pooled data from the 1998 to 2000 and 2000 to 2002 (replenished sample) interviews to provide robust estimates (n = 13 297), and the multivariate analyses used Huber–White sandwich estimates of variance to account for the lack of independence of observations. Multiple imputation methods were used to account for missing data to reduce the potential for inferential bias from the estimates.[24,25]

RESULTS

Descriptive Findings

Table 1 presents descriptive statistics for the oldest old in China separately by gender and residence. Overall, the background characteristics of persons 80 years and older were similar for men and women in urban and rural areas. However, as expected, ethnic minorities were about twice as likely to live in rural locations, and urban residents had slightly higher levels of childhood SES. Men, particularly those in urban areas, had a much higher percentage of education, nonagricultural occupations, and economic independence than did women. By contrast, only 12% of rural women reported having any formal education, and about 5% to 6% of this group reported economic independence or a nonagricultural occupation, respectively.

Men were more than 3 times as likely to be married than were women, whereas men were only half as likely to be religiously active than were women in both urban and rural areas. Although the rural oldest old were shown to reside in slightly larger households,

TABLE 1—Weighted Distributions of the Oldest Old, by Area of Residence and Gender: Chinese Longitudinal Healthy Longevity Survey, 1998–2002

	Urban		Rural	
	Men (n = 2597)	Women (n = 3487)	Men (n = 2857)	Women (n = 4356)
Background characteristics				
Age, y, mean	83.2	83.8	83.0	83.5
Ethnic minority, %	3.1	4.3	7.5	9.1
Childhood SES score,[a] mean	1.9	1.8	1.3	1.3
Mother lived to age ≥ 80 y, %	28.5	29.2	31.9	28.9
Father lived to age ≥ 80 y, %	16.1	15.5	18.9	17.9
Socioeconomic status, %				
Education	77.8	26.0	60.0	12.1
Nonagricultural occupation	74.5	33.8	23.3	6.3
Economic independence	64.8	20.9	21.6	5.3
Social contact and support				
Married, %	51.0	16.9	44.0	14.5
Household size, mean	3.1	3.1	3.7	3.8
High proximity to offspring, %	68.2	70.2	86.5	86.9
Religiously active, %	11.2	27.0	10.2	24.9
Health behavior and diet, %				
Current or past smoker	63.6	20.3	67.8	14.7
Current or past drinker	50.1	19.4	54.3	21.0
Eats vegetables regularly	96.7	97.8	97.1	97.4
Health status, %				
ADL disabled[b]	18.1	22.0	13.5	17.9
Cognitively disabled[c]	15.1	25.7	16.5	35.2
Chronic disease[d]	40.5	36.4	32.2	33.3
Psychological characteristics, %				
Looks at bright side	84.6	80.6	79.8	75.7
Feels anxious	6.4	7.9	6.7	11.3
Feels lonely	8.0	11.4	8.5	13.0

Note. SES = socioeconomic status; ADL = activities of daily living.
[a]Childhood SES was scored from 0 to 5, with 1 point each if respondent was born in an urban area, got adequate medication, went to bed without hunger, both parents were alive at age 10 years, and father's occupation was white collar.
[b]The ADL measure was based on the Katz index scale, and respondents were categorized as ADL disabled if they needed help in 1 or more activities (bathing, dressing, indoor transferring, toileting, eating, and continence).[21]
[c]Cognitive functioning was ascertained by using the Mini-Mental State Examination, which measured orientation, registration, attention, calculation, recall, and language.[22] Persons scoring less than 24 were categorized as being cognitively impaired.[22,23]
[d]Individuals were classified as having a chronic disease (coded 1) if they reported hypertension, a pulmonary disorder, heart attack, or cerebrovascular disease.

almost 87% were in high proximity to their children, compared with approximately 70% of urban men and women. The differences in health behaviors were primarily gender based. Urban and rural men were disproportionately more likely to report current or past smoking and drinking than were their female counterparts. Interestingly, about 97% of men and women in both urban and rural settings reported eating vegetables regularly.

