

Gender Differentials in Cognitive Impairment and Decline of the Oldest Old in China

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Objectives. Research in China has shown that women are significantly disadvantaged in cognitive functioning in old age. This article adds to this line of inquiry by examining gender differentials in the odds of having cognitive impairment at baseline and during follow-up among the Chinese oldest old, as well as the potential pathways linking gender and the likelihood of having cognitive impairment.

Methods. Using two waves (1998 and 2000) of the Chinese Longitudinal Healthy Longevity Survey, the researcher estimated logistic and multinomial regression models of cognitive impairment for a nationwide sample of people aged 80–105 years old ($N = 8,291$).

Results. Among the Chinese oldest old, women were at higher risk than men for having cognitive impairment both at baseline and during 2-year follow-up, controlling for age, activities of daily living disability, and rural residence. Women's disadvantages in socioeconomic status, social network, and participation in leisure activities partially accounted for the gender differentials in cognitive impairment.

Discussion. The findings suggest that oldest old Chinese women are a vulnerable group at higher risk for cognitive impairment than oldest old men. Closing gender disparities in formal education will significantly reduce the gender gap in cognitive impairment in old age.

POPULATION aging historically has been characterized as a social problem faced by developed countries. Today, it is quickly becoming a major social issue in many developing countries (Hayward & Zhang, 2001). For example, China, the most populous developing country in the world, is aging at an unprecedented speed and in an extraordinary scale due to the rigorous family planning program in place during the past several decades, a significant increase in life expectancy, and a population of 1.3 billion people. In 2000, China had the largest number of the oldest old (i.e., people aged 80 and older) in the world, and researchers predict that the number will climb from 13 million to more than 100 million by 2050 (Zeng, Liu, & George, 2003). Such rapid growth of the oldest old foretells a significant future burden of cognitive and functional disability in China and calls for more research into the factors associated with health disadvantages in old age.

Gender is one factor that warrants a closer look in cultural settings such as China where significant differences in gender roles, opportunities, and obligations have conditioned the experiences of men and women throughout the life course. Like most women in developing countries, Chinese women have historically lived in a patriarchal, patrilineal, and patrilocal society in which they were structurally and systematically denied education in early life, mental stimulation through high-skilled occupations during adult life, and a large social network—all of which are associated with cognitive development and maintenance (National Research Council, 2000). Thus theoretically older Chinese women may face higher risk of cognitive impairment than older men due to their lifetime of social and economic disadvantage.

A growing body of research on cognitive impairment and dementia in China confirms that Chinese women are signifi-

cantly disadvantaged in cognitive functioning in old age (Gu & Qiu, 2003; Yu et al., 1989; Zeng et al., 2003). In one of the seminal studies of cognitive impairment in China, Yu and colleagues found large gender disparities in the prevalence of both severe and mild cognitive impairment among those aged 65 and older in the city of Shanghai. However, no studies have yet explored empirically the socioeconomic and cultural factors that could account for the significant gender differences in cognitive impairment in China.

This study intends to fill this gap by addressing two questions: (a) Are there gender differentials in cognitive impairment among the Chinese oldest old? and (b) Do socioeconomic status (SES), social network, leisure activities, and differential survival explain the gender gap in cognitive impairment? This article expands upon the literature in several ways. First, previous studies in cognitive impairment have seldom used nationwide samples. Most studies were conducted in large cities such as Shanghai and Beijing, despite the fact that 75% of the Chinese population lives in rural areas (Liang et al., 2000). The current study used a recently released data set whose survey areas covered 85% of the total population in China. Second, the present study uses longitudinal data to examine gender differences in the onset of cognitive impairment. The majority of previous research has only looked at gender differentials in the prevalence of cognitive impairment. Although prevalence is an important indicator of the burden of cognitive impairment in the older population, it can be influenced by incidence rates as well as the survival rates of those with cognitive impairment. Therefore, it is not easy to interpret these results. Third, no previous study has examined in depth the reasons behind the significant gender differences in cognitive impairment; most studies are largely limited to simple bivariate analyses (e.g., Gu & Qiu, 2003; Zeng et al., 2003).

