ASSOCIATION OF RELIGIOUS PARTICIPATION WITH HEALTH AND SURVIVAL AMONG THE OLDEST OLD IN CHINA[1]

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INTRODUCTION

The present study is unique in several ways, compared with previous studies in this field. It tries to fill the information gap about the association of religious participation with health and survival among the oldest old in China, the largest developing country. It is the first study, in general and in particular in developing countries, on this topic based on nationwide longitudinal surveys with a large sample size of nearly 20,000 observations of the oldest old aged 80-105 including about 4,500 observations of centenarians. It also represents the first large-scale study of the possible health and survival benefits of participating in Eastern religions.

Numerous studies have shown that elderly who are religious are more likely to enjoy better health and longer life (e.g., Koenig et al. 1999; McCullough et al. 2000). However, the majority of studies are focused on Christians in Western societies; a few studies have been conducted in Japan. According to the recent official estimate, there are 100 million people involved in religious activities of one form or another in contemporary China (He 1999), and the majority of them are seniors (Li 1997). Given that China has the largest elderly population in the world and has a variety of religions, it is important to explore the effect of religious participation on health and longevity among Chinese elders.

Buddhism, Daoism, Islam, Catholicism, and Protestantism are five widely recognized institutional religions in contemporary China (Fan 2003)[2]. Although the number of churches of Western religions and

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regular religious services organized by such churches are increasing, Buddhism and Daoism are the dominant religions among Han Chinese people[3], especially among Han elderly. There are two basic differences between Chinese[4] and Western religions. First, as a religious philosophical system, Western religions teach that God created and rules the world and for most denominations, determines whether a person's afterlife will be pleasant or painful. Buddhism's teachings vary, but include the beliefs that the world has always existed or is only perceived to exist, and that the world and everything in it is the Buddha. The Buddha is understood as the human Siddhartha (whose teachings point the way to the correct understanding of the world). By following the teachings of the Buddha, one improves both one's current life and next life. The Dao is generally understood as the natural order. When one attunes one's life to the natural order, one's life will necessarily improve and extend. Confucianism focuses on harmonizing societal relationships, which begins by correcting oneself. While Heaven (Tian) is acknowledged as the creator and ruler of the world and the judge of human actions, Confucianism focuses on human interactions rather than on super-human issues because the harmonization of human relations is the pre-requisite for understanding super-human issues. Some scholars think that Confucianism is a religion, but many others believe that Confucianism is an important philosophy, but not a religion. It is common for Chinese people to follow Confucianism and borrow Buddhism's and/or Daoism's views.

Second, Western religion has a highly organized church-based network that is independent of other social networks. Millions of believers of the Western religions have a fairly regularized life, featured mainly by attending weekly religious services and other activities. Such a highly organized and widely spread network with regular religious activities does not exist in Chinese societies (Melton 2001; Weller and Shahar 1996; Thompson 1996; Yang and Ebaugh 2001).

Chinese religious practitioners may be classified into three groups. The smallest group consists of Buddhist and Daoist monks and nuns, who live in temples and devote their lives to religion. The second group is called "Ju Shi", who live at home but strictly follow the rules and regulations of and regularly

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participate in the activities of one religion. The third (and largest) group consists of people who believe in Buddhism, or Daoism, or another religion and participate regularly or occasionally in religious activities. These people belong to one religion or may simultaneously be associated with more than one religion. They may move freely among different religious groups (Cong, 2002). The Chinese religious activities of the second and the third groups occur either in temples or at people's homes. The Chinese religious network is substantially weaker and the activities are much less organized as compared with those in the Western countries (Melton 2001; Shahar and Weller 1996; Thompson 1996; Yang and Ebaugh 2001). This is the reason we do not use the term "religious attendance" in this paper even though it is widely employed in the literature dealing with Western religions; instead, we use the term "religious participation" to reflect the substantial difference between the Chinese and the Western religions.

Many studies conducted in Western countries have demonstrated that participation in religious activities positively influences health status and survival among elderly people (Berkman and Breslow 1983; Berkman and Syme 1979; Broadhead et al. 1983; Hays et al. 1996; Kaplan et al. 1987; Kaplan et al. 1994; Koenig et al. 1999; LaCroix et al. 1993; Strawbridge et al. 1997; Vogt et al. 1992). For example, a six-year follow-up study of 3,968 adults aged 65 and older in the Piedmont of North Carolina found that, at baseline, frequent religious attendants were physically healthier, had more social support, and lived healthier lifestyles than less frequent attendants. Adjusted for age, gender, education, ethnicity, health conditions, social connections, and health practices, older adults, particularly women, who attend religious activities at least once a week had a significant survival advantage over those who attend religious activities less frequently (Koenig et al. 1999). Strawbridge and colleagues (1997) reported the results of a 28-year follow-up study of 5,286 persons aged 21 to 65 in Alameda County, California. They found that persons who attend religious services at least once a week had a significantly lower risk of dying after controlling for demographic variables, social connections and health practices. The association, however, was reduced to insignificance for men, but remained significant for women when health conditions were controlled. Using recently released nationally representative data from the National

Health Interview Survey, Hummer et al. (1999) found that people who never attend religious services exhibit 1.87 times the risk of death in the follow-up period compared with people who attend once a week or more. Although the magnitude of the negative association between religious participation and mortality varies by cause of death, the direction of the association is consistent across causes. They show that religious activities also work in part through increased social ties and behavioral factors to decrease the risk of death. Based on a national sample of 2,153 older people in a cross-sectional survey conducted in 1996 in Japan, Krause, Ingersoll-Dayton and Liang (1999) concluded that religious activities are positively related to health, and that helping others may explain at least part of this relationship. Using a recent survey with 1,200 elders, Krasue (2003) finds that religion enhances the subjective well-being.