The findings for health status and psychological characteristics were somewhat surprising. Contrary to expectations, the majority of the oldest old did not exhibit an ADL disability and were not cognitively impaired. Among the most physically disabled were urban women (22%), and the least disabled were rural men (14%); the most cognitively impaired were rural women (35%), and the least impaired were urban men (15%). Chronic disease was lowest among the rural oldest old and was highest among urban residents, particularly men (41%). In terms of psychological disposition, most older adults looked on the bright side and did not feel anxious or lonely. A somewhat larger percentage of oldest old in urban areas reported looking on the bright side, and women in both residential locations reported feelings of loneliness.

Multivariate Findings

Table 2 presents the proportional odds ratios (ORs) showing whether the factors associated with longevity varied with advanced age. Among the urban oldest old, the results for both men and women suggested that a combination of background characteristics, SES, social contact and support, health behaviors and diet, and health status had independent associations with older age groups. We found no significant relations between psychological characteristics and advanced age.

Among urban men, those with a mother living to 80 years or older and those residing in larger households were significantly more likely to be categorized at the upper limits of longevity (ORs = 1.28 and 1.09, respectively) than were their respective counterparts. Among urban women, higher levels of childhood SES and household size were associated with older age-group membership (ORs = 1.19 and 1.08, respectively). For both men and women, we found that education, economic independence, marriage, and regularly consuming vegetables were negatively associated with older age after we controlled for other covariates. Unlike urban women, urban men who were current or past smokers were significantly less likely to be among the oldest adults in the population (OR = 0.71).

The relation between health status and longevity was consistent with expectations, although an interesting discrepancy emerged. The odds of being in the oldest age group (≥ 100 years) were 2.06 and 2.49 times as great for men and women, respectively, who were ADL disabled and 2.37 and 2.50 times as great for those who were cognitively impaired than for persons aged 80 to 99 years. Because the odds were proportional, the same increase was found for persons 90 years and older compared with octogenarians. Interestingly, urban men and

TABLE 2—Ordered Logit Models Predicting Longevity, by Area of Residence and Gender: Chinese Longitudinal Healthy Longevity Survey, 1998–2002