Gender Differences in Cognitive Impairment in China

Several studies report unusually large gender differences in cognitive impairment in China. In one study in Shanghai (Yu et al., 1989), the prevalence rate of severe cognitive impairment among women was 3.75 times as high as that among men. Zeng and Vaupel (2002) reported that the gender gap in cognitive functioning among the oldest old was extremely large. Whereas 20% of men aged 90–99 had poor cognitive functioning, as many as 37% of women in the same age group suffered from poor cognitive functioning. Elderly women also had significantly higher prevalence and incidence rates of dementia than elderly men (Zhang et al., 1998; Zhang et al., 1990). During a 3-year follow-up study of a cohort of Chinese elders aged 70 and older in Hong Kong, women had a 2.5-fold increased risk of having cognitive impairment compared with men (Ho, Woo, Sham, Chan, & Yu, 2001). In comparison, research in developed countries has found no gender differences in the incidence of cognitive decline and dementia (Chodosh, Reuben, Albert, & Seeman, 2002; Ruitenberg, Ott, van Swieten, Hofman, & Breteler, 2001) but higher prevalence rates of cognitive impairment and dementia among women than among men (Heeren, Lagaay, Hijmans, & Rooymans, 1991; Weissman et al., 1985).

Reasons for Gender Differences in Cognitive Impairment in China

The recent rise of feminist gerontology as well as current knowledge about the risk factors of cognitive impairment and dementia can lend some insight into the gender differences in cognitive impairment in China. Feminist gerontology argues that gender relations are “constructed power relations embedded in social processes and institutionalized in social arenas with important consequences for life chances” (Calasanti, 2004, p. 306). For the current oldest old Chinese, who spent their childhood and adulthood in a patriarchal society, these power relations privileged men and disadvantaged women with regard to nutrition intake (e.g., sons were often favored and given better food in the family, according to Watson [1991]), educational and occupational opportunities, the formation of large and diversified social networks, and participation in leisure activities. All of the gender inequalities experienced over the life course may put oldest old Chinese women at higher risk for cognitive impairment compared with oldest old men. This article examines four mechanisms potentially linking gender and cognitive impairment in China. The first three focus on Chinese women’s disadvantages in SES, social network, and leisure activities, which previous researchers have identified as important predictors of cognitive impairment in old age (Bassuk, Glass, & Berkman, 1999; National Research Council, 2000; Wang, Karp, Winblad, & Fratiglioni, 2002). The last mechanism is differential survival rates (Perls, Morris, Ooi, & Lipsitz, 1993).

SES.—According to the brain reserve capacity theory, “lack of early education could lower brain reserve and allow for clinical symptoms of dementia to appear at an earlier date in the disease process” (Zhang et al., 1990, p. 436). Previous research suggests that formal education and adult occupation provide cognitive practice that is conducive to the development and

maintenance of cognitive abilities (National Research Council, 2000). For both historical and cultural reasons, the current cohort of oldest old Chinese women was significantly disadvantaged in both educational and occupational achievement compared with their male counterparts. Oldest old women were born and raised in the semi-colonial and semi-feudal Chinese society. Women’s status was extremely low in this patriarchal society. For centuries, women were at the bottom of the social hierarchy: “Except for those few who worked in the fields, women were kept confined to their immediate living quarters, denied an education, and not permitted to own property or to work outside the home” (Walstedt, 1978, p. 380). As a result, the majority of oldest old Chinese women were illiterate and had little exposure to non-agricultural occupations. Lack of education and work opportunities also meant that most of oldest old women were exposed to simple environments (e.g., their living quarters and the fields) throughout their lives. Schooler (1987) suggested that continued exposure to a simple environment may have a negative effect on cognitive functioning due to a lack of diverse stimuli. Thus, Chinese elderly women’s low SES may play a significant role in the gender gap in cognitive impairment.

Social network.—In general, oldest old Chinese women have smaller social networks compared with their male counterparts for at least three reasons. First, due to women’s longer longevity, oldest old women are more likely than oldest old men to be widowed. Whereas men were expected to remarry after the loss of a spouse, women were often expected to remain chaste and unmarried (Walstedt, 1978). Second, marriage has historically been patrilocal. Due to the taboos against same-village marriages, women often left their village upon marriage, entered their husbands’ families and communities as strangers, and had few opportunities to visit their own family, relatives, and friends. Therefore, women’s social ties with their own family and friends were often weakened substantially after marriage whereas men’s social network remained stable (Watson, 1991). Third, many oldest old Chinese women have spent their whole lives staying at home and taking care of their husbands and children; their social network might be relatively smaller than that of older men who worked outside the home and had coworkers and friends. Recent research has shown that structural features of social network (i.e., size and frequency of contact) influence cognitive health in later life (Ho et al., 2001; Zunzunegui, Alvarado, Del Ser, & Otero, 2003). The “use it or lose it” hypothesis suggests that mental stimulation can protect against cognitive decline. Because all social interactions require mobilization of cognitive faculties, people with larger social networks have more opportunities to use their cognitive functions and thus are less likely to lose them (Bassuk et al., 1999). Holtzman and colleagues (2004) found that more frequent contact in larger social networks was associated with less cognitive decline 12 years later. In another study, Swedish researchers reported that an extensive social network protected against dementia (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000).