A majority of previous studies in Western countries and Japan showed that older women were more likely than older men to be involved in religious activities (e.g., Strawbridge et al. 1997; Koenig et al. 1999; Krause et al. 1999). The effects of religious participation on health and survival also were stronger among female elderly than among males (House, Robbins, and Metzner 1982; Koenig et al. 1999; McCullough et al. 2000; Strawbridge et al. 1997). The much higher proportion of widowhood among old women might result in their use of religious activities to fill an otherwise unmet social need for interchange and support (Strawbridge et al. 1997). A previous study demonstrated that elderly women were more likely to pray and say that religion is an important aspect of their lives and depend on religion to cope with stress (Princeton Religious Research Center 1996).

Is religious participation associated with better health and a lower risk of mortality among the elderly in China, an East Asian and developing country? After carefully searching the literatures in both English and Chinese languages, we have not yet found published studies dealing with the association of religious participation with health and survival in the Chinese population using longitudinal data with large sample sizes. Some qualitative and quantitative studies (not focusing on elders) with very small sample sizes in specific communities have examined the relationships between religious participation and health in China. For example, based on their anthropological observations, Xi and Zhou (1996) believe

that the practices of Hinayana Buddhism among the Chinese Thai ethnic minority people in the South-West border areas of China may be beneficial to health. Wang and Wang (1998) argue that, although their living conditions might be poorer than the average, Buddhist monks and nuns were more likely to live longer than ordinary people because of their healthy diet and effective use of traditional Chinese medicine. Their more peaceful thinking and weaker desire for high status, money and sex may also contribute to health and longevity (Wang and Wang 1998). Based on a cross-sectional sample of 890 individual questionnaire interviews in Wu Zhong city in Nixia autonomous region, Huang and Chao (1995) observed that the Chinese urban Hui Moslem folk customs and religious participation played positive roles in health-preservation and body-building. Some other studies also documented that some Chinese elderly become involved in some sorts of religious practice when they have diseases that modern medicine is unable to cure, and they did get support and confidence from religious practice (Holroyd 2002). Religious practice gives them a sense of psychological comfort (Lui and Mackenzie 1999).

Based on previous studies reviewed earlier, we intend to test the following hypotheses in this study, while controlling for demographic, socioeconomic, social ties and health practice factors:

H_1: Chinese oldest old people who are religious participants have better health than non-participants;

H_2: Chinese oldest old people who are religious participants have advantages in survival and longevity, compared to non-participants;

H_3: Oldest old women in China are more likely than men to be involved in religious activities and the effects of religious participation on health and survival are stronger among oldest old females than among oldest old males.

We will present the unique data set, methods, measurements, findings and discussions subsequently.

DATA RESOURCE

The baseline and the follow-up interviews of the Chinese Longitudinal Healthy Longevity Surveys (CLHLS), the largest longitudinal study of oldest old people ever conducted in the world, were carried out in 1998, 2000, and 2002 in a randomly selected half of the counties and cities of the 22 provinces[5]. The survey areas covered 985 million persons, 85 percent of the total population in China. An interview and a basic health examination were conducted at the interviewee's home by an enumerator and a nurse or a medical school student. Extensive questionnaire data on demographic variables, socioeconomic characteristics, health status and lifestyle including religious participation, etc., were collected. The data collected include family structure, living arrangements and proximity to children, Activities of Daily Living (ADL), physical performance, self-rated health, life satisfaction, cognitive function, chronic disease, medical care, social and religious participation, diet, smoking and alcohol consumption, psychological characteristics, economic resources, and caregivers and family support.

To avoid the problems of too small sub-sample sizes at more advanced ages, we did not use a proportional sampling design; instead, we interviewed all centenarians and over-sampled those oldest old who are of more advanced ages, especially males. Consequently, appropriate weights are used to compute the averages of the age groups below age 100, but no weights are needed when computing the average of the centenarians. The method for computing the age-sex and rural-urban specific weights and the associated discussions are presented in Zeng and Vaupel et al. (2001: Appendix A).

The survey interviewed 8,959 voluntary participants aged 80+ in the baseline wave in 1998. Among them, 2,418, 3,013, 3,528 were centenarians, nonagenarians, and octogenarians, respectively. In the second wave in 2000, out of the 8,959 baseline interviewees, 4,474 (53.0%) survived to the time of the 2000 interview, 3,355 (37.4%) had died before the time of 2000 interview, and 860 (9.6%) were lost to follow-up. In the 2000 wave, the total sample reached 11,161 including new respondents who were added into the sample to replace those who had died or were lost to follow-up. Among the 11,161 interviewees in the 2000 wave, the number of centenarians, nonagenarian, and octogenarians were

2,431, 3,812, and 4,918 respectively. Out of the 11,161 respondents interviewed in the 2000 wave, 5,911 (53.0%) survived at the 2002 survey, 3,401 (30.5%) had died before the 2002 interview, and 1,849 were lost to follow-up (16.7%).

