Original Article

Healthy nutritional status among Centenarians in Rugao, China, is associated with bean consumption, daily activity, and muscle mass retention

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Background and Objectives: Nutritional status is presumed essential for healthy longevity. The city of Rugao in Jiangsu province recognized as a long-lived area on the coastal plain of China, with a higher proportion of centenarians than Chinese elsewhere or in the world at large. The nutritional status and related factors of centenarians in Rugao, along with muscle mass and activities of daily living (ADL) have been documented with a view to improved nutritional and health approaches to healthy ageing. **Methods and Study Design:** A cross-sectional study was conducted in Rugao from April 2020 to December 2020. 116 local centenarians agreed to participate in the study. Nutritional status was evaluated by the Mini Nutritional Assessment Short Form (MNA-SF), and ADL was assessed by the Barthel Index (BI). Anthropometric data (e.g., calf circumference) and body composition data (e.g., skeletal muscle mass) were collected as muscle mass variables. **Results:** The age of centenarians ranged from 100 to 109 years. According to MNA-SF assessment, only 6 (5.2%) of 116 centenarians were malnourished, and 57 (49.1%) were at risk of malnutrition. Binary logistic regression results indicated that prealbumin, albumin, bean product consumption, and current exercise status were independent determinants of centenarians' nutritional status. Centenarians with poor nutritional status tended to have worse muscle mass and BI scores. **Conclusions:** Nearly half of the centenarians maintained normal nutritional status, insofar as muscle mass condition and function were concerned. Frequent bean product consumption and routine exercise were conducive to healthier centenarian nutritional status.

Key Words: Centenarians, nutritional status, muscle mass, activities of daily living, related factors

INTRODUCTION

Human life expectancy has been continuously extended due to the vigorous progress of society and the endless evolution of medicine.[1,2] This is regarded as one of the greatest achievements of mankind. New ways to create 'age-friendly' societies are being sought around the world.[3] As a country with the largest geriatric population in the world, China is facing the huge challenge of population aging. Healthy aging is a key way for China to deal with it, which can fundamentally lighten the load of aging.[4] Nutrition is one of the most significant components of health in older adults.[5] Reasonable nutrition has a marked impact on maintaining the elderly's normal physiological function, improving immunity, and postponing senility courses.

Along with the growth of age, the elderly's somatic function shows a trend of continuous decline. Depression of organ function, adverse effects of disease, and changes in diet and lifestyle all put them at greater risk of malnutrition.[6] Malnutrition remains a major burden on health condition in developing countries.[7] Data from the second wave of the Chinese Health and Retirement Longitudinal Study (CHARLS) showed that the prevalence of malnutrition among 6450 Chinese aged people (aged ≥60 years) was 12.6%.[8] Another study conducted in Hainan indicated that 20.8% of centenarians were malnourished and 67.0% were at risk of malnutrition, only 12.3% had normal nutritional status.[9] As a common geriatric syndrome,

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malnutrition is often related to sorts of adverse health outcomes, such as anemia, sarcopenia, frailty, and cognitive impairment.[10-13] Ultimately, it may affect various aspects of the individuals' activities of daily living (ADL), leading to diminished quality of life (QoL) and increased morbidity and mortality.[14,15] Furthermore, the aging process is accompanied by a decline in muscle quantity and quality. Low muscle mass is connected with poor nutritional status and many other negative outcomes, such as function impairments and QoL decline.[16,17] However, the role of low muscle mass in the management of malnutrition has not been fully appreciated.[18] As a result, the decreased muscle conditions and functional dependence of old people which associated with malnutrition require high levels of concern and effective clinical interventions, otherwise serious health problems will arise.