	Urban		Rural	
	Men, OR (95% CI)	Women, OR (95% CI)	Men, OR (95% CI)	Women, OR (95% CI)
Background characteristics				
Minority ethnicity (vs Han)	1.40 (0.81, 2.41)	0.96 (0.60, 1.55)	1.04 (0.71, 1.53)	0.67* (0.47, 0.96)
Childhood SES[a] (scored 0–5)	1.10 (1.00, 1.21)	1.19*** (1.08, 1.31)	1.11 (0.99, 1.24)	1.11 (1.00, 1.23)
Mother lived to ≥80 y (vs no)	1.28* (1.01, 1.61)	0.91 (0.73, 1.14)	0.93 (0.74, 1.17)	1.09 (0.87, 1.35)
Father lived to ≥80 y (vs no)	1.16 (0.88, 1.52)	1.29 (0.98, 1.70)	1.18 (0.90, 1.55)	1.23 (0.96, 1.57)
Socioeconomic status				
Education (vs none)	0.74* (0.58, 0.96)	0.74* (0.56, 0.99)	0.87 (0.69, 1.09)	0.66* (0.45, 0.96)
Occupation (vs agricultural)	0.92 (0.70, 1.22)	1.00 (0.77, 1.32)	1.08 (0.80, 1.46)	0.69 (0.43, 1.12)
Economically independent (vs not)	0.71** (0.55, 0.92)	0.41*** (0.29, 0.59)	0.46*** (0.32, 0.66)	0.57 (0.31, 1.05)
Social contact and support				
Married (vs not married)	0.39*** (0.31, 0.49)	0.14*** (0.09, 0.23)	0.46*** (0.36, 0.57)	0.20*** (0.13, 0.31)
Household size (1–6)	1.09* (1.01, 1.17)	1.08* (1.01, 1.16)	1.00 (0.95, 1.06)	0.99 (0.93, 1.04)
Proximate to children (vs not)	1.22 (0.92, 1.63)	0.87 (0.66, 1.15)	1.14 (0.82, 1.60)	1.06 (0.77, 1.47)
Religiously active (vs not)	1.36 (0.98, 1.89)	0.82 (0.64, 1.05)	1.16 (0.83, 1.63)	0.77* (0.60, 0.98)
Health behavior and diet				
Current or past smoker (vs never)	0.71** (0.57, 0.89)	0.88 (0.67, 1.14)	0.65*** (0.52, 0.82)	0.80 (0.59, 1.08)
Current or past drinker (vs never)	1.09 (0.87, 1.36)	1.02 (0.78, 1.34)	1.09 (0.87, 1.36)	1.30* (1.02, 1.66)
Eats vegetables (vs does not)	0.57* (0.35, 0.95)	0.47* (0.26, 0.85)	0.90 (0.51, 1.59)	0.64 (0.38, 1.08)
Health status				
ADL disabled[b] (vs no)	2.06*** (1.58, 2.68)	2.49*** (1.97, 3.14)	2.24*** (1.71, 2.94)	2.24*** (1.78, 2.84)
Cognitively disabled[c] (vs no)	2.37*** (1.81, 3.11)	2.50*** (2.01, 3.13)	2.33*** (1.82, 2.99)	2.06*** (1.67, 2.53)
Chronic disease[d] (vs no)	0.71** (0.56, 0.89)	0.54*** (0.43, 0.68)	0.66*** (0.52, 0.84)	0.80* (0.64, 0.99)
Psychological characteristics				
Looks at bright side (vs does not)	1.16 (0.86, 1.58)	1.02 (0.78, 1.33)	1.16 (0.89, 1.53)	1.30* (1.02, 1.66)
Feels anxious (vs does not)	0.82 (0.51, 1.31)	0.97 (0.64, 1.46)	0.87 (0.57, 1.34)	0.86 (0.62, 1.20)
Feels lonely (vs does not)	0.86 (0.56, 1.31)	1.03 (0.71, 1.51)	1.00 (0.69, 1.45)	0.98 (0.72, 1.33)

Note. OR = odds ratio; CI = confidence interval; SES = socioeconomic status; ADL = activities of daily living.

[a]Childhood SES was scored from 0 to 5, with 1 point each if respondent was born in an urban area, got adequate medication, went to bed without hunger, both parents were alive at age 10 years, and father's occupation was white collar.

[b]The ADL measure was based on the Katz index scale, and respondents were categorized as ADL disabled if they needed help in 1 or more activities (bathing, dressing, indoor transferring, toileting, eating, and continence).[21]

[c]Cognitive functioning was ascertained by using the Mini-Mental State Examination, which measured orientation, registration, attention, calculation, recall, and language.[22] Persons scoring less than 24 were categorized as being cognitively impaired.[22,23]

[d]Individuals were classified as having a chronic disease (coded 1) if they reported hypertension, a pulmonary disorder, heart attack, or cerebrovascular disease.

*$P \leq .05$; **$P \leq .01$; ***$P \leq .001$.

women with chronic disease were 0.71 and 0.54 times less likely to be among nonagenarians and centenarians than among octogenarians compared to urban men and women without disease. In terms of predicted probabilities (PP), the proportion of men with chronic disease dropped significantly from 80–89 years of age (PP=0.94) to 90–99 years of age (PP=0.06) to almost zero by age 100 years or older; among women, the rates were slightly lower but declined similarly from 80–89 to 90–99 years of age (PP=0.91 and 0.09, respectively) to again almost zero by age 100 years or older.

