

# Characteristics of participants' and caregivers' influence on non-response in a cross-sectional study of dementia in an older population



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## ABSTRACT

**Objective:** The issue of non-response in dementia epidemiological studies, which may result in the underestimation of the prevalence of dementia, has attracted little attention. We aimed to explore the causes and related factors of non-response in a dementia survey among Chinese veterans.

**Methods:** A two-phase, cross-sectional study investigated the prevalence of dementia and mild cognitive impairment in Chinese veterans aged  $\geq 60$  years. We collected the socio-demographic data and prior medical history, evaluated the health status of veterans and their caregivers, assessed the cognitive status of veterans, and evaluated the care burden of caregivers by Caregiver Burden Inventory (CBI).

**Results:** Of 9676 eligible participants, 525 (5.4%) veterans in phase 1 and 1706 (35.0%) veterans among 4875 veterans in phase 2 did not respond. Illness, hospitalization and death accounted for 63.0% and 75.5% non-response in phases 1 and 2, respectively. Non-participation in social activities, self-perceived poor health status, worsened health changes, self-reported need for life care, and history of hearing loss or glaucoma independently predicted non-response in phase 1 or 2. The heavy care burden, suggested by the higher CBI scores and self-reported health deterioration of the primary caregivers, predicted non-response in phase 1 or 2.

**Conclusions:** The negative factors from both the participants and their caregivers independently predicted the non-response in the dementia study in an older population. Preventative strategies from the perspectives of the participants and caregivers should be developed to improve the response rates in both phases in a cross-sectional study.

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## 1. Introduction

The non-response in epidemiological studies of dementia has been recognized in recent decades (Boersma, Eefsting, van den Brink, & van Tilburg, 1997; Helliwell, Aylesworth, McDowell, Baumgarten, & Sykes, 2001). Several studies have reported that the non-responders appeared to be disproportionately cognitively impaired (Chatfield, Brayne, & Matthews, 2005; Lucca et al., 2011;

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Miyamotoa et al., 2009; Matthews et al., 2004; Tyas, Tate, Wooldrage, Manfreda, & Strain, 2006); disregarding this observation may result in an underestimation of the prevalence or incidence of dementia (Lopes, Ferrioli, Nakano, Litvoc, & Bottino, 2012; Tyas et al., 2006). To date, the issue of non-response, a potentially important bias for estimating the prevalence or incidence of dementia, has attracted little attention. The majority of the investigations have reported on the non-response rate; however, few studies have focused on its causes and associated factors as well as the characteristics of the non-responders (Chatfield et al., 2005). For example, one review demonstrated that among 55 longitudinal studies of dementia worldwide during 1966–2002, only 12 studies explored the factors relevant to non-response, of which only two studies (from Japan and Brazil) were performed in Asia or low- and middle-income countries (LMIC) (Chatfield et al., 2005). There were no data from China, the largest LMIC in the world that is facing the serious challenge of a rapidly aging population and an increased burden of dementia (Chatfield et al., 2005).

The majority of the studies have indicated that the primary reasons for non-response in large population-based studies in the elderly were sickness, institutionalization, death, contact failure, moving away from the study area, and refusal to participate (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamotoa et al., 2009; Matthews et al., 2004; Tyas et al., 2006). Several studies found that compared with the responders, the non-responders in the dementia studies were prone to be older, less educated, unmarried, living alone, impaired in activities of daily living, in worse self-perceived health, with worse cognitive ability, and receiving more medications (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamotoa et al., 2009; Matthews et al., 2004; Chatfield et al., 2005; Tyas et al., 2006). However, inconsistency still existed and issues remained to be addressed (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamotoa et al., 2009; Matthews et al., 2004; Chatfield et al., 2005; Tyas et al., 2006; Bootsma-van der Wiel et al., 2002). The above-mentioned factors regarding the participants deserve attention. Furthermore, the impact from the heavy burden of the participants' family caregivers, which could potentially increase the occurrence of non-response, should not be neglected (Coley et al., 2008). Several cohort studies have shown that factors related to non-response may vary among the different stages of follow-up and the initial baseline interviews (Matthews et al., 2004; Bootsma-van der Wiel et al., 2002; Zunzunegui, Béland, & Gutiérrez-Cuadra, 2001). However, only a few studies have explored the issue of non-response in phase 1 of a two-phase (including screening and systemic neuropsychological examinations) cross-sectional research due to the difficulty of collecting initial baseline data in phase 1. Additionally, the caregivers' factors that correlated with non-response have not been sufficiently emphasized in a cross-sectional survey. Moreover, with particularly rapid increases in the number and proportion of older people and the oldest old population (aged  $\geq 80$  years), the resources of cross-sectional studies in dementia from LMIC is considerably increasing (Prince et al., 2013). However, considering the burden of dementia that LMIC are facing, the high prevalence of dementia among the oldest old, and the common phenomenon of non-response in the dementia prevalence research, the data of non-response from cross-sectional studies involving the causes and related factors remain insufficient (Chatfield et al., 2005; Prince et al., 2013).

In 2009–2011, we conducted a multi-center, two-phase, cross-sectional study to estimate the prevalence of dementia and mild cognitive impairment (MCI) among Chinese veterans based on the “Chinese Veteran Clinical Research (CVCR) Platform” for assessing the primary chronic disabling non-communicable diseases (NCDs) in older veterans (Tan et al., 2014). Because the majority of the participants in this survey were the oldest old (aged  $\geq 80$  years)

who needed more life care, we found that the non-response rates of veterans in the two phases were higher. The primary objective of this study was to explore the causes and related factors of non-response at the two phases from the perspectives of both veterans and their caregivers who might influence the non-response of veterans. Using the available data of the veterans and caregivers, we aimed to investigate whether the poor health status of the veteran population and the characteristics of the veterans' caregivers, such as heavy care burden, were predictive of non-response for the two-phase interviews and whether there were differences in the causes and associated factors of non-response between the two phases of the dementia study. Recognizing that a high percentage of non-response can lead to a severe bias in estimating the prevalence of dementia, we are optimistic that our study will contribute useful information for reducing the non-response in dementia studies and improving the estimation accuracy of the burden of diseases associated with dementia among the oldest old in LMIC.