Rugao is an historical and cultural city in the Nantong jurisdiction, Jiangsu Province, north of the Yangtze River Delta region, China. Its economy and industry are relatively developed, mainly inhabited by the Han ethnic group. It is a county-level city with the largest number of centenarians in China, and it is also the only longevity region located on the coastal plain.[19] The proportion of centenarians here reached 3.7 per 10,000 people, much higher than the standard set by the United Nations. Centenarians are thought to able to escape major age-related diseases and live close to the human lifespan limit. Their existence is the optimal example that represents the realization of successful aging.[20,21] Taking Rugao centenarians as an example, this study explored the reasons for the maintenance of health status of the oldest-old, which has unique reference value for improving the understanding of healthy aging. Exploration of the nutritional status and its determinants among long-lived people in various regions of China, may provide a working basis for nutrition intervention strategies with advancing years in China and elsewhere. To the end, we have investigated the nutritional status and related factors of centenarians in Rugao, Jiangsu province, with a focus on diet, daily activity and muscle mass.

METHODS

Study design and participants

From April 2020 to December 2020, this cross-sectional study was conducted in Rugao, Jiangsu province, China. We recruited local centenarians as listed by the Rugao People's government. Home-based interviews and assessments, including questionnaires, anthropometry, body composition analysis, and blood examination were performed by a trained research team. The study was approved by the Ethics Committee of Affiliated Hospital of Nantong University (2019-K045). The inclusion criteria were as follows: (1) aged at least 100 years, their age was confirmed by the year of birth recorded on their identification card; (2) permanent residents of Rugao; (3) volunteered to participate in the study and signed informed consent. The exclusion criteria were: (1) unable to complete the questionnaire due to hearing impairment, cognitive disorder and other conditions; (2) refused to participate in this study. Finally, 116 local centenarians completed informed consent and were enrolled in this study.

Sociodemographic, behavioral and health characteristics

Basic sociodemographic information was gained via face-to-face interviews by self-designed questionnaire, which contained the information of age, gender, place of residence, living arrangement, educational level, marital status, occupation before the age of 60, and self-reported standard of living compared with neighbors. Medical history and presence of chronic diseases were self-reported. The frequency of food intake was obtained by asking participants themselves or their caregivers. In addition, they reported usual personal behavior, including exercise.

Following the questionnaire surveys, participants did not eat breakfast the next morning. Fasting blood collected by nurses was sent to the Affiliated Hospital of Nantong University at 4°C for analysis. Biochemical indicators included prealbumin, albumin, total lymphocyte count, and hemoglobin.

Nutritional status

The Mini Nutritional Assessment Short Form (MNA-SF) was used to assess nutritional status in our study.[22,23] The Chinese version of MNA-SF is used widely for Chinese elderly.[24,25] Brief questions in the 6-item scale are: (1) weight loss during last three months; (2) BMI; (3) psychological stress or acute disease in the past three months; (4) mobility; (5) neuropsychological problems and (6) food intake over the past three months. Total scores range from 0 to 14, less than 8 points indicating malnutrition, 8 to 11 points a risk of malnutrition, and 12 to 14 points normal nutritional status. Because of sample size, we combined the malnourished with those at risk of malnutrition as a 'poor nutritional status' group.[9,24] The population was then considered as of 'normal' or 'poor' nutritional status.

Activities of daily living (ADL)

Barthel index (BI) is a general scale utilized to evaluate an individual's functional status.[26] It contained ten items to do with the basic daily needs of the elderly: feeding, bathing, grooming, dressing, bowel continence, bladder continence, toilet use, transfers, walking, and stair climbing. Each item is given a score and the global scores summed, ranging from 0 to 100, with higher scores indicating greater ability to perform ADL.

Body compositional indicators

Anthropometric and body composition information were used to derive muscle mass. BMI was calculated by dividing weight (kilograms) squared by height (meters). Waist circumference (WC), hip circumference (HC), left and right mid-upper arm circumferences (MUAC), together with left and right calf circumferences (CC) were measured with an inextensible tape (cm). The largest horizontal plane of the muscle without contraction was measured. MUAC was measured at the biceps brachii's widest, and CC was measured at the widest triceps surae. The waist-hip ratio (WHR) was calculated by dividing WC by HC. Body composition data such as fat, fat-free mass (FFM), percentage of body fat (PBF), visceral fat area (VFA), skeletal muscle mass (SMM), and skeletal

muscle mass index (SMI) were assessed by bioelectrical impedance analysis (BIA, InBody S10).