To produce more robust results, as was done in some previous studies (e.g., Crimmins et al. 1994), we have pooled the 1998 and 2000 waves' data in our cross-sectional logistic regression analysis; we have pooled the follow-up survival/death data collected in all three waves of 1998, 2000, and 2002 in our Cox hazard model survival analysis. This implies that the interviewees who were interviewed in 1998 and survived to participate in the 2000 survey contribute "two observations" in both of our cross-sectional logistic regression and Cox hazard model survival analyses. To correct the intra-subject correlation due to some subjects' contributing two observations to the pooled data set, an appropriate procedure is employed in our statistical modeling estimates (Cleves Gould, and Gutierrez 2002; Liang and Zeger 1986; Neuhaus 1992). Similar to our previous studies (Zeng et al. 2002; Zeng and Vaupel 2004; Zeng, Gu, and Land, 2004), persons who reported age 106 or higher at initial interview for the first time (either in 1998 or 2000) are excluded from this study due to insufficient information for us to validate their reported extremely high age. The total numbers of observations included in our cross-sectional logistic regression and Cox hazard model survival analysis are 19,778 (8,447 aged 80-89, 6,825 aged 90-99, and 4,506 aged 100-105) and 17,307 (7298 aged 80-89, 5968 aged 90-99, and 4041 aged 100-105.), respectively.

Age reporting is crucial in studies of older people, especially the oldest old. Older persons rather often misreport their ages in many developing countries and in some sub-populations in Western countries, such as African Americans in the U.S. (Coale and Kisker 1986; Elo and Preston 1992; Mosley and Gray 1993). Coale and Li (1991) concluded that the age reporting of oldest old persons in most of China's provinces where Han Chinese, who know precisely their birth dates and who constitute the majority, was as reliable as that in developed countries. But in some regions (such as Xingjiang) where the majority or a significant proportion of the population belongs to ethnic groups other than Han,

age reporting may be inaccurate. This is the main reason why the survey was restricted to the 22 provinces where Han Chinese people are the overwhelming majority[6]. A recent study focusing on the age validation of Chinese Han centenarians through rigorous comparison of the demographic indices of the age reporting with Sweden, Japan, France and Italy is consistent with Coale and Li's findings (Wang et al. 1998). The age distributions of centenarians interviewed in our 1998 survey and Swedish centenarians are quite similar (see Figure 1 in Zeng et al. 2001), and lead us to believe that age reporting in our 1998 survey is generally good. A careful data quality evaluation (e.g., reliability coefficients, factor analysis, rates of logically inconsistent answers) has shown that the Chinese Longitudinal Healthy Longevity Survey is of generally good quality (see Zeng et al. 2001, for more detailed information).

MEASUREMENTS AND METHODS

Religious Participation

A straightforward and rather simple question on religious activities was asked of the interviewees (or a close family member if the interviewee was not able to answer): "At the present time, do you participate in religious activities?" Interviewees (or proxy) could choose one of three answers: almost everyday; sometimes; do not participate. People who believe in Buddhism or Daoism or other Chinese religions constitute a large majority of the religious population in China. They go to Chinese temples either occasionally or regularly to participate in religious activities. Many of them perform religious activities at home. Some of them may perform home-based religious activities almost everyday, and some of them do it occasionally. The proportions of respondents who reported that they participated in religious activities almost every day, sometimes, and did not participate were 3.9%, 12.1%, and 84%, respectively. The large majority of the Chinese oldest old did not participate in religious activities. The frequent (almost everyday) participants constitute a too small portion of the sample to be coded as a separate

category. Responses were, therefore, dichotomized into "do not participate (code=0)" and "participate almost everyday or sometimes (code=1)".

Covariates

The frequency distributions of covariates included in our statistical models are listed in Table 1. These covariates were chosen because of their potential relationships (either direct or indirect) with religious participation and/or health/survival based on previous studies (See a review by McCullough et al. 2000), and because they are available in our data set. We follow as closely as possible the method of handling the variables and analyzing the data employed in Koenig et al. (1999) and Strawbridge et al. (1997) so that results can be compared. For that reason, all covariates except age were dichotomized.

--Table 1 is about here—

Demographic Variables

Demographic variables include age (80-89, 90-99, 100-105), gender, residence (rural vs. urban), ethnicity (Han vs. minorities), education (0 year of schooling vs. ≥1 year schooling)[7] and economic independence (independence vs. dependence)[8].

Social/Family Support and connections

The following variables are used to approximately measure family/social support and connections. Marital status was measured as currently married and not-currently married[9]. Proximity to children: participants who lived with their children or had at least one child close-by (in the same village or on the same street) were compared with those who had neither children living with them nor children living close-by. Living alone was compared with not living alone. Those elders who could get adequate medication at present when the elders were sick were compared with those who could not get adequate medication. Playing cards and/or mah-jong regularly at the present time was compared with not playing.

Elders whose spouse and/or other family members took care of them when they were sick were compared with those elders with non-family members as care giver.

Health Practices

Cigarette smoking was assessed by the following question: "Do you smoke regularly at the present time?" Response options were "no" and "yes".

Alcohol consumption was determined by the following three questions: (1) "Do you drink alcohol at the present time?" (2) "If you drink alcohol at the present time, how much per day on average do you drink?" The measurement unit employed was "liang", which is approximately equal to 50 grams and is a widely used unit to measure alcohol consumption in people's daily conversations in China. (3) "If you drink at the present time, what kind of alcohol do you mainly drink?" The answer options were liquor, wine or rice wine. We code subjects as "heavy alcohol drinker" if they drink more than two liang (100 grams) of liquor per day or drink more than six liang (300 grams) of wine per day or drink 8 liang (400 grams) of rice wine per day; otherwise, the subject is coded as "not heavy alcohol drinker."[10]

Exercise was assessed based on the following question: "Do you exercise regularly at the present time?" Response options were "yes" and "no".