Leisure activities.—Oldest old Chinese women are also less likely than their male counterparts to participate in leisure activities such as reading, writing, and playing cards or mah-jong

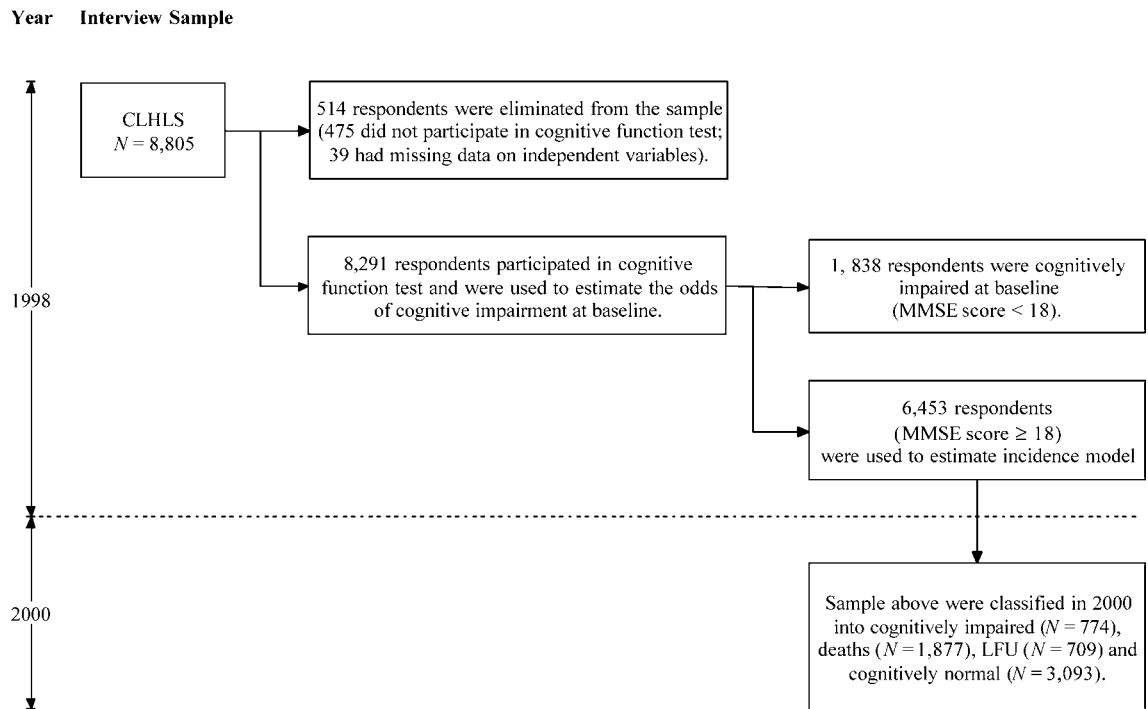


Figure 1. Diagram of sample design for analysis.

due partly to their lack of education (Zeng et al., 2003) and partly to the centuries-old idea that women should be at home serving their husbands and taking care of children rather than pursuing their own hobbies. Recent literature shows that different leisure activities—including social, physical, and intellectual activities—requires the use of different cognitive components such as memory, planning, and time and space orientation and thus could protect against cognitive decline in old age (Wang et al., 2002). Moreover, engaging in leisure activities entailing high cognitive effort (such as playing games or cards and reading books or newspapers) was more strongly associated with having cognitive ability than engaging in activities low in cognitive effort (such as gardening and performing household tasks; Singh-Manoux, Richards, & Marmot, 2003).

Differential survival rates.—The higher prevalence of cognitive impairment among oldest old Chinese women compared with men may be caused in part by differential mortality selection (Perls et al., 1993; Zhang et al., 1990). For example, Perl and colleagues found that while mortality rates for men and women with normal cognitive function were similar, demented women in two age groups (80–89 years old and 90–99 years old) were more likely than demented men to survive. Preliminary research in Shanghai also suggests that mortality rates for demented men may be slightly higher than for demented women. Nonetheless, the gender gap in the prevalence of cognitive impairment in China is so great that differential mortality is unlikely to be the major factor (Zhang et al., 1990).

Based on previous research, this article hypothesizes that among the Chinese oldest old (a) women are at higher risk than men for cognitive impairment, and (b) women's disadvantages

in SES, social network, and leisure activities largely account for their higher risk of cognitive impairment compared with men.

METHODS

Data

Using two waves (1998 and 2000) of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), I examined gender differentials in the risk of cognitive impairment among the Chinese oldest old. The CLHLS was conducted in a randomly selected one half of the counties and cities of China's 22 provinces. The survey area covered 85% of the Chinese population. The target respondents were aged 80 and older in 1998; they were interviewed again in 2000. In the baseline survey, 8,959 respondents aged 80 and older were interviewed; in the second wave, 4,744 surviving respondents (53%) completed the interview. The richness of information collected on cognitive functioning, SES, social network, and lifestyles makes the CLHLS particularly suitable for research on gender disparities in cognitive impairment among the Chinese oldest old.