## 2. Methods

### 2.1. Study design of the Chinese Veteran Clinical Research (CVCR) platform

This research was conducted in accordance with the CVCR Platform, which was constructed for clinical research of NCDs in older Chinese veterans, particularly disabling NCDs in the oldest old (Tan et al., 2014). The CVCR participants were veterans who fulfilled the following criteria: (1) aged  $\geq 60$  years; (2) had lived in veteran communities (in which the older retired cadres of the army system reside) for more than 1 month; and (3) worked in the army system before retirement (Tan et al., 2014). Community workers and veterans' spouses were not included in this platform. We adopted a stratified cluster sampling because of the similarities in the age and gender composition of veterans in the veterans' communities. The sample size for cities with a centralized distribution of veterans' communities is 500–1000 people and 100–300 people for those cities with a smaller distribution.

This study commenced after the research protocol was approved by the Institutional Review Board of the Chinese People's Liberation Army General Hospital, and written informed consent was obtained from all of the participants or their legal representatives. More details regarding the CVCR Platform design have been presented in our previous article (Tan et al., 2014).

### 2.2. Study design of dementia and MCI prevalence investigation

A multi-center, two-phase, cross-sectional study was performed to investigate the prevalence of dementia in older veterans using the CVCR Platform. The investigators were qualified medical staff from the departments of geriatrics or neurology of the PLA General Hospital and other participating hospitals. A uniform training was performed before the investigators conducted face-to-face interviews with veterans in the clinics of the veterans' communities. The disabled veterans were interviewed using a household survey. The working staff of the veterans' communities and medical staff of the veterans' community clinics assisted in organizing the interviews and encouraging the veterans to participate in the CVCR Platform. This approach aimed to increase the survey response rate and improve the reliability of the survey data.

#### 2.2.1. Phase 1: screening

**2.2.1.1. Collection of the baseline data of veterans.** All of the CVCR participants who were aged  $\geq 60$  years were eligible for phase 1 in

the dementia study. The investigators conducted face-to-face interviews to collect the socio-demographic data of the veterans, including age, gender, education, marital status, living arrangement, physical and social activities, and life care. Physical activity was defined as 30 min or more daily at an intensity equal to or greater than walking. Social activity referred to participation in organizational activities involving social contact. Life care meant that the veterans' daily life required help from others. Information about the previous history of NCDs and family history of neuropsychiatric diseases was also collected according to the veterans' medical records in the community clinics and their self-reported illness status.

**2.2.1.2. Screening for likely cognitive impairment and covariates of veterans.** The Chinese version of the Mini Mental State Examination (MMSE) (Zhang et al., 1999) and the Montreal Cognitive Assessment (MoCa) (Wen, Zhang, Niu, & Li, 2008) were used to screen for cognitive impairment in the veterans. A higher total score on the MMSE or the MoCa indicated a better cognitive state. The cutoff scores of the MMSE for likely cognitive impairment were as follows: 20 for those with <1 year of education, 23 for those with 1–6 years of education, and 27 for those with 7+ years of education (Zhang et al., 1999). Veterans with a total score on the MMSE lower than the above cutoff scores or the MoCa lower than 26 points (Zhang et al., 1999; Wen et al., 2008) were screened positive and should be included in phase 2.

The 20-item version of activities of daily living (ADL), evaluating the personal ADL [PADL] and the instrumental ADL [IADL] (Zhang, Yu, & He, 1995), was used to evaluate the functional dependence of the veterans. The veterans who had difficulty performing any IADL or PADL task were considered as dependent. Their general health status and health changes compared with 6 months previously were evaluated using a subset of the SF-36 Health Survey (Li, Wang, & Shen, 2002). Their sleep status as well as depressive symptoms were examined using the Center for Epidemiological Studies Depression Scale (CES-D) (Wu, Zhang, Yu, Fu, & Bao, 1989) and the Pittsburgh Sleep Quality Index (PSQI) (Liu et al., 1996). A total score on the CES-D or the PSQI higher than 15 or 7 points, respectively, was suggestive of depressive symptoms or sleep disorders, respectively (Wu et al., 1989; Liu et al., 1996).

**2.2.1.3. Collection of the socio-demographic and health data of caregivers.** The veterans' primary caregivers referred to the persons who spent the most time caring for the veterans in the family (World Health Organization & Alzheimer's Disease International, 2012). The caregivers' socio-demographic data including age, gender, education, marital status, working status, income, and care-training experience were collected by face-to-face interviewers of the investigators. The subset of the SF-36 Health Survey, the Caregiver Burden Inventory (CBI) (Yue et al., 2006), and the Hospital Anxiety and Depression Scale (HADS) (Wang, 2005) were applied to evaluate the general health status and health changes, anxious and depressive symptoms, and the care burden of caregivers. The subjects with total HADS scores of  $\geq 8$  were considered to exhibit symptoms of anxiety or depression (Wang, 2005). A higher score on the CBI suggested a higher burden of the caregivers (Yue et al., 2006). Additionally, information was collected regarding whether there had been secondary caregivers to supplement the care of the veterans (World Health Organization & Alzheimer's Disease International, 2012).

## 2.2.2. Phase 2: neuropsychological and clinical examination

All of the veterans screened positive for cognitive impairment in phase 1 and those who screened negative but were diagnosed with cognitive impairment before the study were admitted to phase 2. During phase 2, the veterans underwent a comprehensive

neuropsychological evaluation to assess their memory, language, visuospatial perception, calculation, abstract reasoning, and executive function. The tests used in this study have been validated in the Mandarin language, and there are normative data for the Chinese population. The cutoff scores on the neuropsychological tests were 1.5 standard deviations (SD) and 2.5 SD below the norms to diagnose MCI and dementia, respectively. A clinical examination was also performed during phase 2, including the collection of the patients' medical history, physical examinations and neurological assessments, laboratory tests, and neuroimaging scan (computed tomography [CT] or magnetic resonance imaging [MRI]) results.