Physical and Mental Health Variables

Physical and mental health variables include Activities of Daily Living (ADL), cognitive, and depression symptoms[11].

The ADL tasks of eating, dressing, transferring, using the toilet, bathing, and continence are used to measure the elders' level of independence in daily living[12]. In this paper, if none of the six ADL activities is impaired, the elder is classified as "No impaired ADL function"; if one or more activities are impaired, the elder is classified as "Impaired ADL function".

Mental status was screened by the Chinese version of the Mini-Mental State Examination, which was translated and adopted into the Chinese language based on the international standard of the MMSE questionnaire (Folstein, Folstein, and McHugh 1975), and was carefully tested in our pilot survey interviews. The Chinese version of the MMSE tries to meet the cultural and socioeconomic conditions among the oldest old persons in China, to make the questions easily understandable, and practically relevant if the subject's cognitive function is normal (see Zeng and Vaupel 2002, for details). The total score of the MMSE is 30; the methods of determining the score for each item of the orientation, registration, attention, calculation, recall, and language are the same as the international standard. We also use the cutoffs for the MMSE international standard, defining a score of 24 or above as "No cognitive function impaired", and <24 as "Impaired cognitive function" (see, e.g., Deb and Braganza 1999; Osterweil et al. 1994).

The two questions "How do you rate your health at present?" and "How do you rate your life at present?" were asked of each interviewee with the possible answers: excellent, good, fair, poor or not able to answer (no proxy answers were allowed). Responses were dichotomized into good/fair versus poor/very poor (including not able to answer) in these two subjective health and well-being variables.

The data collected in the Chinese survey consist of answers to three questions about "looking at the bright side of things", "not feeling lonely", and "feel as happy now as when I was young". These items represent a brief assessment of depression symptoms that is culturally relevant to the sample[13]. If an elder answered "no" to all of these three questions, he or she was classified as "depressed". Otherwise, he or she was classified as "not depressed".

Missing values were imputed using a multiple imputation approach if the proportion of missing value of a variable was more than 2% (Allison 2002). If the proportion of missing value of a variable was less than 2%, we imputed missing values with the mean of corresponding variables (Landerman, Land and Pieper 1997).

Statistical Models

We address how religious participation is related to health status through multivariate logistic regression analysis after correcting intra-subject correlations due to some subjects contributing two observations. The dependent variables are ADL, MMSE, self-rated health, self-rated life satisfaction, and depression symptoms. The independent variables are religious participation plus other covariates measuring demographic characteristics, social connections, family support, health practices, as described earlier.

The association between religious participation and survival among the Chinese oldest old is examined using a Cox proportional hazards regression model (Cox 1972). Survival time was entered as days. The validity of the proportional hazards assumption was examined and confirmed both graphically and with the statistical test of the proportionality (Cleves Gould, and Gutierrez 2002; Grambsch and Therneau 1994)[14]. Demographic characteristics, social connections, family support, health practices, and health status are included in the Cox proportional hazards regression model as covariates. Results based on sequential model will be presented to show how the effects of religious participation on survival were moderated by different confounders[15]. All models were run using STATA 8.0 (STATA Corporation 2003).

RESULTS

Frequency distributions of the covariates and their associations with religious participation

Table 1 presents the frequency distributions of the covariates; it also shows the associations between religious participation and the covariates among the Chinese oldest old, adjusted for age, gender, rural/urban residence, education, economic independence, and ethnicity (last column in Table 1). The higher the age, the lower the level of likelihood of religious participation. A striking finding is that, being equal in age, rural/urban residence, education, economic status, and ethnicity, the frequency of participation in religious activities among Chinese oldest old women is 3.36 times as high as that among Chinese oldest old men. Religious participants were more likely to be urban residents, better educated, and Han. Adjusting for the basic demographic and socioeconomic factors, those who reported poor or

very poor health were less likely to be involved in religious activities. The religious participants were more likely to be unmarried, to live alone, but to have stronger family/social connections and support. The results also show that all other things being equal, the non-smoking oldest old in China were 27 percent more likely to participate in religious activities, and the Chinese oldest old who were not heavy alcohol drinkers were 29 percent more likely to be involved in religious activities. This is consistent with findings for the American elderly (Koenig et al. 1999). Koenig et al. (1999) also found that American frequent religious participants were less likely to smoke cigarettes and/or consume alcohol.

Associations between Religious Participation and Health based on Cross-Sectional Data

Table 2 shows the associations between religious participation and selected health variables, adjusted for demographic characteristics, family/social support and connection, and health practices (as listed in Table1), using pooled cross-sectional data collected in the 1998 and 2000 waves of the CLHLS survey. The associations are estimated using multivariate logistic regression for the total sample and for males and females separately, corrected for the possible biases caused by intra-subject correlation due to some subjects' contributing two observations to the pooled data set. We shall present the estimates of the association of religious participation with health status here, while the detailed estimates for each of the other covariates included in the multivariate logistic regression models, which are not the focus of this article, are listed in Table A-1 of the Appendix.

Controlling for demographic characteristics, social connections, family support and health practices, the Chinese oldest old who participated in religious activities had a 46, 35, 36, 48, and 57 percent lower risk of being ADL impaired, MMSE impaired, self reporting poor health, self reporting poor life satisfaction, and having depression symptoms, respectively. All of the estimates are statistically significant at a level of $p<0.001$, except one case of $p<0.10$. These interesting results suggest a strong association of religious participation with health among Chinese oldest old.

