Short Communication

Prevalence and predictors of malnutrition in elderly Chinese adults: results from the China Health and Retirement Longitudinal Study

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Abstract

Objective: China has the largest population of elderly citizens in the world, with 177 million adults aged 60 years or older. However, no national estimate of malnutrition in elderly Chinese adults exists. We estimated the prevalence and predictors of malnutrition in this population.

Design: Data from the second wave of the Chinese Health and Retirement Longitudinal Study (CHARLS) include interview and biomarker data for 6450 subjects aged 60 years or older from 448 different communities in twenty-eight provinces, allowing for nationally representative results. Malnutrition was identified based on the ESPEN (European Society of Parenteral and Enteral Nutrition and Metabolism) criteria. We used multivariable regression to investigate the predictors of malnutrition, including demographic factors, marital status, self-reported health status, self-reported standard of living, health insurance status and education.

Setting: China.

Subjects: Community-dwelling Chinese adults aged 60 years or older.

Results: The prevalence of malnutrition in elderly Chinese adults was 12·6 %. Malnutrition was most common among those who were older (OR = 1·09; 95 % CI 1·07, 1·10), male (OR = 1·41; 95 % CI 1·10, 1·79), lived in rural areas (*v.* urban: OR = 0·75; 95 % CI 0·57, 1·00) or lacked health insurance (*P* < 0·01).

Conclusions: The burden of malnutrition on elderly Chinese adults is significant. Based on current population estimates, up to 20 million are malnourished. Malnutrition is strongly associated with demographic factors, shows a trend to association with health status and is not strongly associated with standard of living or education. A coordinated effort is needed to address malnutrition in this population.

China has a large and growing elderly population. In 2012, 177 million Chinese residents (13·3 % of the population) were over 60 years old[1], and this segment of the population is expected to grow to 487 million (36·5 % of the population) by 2050[2]. As a group, this cohort has seen tremendous changes in Chinese society. Many were born before the founding of the People's Republic of China in 1949 and all have witnessed the subsequent industrialization, urbanization and economic growth of their country.

As China's society has changed, so have the health-care needs of its citizens. Several researchers have documented this shift, focusing on the epidemiological transition from infectious to chronic disease and the rapidly ageing Chinese population[3–7]. In the realm of nutrition, most of the focus has been on how changes in the Chinese diet may lead to increased incidence of hypertension, obesity and heart disease[4,8]. Although obesity is an important aspect of malnutrition, the present study focuses instead on

undernutrition and references to malnutrition should be understood in this context.

Despite the size of the elderly population in China, the expected growth of this population and their impact on the burden of malnutrition, surprisingly little attention has been paid to malnutrition among Chinese elderly and national estimates of malnutrition prevalence are unavailable. Most estimates of nutrition status in elderly Chinese persons have relied on data from the China Health and Nutrition Survey (CHNS) which 'was not designed to be representative of China but (...) to provide data from randomly selected households in eight provinces'[9]. An analysis of the 2009 wave of the CHNS found that 8·5 % of participants aged 60 years or older were underweight according to the standard WHO definition (BMI ≤ 18·5 kg/m^2)[10]. Other studies have used data from regional populations. Zhang *et al.* found that 5·3 % of study participants over 55 years old in three rural China towns were underweight according to the WHO definition[11]; Han *et al.* found that 36·4 % of the elderly in Wuhan, China were at risk of malnutrition and 8·0 % were malnourished according to the Mini Nutritional Assessment (MNA)[12]; and Xu-Feng *et al.* found that 21 % of retired residents surveyed in Shanghai were either malnourished or at high risk of malnutrition according to the MNA[13].

Similarly, there is little evidence on the predictors of malnutrition in China. One study based on evidence from Wuhan, China found that chronic conditions, age, functional status and marital status were related to malnutrition[12]. A study of compliance to dietary guidelines in elderly Chinese found that women, those living in medium and high urbanicity areas and those with high education adhered better to dietary guidance[14].

The purpose of the present study was to provide a nationally representative estimate of the prevalence of malnutrition in elderly Chinese adults and to determine predictors of malnutrition in this population.