Statistical analyses

All statistical analyses were performed by IBM SPSS Statistics 21.0. One-sample Kolmogorov-Smirnov non-parametric tests were used to analyze whether the descriptive data obeyed normal distribution. If they were normally distributed, means ± standard deviations (SDs) were used to describe the continuous variables' characteristics, otherwise medians (lower quartiles, upper quartiles) were expressed to describe the non-normal distributed variables' characteristics. For categorical variables, frequencies (percentage) were used. Independent-Samples T-tests, Mann-Whitney U tests, and Chi-square tests or Fisher's exact tests were applied to compare the differences of normally distributed continuous data, non-normally distributed continuous data, and categorical data in the two groups, respectively. Age, gender and all variables that were statistically different in univariate analysis were included in the model. Binary logistic regression was used to identify the predictors of poor nutritional status in centenarians. Two-sided *p* values below 0.05 were considered statistically significant.

RESULTS

Study population sociodemography

The characteristics of the study population are shown in Table 1. For the 116 participants, age ranged from 100 to 109 years, with a median of 101 years; 89 were women (76.7 %). The majority lived in rural areas (87.1%), worked as farmers before the age of 60 (90.5%), did not receive a formal education (84.2%) and had a medium standard of living (74.3%). The majority were single, divorced, or widowed (98.3%), though only 1 (0.9%) centenarian lived alone. The median MNA-SF was 11 points: 6 (5.2%) were malnourished, 57 (49.1%) were at risk of malnutrition, and 53 (45.7%) had a normal nutritional status.

Nutrition group characteristics and health status

The two nutritional groups are compared in Tables 2 and 3. There were no differences in sociodemographic characteristics between the groups (p>0.05). Those with a poor nutritional status were more likely to suffer from heart disease (p=0.031). All blood indices differed by nutrition group (p<0.05). Frequent bean product consumption (p=0.035) and habitual exercise (p=0.004) were associated with better nutritional status.

Predictors of poor nutritional status in centenarians

Age, gender, and all variables which differed on univariate analysis were modelled. Binary logistic regression (Table 4) revealed that bean product consumption, habitual exercise, and biochemical prealbumin and albumin measurements were independent determinants of nutritional status in centenarians (p<0.05).

Muscle mass and ADL performance by nutritional status

There were differences in BMI, WC, HC, WHR, left and right MUAC and CC between the two groups (p<0.05). All body composition variables were different (p<0.05). Consistent with the nutritional group assignment by MNA-SF, individuals with poor nutritional status also had lower BI total scores and lower scores for the first nine of the ten subitems' scores (p<0.05) (Table 5).

DISCUSSION

Using MNA-SF as an index of nutritional status in Rugao centenarians, connections between it and dietary habits together with habitual exercise habits, and greater muscle mass were found. Of functional relevance, ADL were better in the nutritionally advantaged, as was self-reported heart disease. This picture of being centenarian in Rugao has not previously been reported. It may be a phenomenon to be found elsewhere in China or elsewhere (Table 6). In the present study, only 5.2% of were malnourished, lower than the prevalence among Hainan centenarians

Table 1. Centenarians sociodemography and nutritional indices

Variables	Total (N=116)
Sociodemographic characteristics	
Age (years)†	101 (100, 102)
Gender, male‡	27 (23.3)
Place of residence, rural‡	101 (87.1)
Living arrangement, living alone‡	1 (0.9)
Education level, illiterate‡	96 (84.2)
Marital status, married‡	2 (1.7)
Occupation before the age of 60, farmer‡	105 (90.5)
Self-reported standard of living‡	
Very rich/rich	16 (14.2)
Fair	84 (74.3)
Poor/very poor	13 (11.5)
MNA-SF	
MNA-SF total scores†	11 (10, 13)
MNA-SF classification‡	
Normal nutritional status	53 (45.7)
Risk of malnutrition	57 (49.1)
Malnutrition	6 (5.2)

MNA-SF: mini nutritional assessment short form.
†Median (lower quartile, upper quartile).
‡Number (%).