Based on the above-mentioned assessments, clinical diagnoses were performed to determine the patients' cognitive status. The diagnosis of MCI was made according to the core clinical criteria recommended by the National Institute on Aging and the Alzheimer's Association workgroup (Albert et al., 2011) and included all the following: (i) cognitive decline compared with the participant's previous level (obtained from the subject or an informant); (ii) impairment in one or more cognitive domains; (iii) preservation of independence in functional abilities; and (iv) not meeting the criteria for dementia. The diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders IV were used to diagnose dementia (American Psychiatric Association, 1994).

## 2.3. Definition of the non-responders in the two phases

The veterans who completed neither the MMSE nor the MoCa screening were defined as non-responders in phase 1. The non-responders in phase 2 were those who failed to complete all of the neuropsychological batteries and their diagnosis was difficult to make because of insufficiency of neuropsychological or clinical information. The causes for non-response were collected by the working staff of the veterans' communities and medical staff of the veterans' community clinics. The difference between the responders and non-responders in the two phases was compared separately.

## 2.4. Database creation and statistical analyses

We constructed a database using Lauritsen JM & Bruus M. EpiData (version 3.1, The EpiData Association, Odense, Denmark). The data were entered separately by two certified neurologists to allow for verification. The statistical analyses, including the descriptive analyses, were performed using SPSS software (version 18.0, SPSS, Inc., Chicago, IL, USA). The causes for the non-response were shown as a number (percentage [95% Confidence Interval, 95% CI]). There were missing data for the multiple variables; hence, the subject number and the percentage of missing data were marked for each variable in the tables. The missing data were excluded from the analyses. The numeric variables were not normally distributed and are presented as the medians (inter-quartile range, IQR). The Mann-Whitney nonparametric test was used to compare the differences of numerical variables, e.g., age, education, and the total scores of MMSE, MoCa, CBI and HADS. The Pearson chi-squared ( $\chi^2$ ) test and Fisher's exact test were used to compare the nominal variables, including the majority of the variables relating to the socio-demographic and health characteristics of the veterans and their primary caregivers. The prevalence of NCDs, depressive and anxious symptoms, sleep disorders, IADL and PADL dependence, and the family history of neuropsychiatric disorders among the different groups were also analyzed using the  $\chi^2$  test or Fisher's exact test. When  $P$  was  $<0.1$  in the univariate analysis, the corresponding variable was included in the logistic regression models of the multivariate analysis. The logistic regression was applied for the multivariate analysis to ascertain the factors associated with the non-response. The backward

method (LR) was used for the variable selection to calculate the odds ratio (OR) and 95% CI. The variable was considered to be statistically significant as a related factor to the non-response when  $P$  was  $<0.05$  in the logistic regression analysis.

### 3. Results

#### 3.1. Rates and causes of non-response in phases 1 and 2

The survey was conducted from December 2009 to December 2011 in the following 18 cities: Beijing, Shanghai, Guangzhou, Tianjin, Qingdao, Dalian, Fuzhou, Shijiazhuang, Yantai, Baoding, Wuhan, Xi'an, Chengdu, Harbin, Lanzhou, Taiyuan, Hohhot and Guiyang. A total of 277 veterans' communities were selected and 9676 Chinese veterans who fulfilled the inclusion criteria were recruited to participate in the CVCR Platform (Tan et al., 2014). A total of 9151 (94.6%) veterans responded in phase 1, making the rate of non-response 5.4%. In phase 1, there were 170 non-responders (32.4% [28.4%, 36.6%]) due to illness, 123 (23.4% [19.9%,

27.3%]) due to hospitalization, 148 (28.2% [24.4%, 32.3%]) due to absence during the study period, 34 (6.5% [4.6%, 9.0%]) and 50 (9.5% [7.2%, 12.4%]) due to death and refusal, respectively (Fig. 1).

A total of 4735 veterans screened positive for cognitive impairment in phase 1, and 140 veterans screened negative but were diagnosed with cognitive impairment before the study and were all entered into phase 2. Among 4875 veterans in phase 2, 1706 (35.0%) veterans were defined as non-responders because their final diagnosis could not be determined because of insufficiency of neuropsychological or clinical information. There were 666 non-responders in phase 2 (39.0% [36.7%, 41.1%]) due to illness, 290 (17.0% [15.3%, 18.9%]) due to hospitalization, 246 (14.4% [12.8%, 16.2%]) due to absence during the study period, 172 (10.1% [8.7%, 11.6%]) and 332 (19.5% [17.6%, 21.4%]) due to death and refusal, respectively. The number of responders and non-responders who needed life care in phases 1 and 2 were 1427 (15.6%) and 188 (35.8%), 616 (19.4%) and 344 (20.2%), respectively. The number of primary family caregivers of the responders and non-responders in phases 1 and 2 who completed the investigations