The present study focuses on 8,805 respondents aged 80–105 years old in 1998 (see Figure 1). I excluded those who reported being aged 106 or older due to insufficient information to validate their old age (Zeng & Vaupel, 2002). The analytic sample for the odds of having cognitive impairment at baseline was restricted to 8,291 respondents, which reflects the elimination of 39 persons with missing data on key independent variables and 475 respondents who did not participate in the cognitive test due to hearing or vision impairments, sickness, refusal to participate, or other unspecified reasons. The analytic

sample for the onset of cognitive impairment from 1998 to 2000 was restricted to 6,453 respondents whose cognition was considered normal in 1998 based on their scores in the cognitive test. Of these respondents, 774 (12%) experienced the onset of cognitive impairment during the two-year interval, 1,877 (29%) died, and 709 (11%) were lost to follow-up or could not take the cognitive test due to various reasons.

Measures

Dependent variables.—I measured the cognitive functioning of the Chinese oldest old by using the Chinese version of Mini-Mental State Examination (MMSE), which tests four aspects of cognitive functioning: orientation, calculation, recall, and language (Folstein, Folstein, & McHugh, 1975). The Chinese version of the MMSE (see Appendix) was culturally translated from the international standard of the MMSE questionnaire and was carefully tested in pilot survey interviews. On the whole, most items could be translated without modification. However, some items were changed in order to adapt to the cultural and socioeconomic conditions of the Chinese oldest old so that all questions would be easily understandable and answerable if the respondent had normal cognitive functioning. For example, the Chinese MMSE asks respondents to name as many foods as possible instead of writing a sentence (which is an impossible task to ask of this group of the oldest old, the majority of whom are illiterate). In calculation, the question was simplified (Zeng & Vaupel, 2002). Consistent with previous studies, the number of “unable to answer” answers was much higher for the relatively difficult tasks compared with the relatively easy tasks. As has been recommended in the literature, I counted responses of “unable to answer” as incorrect answers (Herzog & Wallace, 1997). The range of scores for the MMSE is 0 to 30, with lower scores indicating poor cognitive ability. For the current sample, the reliability of the MMSE scale was high (Cronbach’s $\alpha = .94$), and the weighted mean score was about 25.

Because there are no established guidelines for determining cognitive impairment in the Chinese oldest old, I followed the criteria set by the international standard and by previous studies conducted in China. Respondents were defined as having “moderate-severe cognitive impairment” (hereafter “cognitive impairment”) if their score of MMSE was less than 18 (Gu & Qiu, 2003; Nguyen, Black, Ray, Espino, & Markides, 2003; Yu et al., 1989). The choice of using a very low cut-off point such as 18 reduced MMSE measurement error because those individuals who scored less than 18 had a very high probability of being cognitively impaired, regardless of education (Folstein et al., 1975; Zhang et al., 1990). Although significant improvements have been made on the cognitive screening instrument for illiterate and low education populations, it is unrealistic to expect the full elimination of the influence of education on screening tests (Teng et al., 1994). For example, respondents with no formal education were usually less familiar with the test procedures and more nervous during the testing than those who had some formal education (Zhang et al., 1998; Zhang et al., 1990). Given that the overwhelming majority of oldest old Chinese women are illiterate and that oldest old Chinese men have very limited education, it is appropriate to use a very low cut-off point to measure cognitive impairment.

The odds of having cognitive impairment were based on the individual’s MMSE score in 1998. Scores lower than 18 were coded as 1, indicating the presence of cognitive impairment; scores equal to or higher than 18 were coded as 0, indicating no cognitive impairment. The onset of cognitive impairment within the approximately 2-year interval (1998–2000) was based on whether MMSE scores for respondents whose cognition was considered normal at baseline fell below 18 at follow up. The dependent variable in the longitudinal model has four outcomes: cognitively impaired, death, loss to follow up, and cognitively normal (the reference category).

Independent variables.—In this study, gender (female = 1) was the focal independent variable. I examined three blocks of variables that might mediate gender differentials in cognitive impairment and measured each at baseline. The first block was SES. Two indicators were created to reflect a respondent’s overall SES: education and primary lifetime occupation. Because educational attainment of the Chinese oldest old is extremely low, years of schooling were grouped into two categories: 0 years (no formal education = 1) and one or more years. Primary lifetime occupation was measured as a dummy variable including non-agriculture and agriculture/housework (the reference category). Previous research in China has found that people working in the fields as well as those without paid jobs are at higher risk for cognitive impairment in late life than those working in a non-agriculture sector (Gu & Qiu, 2003). The second block was social network, which included marital status (single = 1), the number of children who frequently visited (0–5), and whether the respondent had frequent sibling visits. The third block was participation in leisure activities, including exercising, garden work/growing vegetables, reading newspapers or books, playing cards or mah-jong, watching TV or listening to the radio. All were measured as dummy variables.