Table 2. Sociodemographic and health-related characteristics of centenarians by nutritional status

Variables	Normal nutritional status (N=53)	Poor nutritional status (N=63)	*p*
Sociodemographic characteristics			
Age (years)†	100 (100, 102)	101 (100, 102)	0.085
Gender, male‡	15 (28.3)	12 (19.0)	0.240
Place of residence, rural‡	46 (86.8)	55 (87.3)	0.935
Living arrangements, living alone‡	0 (0.0)	1 (1.6)	>0.999
Education level, illiterate‡	43 (82.7)	53 (85.5)	0.684
Marital status, married‡	1 (1.9)	1 (1.6)	>0.999
Occupation before the age of 60, farmer‡	48 (90.6)	57 (90.5)	0.987
Self-reported standard of living‡			0.127
Very rich/rich	6 (11.5)	10 (16.4)	
Fair	43 (82.7)	41 (67.2)	
Poor/very poor	3 (5.8)	10 (16.4)	
Health status			
Physical examination‡			0.433
Once or twice a year	13 (24.5)	19 (31.1)	
Seldom/Never	40 (75.5)	42 (68.9)	
Hypertension, yes‡	18 (34.0)	12 (19.0)	0.068
Diabetes, yes‡	1 (1.9)	3 (4.8)	0.624
Gastrointestinal disease, yes‡	11 (20.8)	15 (23.8)	0.694
Heart disease, yes‡	0 (0.0)	6 (9.5)	0.031*
Respiratory disease, yes‡	5 (9.4)	6 (9.5)	0.987
Biochemical indicators			
Prealbumin (mg/L)§	181.65±41.35	141.14±45.27	<0.001***
Albumin (g/L)§	39.14±3.10	35.83±3.73	<0.001***
Total lymphocyte count (*10^9/L) §	1.82±0.56	1.53±0.63	0.014*
Hemoglobin (g/L)§	126.85±14.08	117.05±23.67	0.010*

Nutritional status was evaluated by the Mini Nutritional Assessment Short Form (MNA-SF), less than 12 points indicating poor nutritional status, and 12 to 14 points indicating normal nutritional status.
†Median (lower quartile, upper quartile), analyzed by Mann-Whitney U test.
‡Number number (%), analyzed by Chi-square test or Fisher's exact test.
§Mean±standard deviation, analyzed by Independent-Samples t-test.
*p<0.05; ***p<0.01.

(20.8%), Nicoya (Costa Rica) centenarians (27.9%) and Mexican centenarians (30.2%). The prevalence of malnutrition risk among Rugao centenarians was 49.1%, lower than Hainan centenarians (67.0%) and Mexican centenarians (52.4%), and close to Nicoya centenarians (44.2%).[9,27,28] A study in Sichuan province found that the prevalence of malnutrition and of those at risk of malnutrition in community-living older adults aged 90 and above were 5.7% and 70.4%, respectively.[29] High rates of poor nutritional status in longevity populations demonstrate that its recognition and management remain an opportunity for further advances in healthy longevity.

Ageing itself is regarded as a risk factor for malnutrition, as it is accompanied by physiological changes that affect dietary patterns and quality, nutrient intake, such as oral problems and decreased taste, smell and appetite.[6,29] Our centenarians study was not designed to evaluate the independent and cumulative role of chronological, societal or biological age on functional or health outcomes, as supposed to contemporary personal behaviors and nutritional status and linked with a poor prognosis.[30] The time courses to the abnormal biochemical indices assessed will have been relatively recent although serum albumin and prealbumin were independently related to nutritional status; and protein intakes are not the only determinants which are multinutritional and inflammatory as well.[31]