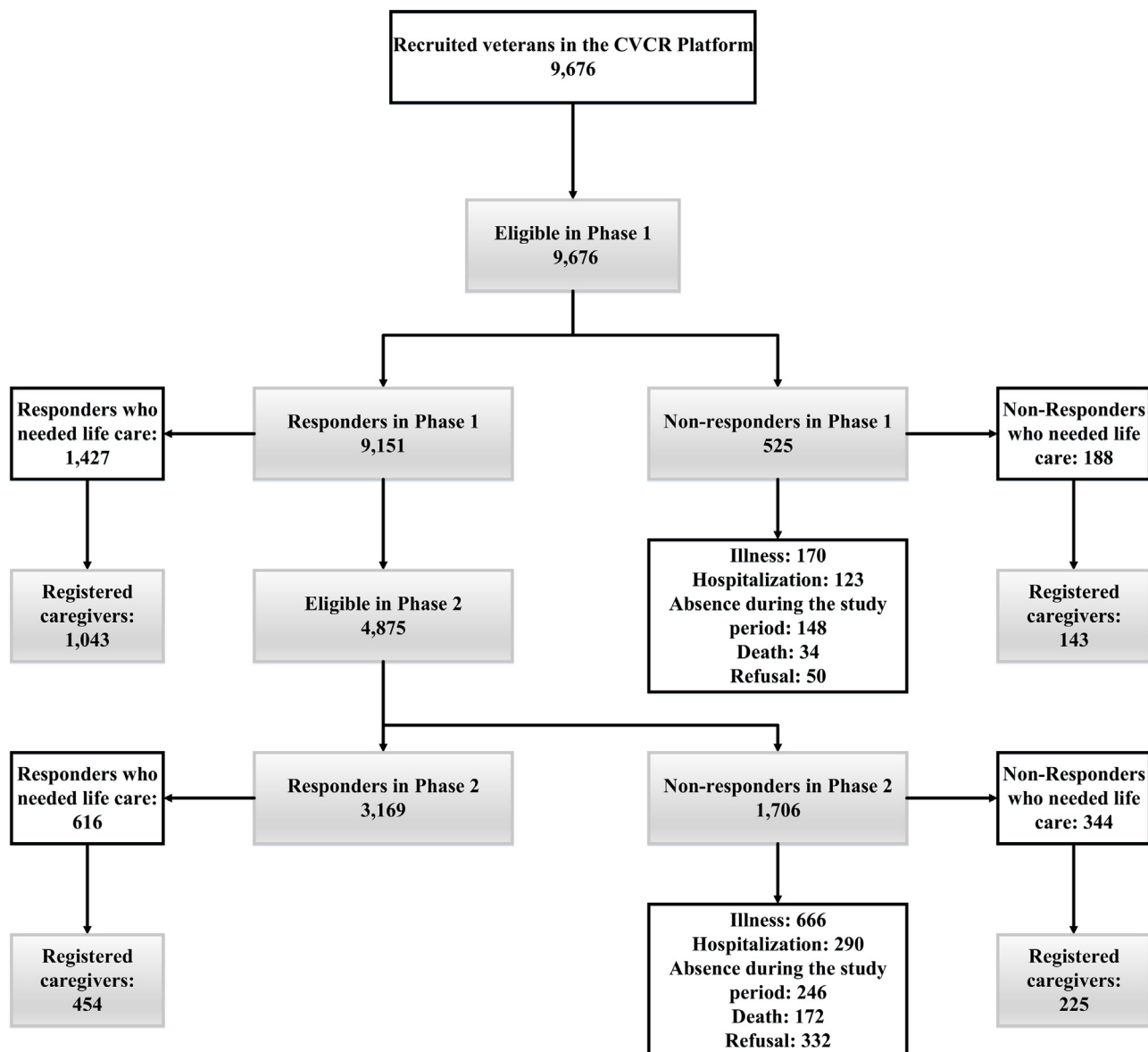


Fig. 1. Flow chart of the study.

Abbreviations: CVCR, Chinese Veteran Clinical Research.



were 1043 (73.1%) and 143 (76.1%), 454 (73.7%) and 225 (65.4%), respectively (Fig. 1).

### 3.2. Socio-demographic characteristics and health, functional, mood and cognitive status

Compared with the responders, the non-responders in phase 1 appeared to be slightly older and less educated, participated in fewer physical and social activities, required more life care, reported poorer health status, and had a higher PADL and IADL dependence (Table 1). The differences in marital status and living arrangement were also statistically significant between the non-responders and responders in phase 1 (Table 1). However, there were no differences between the non-responders and responders in phase 1 with regard to gender distribution and the prevalence of depressive symptoms and sleep disorders (Table 1). The MMSE and the MoCa scores could not be compared because they were not completed by the non-responders in this phase (Table 1).

Similar to the non-responders in phase 1, the non-responders in phase 2 participated in fewer physical and social activities and had a poorer health status than the responders; the chi-square test showed significant differences between them (Table 1). The total scores of the MMSE and the MoCa between the responders and non-responders were also significantly different (Table 1). However, there were no differences in other socio-demographic, functional and mood factors between the responders and non-responders in phase 2 (Table 1).

### 3.3. Previous history of NCDs and family history of neuropsychiatric diseases

Regarding the previous medical history and family history, cardiac diseases, cerebral hemorrhage, anemia, osteoarthritis, cataract and hearing loss, as well as family history of dementia and psychiatric diseases were markedly different between the responders and non-responders in phase 1 (Table 2). The history of cardiac diseases, fracture, glaucoma, osteoarthritis, cataract, and family history of dementia were significantly associated with non-response in phase 2 (Table 2).

### 3.4. Demographic characteristics and health status of the primary family caregivers

The primary family caregivers of the non-responders and responders in phase 1 demonstrated significant differences in gender, education level, assistance provided by the secondary caregivers, general health status, health changes compared one year ago and before caring for patients, time for care per day, income, and the CBI and HADS scores (Table 3). Other characteristics of the caregivers were not associated with the non-response in phase 1 (Table 3). In phase 2, the CBI scores of the primary caregivers for the non-responders were significantly higher than the scores of the responders; however, none of the other caregivers' characteristics were found to be significantly different between them (Table 3).

**Table 1**  
Socio-demographic characteristics and health, functional, mood and cognitive status of the responders and non-responders.