The control variables included age, activity of daily living (ADL) disability, and place of residence (rural = 1). Advancing age is associated with cognitive impairment (e.g., Zeng et al., 2003; Zunzunegui et al., 2003). ADL disability has been linked with higher prevalence rates of cognitive impairment (Gu & Qiu, 2003; Yu et al., 1989) and higher incidence rates of cognitive decline (Black & Rush, 2002), although the specific mechanisms remain unclear. I indexed ADL disability by counting the number of ADLs that a respondent could not perform independently. (The six ADLs items were bathing, dressing, eating, indoor transferring, toileting, and continence.) The summated scale ranges from 0 to 6 (Cronbach’s $\alpha = .86$). In China, there are large disparities in standards of living between rural and urban areas. Compared with their urban counterparts, rural residents are disadvantaged in many aspects, including quality of education, access to good jobs, health care, and geographic mobility (Liang et al., 2000). Previous research on China has found that the urban oldest old have better cognitive functioning compared with rural residents (Zeng & Vaupel, 2002).

Analytic Strategy

I first examined the characteristics of the Chinese oldest old by gender (this article reports means for continuous variables and percentages for categorical variables). Then a series of nested logistic regression models were estimated to test the

Table 1. Characteristics of the Oldest Old in China, by Gender: 1998

Variable	Male (n = 3,418)	Female (n = 4,873)
Age (years)	83.3	83.8
Rural residence (%)	67.9	67.5
No. of ADL disabilities (0–6)	0.3	0.4
No formal education (%)	33.2	81.0
Nonagricultural occupations (%)	45.0	18.3
Single (%)	53.3	87.2
Frequent sibling visits (%)	31.7	26.6
Frequent children visits (0–5)	2.5	2.0
Leisure activities (%)		
Exercise	43.7	26.6
Garden work, grow vegetables	37.6	25.0
Reading newspaper or books	38.9	9.3
Playing cards and/or mah-jong	21.6	15.4
Watching TV and/or listening to radio	71.8	59.9
Cognition impairment (%)	4.4	9.7

Note: ADL = activity of daily living. For the table, $N = 8,291$. The means and percentages are weighted based on distribution of age, gender, and rural residence of the whole population of the oldest old in sampled provinces in 1998.

gender differentials in the odds of cognitive impairment among the Chinese oldest old. The first model estimated the total effect of gender, controlling for age, ADL disability, and place of residence. The second model incorporated socioeconomic factors achieved earlier in life, which are most exogenous to cognitive impairment in advanced age. Then social network and leisure activities were entered sequentially to assess the changes in the main effects of gender on cognitive impairment. Reductions in the main effects after the introduction of these variables would point to the importance of SES, social network, and leisure activities as mechanisms that contribute to gender differentials in cognitive impairment.

I used multinomial logistic regression to examine the onset of cognitive impairment. The total effect of gender was estimated first, controlling for age, ADL disability, and rural residence; then SES, social network, and leisure activities were entered sequentially to assess whether the main effects of gender on the incidence of cognitive impairment were reduced. Unless otherwise noted, this article presents results based on unweighted data. As the sampling weights in the data set are solely a function of the major independent variables used in the analysis (i.e., age, gender, and rural residence), the unweighted estimates are preferable because they are unbiased, consistent, and have smaller standard errors than weighted estimates (Winship & Radbill, 1994).

RESULTS

The descriptive profiles in Table 1 demonstrate substantial differences in the characteristics of oldest old men and women in China. As expected, oldest old women were older, less educated, and less likely to work in a non-agricultural sector than oldest old men. As high as 81% of oldest old women had received no formal education, compared with 33% of oldest old men. Only 18% of oldest old women had ever held a job in a non-agricultural sector compared with 45% of their male counterparts. Compared with oldest old men, oldest old women

Table 2. Estimated Odds Ratios from Logistic Regression Models of the Probability of Cognitive Impairment Among the Oldest Old in China: 1998