It is clear that, adjusted for various confounding factors, the oldest old Chinese religious participants were healthier than the non-participants. Therefore, Hypothesis H_1 is verified.

--Table 2 is about here—

Associations of Religious Participation with Survival based on Longitudinal Data

Table 3 and Table 4 present the main results of the association of religious participation with survival for both sexes combined, males and females separately, from the multivariate Cox hazards regression sequential models using the CLHLS longitudinal data. Again, the detailed estimates for each of the covariates other than religious participation included in the multivariate Cox hazards regression models, which are not the focus of this article, are listed in Table A-2 and Table A-3 of the Appendix.

When age, gender, rural/urban residence, education and ethnicity were included as covariates in the model, the relative mortality risk of religious participants was 20 percent lower than that of the non-participants -- a highly significant difference (RH 0.80, 95% CI 0.75-0.86, Model I; see Table 3). Adding family/social support and connections to the model slightly further reduced the magnitude of the relationship between religious participation and survival; but the relationship remained significant (RH 0.82, 95% CI 0.76-0.88, Model II; see Table 3). Further inclusion of health practices (smoking, heavy alcohol drinking, and exercise) did not significantly affect the estimates of relative risk of mortality between participants and non-participants (RH 0.83, 95%CI 0.77-0.89; Model III, see Table 3). After health conditions were controlled, the relative risk of death among religious participants was 6 percent lower than that of the non-participants, with marginally significant (RH 0.94, 95% CI 0.87-1.01, Model IV, see Table 3). The results presented in Table 3 suggest that our Hypothesis H_2 is not fully, but marginally verified.

-- Table 3 is about here—

Gender Differences

Table 1 indicates that the oldest old females are 3.4 times more likely to participate in religious activities, as compared to their male counterparts. Table 2 reveals that the association of religion with health status among female oldest old is mostly stronger than that among the male oldest old. The estimates presented in Table 3 indicate that the association between religious participation and survival is significantly greater in Chinese oldest old females than males. Controlling for covariates of demographic characteristics, family/social support and connection, Chinese oldest old women who were religious participants were about 20 percent less likely to die during the 2.2 year follow-up period than female non-participants. For the Chinese male oldest old, the direction of this effect remained the same, but was weaker with about a 12-14% lower chance to die. After controlling for the health practices, Chinese female oldest old religious participants still had a significantly lower risk of dying than the female non-participants; the male counterparts also had a lower mortality risk, but the estimates were not statistically significant. When health conditions were added to the model, the beneficial effect of religious participation on survival for females turns out to be marginally significant at a statistical level of $p<0.10$ (the relative risk of death of religious participants is 8% lower than that of the non-participants); but no beneficial effect for male oldest old religious participants was observed.

Clearly, our Hypothesis H_3 concerning the gender differentials of religious participation and its association with health status and mortality among Chinese oldest old is verified.

DISCUSSION

Based on a unique longitudinal data set collected in 1998, 2000, and 2002 from nearly 20,000 observations of the oldest old aged 80-105 in China, we investigated the associations of religious participation with health status and survival at advanced ages in China. Adjusting for basic demographic factors, we found that oldest old females are 3.4 times more likely to participate in religious activities, as compared to their male counterparts; we also found that the higher the age, the lower the level of religious

participation. Religious participants were more likely to be urban residents, better educated, Han, unmarried, living alone, and to have better social connections and support. Compared with non-participants, the health conditions of religious practitioners in terms of ADL functioning, cognitive functioning, self-reported health, self-reported life satisfaction, and depression symptoms were much better than those of the non-participants, adjusting for demographic, social connection, family support and health practice factors. This is in line with previous findings that religiousness has positive associations with health (Krasue 2003; Krause et al. 1999).

Our Cox hazard survival analysis for males and females combined (including gender as one of the covariates) shows that, after demographic, social/family connection and support, health practice, physical and mental health as well as subjective well-being are controlled, the risk of dying among religious participants was 6% lower than among non-participants with a statistically significant level of $p<0.10$. The separate models for oldest old males and females indicate that the association between religious participation and survival was much stronger for women than for men. The estimates for women were highly significant in all models except in model IV (where physical, mental, and other health variables are controlled), which was significant at a statistical level of $p<0.10$, while the estimates for men were statistically significant in Model I and II only, but not significant in Models III and IV (see Table 3).

Our findings are in general consistent with those of the 28-year follow-up study of 5,286 subjects in Alameda County conducted by Strawbridge and colleagues and the 6-year follow-up study in North Carolina by Koenig and colleagues. Strawbridge et al. (1997) reported that, compared to that of less frequent participants, the risk of dying among frequent religious participants was 23% less for both sexes combined (RH 0.77, 95% CI 0.64-0.93); 34% less and highly significant for women (RH 0.66, 95% CI 0.51-0.86), but 10% less and not significant for men (RH 0.90, 95% CI 0.70-1.15). Koenig et al. (1999) also found that the effects of frequent religious activities on survival are stronger among women than among men, and are significant for both women and men. Our results, however, are unique because we focus on the oldest old using an unprecedented sample of nearly 20,000 observations of subjects aged 80-

105 including more than 4,500 observations of centenarians, and our sample was drawn nationwide in China, the largest developing country.