	Phase 1		Phase 2	
	Responders (n = 9151)	Non-responders (n = 525)	Responders (n = 3169)	Non-responders (n = 1706)
Median age (IQR), years	81.9 (4.9)	82.9 (4.9)****	82.5 (4.6)	82.5 (4.9)
Median education (IQR), years	8.0 (6.0)	7.0 (9.0)****	7.0 (6.0)	7.2 (6.5)
Gender (male), n (%)	8638 (95.7)	458 (95.8)	3010 (96.3)	1598 (95.7)
Marital status (married), n (%)	7455 (83.0)	373 (79.9)**	2544 (81.7)	1361 (82.2)
Living alone, n (%)	216 (2.9)	3 (0.8)****	71 (2.7)	42 (3.2)
Living with nursemaid, n (%)	249 (3.3)	18 (4.6)	93 (3.5)	47 (3.6)
Living with spouse, n (%)	6850 (90.7)	342 (87.7)	2378 (90.2)	1173 (89.8)
Living with spouse and children, n (%)	234 (3.1)	27 (6.9)	94 (3.6)	44 (3.4)
Physical activity (non-participation), n (%)	1465 (16.3)	180 (39.2)****	565 (18.1)	385 (23.3)****
Social activity (non-participation), n (%)	5550 (62.3)	342 (77.4)****	1970 (63.5)	1091 (66.9)*
Life care (necessary), n (%)	1427 (16.1)	188 (41.6)****	616 (19.9)	344 (21.1)
General health status <sup>a</sup> (worse), n (%)	668 (7.5)	102 (22.2)****	252 (8.1)	169 (10.3)**
Health change compared 6 months ago <sup>a</sup> (worse), n (%)	2155 (24.1)	158 (34.3)****	810 (26.1)	495 (30.1)***
PADL (dependence), n (%)	2443 (27.4)	47 (74.6)****	1125 (36.5)	629 (37.7)
IADL (dependence), n (%)	3780 (46.5)	46 (88.5)****	1673 (60.0)	881 (58.2)
Depressive symptoms <sup>b</sup> (yes), n (%)	650 (7.5)	2 (6.7)	300 (9.9)	178 (11.1)
Sleep disorders <sup>c</sup> (yes), n (%)	2400 (28.3)	6 (16.7)	959 (32.3)	524 (34.3)
Median MMSE total score (IQR)	–	–	26.0 (5.0)	26.0 (5.0)**
Median MoCa total score (IQR)	–	–	21.0 (6.0)	21.0 (5.0)*

The difference between the responders and non-responders in two phases was compared separately.

In phase 1, the total percentages of the missing data of PADL and IADL dependence, depressive symptoms, sleep disorders, and living arrangement were 7.3%, 15.5%, 9.7%, 12.0%, and 18.0%, respectively. In phase 2, the total rates of the missing data of IADL dependence, sleep disorders, living arrangement, and the MMSE and MoCa total scores were 11.8%, 7.7%, 19.1%, 7.7%, and 7.7%, respectively. The rates of the missing data among the other variables were 0.9–4.6%. All of the missing data were excluded from the analyses. Abbreviation: n, number; IQR, Interquartile Range; ADL, activities of daily living; PADL, personal ADL; IADL, instrumental ADL; MMSE, Mini Mental State Examination; MoCa, the Montreal Cognitive Assessment.

The *P* value indicates the significant difference between the responders and the non-responders in the two phases compared separately using univariate analysis.

\* *P* < 0.1.

\*\* *P* < 0.05.

\*\*\* *P* < 0.01.

\*\*\*\* *P* < 0.001.

<sup>a</sup> The general health status and the health changes compared 6 months ago were tested using a subset of the SF-36.

<sup>b</sup> The depressive symptoms were evaluated with the CES-D.

<sup>c</sup> The sleep disorders were examined using the PSQI.

**Table 2**

Previous history of NCDs and family history of neuropsychiatric disorders of the responders and non-responders.

n (%)	Phase 1		Phase 2	
	Responders (n = 9151)	Non-responders (n = 525)	Responders (n = 3169)	Non-responders (n = 1,706)
Cardiac diseases	6187 (69.2)	360 (78.8) <sup>****</sup>	2260 (72.8)	1115 (68.1) <sup>**</sup>
Cerebral infarction	1907 (21.4)	109 (24.3)	775 (25.0)	389 (23.9)
Cerebral hemorrhage	166 (1.9)	21 (4.7) <sup>****</sup>	68 (2.2)	37 (2.3)
Parkinson disease	296 (3.3)	20 (4.5)	139 (4.5)	62 (3.8)
Brain trauma	244 (2.7)	11 (2.4)	115 (3.7)	50 (3.1)
Hypnotics, 1 time per week	790 (9.0)	4 (10.0)	274 (9.0)	138 (8.5)
Hypnotics, 1–2 times per week	441 (5.0)	4 (10.0)	174 (5.7)	92 (5.6)
Hypnotics, ≥3 times per week	1186 (13.5)	5 (12.5)	486 (15.9)	247 (15.2)
Diabetes	2442 (27.3)	138 (30.5)	904 (29.1)	483 (29.4)
COPD	1189 (13.3)	51 (11.4)	467 (15.1)	267 (16.4)
Anemia	334 (3.7)	25 (5.6) <sup>**</sup>	122 (3.9)	63 (3.9)
Fracture	787 (8.8)	46 (10.3)	312 (10.1)	137 (8.4) <sup>*</sup>
Osteoarthritis	1981 (22.5)	80 (18.4) <sup>**</sup>	768 (25.1)	339 (21.1) <sup>***</sup>
Cataract	5048 (57.0)	210 (48.4) <sup>****</sup>	1887 (61.2)	924 (57.2) <sup>***</sup>
Glaucoma	297 (3.3)	21 (4.7)	101 (3.3)	70 (4.3) <sup>*</sup>
Eyeground disorders	1848 (21.5)	94 (22.8)	705 (23.5)	373 (24.0)
Hearing loss	2293 (25.8)	152 (34.5) <sup>****</sup>	886 (28.7)	487 (30.1)
Family history of dementia	122 (1.4)	4 (0.9) <sup>****</sup>	49 (1.6)	16 (1.0) <sup>**</sup>
Family history of psychiatric diseases	94 (1.1)	2 (0.5) <sup>****</sup>	33 (1.1)	15 (0.9)

The difference between the responders and non-responders in the two phases was compared separately.