Variable	Model 1	Model 2	Model 3	Model 4
Demographics				
Female	2.20**	1.59**	1.43**	1.30**
Age	1.11**	1.10**	1.09**	1.08**
Rural residence	1.59**	1.37**	1.41**	1.16 [†]
No. of ADL disabilities (0–6)	1.57**	1.58**	1.58**	1.48**
Socioeconomic status				
No formal education		1.78**	1.74**	1.41**
Nonagricultural occupations		0.74**	0.74**	0.80*
Social networks				
Single			1.70**	1.61**
Frequent sibling visits (0–1)			0.83 [†]	0.87
Frequent children visits (0–5)			0.93**	0.93**
Leisure activities				
Exercise				0.63**
Garden work, grow vegetables				0.54**
Reading newspaper or books				0.73 [†]
Playing cards and/or mah-jong				0.38**
Watching TV and/or listening to radio				0.50**
-2 log likelihood	6,563.38	6,502.87	6,464.16	6,189.77

Note: For the table, $N = 8,291$.

* $p < .05$; ** $p < .01$; [†] $p < .1$.

were more likely to be single, less likely to have frequent visits by siblings, and had fewer children who visited frequently. In addition, oldest old women were less likely than oldest old men to participate in all five leisure activities. The prevalence of cognitive impairment for oldest old women was 2.2 times as high as that for oldest old men.

Table 2 shows the results of logistic regression models, which examined the roles that SES, social network, and leisure activities play in gender disparities in the odds of cognitive impairment at baseline, net of age, ADL disability, and rural residence. According to Model 1, the odds of having cognitive impairment were 2.2 for oldest old women in relation to oldest old men, controlling for age, rural residence, and ADL disability. As expected, adding SES in Model 2 significantly reduced the gender effect on cognitive impairment. Model 3 incorporated social network. The gender effect was reduced slightly but remained statistically significant. Model 4 incorporated leisure activities, and the gender effect was further reduced but remained statistically significant. The odds of being cognitively impaired were 1.3 for oldest old women in relation to their male counterparts, controlling for all the covariates.

Consistent with previous findings about correlates of cognitive impairment, results in Model 4 show that age and ADL disability were positively associated with cognitive impairment. Rural residents had slightly higher odds of cognitive impairments than their urban counterparts ($p < .1$). Respondents with no formal education were at higher risk for cognitive impairment than respondents with some education; respondents who had worked in a non-agricultural sector had less risk of cognitive impairment than those who had worked in the agricultural sector or had no paying job. Being single was associated with higher odds of cognitive impairment, whereas having children who frequently visited was associated with

Table 3. Multinomial Logistic Models of the Odds of Cognitive Decline, Death, and Loss to Follow-Up Among Cognitively Normal Oldest Old in China: 1998–2000

Variable	Cognitively Impaired vs Cognitively Normal				Dead vs Cognitively Normal	Missing vs Cognitively Normal
	Model 1	Model 2	Model 3	Model 4	Model 4	Model 4
Demographics						
Female	1.66**	1.36**	1.28*	1.21 [†]	0.57**	1.11
Age	1.09**	1.09**	1.09**	1.08**	1.09**	1.01
Rural residence	1.33**	1.19 [†]	1.22*	1.15	1.08	0.58**
No. of ADL disabilities (0–6)	1.24**	1.24**	1.24**	1.19**	1.34**	1.24**
Socioeconomic status						
No formal education		1.35**	1.34**	1.24 [†]	1.08	0.87
Nonagricultural occupations		0.81 [†]	0.82 [†]	0.84	0.98	1.11
Social networks						
Single			1.14	1.10	1.39**	1.14
Frequent sibling visits (0–1)			0.84	0.86	0.87	0.75*
Frequent children visits (0–5)			0.95*	0.95*	0.94**	0.94*
Leisure activities						
Exercise				0.86	0.65**	0.99
Garden work, grow vegetables				0.67**	0.66**	0.75**
Reading newspaper or books				0.98	0.90	1.47**
Playing cards and/or mah-jong				0.67**	0.85 [†]	0.82 [†]
Watching TV and/or listening to radio				0.84 [†]	0.86*	1.18
–2 log likelihood	14,481.02	14,437.11	14,387.04	14,251.00	14,251.00	14,251.00

Note: For the table, $N = 6,453$.

* $p < .05$; ** $p < .01$; [†] $p < .1$.

lower odds. The effect of sibling visits was in the expected direction but was not statistically significant. Consistent with previous research, each leisure activity was associated with having lower odds of cognitive impairment.