In both previous U.S. studies (Strawbridge et al. 1997) and this study, the effects of religious participation on mortality were reduced to non-significance for men when health conditions and various other factors were statistically controlled. The findings for women differ across societies, however. For U.S. samples, religion remains a very strong significant predictor of mortality for women, even with health conditions and various other factors controlled. In this sample of the female Chinese oldest old, religion was a marginally significant (at $p<0.10$ level) predictor of mortality in the final stage of the model where physical, mental and other health variables are added as covariates. As has been described, religious practices vary substantially between the U.S. and China and may account for the lack of highly similar findings. Two other explanations are possible as well, however. First, in this study, the measures were used to predict mortality over only a two-year period. The surveillance intervals in the U.S. samples were much longer, ranging from 6 to 28 years. Second, this study focuses on the oldest-old aged 80-105. In contrast, the Strawbridge et al. study (1997) included persons aged 18 and older at baseline and the Koenig et al. study (1999) included adults aged 60 and older at baseline, but included an extremely small sub-sample size for the oldest old. It is possible that at very advanced ages, when life span limits are approached, social factors cannot exert as powerful effects as they can earlier in the life course.

If religious participation did affect health and survival among the Chinese oldest old, how might this have occurred and how can it be explained? A few preliminary interpretations may shed some light on answering these questions. First, we have seen in both this study (Table 1) and others (Ellison and George 1994; Maton 1989; Strawbridge etc. 1997) that religious participants have more social connections and thus receive higher levels of social support than non-participants. Larger social connections/supports might provide religious participants with greater surveillance of and checking for health problems. In the Chinese case, many religious functionaries are familiar with or have expertise in traditional Chinese medicine. If a participant's health problem is identified through religious contacts, she

or he might be encouraged or assisted to consult with a doctor of either Western or Chinese medicine. Stronger social connections and support may also help the oldest old to cope with quickly declining physical and cognitive function and to eliminate loneliness. Satisfaction with social connections and support might have positive effects on the immune system to fend off disease, facilitate recovery, and extend survival (Spiegel et al. 1989; Spiegel 1992).

Second, similar to Western religions, Chinese religions teach and promote kindness (Shan) and discourage fighting and hurting each other. For example, the famous (and perhaps primary) idol among Chinese religious people, especially women, is Bodhisattava Guanyin, an extremely kind and powerful woman who always helps others to overcome life's difficulties. Assistance to other persons based on the philosophy of kindness may earn respect and positive feedback from others, which may increase religious participants' social status and life satisfaction. Kindness might also reduce the risks of physical and mental injuries due to fighting with others.

Third, almost all Chinese religious activities involve sitting and thinking quietly (samadhi), which may help to reduce depression, anxiety, and stress. Chinese religion tends to generate forces of hope, continuity, and connection, and so is equated with health-seeking behaviors (Holroyd 2002). The fact that the proportion of religious participants among Chinese oldest old who do not have depression symptoms (17.2%) is more than twice as high as that of the oldest old who have depression symptoms (7.7%) may support this speculation. Lower rates of depression, like social support, result in stronger immune systems and better defenses against disease (Irwin et al. 1990; Leserman et al. 2000).

Fourth, most Chinese religions promote happiness even under poor living conditions and other difficulties. For example, the *Analects of Confucius,* the bible of Confucianism, starts with the three aspects of happiness. The most popular Buddhist symbol is a monk with a truly lively smile and a big abdomen. Daoism searches for the secret of longevity. The old Chinese saying "Knowing satisfaction leads to constant happiness (Zhi zu chang le)," is favored and promoted by Chinese religions. Other possible explanations are that religious activities may foster mobility because participants need to visit

temples or other places at least occasionally for religious activities, which in turn may improve their health. Chinese religious participants might be more likely to practice a healthy diet such as vegetarianism or consuming less or no meat and alcohol.

It is not clear why the association of religious participation and health and survival should be stronger among Chinese oldest old women than among their male counterparts, although this pattern is consistent with the findings from American studies (Strawbridge etc. 1997; Koenig et al. 1999; House et al. 1982). In the present study, the likelihood of participating in religious activities among Chinese oldest old women was 3.4 times as high as that of oldest old men, adjusting for age, rural/urban residence, education, economic independence, and ethnicity. The much higher proportion of oldest old women who are widowed might result in them being more involved in religious activities to fill otherwise unmet social needs for interchange and support (Strawbridge etc. 1997). Nevertheless, the mechanisms and pathways that explain the strong gender differences in the relationship between religious participation and health and survival remain somewhat a mystery and deserve further investigation.

Although this study makes a unique contribution to studies on religion and health, we also recognize the several weaknesses of this study. First, detailed data on the frequency of religious activities among participants were not available. Second, we could not distinguish public religious activities from private religious activities in our data set. Third, the measure of depression symptoms is limited, compared to most relevant research. Fourth, detailed clinical measures of physical and mental health were also lacking in our study. Fifth, the mechanism of how Chinese oldest old people's health status and survival are influenced by religiousness is not fully investigated due mainly to the limitation of the data. These facts all indicate that more in-depth studies are needed to deepen our knowledge about the associations of religious participation with health and survival and the mechanisms that explain these associations.

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Endnotes

[1] This paper is based on data derived from the 1998 and 2000 Chinese Longitudinal Healthy Longevity Surveys, which were supported by the NIA/NIH grant P01 AG 08761 awarded to Duke University and the Chinese matching resources to cover personnel costs and some local expenses. The Max Planck Institute for Demographic Research provided support for international training. We sincerely thank the strong support provided by Peking University, China National Research Center on Aging, and China Mainland Information Inc. We are very grateful to all interviewers and interviewees who participated in the survey. Without their efforts and collaboration, this nationwide project could never have been conducted.