The missing data of hypnotics in phase 1 were 8.8%, whereas the missing data of the other variables in both phases were 2.3–4.7%. All of the missing data were deleted from the analysis.

Abbreviation: n, number; NCDs, non-communicable diseases; COPD, chronic obstructive pulmonary disease.

<sup>\*</sup>  $P < 0.1$ .<sup>\*\*</sup>  $P < 0.05$ .<sup>\*\*\*</sup>  $P < 0.01$ .<sup>\*\*\*\*</sup>  $P < 0.001$ .**Table 3**

Socio-demographic characteristics and health status of the primary family caregivers among the responders and non-responders.

	Phase 1 caregivers		Phase 2 caregivers	
	Responders (n = 1043)	Non-responders (n = 143)	Responders (n = 454)	Non-responders (n = 344)
Median age (IQR), years	70.0 (17.0)	61.0 (16.0)	70.0 (31.0)	71.5 (16.0)
Gender (male), n (%)	147 (14.1)	31 (21.7) <sup>**</sup>	66 (14.5)	32 (14.2)
Education of illiterate, n (%)	81 (7.8)	9 (6.4) <sup>*</sup>	38 (8.4)	17 (7.6)
Education of primary school, n (%)	231 (22.3)	28 (19.9)	98 (21.8)	48 (21.3)
Education of secondary studies, n (%)	542 (52.4)	66 (46.8)	233 (51.8)	129 (57.3)
Education >secondary studies, n (%)	181 (17.5)	38 (27.0)	81 (18.0)	31 (13.8)
Marital status (married), n (%)	995 (95.5)	132 (93.0)	439 (96.9)	210 (93.3)
Care skill training (not participate), n (%)	903 (87.5)	126 (89.4)	394 (87.8)	189 (85.1)
Having secondary caregivers <sup>a</sup> (no), n (%)	688 (67.4)	78 (56.5) <sup>**</sup>	137 (30.9)	66 (30.4)
General health status <sup>b</sup> (worse), n (%)	274 (26.6)	62 (43.7) <sup>****</sup>	112 (25.0)	57 (25.8)
Health change compared 1 year ago <sup>b</sup> (worse), n (%)	52 (5.1)	12 (8.5) <sup>*</sup>	17 (3.8)	9 (4.1)
Health change compared before caring for veterans <sup>b</sup> (worse), n (%)	333 (32.5)	65 (46.1) <sup>**</sup>	146 (32.6)	71 (32.1)
Median time (IQR) for care per day	16.0 (16.0)	24.0 (12.0) <sup>***</sup>	14.0 (16.7)	15.0 (16.0)
Median income (IQR), RMB	1800.0 (1200.0)	2000.0 (2125.0) <sup>*</sup>	1600.0 (2000.0)	1700.0 (1940.0)
Median CBI score (IQR)	18.0 (24.0)	29.0 (26.7) <sup>****</sup>	15.0 (20.0)	18.0 (22.0) <sup>**</sup>
Median anxiety score (IQR) of HADS	2.0 (4.0)	4.0 (5.0) <sup>****</sup>	2.0 (4.0)	2.0 (4.0)
Median depression score (IQR) of HADS	2.0 (6.0)	5.0 (6.8) <sup>****</sup>	2.0 (6.0)	3.0 (6.0)

The differences of caregivers between the responders and non-responders in the two phases were compared separately.

The quantity of the missing data for income was 19.7% and the quantity of the missing data for the other variables was 0.0–5.0%. All of the missing data were deleted from the analyses.

Abbreviation: n, number; IQR, interquartile range; HADS, hospital anxiety and depression scale.

<sup>\*</sup>  $P < 0.1$ .<sup>\*\*</sup>  $P < 0.05$ .<sup>\*\*\*</sup>  $P < 0.01$ .<sup>\*\*\*\*</sup>  $P < 0.001$ .<sup>a</sup> Secondary caregivers are those who play a supplementary role to the care of the veterans.<sup>b</sup> The general health status and the health changes compared 1 year ago and before caring for veterans was tested using the subset of SF-36.

### 3.5. Factors associated with non-response in the dementia study

The information of non-responders in phase 1 was limited and only 35 non-responders were included in the multivariate analysis when considering the veterans' factors. Conducting a single multivariate analysis for both factors from the veterans and caregivers could not be performed because of the insufficient

numbers of cases for the analysis. Therefore, two different multivariate analyses were performed, respectively, in phase 1: one multivariate analysis for the veterans' factors and another analysis for the caregivers' factors. The veterans' factors that increased the non-response in phase 1 were as follows: non-participation in social activities, report of worse general health status, need for life care and history of hearing loss. Additionally,

**Table 4**  
Multivariate analyses of the factors associated with non-response in phase 1.

Factors	OR	95% CI
<b>Veterans<sup>a</sup></b>		
Social activities (non-participant vs. participant)	1.33	1.06–1.66
General health status (worse vs. better)	1.23	1.03–1.48
Life care (necessary vs. not necessary)	20.82	8.16–53.16
Hearing loss (yes vs. no)	2.48	1.20–5.13
Cataract (yes vs. no)	0.33	0.16–0.69
<b>Caregivers<sup>b</sup></b>		
Gender (female vs. male)	0.53	0.30–0.93
Health change compared 1 year ago (worse vs. better)	2.10	1.34–3.29
CBI score	1.01	1.00–1.01

Abbreviation: OR, odds ratio; CI, confidence interval; CBI, Caregiver Burden Inventory.

<sup>a</sup> The logistic regression analysis of the veterans' factors: Nagelkerke  $R^2$ : 0.254,  $P$  value of Hosmer & Lemeshow test: 0.437; The numbers of the responders and non-responders included in the analysis were 6033 and 35 respectively.

<sup>b</sup> The logistic regression analysis of the caregivers' factors: Nagelkerke  $R^2$ : 0.066,  $P$  value of Hosmer & Lemeshow test: 0.066; The numbers of caregivers of the responders and non-responders included in the analysis were 708 and 98 respectively.