What probably matters most in our findings is that diet and regular exercise remain important determinants of nutritional health into extreme longevity. 94.2% of centenarian ate vegetables daily, and bean product were consumed more frequently than by the poor nutritional status group (p=0.035), in accord with the dietary habits of other long-living peoples in the so-called 'blue zone'.[32] That legumes or beans favour longevity with affordable and sustainable diets across food cultures is well-established.[33-35] In the case of soy, besides having high-quality protein, it has soluble dietary fibre, oligosaccharides, phyto-oestrogenic isoflavones, essential fatty acids, phytosterols, and other nutrients, as important, it has physicochemical characteristics conducive to appropriate food component delivery and gut microbiomics.[36,37] Regular physical activity, even for short intervals , and in the face of disorders of body composition and chronic disease, prolongs healthy lifespans in people of Chinese ancestry.[38,39] The present study supports this strategy. It is plausible that the dietary and physical activity associations found in the present study act synergistically to benefit body composition.[40] That they are operative in a rice-based culture may allow appropriate protein intakes for muscle mass on the one hand and renal function on the other, although we do not report the state of kidney function.[41,42]

Those with poor nutritional status exhibited less good muscle mass condition from both anthropometric and direct body composition measurements, consistent with other reports.[11,12,43] Senior citizens are prone to falls, as a feature of sarcopenia and reduced muscle strength, often a defining episode in the quest for longevity, being a major

Table 3. Dietary and other behavioral characteristics of centenarians by nutritional status

Variables	Normal nutritional status (N=53)	Poor nutritional status (N=63)	*p*
Dietary habits			
Have fixed meal time, yes†	51 (96.2)	55 (87.3)	0.107
Fruits†			0.963
Every day	10 (19.2)	11 (17.7)	
Every week	15 (28.8)	16 (25.8)	
Every month	6 (11.5)	7 (11.3)	
Seldom/Never	21 (40.4)	28 (45.2)	
Vegetables†			0.322
Every day	49 (94.2)	53 (84.1)	
Every week	1 (1.9)	5 (7.9)	
Every month	1 (1.9)	1 (1.6)	
Seldom/Never	1 (1.9)	4 (6.3)	
Red meat†			0.386
Every day	17 (32.1)	15 (23.8)	
Every week	29 (54.7)	32 (50.8)	
Every month	4 (7.5)	8 (12.7)	
Seldom/Never	3 (5.7)	8 (12.7)	
Poultry†			0.314
Every day	2 (3.8)	4 (6.3)	
Every week	22 (41.5)	16 (25.4)	
Every month	12 (22.6)	16 (25.4)	
Seldom/Never	17 (32.1)	27 (42.9)	
Fish†			0.704
Every day	3 (5.7)	6 (9.5)	
Every week	21 (39.6)	19 (30.2)	
Every month	11 (20.8)	14 (22.2)	
Seldom/Never	18 (34.0)	24 (38.1)	
Seafood [a]			0.053
Every day	0 (0.0)	1 (1.6)	
Every week	5 (9.6)	8 (12.7)	
Every month	13 (25.0)	5 (7.9)	
Seldom/Never	34 (65.4)	49 (77.8)	
Eggs†			0.705
Every day	31 (58.5)	39 (62.9)	
Every week	17 (32.1)	19 (30.6)	
Every month	3 (5.7)	1 (1.6)	
Seldom/Never	2 (3.8)	3 (4.8)	
Bean product†			0.035*
Every day	8 (15.1)	6 (9.5)	
Every week	29 (54.7)	31 (49.2)	
Every month	11 (20.8)	7 (11.1)	
Seldom/Never	5 (9.4)	19 (30.2)	
Dairy†			0.623
Every day	12 (23.1)	21 (33.3)	
Every week	15 (28.8)	16 (25.4)	
Every month	1 (1.9)	2 (3.2)	
Seldom/Never	24 (46.2)	24 (38.1)	
Grain (cereal) foods†			0.138
Every day	26 (49.1)	27 (43.5)	
Every week	16 (30.2)	11 (17.7)	
Every month	5 (9.4)	8 (12.9)	
Seldom/Never	6 (11.3)	16 (25.8)	
Behavioral variables			
Smoking†			0.824
Non-smoker	45 (84.9)	55 (87.3)	
Former smoker	6 (11.3)	7 (11.1)	
Current smoker	2 (3.8)	1 (1.6)	
Drinking†			0.558
Non-drinker	33 (63.5)	39 (62.9)	
Former drinker	7 (13.5)	5 (8.1)	
Current drinker	12 (23.1)	18 (29.0)	
Current exercise status, yes†	15 (28.3)	5 (7.9)	0.004**
Bowel movement frequency†			0.068
≥3 times/week	44 (84.6)	42 (70.0)	
<3 times/week	8 (15.4)	18 (30.0)	