Methods

Our analysis was based on data from the China Health and Retirement Longitudinal Study (CHARLS)[15]. The CHARLS used a complex, multistage design to create a nationally representative sample of community-dwelling Chinese adults over the age of 45 years. The survey used probability-proportional-to-size sampling and stratification by region, urban/rural counties and per capita gross domestic product. Each individual in the study was assigned a weight based on the probability of inclusion and our analysis used these weights to generate nationally representative results. Full details on the survey design have been published elsewhere[15].

Respondents completed a detailed questionnaire on demographics, socio-economic status, health status and functioning, health-care use, health insurance and income.

Researchers also obtained a series of biomarkers for each respondent, including height and weight. The CHARLS was first conducted in 2011 and then repeated with the same individuals (where possible) in 2013. Our results are estimated using the second wave of CHARLS data. We limit our analysis to adults aged 60 years or older. The CHARLS contains 6450 individuals in this age group from 448 different communities in twenty-eight provinces of China. All respondents who agreed to participate in the study signed a form indicating informed consent, and the study was approved by the Ethical Review Committee at Peking University in January 2011[16].

Although the CHARLS does not contain a direct measure of malnutrition, several variables collected in the CHARLS data relate to nutritional status. The European Society of Parenteral and Enteral Nutrition and Metabolism (ESPEN)[17] definition of malnutrition is most easily applicable to the CHARLS data. This definition specifies that an individual is malnourished if the first condition (1) below holds, or if one of the conditions for weight loss (2.1 or 2.2) AND either low BMI (3.1) or low fat-free mass index (3.2) are met:

1. BMI is less than 18·5 kg/m^2;
2.1. Greater than 10 % weight loss over an indefinite time;
2.2. Greater than 5 % weight loss in the last three months;
3.1. BMI less than 20 kg/m^2 if aged under 70 years or less than 22 kg/m^2 if aged over 70 years;
3.2. Fat-free mass index less than 15 kg/m^2 for women and 17 kg/m^2 for men.

It should be noted that the ESPEN definition of malnutrition, which was designed for use in clinical practice, does not require that all conditions of the definition be available to make a diagnosis[17]. BMI (conditions 1 and 3.1) was easily calculable using the biomarkers from the data. For those who were in both waves of the survey (2011 and 2013), we identified individuals who had a 10 % weight loss between survey waves (condition 2.1). However, the CHARLS did not contain data on body composition, nor did it look specifically at weight loss in the last three months, so conditions 2.2 and 3.2 were not used in our determination of nutritional status. Theoretically, this may lead us to underestimate the prevalence of malnutrition, but we expect this bias to be minimal based on research from Rojer *et al.*, which found that no geriatric patient in their sample of 135 was identified by fat-free mass index who was not also identified by BMI[18]. In sum, we use conditions 1, 2.1 and 3.1 as our ESPEN definition of malnutrition.

Prevalence estimates were calculated separately for BMI less than 18·5 kg/m^2, 10 % weight loss and BMI below age-defined cut-offs, and for the ESPEN definition as a whole.

Predictors of malnutrition included variables commonly cited in the malnutrition literature[19], which also appeared

in CHARLS. Demographic factors such as age, gender, race and marital status were recorded in response to the CHARLS questionnaire. Similarly, socio-economic factors such as level of education obtained, standard of living compared with neighbours, health status and health insurance status were also collected by respondent response. The respondent's location (either urban or rural) was determined by his/her address when the interview occurred. Additionally, the respondent's family background (urban or rural) was determined by his/her Hukou status, regardless of where the respondent lived when the study was conducted (Hukou status is determined by an individual's parents' Hukou registration and plays an important role in accessing many government resources).

Predictors were analysed using multivariable logistic regression and OR are reported. Separate multivariable logistic regressions were performed for BMI less than 18.5 kg/m^2, 10% weight loss and BMI below age-defined cut-offs, and for the ESPEN definition as a whole. Survey weights were included to yield nationally representative results. For binary and continuous variables, t tests were used to assess the statistical significance of model parameters in logistic regression. For other categorical variables, the Wald test was used to test the joint significance. All analyses were performed using the statistical software package Stata version 13.