**Table 5**  
Multivariate analysis of the factors related to non-response in phase 2.

	OR	95% CI
Physical activities (non-participant vs. participant)	1.46	1.23–1.74
Health change compared 6 months ago (worse vs. better)	1.22	1.04–1.42
Glaucoma (yes vs. no)	1.59	1.10–2.28
Osteoarthritis (yes vs. no)	0.75	0.64–0.89
Cardiac diseases (yes vs. no)	0.78	0.67–0.91

Abbreviation: OR, odds ratio; CI, confidence interval.

The logistic regression analysis: Nagelkerke  $R^2$ , 0.020,  $P$  value of Hosmer & Lemeshow test, 0.354; the numbers of the responders and non-responders included in the analysis were 2483 and 1193, respectively.

the health changes reported to be worse and the high CBI scores of the primary caregivers were related to the high non-response rate in phase 1. However, cataract history of the veterans and female caregivers was associated with the lower non-response rate in phase 1 (Table 4).

The univariate analysis showed that only one factor from the primary caregivers, i.e., high CBI total score, was associated with non-response in phase 2 (Table 3). Thus, a single multivariate analysis for factors from the veterans was conducted in phase 2. The associated factors of non-response in phase 2 primarily originated from the veterans themselves, including non-participation in physical activity, worsened health changes, previous history of glaucoma, osteoarthritis and cardiac diseases (Table 5). Among these factors, a history of osteoarthritis and cardiac diseases was related to the decreasing non-response rate in phase 2 (Table 5). Neither the total score of the MMSE nor that of the MoCa was related to the non-response in phase 2. Whether they were included in the multivariate logistic regression simultaneously or respectively had no significant impact on the final results regarding the other associated factors in phase 2. The numbers of responders and non-responders included in the analysis decreased from 2483 and 1193 to 304 and 149, respectively, when the CBI total score was entered into the multivariate analysis. The results were markedly changed compared with Table 5 and only the non-participation in physical activity was related to the non-response in phase 2; its OR (95% CI) was 1.65 (1.10–2.47).

#### 4. Discussion

Compared with the increase in the cross-sectional studies of dementia from LMIC, research regarding the causes of non-

response and its related factors appears to be disproportionately insufficient (Chatfield et al., 2005; Prince et al., 2013). In the present study, we aimed to address this issue in two research phases. Our findings demonstrated that illness and hospitalization were the most common reasons for non-response in both phases, accounting for more than 55%. The percentage of death and refusal to participate in phase 2 was higher, causing a non-response rate in phase 2 to be nearly 7 times higher than that in phase 1. The screening tests, including the MMSE and MoCa in phase 1, were easy compared with the more comprehensive neuropsychological batteries used in phase 2. The baseline information, such as demographic data, were available from the database of the healthcare system of veterans, all of which also contributed to the higher non-response in phase 2 than that in phase 1. The characteristics of the non-responders in the two phases were similar: compared with the responders, the non-responders were more likely to refrain from physical or social activities, require increased life care, report poor health status, suffer from many NCDs, and have a family history of neuropsychiatric disorders. Unfavorable conditions were experienced not only by the non-responders themselves but also by their caregivers, whose health condition was worse and their care burden was heavier than that of the responders' caregivers. The multivariate analysis suggested that the general health status and concomitant NCDs of veterans and the heavy burden of their caregivers were the principal independent associated factors of non-response in both phases.

The veterans included in this study constitute a stable population living in Chinese veterans' communities and have an optimal health management system. It is reliable and convenient to collect such participants' detailed, long-term medical records and describe the characteristics of their caregivers (Tan et al., 2014). Therefore, the majority of the baseline information could easily be obtained from the veterans' healthcare system; the non-response rate in phase 1 was only 5.4%, which was lower than the majority of the dementia studies in older adults or the oldest old (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamoto et al., 2009; Chatfield et al., 2005; Tyas et al., 2006; Lopes et al., 2012; Bootsma-van der Wiel et al., 2002). Support and assistance from the veterans' communities persisted, despite the increase (to 35.0%) in the non-response rate in phase 2. This rate is significantly higher than that of previous similar studies despite our effort to perform home interviews for those disabled or prone to drop out for other reasons (Helliwell et al., 2001; Lucca et al., 2011; Miyamoto et al., 2009). Considering the difference in research content between these two phases, we proposed that the perceived burden of the complex and time-consuming neuropsychological tests in phase 2 may have discouraged those non-responders to participate. Therefore, a one-phase study design combining screening and sensitive neuropsychological examinations, such as "the Monzino 80-plus Study" (Lucca et al., 2011) or the "10/66 study" for LMIC (Llibre et al., 2008), may effectively shorten the interview length and consequently increase the response rate in dementia studies involving the oldest old.

For the oldest old, their poor health state may be the primary negative factor related to non-response (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamoto et al., 2009; Chatfield et al., 2005; Tyas et al., 2006; Lopes et al., 2012; Bootsma-van der Wiel et al., 2002). In our study, illness, hospitalization, and death were the primary reasons for non-response in both phases, accounting for 63.0% and 75.5% of non-response in phases 1 and 2, respectively. The higher death rate among the non-responders in phase 2 appeared to be indicative of their pre-existing weaker health state than that of non-responders in phase 1. Compared with other dementia studies (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamoto et al., 2009; Chatfield et al., 2005; Tyas et al., 2006; Lopes et al., 2012; Bootsma-van der Wiel

et al., 2002; Vega et al., 2010), refusal and absence during the study period were also common factors in our study; however, having non-contact, moving away from the study area and being unreachable were not contributors because the veterans have fixed habitation in veterans' communities and their healthcare staff maintain communication with them.