[2] This excludes folk religions, superstition and worship of ancestors (Fan 2003).

[3] Han Chinese constitute about 92 percent of the total population in China (NBSC 2001)

[4] In this study, China religions mainly refer Daoism and Buddhism.

[5] The 22 surveyed provinces are Liaoning, Jilin, Heilongjiang, Hebei, Beijing, Tianjing, Shanxi, Shaanxi, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shangdong, Henan, Hubei, Hunan, Guangdong, Guangxi, Sichuan, Chongqing. There are 31 provinces in total in Mainland China. There were 631, 777, and 866 counties and cities in our 1998, 2000, and 2002 surveys, respectively. The increase in numbers of survey units was partly due to some county townships' becoming cities in the later wave, and partly due to some selected counties/cities' having no centenarians in an earlier wave but having centenarians in a later wave.

[6] The other nine provinces (Xinjiang, Qinghai, Ningxia, Inner Mongolia, Tibet, Gansu, Yunnan, Guizhou, and Hainan), all of which have a high proportion of inhabitants belonging to ethnic minorities, are not included in this study. However, while we are sure that the quality of age reporting is very poor in Xinjiang, it is not certain that the quality is poor or acceptable for all other ethnic minority groups in the other eight provinces that were not included in the survey. We did not include them because we are unsure of the quality of the age reporting of the ethnic

minority groups in these eight provinces, we lacked detailed age-ethnic-specific data to evaluate them, and because of fund constraints.

[7] By U.S. standards, "0 year of schooling vs. ≥1 year schooling" would constitute a very crude measurement of education. Among these Chinese oldest old cohorts, however, two thirds received no formal education (i.e., 0 year of schooling).

[8] Independence was defined as the respondent having his/her own retirement wage and/or work money.

[9] Cohabitation among Chinese oldest old is extremely rare.

[10] According to this arbitrary criterion, heavy alcohol drinkers consist of 5.7% of the entire sample, which is similar to the percent distribution of the category of heavy alcohol drinkers (6.1%) reported in Koenig et al. (1999: M372). We also tried other criteria to define heavy alcohol drinkers, but the results are essentially the same.

[11] The presence or absence of chronic conditions was self-assessed in the Chinese Longitudinal Healthy Longevity Survey. The medical records and clinical diagnoses of diseases for Chinese oldest old persons, especially for those rural people constituting the majority of the population, are very poor. We, therefore, do not believe that the self-assessed chronic condition is reliable, because many oldest old, especially those living in rural and poor areas, might never have heard the names of some chronic diseases even if they actually had them. Employing the measurements of ADL, MMSE, self-rated health, self-rated life satisfaction, and proxy of depression is the best we can do (and is probably good enough) to measure the health conditions of the Chinese oldest old today. On the other hand, the CLHLS collected data about the number of serious illnesses suffered in the past two years before the interview, which approximately reflects an interviewee's physical conditions to some extent. Previous research has suggested that

physical health conditions are confounding factors in examining the association between religious involvement and mortality. This variable, therefore, was added into models as a covariate when we investigate the relation between religiousness and mortality.

[12] Based on the international standard of Katz' ADL index (e.g., Katz et al 1963), its adoption to the Chinese cultural/social context, and its careful testing by pilot studies/interviews, six questions about ADL functional statuses (can do it, or can do it but need assistance, or cannot do it) were asked of the oldest old or a close family member if the elder was not able to answer the questions. "Eating" refers to feeding oneself; "dressing" refers to getting clothes and getting dressed, including tying shoes; "transferring" refers to getting in and out of bed as well as in and out of a chair; "using the toilet" refers to going to the toilet and cleaning afterwards; "bathing" refers to a sponge bath, shower, tub bath, or washing the body with a wet towel; "continence" refers to control of urination and bowel movement.

[13] The reliability coefficient is 0.89, above the 0.7 criteria suggested for group comparisons (Nunnally 1994; Steward, Hays, and Ware 1992)

[14] The variable of ADL functioning in male model, female model, and two-sexes combined model, and the variables of education and suffering serious illness or not last two years in females model and two-sexes combined model didn't pass the proportionality requirement. Following the suggestion given by Cleves et al. (2002: 144-147), we add interaction term of ADL functioning with analysis time, and interaction term of suffering serious illness or not with analysis time into model. It seems to us that the interaction term of education with analysis time at the oldest-old ages is less meaningful, we, therefore, treated it as a strata variable in analysis. To keep consistency, we treat these three variables in the same way in female model, male model, and two-sexes combined model. The result is almost identical for the effect of religious activities on survival if we treat these three variables different in different model. Parametric models are also tried and results are very close to that in Cox model.

[15] Those subjects lost to follow-up were dropped from analysis.