The results for the rural oldest old showed some differences with the rural population. Unlike urban men, increased longevity among men in rural areas was not related to the prolonged survival of one's mother, education, household size, or vegetable consumption. Instead, we found that rural men who were economically independent (OR=0.46), married (OR=0.46), and current or past smokers (OR=0.65) were significantly less likely to be among the oldest adults in China. Contrary to urban women, increased longevity among rural women was not associated with childhood SES, economic independence, or routinely eating vegetables. However, the negative associations between education (OR=0.66) and being married (OR=0.20) and advanced age were consistent with the oldest-old women in urban areas.

For men and women in rural areas, the odds of being in the oldest age categories were 2.24 times as great for persons who were ADL disabled and 2.33 and 2.06 times as great, respectively, for persons who were cognitively impaired. Again, rural men were .66 times and women .80 times less

likely to be among the cumulatively older adult population in China.

The results for rural women, perhaps the most disadvantaged subpopulation, showed some unique findings. Women who were religiously active were .77 times less likely to be represented among the longest-lived adults in the population. Likewise, women who were ethnic minorities were .67 times less likely to be among the oldest age groups. Alternatively, the odds of being 100 years or older were 1.30 times as great for rural women who reported current or past drinking or a positive outlook than for those who were younger than 100 years. The same proportional odds for drinking and positive outlook were also applicable to persons 90 years and older compared with octogenarians. These findings were particularly striking because rural women reported the highest rates of anxiety and loneliness (Table 1) and had the fewest socioeconomic resources, which among other things, may limit the purchase of alcohol.

Finally, we examined whether the factors associated with longevity were also predictive of subsequent mortality (results available upon request). The findings from these analyses were mixed and yielded surprisingly few significant effects. For men and women across all age groups, persons who were ADL disabled or cognitively impaired were significantly more likely to die, whereas having a chronic condition had almost no effect on mortality. For men 99 years and younger, those who were married were less likely to die and those who reported loneliness were more likely to die. For men 100 years and older, the only significant predictor of mortality (with the exception of ADL and cognitive impairments) was that the regular consumption of vegetables reduced mortality by roughly 30%. For women, lower rates of mortality were found among nonagenarians with a positive outlook and among centenarians who were ethnic minorities. These results were generally consistent for urban and rural residents except for male centenarians, who exhibited slightly higher mortality in urban areas.

DISCUSSION

Only a limited amount of research has focused on the oldest old in China, and much of our knowledge is based on descriptive statistics.[14,15] We were the first to use the largest nationally representative longitudinal sample of oldest-old adults to investigate the characteristics associated with advanced age. To our knowledge, we were also the first to use multivariate methods to identify the key factors associated with successful aging and longevity in China. Overall, we found that many of the established relations found in the health-inequality literature were not observed in the oldest-old population and, in many cases, were in the opposite direction.

We found that differing combinations of demographic, social, physical, and behavioral factors were significantly related to longevity for men and women in urban and rural areas. Except for rural women, the psychological characteristics of the oldest old did not vary significantly by age. We also found that gender differences were generally smaller in urban areas than in rural areas and that urban–rural differences were more pronounced among women than among men.

For both urban men and urban women, education, economic independence, being married, and regularly consuming vegetables were each independently associated with advanced age. Smoking and having a mother live to age 80 years or older were also significant for urban men, and childhood SES was significant for urban women. The results for rural men suggested that only smoking, economic standing, and marital status were linked to longevity aside from health status. For rural women, we found that ethnicity, education, marital status, religious activity, alcohol consumption, and positive outlook were important factors that increasingly characterized the oldest-old population.

Not surprisingly, physical and cognitive impairments were the most robust factors associated with longevity. However, a somewhat unexpected finding was that chronic disease was negatively related to advanced age. Although it is plausible that this finding was caused by the selective mortality of sick individuals from the oldest-old population, this claim was not supported by our secondary analyses, which showed that chronic disease was not related to prospective mortality. It may be that the relation between chronic disease and mortality was eliminated once the severity and symptomatology of the conditions were taken into account (e.g., ADLs). Alternatively, we suspected that the strong negative association between disease and longevity may be because disease recognition diminished with age as the result of cognitive decline or limited health care utilization and diagnoses. However, such interpretations remain guarded until other studies corroborate this finding.