Results

Weighted summary statistics for the survey population are reported in Table 1. Males made up slightly less than half of the population (49·4%), most of the population was from the Han ethnic group (93·0%) and the majority was married (76·2%). Most of the sample was from the agricultural Hukou, indicating that they come from a rural background (66·8%), and 47·9% lived in an urban community. Almost all individuals had some form of medical insurance, with the New Rural Cooperative Medical Scheme (NRCMS) covering 66·5% of respondents and 31·4% of them covered by other health insurance. Approximately a quarter (25·0%) of the population had a middle school education, while many (51·7%) had no

Table 1 Population summary statistics for China Health and Retirement Survey (CHARLS) participants aged 60 years or older

Variable	n	%		95% CI
Age (years)	6394			
60–64		34·6		32·7, 36·5
65–69		23·3		21·9, 24·9
70–74		19·3		17·1, 21·7
75–79		13·8		11·6, 12·3
≥ 80		9·0		8·0, 10·0
Male	6394	49·4		47·1, 51·7
Han ethnicity	6394	93·0		92·2, 93·8
Agricultural Hukou†	6394	66·8		64·0, 69·5
Married	6394	76·2		74·2, 78·1
Urban	6394	47·9		45·5, 50·2
New Rural Cooperative Medical Scheme	6328	66·5		63·8, 69·0
Other insurance	6328	31·4		28·8, 34·1
Highest level of education	6392			
No education		51·7		49·4, 54·1
Elementary school or Sishu‡		23·3		21·4, 25·3
Middle school or higher		25·0		22·5, 27·6
Health status	6368			
Poor or very poor		29·2		27·5, 30·9
Fair		48·2		45·9, 50·5
Good		14·9		12·7, 17·3
Excellent or very good		7·8		6·9, 8·7
Standard of living compared with neighbours	5392			
Much worse		16·2		14·1, 18·7
A little worse		19·9		17·4, 22·6
About the same		54·6		52·0, 57·1
Much better or a little better		9·3		8·1, 10·5
		Mean	SE	
BMI (kg/m²)				
Males	3136	23·7	0·37	22·9, 24·4
Females	3113	24·2	0·23	23·8, 24·7

All statistics are adjusted by population weights to provide nationally representative estimates.
†Hukou is a system of household registration in China which classifies citizens as either rural or urban and is tied to delivery of many social programmes. Unlike the urban indicator, which describes the individual's current residence, the Hukou is assigned based on the individual's parents' location and does not change over the individual's life.
‡Sishu is a traditional school roughly equivalent to elementary school.

Table 2 Prevalence of malnutrition and of malnutrition indicators used in the ESPEN definition among China Health and Retirement Survey (CHARLS) participants aged 60 years or older

ESPEN indicator of malnutrition	n	Prevalence (%)	95 % CI
ESPEN definition of malnutrition	6288	12·57†	11·55, 13·67
BMI < 18·5 kg/m^2	6288	7·68	6·93, 8·51
Weight loss > 10 % AND BMI < 20 kg/m^2 if aged <70 years OR BMI < 22 kg/m^2 if aged ≥70 years	6260	7·18	6·42, 8·03

ESPEN, European Society of Parenteral and Enteral Nutrition and Metabolism.
†Malnutrition prevalence based on the ESPEN definition is less than the sum of the two malnutrition indicators because of overlapping patients who qualify under both indicators.

formal education at all. Less than a third of respondents (29·2 %) reported poor or very poor health status, and 36·1 % said that their standard of living was a little worse or much worse than that of their neighbours.

The prevalence estimates for malnutrition are given in Table 2. The overall prevalence of malnutrition was 12·57 % using the ESPEN definition. This includes the population with a BMI less than 18·5 kg/m^2 (7·68 %), as well as those who experienced 10 % weight loss and had BMI less than 20 kg/m^2 if aged under 70 years or less than 22 kg/m^2 if aged over 70 years (8·67 %). The overall prevalence rate (12·57 %) is less than the sum of the two indicators (7·68 + 8·67 % = 16·35 %) because the definitions overlap in 3·78 % of the population.