Next, I estimated multinomial logistic regression models to examine (a) whether there were gender differences in the onset of cognitive impairment among the oldest old whose cognition was normal at baseline, and (b) what factors contributed to gender differences in the risk of cognitive impairment. Table 3 summarizes the results from the series of nested models. Model 1 shows that gender had a significant effect on the risk of cognitive impairment, controlling for age, ADL disability, and rural residence. Oldest old women were 66% more likely than oldest old men to experience the onset of cognitive impairment. Age, ADL disability, and rural residence significantly increased the risk of cognitive impairment. Adding SES to Model 1 substantially reduced the gender effect, although it remained strong and statistically significant. Model 2 suggests that the gender effect was partially mediated by gender differences in education and primary lifetime occupation, both of which are risk factors of cognitive impairment. Model 3 incorporated the social network variables. The gender effect was further reduced but remained statistically significant. Model 3 shows that having children who frequently visit significantly reduced the risk of cognitive impairment. However, sibling visits and marital status did not have the same protective effects against cognitive impairment. In Model 4, the gender effect was reduced slightly and became statistically nonsignificant after the introduction of the five leisure activities. Consistent with previous studies in China and other countries, the present study found that people who did garden work or grew vegetables, played cards or mah-jong, or watched TV or listened to the radio ($p < .1$) were less likely than those who did not par-

ticipate in these activities to experience the onset of cognitive impairment.

The sixth column of Table 3 shows the risk of death relative to being cognitively normal from 1998 to 2000. Strong gender differences in mortality existed among those who were cognitively normal at baseline: Oldest old women were significantly less likely (odds ratio = 0.57) than their male counterparts to die, controlling for all the covariates. Age and ADL disability significantly increased the risk of death. On the other hand, being married, having children who frequently visit, exercising, gardening, and watching TV or listening to the radio significantly reduced the risk of death.

The last column of Table 3 shows the risk of loss to follow up relative to being cognitively normal. Those who lived in rural areas, did garden work or grew vegetables, or had siblings or children who frequently visited were less likely than those who did not participate in these activities to drop out of the study. Those who had ADL disability or could read newspapers or books were more likely to drop out. These findings are consistent with previous studies in China and Japan that showed that people with higher SES were more likely than people with lower SES to drop out of research studies, partly due to greater mobility among those with higher SES (Gu, 2005).

Finally, I performed an indirect test to examine whether the gender differential in the prevalence of cognitive impairment was partly due to the differential mortality selection among men and women with cognitive impairment. Table 4 shows the results of the logistic regression model that regresses the log odds of death between 1998 and 2000 on age, rural residence, cognitive impairment at baseline, being female, and the interaction terms of female and cognitive impairment at baseline. Consistent with previous findings, oldest old women with cognitive impairment were significantly less likely than their male counterparts to die. The odds of death were 59% ($0.75 \times$

0.79 = 0.59) as high for oldest old women with cognitive impairment as for their male counterparts, net of age and rural residence.

Using models not shown here, I tested whether the effects of SES, social network, and leisure activities on the risk of cognitive impairment differed for women and men at baseline and during follow-up. Results suggested few statistically significant gender interaction effects, with one exception. Having an occupation in a non-agricultural sector lowered women's odds of having cognitive impairment at baseline more than they did men's.

DISCUSSION

Gender may be an important risk factor of cognitive impairment in developing countries such as China, where older women have been oppressed in a patriarchal and patrilineal society from early childhood to adulthood. Previous research in large Chinese cities such as Shanghai and Beijing report substantial gender inequalities in the prevalence of cognitive impairment.

This article added to this research by examining the gender effect in the likelihood of cognitive impairment in the oldest old. It is the first article that uses nationwide longitudinal data to study gender differentials in cognitive impairment in a developing country as well as specific mechanisms leading to those differentials. Results showed that gender has a significant effect on the risk of cognitive impairment in the Chinese oldest old, controlling for age, ADL disability, and rural residence. Adding SES substantially reduces the gender differentials in the risk of cognitive impairment, suggesting that the low SES status of Chinese oldest old women contributes to their poor cognitive functioning in old age. As for the explanatory powers of the three blocks of variables (SES, social network, and leisure activities), SES appears to be the most powerful, accounting for 42% of the gender differentials. Social network and participation in leisure activities together explain about 24% of the gender differentials, net of SES. However, the remaining 34% of the gender differentials cannot be explained in the full model. Previous research as well as the indirect test of differential survival rates of oldest old men and women with cognitive impairment suggest that the survival advantages of oldest old women with cognitive impairment compared with their male counterparts might play a role in the remaining gender gap in the prevalence of cognitive impairment.

The results from the multinomial logistic regression models show that SES is also the most powerful mediating variable. The SES block explains about 39% of the gender effect in the onset of cognitive impairment. Social network and participation in leisure activities also play important roles. Together they explain about 24% of the gender effect, net of SES.