Another noteworthy finding was that persons who resided in large households were more likely to be among the longest-lived adults in urban areas but not in rural areas. This finding was striking because living arrangements in urban areas are extremely limited, and most institutionalized adults in China are urban residents (≈80%). This suggests that persons who indeed live with relatives may benefit from the greater resources afforded by urban families compared with rural households. A related and perhaps contradictory finding was that vegetable consumption was negatively associated with advanced age for the urban elderly but not the rural elderly. The urban–rural discrepancy may well have been attributed to the fact that vegetables are more widely accessible in rural areas than in urban areas. However, the negative relation between eating vegetables and longevity was more difficult to explain. It may be have resulted from the urban oldest old facing greater obstacles obtaining vegetables given their lower proximity to children and smaller households (Table 1), despite a moderate increase in household size across age. Interestingly, we found that urban individuals who were most likely to consume vegetables were centenarians in the largest households and in closest proximity to their children (results not shown).

Although this study provides new insight into the relatively understudied oldest-old population, it also raises several unanswered questions that should be addressed in future research. First, we focused on the largest population of the oldest old in the world; however, China is a unique society and it is unknown whether the results from this analysis are representative of other developing countries. For example, in 2000, the average life expectancy in China was 69 years for men and 73 years for women, compared with 75 and 80 years for men and women in the

United States and 78 and 85 years in Japan, respectively. We encourage additional research to consider our findings in light of dramatic increases in life expectancy and the number of oldest old worldwide and to extend this research to other aging nations.

Second, what do the current findings tell us about health disparities across the majority of the life course? Excluding a selection argument, the results suggest that despite exhibiting 1 or more disadvantages, some individuals overcome their risks and live well beyond their more disadvantaged (and advantaged) peers. Future research should recognize the value of studying individuals who defy their aggregated likelihood of following a predicted health trajectory.

Finally, what are the policy implications associated with a heterogeneous oldest-old population? Our multivariate findings identified several factors related to the survival of the oldest living adults in urban and rural China; these findings may allow health policymakers to target individuals who may require the greatest amount of care and services. For example, recent evidence suggests that the institutionalized oldest old in China are a diverse group of individuals who often lack adequate family-care resources.[26] Given that the vast majority of oldest-old Chinese do not receive institutional care, it is imperative to further disentangle the heterogeneous makeup of the oldest old who reside among the general population.

In sum, our findings were unique because they showed not only that the oldest old were a diverse group of adults, but that the characteristics of the population changed as individuals reached the upper limits of life. Whether the explanation for these findings is selective mortality at younger ages, heredity, or some other factor is not entirely clear and warrants further investigation. As the recent and spirited debate on forecasting life expectancy continues to garner wide attention in the literature,[9–11,27] we strongly encourage additional studies to consider the age-varying characteristics of the surviving oldest-old population and to further identify the key factors associated with exceptional longevity. ■

About the Authors

At the time of the study, Matthew E. Dupre was with the Carolina Population Center, University of North Carolina, Chapel Hill, Guangya Liu was with the Department of Sociology and Anthropology, North Carolina State University, Raleigh, and Danan Gu was with the Center for the Study of Aging and Human Development, Duke University, Durham, NC.

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Contributors

M.E. Dupre originated the study and took the lead on all phases of the research. G. Liu helped to conceptualize ideas, helped to interpret findings, and reviewed drafts of the article. D. Gu assisted with data and analyses and reviewed drafts of the article.

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Human Participant Protection

Institutional review board approval was not obtained for this research because it used data that are publicly available and did not include identifying information of the participants.

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