Table 1. Frequency distributions of the covariates and odds ratios of religious participation

Variables	Categories	Distribution		Odds ratio of religious participation and 95% confidence interval
		%	Number	
Demographic Characteristics				
Age	80-89	42.7	8,447	1.00
	90-99	34.5	6,825	0.73 (0.64-0.82)***
	100-105	22.8	4,506	0.54 (0.47-0.61)***
Gender	Male	41.2	8,142	1.00
	Female	58.8	11,636	3.36 (2.80-4.03)***
Residence	Rural	51.0	10,096	1.00
	Urban	49.0	9,682	1.06 (0.92-1.22)
Ethnicity	Han group	93.5	18,494	1.00
	Minority	6.5	1,284	0.32 (0.21-0.47)***
Education	No	65.1	12,888	1.00
	Yes	34.9	6,890	1.12 (0.93-1.34)
Economic independence	No	81.0	16,017	1.00
	Yes	19.0	3,761	1.06 (0.87-1.29)
Social /family support, connection				
Married	No	81.8	16,169	1.00
	Yes	18.2	3,609	0.87 (0.72-1.05)
Living alone	No	88.9	17,580	1.00
	Yes	11.1	2,198	1.49 (1.23-1.81)***
Proximity to children	Low	21.1	4,182	1.00
	High	78.9	15,596	1.07 (0.90-1.26)
Spouse/family member as a caregiver	No	9.8	1,929	1.00
	Yes	90.2	17,849	1.10 (0.88-1.36)
Get adequate medication	No	4.6	910	1.00
	Yes	95.4	18,868	0.82 (0.61-1.11)
Play cards/ mah-jong	No	87.1	17,206	1.00
	Yes	12.9	2,557	1.32 (1.10-1.58)***
Health practices				
Currently doing regular exercise	No	81.1	16,038	1.00
	Yes	18.9	3,740	0.99 (0.85-1.17)
Currently smoker	No	83.1	16,437	1.00
	Yes	16.9	3,341	0.73 (0.59-0.90)**
Currently heavy alcohol drinker	No	94.3	18,652	1.00
	Yes	5.7	1,126	0.71 (0.51-0.98)*
Health Status				
ADLs impaired	No	64.3	12,720	1.00
	Yes	35.7	7,058	0.51 (0.42-0.61)***
Cognitive function impaired	No	55.4	10,949	1.00
	Yes	44.6	8,829	0.72 (0.61-0.84)***
Self-reported health	Good/Fair	82.6	16,336	1.00
	Poor/very poor	17.4	3,442	0.62 (0.55-0.69)***
Self-reported life satisfaction	Good/Fair	88.9	17,564	1.00
	Poor/very poor	11.1	2,193	0.64 (0.48-0.87)***
Depression symptoms	No	88.3	17,462	1.00
	Yes	11.7	2,316	0.61 (0.43-0.85)**

Notes: (1) The odds ratios of the religious activities presented in the last column are adjusted for age, gender, rural/urban residence, education, economic independence, and ethnicity. The possible intra-subject correlation of the "two-observation" from the same interviewee is also statistically adjusted for. (2) A value of 1.00 of the odds ratio refers to the reference group. (3) *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

Table 2. Association between religious participation and selected health indicators

Model and dependent variables	Both sexes (N=19,778) OR (95% CI)	Female (n=11,636) OR (95% CI)	Male (n=8,142) OR (95% CI)
ADL impaired	0.54 (0.49-0.60)***	0.54 (0.48-0.61)***	0.53 (0.43-0.65)***
MMSE impaired	0.65 (0.60-0.72)***	0.64 (0.57-0.72)***	0.70 (0.58-0.85)***
Self-reported bad health	0.64 (0.57-0.72)***	0.68 (0.60-0.78)***	0.54 (0.42-0.70)***
Self-reported poor life satisfaction	0.52 (0.45-0.61)***	0.47(0.40-0.56)***	0.75 (0.56-1.01)#
Depression symptoms	0.43 (0.36-0.51)***	0.42 (0.35-0.51)***	0.45 (0.31-0.65)***

Notes: (1) OR =Odds ratio. CI =confidence interval. OR and CI for "Both sexes" are estimates for males and females combined with sex as one of the confounding variables. OR and CI for "Males" and "Females" are estimated from separate models of males and females. All OR and CI estimates are adjusted for demographic, family/social support and connections, and health practice listed in Table 1 while correcting for the intra-subject correlation due to some subjects' contributing two observations to the pooled data set. (2) The degree of freedom of models for males and females separately is 16; the degree of freedom of the models for both sexes is 17. (3) #, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

Table 3. Relative mortality risks of religious participants versus non-participants

Sequential model and covariates	Both sexes (N=17,307) RH (95% CI)	Female (n=10,177) RH (95% CI)	Male (n=7,130) RH (95% CI)
I. Religious participation plus demographic variables	0.80 (0.74-0.86)***	0.78 (0.71-0.85)***	0.86 (0.75-0.97)*
II. Model I plus family/social support, and connection	0.81 (0.76-0.88)***	0.80 (0.73-0.87)***	0.88 (0.76-0.99)*
III. Model II plus health practices	0.83 (0.77-0.89)***	0.81 (0.74-0.88)***	0.89 (0.78-1.02)
IV. Model III plus health conditions	0.94 (0.87-1.01)#	0.92 (0.84-1.01)#	1.00 (0.88-1.15)

Notes: (1) RH =Relative risk. CI =confidence interval. RH and CI for "Both sexes" are estimates for males and females combined with sex as one of the confounding variables. RH and CI for "Males" and "Females" are estimated from separate models of males and females. All RH and CI estimates are based on the Weibull hazards regression sequential model adjusted for selected covariates listed in Table 1, while correcting for intra-subject correlation due to some subjects' contributing two observations to the pooled data set. (2) The degrees of freedom of Model I, Model II, Model III, and Model IV for males and females separately are 7, 13, 16, and 22, respectively, while the corresponding numbers for both sexes are 8, 14, 17, and 23. (3) #, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.