A caveat in interpreting these results is that the life experiences of the current cohort of Chinese oldest old are vastly different from those of future cohorts of older adults. The cohorts in this study experienced much political and social unrest in 20th century China: the Revolution of 1911 that overthrew the Qing Dynasty, the 10-year civil war between the Communist Party and Kuomintang, the 8-year war against the Japanese invasion in the mid-1930s, the subsequent civil war that led to the founding of the People's Republic of China in

Table 4. Estimated Odds Ratios from Logistic Regression Models of the Likelihood of Death Among Oldest Old in China: 1998–2000

Variable	Model 1	Model 2
Age	1.09**	1.09**
Rural residence	1.22**	1.23**
Cognitive impairment in 1998	2.23**	2.63**
Female	0.71**	0.75**
Female × Cognitive impairment in 1998		0.79*
–2 log likelihood	9,727.48	9,723.53

Note: For the table, $N = 8,326$.

* $p < .05$; ** $p < .01$.

1949, the terrible famine in 1959–1960, and the 10-year Cultural Revolution (1966–1976) that led to nationwide turmoil and political persecution. In other words, the current cohort of the oldest old are lucky survivors of wars, famines, and political persecution. The exceptionally good health of the Chinese oldest old, men in particular, may also reflect this selection effect. Because each new cohort is exposed to distinct experiences that may affect their cognitive functioning in their twilight years, monitoring the gendered health pattern of the future cohorts of older people is crucial in helping researchers understand the roles that aging, cohorts, and time periods play in cognitive impairment (Alwin, McCammon, Rodgers, & Wray, 2004).

The present study has several strengths, including the use of longitudinal data, the use of a large nationwide sample of the oldest old, and the exploration of mediating roles of SES, social network, and leisure activities in the gender differentials in cognitive impairment. However, researchers should consider several limitations when interpreting the results. First, a brief epidemiological screening instrument for dementia rather than a comprehensive clinical evaluation was used to detect moderate-severe cognitive impairment. Obviously, clinical evaluations are more accurate; however, due to budget limitations, the CLHLS did not conduct clinical tests. Nevertheless, the effects of the major independent variables on cognitive impairment in the study are consistent with previous studies that used clinical tests to detect cognitive impairment. Second, although the CLHLS included self-reports of major diseases—some of which are risk factors for cognitive impairment—this information was not included in the present analysis because the data were inaccurate. Most Chinese oldest old, particularly those in rural areas, do not have medical records and access to clinical diagnosis due to poor medical facilities.

In spite of these limitations, this article extends researchers' understanding of the excess gender differentials of cognitive impairment among Chinese oldest old. Although oldest old women have significantly lower mortality rates than oldest old men, they are at much higher risk for cognitive impairment due to their lifetime disadvantages in SES, social network, and leisure activities. Chinese oldest old women are a vulnerable group that needs much help. These findings also suggest that women in other developing countries may face the same problems as Chinese women as life expectancy continues to improve. This is because women in most developing countries are less educated, have fewer opportunities to develop their cognitive skills over their life course, and hold a lower social and economic status than men.

In less than 50 years, China's oldest old population is projected to reach 100 million. Most of the future cohorts of older people will have only 1 or 2 children due to the one-child policy. It will be increasingly difficult for elderly parents to rely totally on adult children to take care of them. The increasing rate of cognitive impairment among women and other economically disadvantaged groups poses significant problems not only for the individuals and families but for Chinese society as a whole. Future research should focus on whether modifications of some predictors of cognitive decline in later life—such as life-long learning, volunteer work, participation in social and leisure activities either at home or in community centers for elders, and strengthening intergenerational ties—could delay the onset of cognitive impairment. Ultimately, this article suggests that investment in girls' education will have long-term payoffs, even to the oldest old age, and closing gender disparities in formal education will significantly reduce the gender gap in cognitive impairment in old age.

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APPENDIX

The Chinese Version of the Mini-Mental State Exam (MMSE)

Item	MMSE	Score (Total = 30)
1. Orientation	What time of day is it right now (morning, afternoon, evening)?	1
	What is the animal year of this year?	1
	What is the date (day and month) of the mid-autumn festival?	1
	What is the season right now?	1
	What is the name of this county or district?	1
2. Naming foods	Please name as many kinds of food as possible in 1 minute (1 point for each food and 7 points for those who name 7 or more foods)	7
2. Registration	Table, apple, cloth. Please repeat these three objects.	3
3. Attention and calculation	I will ask you to spend \$3 from \$20, then you must spend \$3 from the number you arrived at and continue to spend \$3 until you are asked to stop.	5
4. Copy a figure	The individual is asked to draw a figure of overlapping pentagons.	1
5. Recall	Name the three objects learned earlier (table, apple, and cloth).	3
6. Language	Naming pen and watch	2
	Repeating the following sentence: "What you plant, what you will get."	1
	The individual is asked to follow the interviewer's instruction: "Take the paper using your right hand, fold it in the middle using both hands, and place the paper on the floor."	3