Nutritional status was evaluated by the Mini Nutritional Assessment Short Form (MNA-SF), less than 12 points indicating poor nutritional status, and 12 to 14 points indicating normal nutritional status.
†Number (%), analyzed by Chi-square test or Fisher's exact test. *$p<0.05$; **$p<0.01$.

Table 4. Dietary, physical activity and nutritional biochemical factors associated with poor centenarian nutrition by binary logistic regression analysis

Variables	Beta	Standard error	OR (95% CI)	*p*
Bean product				0.016
Every day	-2.548	0.968	0.078 (0.012-0.522)	0.008
Every week	-1.783	0.721	0.168 (0.041-0.691)	0.013
Every month	-2.647	0.900	0.071 (0.012-0.414)	0.003
Seldom/Never			Reference	
Current exercise status				
Yes	-1.446	0.650	0.236 (0.066-0.841)	0.026
No			Reference	
Prealbumin	-0.017	0.007	0.983 (0.969-0.997)	0.015
Albumin	-0.200	0.096	0.819 (0.678-0.988)	0.037

In this model, age, gender, heart disease, total lymphocyte count and hemoglobin became nonsignificant.

Table 5. Centenarian muscle mass and functional status by nutritional status

Variables	Normal nutritional status (N=53)	Poor nutritional status (N=64)	*p*
Anthropometric measurements			
BMI (kg/m²)‡	22.8 (21.6, 25.2)	18.7 (17.8, 20.4)	<0.001***
WC (cm)†	87.5±8.9	76.4±10.4	<0.001***
HC (cm)†	90.7±8.2	82.9±7.6	<0.001***
WHR†	1.0±0.1	0.9±0.1	0.001**
Left MUAC (cm)†	24.6±3.2	21.6±3.4	<0.001***
Right MUAC (cm)†	24.7±3.2	21.8±3.5	<0.001***
Left CC (cm)†	28.8±3.8	25.1±3.6	<0.001***
Right CC (cm)†	28.8±3.8	25.1±3.5	<0.001***
Body composition			
Fat (kg)†	18.7±6.8	13.0±5.4	<0.001***
FFM (kg)†	31.0±7.0	28.0±6.0	0.016*
PBF (%)†	37.3±9.4	31.5±10.4	0.003**
VFA (cm²)‡	105 (77.9, 145)	69.0 (54.6, 92.3)	<0.001***
SMM (kg) †	15.8±4.3	14.0±3.7	0.019*
SMI (kg/m²)†	5.2±2.2	4.5±1.3	0.029*
BI total scores‡	85.0 (75.0, 90.0)	65.0 (15.0, 90.0)	0.001**
Feeding‡	10.0 (10.0, 10.0)	10.0 (5.0, 10.0)	<0.001***
Bathing‡	5.0 (0.0, 5.0)	0.0 (0.0, 5.0)	0.014*
Grooming‡	5.0 (5.0, 5.0)	5.0 (0.0, 5.0)	<0.001***
Dressing‡	10.0 (10.0, 10.0)	5.0 (0.0, 10.0)	<0.001***
Bowel continence‡	10.0 (10.0, 10.0)	10.0 (0.0, 10.0)	<0.001***
Bladder continence ‡	10.0 (10.0, 10.0)	10.0 (5.0, 10.0)	0.014*
Toilet use‡	10.0 (10.0,10.0)	10.0 (0.0, 10.0)	<0.001***
Transfers‡	15.0 (10.0, 15.0)	10.0 (0.0, 15.0)	0.001**
Walking‡	15.0 (10.0, 15.0)	10.0 (0.0, 15.0)	<0.001***
Stair climbing‡	0.0 (0.0, 5.0)	0.0 (0.0, 0.0)	0.411