Estimates of the predictors of malnutrition are given in Table 3. Unsurprisingly, the probability of meeting the ESPEN criteria for malnutrition increased with age. For every 1-year increase in age, the odds of being malnourished increased by 8·5 % (OR = 1·09; 95 % CI 1·07, 1·10; P < 0·01). The odds of being malnourished were 41 % higher for males than for females (OR = 1·41; 95 % CI 1·10, 1·79; P < 0·01).

Neither ethnic group nor Hukou status appeared to be a significant predictor of malnutrition diagnosis (OR = 0·76; 95 % CI 0·54, 1·08; OR = 1·23; 95 % CI 0·70, 2·14, respectively); however, those living in an urban community were less likely to be malnourished than those in a rural community (OR = 0·75; 95 % CI 0·57, 1·00; P = 0·048).

Neither education nor standard of living was predictive of malnutrition (P = 0·809; P = 0·285, respectively). Individuals who rated their health as 'fair' or 'very good or excellent' had significantly lower probability of being malnourished than those who rated their health as 'poor' or 'very poor' (P < 0·05). Those who rated their health as 'good' also had lower odds of being malnourished compared with those whose health was 'poor' or 'very poor', but the difference was not statistically significant. A joint test of self-reported health status failed to demonstrate significance at P < 0·05 but demonstrated a trend towards significance as a predictor of malnutrition (P = 0·083).

Health insurance was a statistically significant predictor of malnutrition (P < 0·01). Individuals with NRCMS and individuals with other insurance were less likely to be malnourished than those with no insurance (OR = 0·53; 95 % CI 0·32, 0·87; OR = 0·34; 95 % CI 0·18, 0·64, respectively).

Discussion

The present study is subject to several limitations. Data on health status and standard of living are self-reported, and are not independently verified, which may bias results. The cut-off points for BMI in the ESPEN definition of malnutrition used in the study were designed for use in European populations and the authors of the ESPEN definition acknowledge that 'ethnic and regional variability in BMI may need to be considered'[17]. Also, the CHARLS data do not contain information on body composition or weight loss in the last three months, preventing the use of two of the five criteria in the ESPEN definition of malnutrition (although, as discussed in the 'Methods' section, the resulting bias is expected to be minimal). Finally, although our study contains clinical measures for weight loss, we are unable to assess if this weight loss is intentional or unintentional. Nevertheless, in a follow-up discussion to the ESPEN definition the authors of the definition agree that the distinction between intentional and unintentional weight loss is not 'of major importance'[20].

Malnutrition is significant among the elderly population in China and the number of malnourished elderly Chinese will grow as this segment of the population expands. Since the present study is the first to use the ESPEN malnutrition criteria in elderly Chinese adults, no direct comparison with previous studies is possible. However, our estimated prevalence of low BMI (7·7 % with BMI ≤ 18·5 kg/m^2) is similar to previous estimates of low BMI in more limited elderly adult Chinese populations[10,11]. Internationally the current study is most comparable to a 2016 study conducted on geriatric outpatients in the Netherlands which found that only 7·4 % were malnourished according to the ESPEN criteria, compared with 12·57 % in China[18]. Our results on the predictors of malnutrition in elderly Chinese are directionally consistent with results from Han *et al.*, which found that being older, widowed and having poor health were associated with malnutrition[12].