Several studies of dementia have indicated that poor self-rated health and mobility were associated with non-response (Matthews et al., 2004; Chatfield et al., 2005; Bootsma-van der Wiel et al., 2002; Vega et al., 2010; Matthews et al., 2006; Matthews, Chatfield, & Brayne, 2006). Similarly, our findings showed that the non-responders in phases 1 and 2 appeared to have a worse health status and were less active. Furthermore, the multivariate analyses demonstrated that non-participation in social or physical activities, self-perceived worse health status evaluated using SF-36, and a self-reported need for life care notably increased the non-response rate of phase 1 or 2. These factors were independent predictors of non-response in the oldest old.

A history of hearing loss and glaucoma, increasing the difficulty for the oldest old to complete the neuropsychological batteries, was associated with non-response in phase 1 or 2 of this study. However, the non-responders in these two phases had a lower prevalence of cataracts, osteoarthritis and cardiac diseases than that of responders. This seemingly contradictory finding may be evident because those diseases were controlled well and did not disturb their ability to participate in the study. Other important NCDs, such as stroke, depression and family history of neuropsychiatric diseases, were not correlated with the non-response in the present study. Previous studies, including "MRC CFAS" (Matthews et al., 2006), "the Monzino 80-plus Study" (Lucca et al., 2011) and "the 90+ Study" (Paganini-Hill, Ducey, & Hawk, 2013), demonstrated that the responders did not differ from the non-responders with regard to the aforementioned NCDs and family history of dementia.

Evidence has indicated that there is no effect of cognitive difficulties on non-response (Zunzunegui et al., 2001; Paganini-Hill et al., 2013), although several studies have suggested that cognitive impairment was a primary independent factor related to non-response (Anstey & Luszcz, 2002; Chatfield et al., 2005; Lucca et al., 2011; Levin et al., 2000; Matthews et al., 2006, 2004; Miyamoto et al., 2009; Tyas et al., 2006; Vega et al., 2010). Similarly, the multivariate analysis in this study documented that cognitive function evaluated by both the total scores of the MMSE and the MoCa was not associated with the non-response in phase 2. Moreover, other factors formerly identified as contributors to poor response rates, such as age, marriage, and ADL dependence, were not verified in our study. Those disparities could be explained by the different participants' backgrounds or different measurement instruments and outcome predictors (Boersma et al., 1997; Helliwell et al., 2001; Lucca et al., 2011; Miyamoto et al., 2009; Chatfield et al., 2005; Tyas et al., 2006; Bootsma-van der Wiel et al., 2002; Coley et al., 2008; Vega et al., 2010; Matthews et al., 2006; Paganini-Hill et al., 2013; Levin et al., 2000; Anstey & Luszcz, 2002).

A heavy burden of the primary caregivers (reflected by the CBI score) (Coley et al., 2008; Koss, Peterson, & Fillenbaum, 1999) and their concomitant self-reported health deterioration were two important determinants of non-response. The difference was that the former impacted on both phases, whereas the latter only impacted on phase 1. Not all of the factors identified from the caregivers were negative: the female caregivers seemed to be able to motivate the veterans to participate in this study in phase 1. The majority of the female caregivers were the participants' wives. This finding is identical to the results reported by Coley et al. (2008), who noted that the patients who were cared for by their spouse were less likely to drop out than those who were cared for by an unrelated caregiver. Regarding the important role that the primary

caregivers played, improving their quality of life and reducing their care burden might shed light on limiting the non-response in future studies of dementia.

Several studies have confirmed that the "non-responders" in the epidemiological studies of dementia not only displayed poor health and cognitive functions (Matthews et al., 2004, 2006; Chatfield et al., 2005; Anstey & Luszcz, 2002), but they also had a significantly higher risk of dementia than the "responders," with an OR of 2.91 (Vega et al., 2010). Correcting for the non-response significantly affects the prevalence or incidence of dementia. For example, before correcting for the non-response, the prevalence of dementia in Brazil was 5.9%, whereas after the correction, the prevalence of dementia was 12.5% (Lopes et al., 2012). The incidence of dementia in a Canadian study before correcting for non-response was 17.8/1000 person-years, which increased to 25.3/1000 person-years after the correction (Tyas et al., 2006). Therefore, ignoring non-responders with "a high risk of dementia" will inevitably produce biased results that significantly underestimate the prevalence of dementia. Furthermore, because of developments in clinical epidemiology and methodology and improvements in analytical software, several statistical methods (e.g., inverse probability weighting and multiple imputation) have demonstrated efficacy in managing the effect of the missing data by the non-responders (Hernan, Hernandez-Diaz, & Robins, 2004; Klebanoff & Cole, 2008; Little & Rubin, 2002). However, the analytical methods were underutilized in dementia investigations (Hernan et al., 2004; Klebanoff & Cole, 2008; Little & Rubin, 2002; Resseguier et al., 2013; Taylor et al., 2002).

This exploratory investigation has several limitations. The participants in this study are urban community-based male veterans and are therefore not representative of the entire population of older adults in China. There was a high proportion of missing data in several variables, weakening the statistical power and thus the reliability of the results. A multivariate analysis in which both factors from the veterans and caregivers were included was difficult to perform because there were fewer data of the non-responders in phase 1. There was also limited caregivers' information in both phases, which influenced the accuracy of the outcome. Therefore, the non-response in phase 1 and the caregivers' factors that correlated with the non-response in the dementia study should be investigated. Additionally, the factors relevant to the non-response due to different reasons cannot be discussed because of the small sample size when further divided according to different reasons of the non-response. Despite these limitations, our study of non-response is worthwhile because it involves one of the largest cohorts of the oldest old in a LMIC. The determinants of the non-response have seldom been studied. Finally, among the studies of dementia in the oldest old in LMIC, this study is the first to investigate the caregivers' characteristics as associated factors of non-response.

In conclusion, the non-responders generally rated their health as being poorer, were less active, were more likely to die, and had more disabling NCDs. The caregivers' factors, especially heavy care burden, and study design may influence non-response. Such information may help us to develop better preventative strategies for improving the response rates and the study quality in the future.

## Conflict of interests

The authors declare that they have no conflict of interests.

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