WC: waist circumference; HC: hip circumference; MUAC: mid upper arm circumference; CC: calf circumference; FFM: fat-free mass; PBF: percentage of body fat; VFA: visceral fat area; SMM: skeletal muscle mass; SMI: skeletal muscle mass index; BI: Barthel index. Nutritional status was evaluated by the Mini Nutritional Assessment Short Form (MNA-SF), less than 12 points indicating poor nutritional status, and 12 to 14 points indicating normal nutritional status.
†Mean ± standard deviation, analyzed by Independent-Samples t-test.
‡Median (lower quartile, upper quartile), analyzed by Mann-Whitney U test.
*p<0.05; **p<0.01; ***p<0.01.

Table 6. Dietary, physical activity and nutritional biochemical factors associated with poor centenarian nutrition by binary logistic regression analysis

Country/Region	Sample size	Scales	Normal nutritional status	Risk of malnutrition	Malnutrition
Nicoya (Costa Rica)[27]	43	MNA	12 (27.9)†	19 (44.2)†	12 (27.9)†
Mexico[28]	393	MNA	68 (17.3)†	206 (52.4)†	119 (30.2)†
Oklahoma[47]	151	MNA-SF	83 (55)†	68 (45)†	
France[48]	39	MNA	2 (5)†	23 (59)†	14 (36)†
China (Hainan)[9]	1002	MNA-SF	123 (12.3)†	671 (67.0)†	208 (20.8)†

MNA: mini nutritional assessment; MNA-SF: mini nutritional assessment short form.
†Number (%).

cause of injury death among the elderly in China.[44] Malnutrition coexistent with sarcopenia is a high-risk factor for overall well-being and health. It can be evidence by weight loss and loss of appetite.[45] The clinical picture is one where there is impaired ADL performance as in the present poor nutrition group, and others have reported.[24,29] A decline of ADL is, therefore, a useful monitoring index of independent living, social withdrawal and isolation.[46] The inability to take care of oneself adds to the reliance caregivers, the burden on families and on society. Somewhat optimistically, in our study, there was no recognizable difference in stair climbing between the two nutritionally defined groups. This might be attributable to rural living by many participants, however, where people usually live on the ground floor. In view of these collective findings, the case for nutritional screening and support, along with routine medical assessments and physical training is strengthened. The Rugao centenarian observations are likely to mimic in many respects the developing need for health and nutrition care to take into account the very old and their peculiar needs, ones somewhat preventable and minimizable. Nevertheless, sociocultural and geo-nutritional diversity obtains across China, so that locally designed programs will be required.

Limitations

Firstly, the cross-sectional design study of our study is inherently limited in interpretation to do with causality. Secondly, age-related as opposed to ageing phenomena are difficult to separate and assign relevance. Thirdly, the study is of survivorship, where factors which were adverse for the population as a whole have been outlived by the few. Fourthly, the persistence of early life exposures with their historical context, beginning pre-conception and continuing in utero, are difficult to recognize and retrieve. Fifthly, cognitive impairment may have compromised survey reliability. longitudinal studies are required, as are earlier life intervention studies to address these concerns.

Conclusions

Remarkably, almost half of the centenarians in Rugao maintained a normal nutritional status. Frequent bean product consumption and habitual exercise were nutritionally protective. Low muscle mass and limited ADL performance were associated with poor nutritional status. Early monitoring of nutritional status for healthy longevity is likely to add more health to years in China and elsewhere.

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AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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