Given that the population of elderly Chinese adults is currently 177 million[1], our estimates suggest that over 20 million are malnourished. If prevalence remains unchanged and the elderly Chinese population continues to grow at the expected rate, there will be 62 million malnourished elderly Chinese people by 2050. Given that malnutrition often leads to co-morbidities, increased medical costs and

Table 3 Multivariable logistic regression results for predictors of malnutrition and of malnutrition indicators used in the ESPEN definition among China Health and Retirement Survey (CHARLS) participants aged 60 years or older

Predictor variable	ESPEN definition		BMI < 18.5 kg/m²		Weight loss > 10 % AND BMI < 20 kg/m² if aged <70 years OR BMI < 22 kg/m² if aged ≥70 years	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
Age	1·09**	1·07, 1·10	1·07**	1·05, 1·09	1·08**	1·06, 1·11
Male	1·41**	1·10, 1·79	1·48**	1·13, 1·94	1·53*	1·09, 2·13
Han ethnicity	0·76	0·54, 1·08	0·69	0·46, 1·03	0·77	0·47, 1·26
Agricultural Hukou	1·23	0·70, 2·14	1·19	0·58, 2·44	1·71	0·85, 3·45
Married	0·75	0·56, 1·00	0·91	0·66, 1·26	0·54**	0·37, 0·79
Urban	0·75*	0·57, 1·00	0·80	0·58, 1·12	1·06	0·73, 1·52
Highest level of education† (Ref.: no education)						
Elementary school or Sishu	0·92	0·70, 1·21	0·91	0·67, 1·23	0·87	0·57, 1·32
Middle school or higher	1·01	0·70, 1·45	0·81	0·54, 1·21	1·18	0·72, 1·93
Self-reported health status† (Ref.: poor or very poor)**						
Fair	0·79*	0·62, 1·00	0·74*	0·57, 0·96	0·86	0·62, 1·21
Good	0·96	0·66, 1·39	0·90	0·60, 1·34	1·07	0·64, 1·80
Excellent or very good	0·60*	0·36, 0·98	0·37**	0·19, 0·71	0·87	0·45, 1·67
Insurance† (Ref.: no insurance)	**		**			
New Rural Cooperative Medical Scheme	0·53*	0·32, 0·87	0·50*	0·27, 0·90	0·58	0·30, 1·12
Other insurance	0·34**	0·18, 0·64	0·21**	0·09, 0·48	0·62	0·27, 1·42
Standard of living compared with neighbours† (Ref.: much worse)						
A little worse	1·33	0·92, 1·92	1·08	0·73, 1·60	1·52	0·92, 2·52
About the same	1·13	0·82, 1·56	1·00	0·70, 1·43	1·15	0·75, 1·76
Much better or a little better	0·87	0·53, 1·45	0·71	0·39, 1·29	0·99	0·52, 1·91
n	5251		5251		5251	

ESPEN, European Society of Parenteral and Enteral Nutrition and Metabolism; Ref., reference category.
Weight loss calculated between the first wave of the CHARLS (2011) and the second wave of the CHARLS (2013).
*$P < 0.05$, **$P < 0.01$.
†Results for joint significance using the Wald test are displayed on this line.

loss of functional independence, malnutrition represents a tremendous challenge to the Chinese people.

Our analysis of the predictors of malnutrition suggests how this challenge might be effectively addressed. We find that socio-economic factors (i.e. Hukou, highest level of education obtained, self-reported standard of living compared with neighbours) are not statistically significant predictors of malnutrition in the Chinese elderly. This suggests that malnutrition is not the result of resource constraints, as is often the case in developing countries[21]. Instead, the primary predictors of malnutrition are lack of health insurance and rural residence, and a trend towards significance for poor self-reported health status. This suggests that, like most developed countries, malnutrition in elderly Chinese people is largely driven by disease[22].

Our results also suggest that efforts to address malnutrition should be targeted towards the elderly population with poor self-reported health status. To this end, malnutrition screening should be incorporated into both inpatient and outpatient health-care visits. Patients who are identified at risk of malnutrition should receive nutritional interventions, including nutritional counselling and recommendations for nutritional supplements when appropriate.

The elderly in China have witnessed tremendous changes as their country has transformed over the last seven decades. As life expectancy has increased and infectious disease diminished, they are now faced with a high burden of malnutrition. We hope that this research will inform a coordinated approach by government officials, health-care providers and nutrition experts to address the significant burden of malnutrition at both the clinical and public health levels.

Acknowledgements

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