

# Determinants of Successful Aging Using a Multidimensional Definition Among Chinese Elderly in Singapore

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**Objective:** Most studies of successful aging have used restricted definitions based on the absence of disability and identified a small number of predictors. The authors aimed to examine whether a broad multidimensional definition of successful aging has good construct validity and identified a wider range of predictors that are relevant for multifaceted interventions. **Methods:** Cross-sectional and longitudinal data analyses were performed on 1,281 community-living Chinese elderly of 65 years and above in the Singapore Longitudinal Aging Study cohort. Successful aging was measured in multiple dimensions of functioning and wellness: cognitive and affective status, physical health, social functioning and engagement and life satisfaction, and a summary composite measure created across dimensions to form a dichotomous variable. Potential determinants included sociodemographic, psychosocial, behavioral variables. **Results:** Successful aging was determined in 28.6% of respondents and in multivariate models was significantly ( $p < 0.05$ ) associated with age (OR = 0.90), female gender (OR = 1.37),  $\geq 6$  years of education (OR = 2.31), better housing (OR = 1.41), religious or spiritual beliefs (OR = 1.64), physical activities and exercise (OR = 1.90), and low or no nutritional risk (OR = 2.16). **Conclusion:** In contrast to findings based on more restricted biomedical definitions of successful aging, a multidimensional definition of successful aging identified more variables including demographic status, psychosocial support, spirituality, and nutrition as salient determinants. (Am J Geriatr Psychiatry 2009; 17:407–416)

**Key Words:** Successful aging, active aging, healthy aging, spirituality, Asian, Chinese

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Successful aging is of great interest to geriatric care and public health. A central focus of research is on better understanding and defining successful aging and identifying its predictors so that clinical

care and preventive programs can be more meaningfully informed.

Early research has variously defined successful aging using narrowly defined single dimensional bio-

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medical, psychological, or social functioning constructs.<sup>1</sup> In recent years, however, a multidimensional concept of successful aging is increasingly being recognized.<sup>2-6</sup> A multidimensional concept of successful aging is in line with the World Health Organization's definition of health as a state of complete physical, mental, social, and spiritual well-being. Thus, more than the mere absence of disease or infirmity, successful aging is being defined by all aspects of personal well-being including mental well-being, maintenance of an active life style, good supportive relationships, and life satisfaction.

In empirical research, the concept of successful aging is seldom defined or is only implied by choice of measures, and few models are truly multidimensional.<sup>2</sup> A majority of studies using restricted biomedical definitions of successful aging such as the absence of disability with few psychosocial variables<sup>7,8</sup> have most strongly identified younger age, nonsmoking, absence of disability, arthritis, and diabetes as significant correlates. Only moderate support was found for a positive relationship with physical activity, social contacts, self-rated health, absence of depression and cognitive impairment and number of medical conditions, and generally no relationships were found for gender, income, education, and marital status.<sup>9</sup> Of note, although psychosocial variables have received less research attention, they were clearly identified by elderly persons themselves as integral to successful aging.<sup>10</sup> Recent studies of Chinese elderly in Hong Kong and Shanghai,<sup>11,12</sup> which used multidimensional criteria of successful aging, have identified sociodemographic factors including younger age, male gender, education, currently married, financial well-being, and psychosocial factors and leisure activities as determinants of successful aging.

As it is, there is currently limited understanding of the full extent to which many different determinants of successful aging could be usefully identified for effective interventions. For example, resource and behavioral factors including nutrition are important in social and health interventions in the elderly, but few studies have explored them as primary determinants of successful aging.<sup>13</sup> Positive spirituality is regarded as integral to successful aging,<sup>14</sup> but it is a missing component in studies of successful aging.

Successful aging is likely to be influenced by culture. Given the cultural importance of family bonds

and spirituality in Asian societies, psychosocial support is shaped by moral values, such as respect for old age and filial piety (a primary duty to respect and care for one's parents by every means that is only abrogated with shame). Hence, it is of great interest to explore successful aging in Asian seniors.

Successful aging may be conceptualized as a developmental and maintenance process in which age is associated with the attainment of at least optimal if not the highest possible physical, intellectual, emotional, social, vocational and spiritual functioning, and well-being that is consistent with normal aging. In this study, we aimed to demonstrate the concurrent and predictive validity of a multidimensional definition of successful aging in Chinese seniors in Singapore.

We operationally defined as successful aging seniors those who were in good or excellent self-reported health status, independent in instrumental activities of daily living, high level of cognitive functioning (Mini Mental State Examination, MMSE  $\geq 26$ ), having few depressive symptoms (Geriatric Depression Scale, GDS  $< 5$ ), were engaging in at least one social activities and in at least one productive activities, and reported a high level of life satisfaction.

On the basis of the above literature review,<sup>2,11-14</sup> we hypothesized that successful aging as defined above would be associated concurrently with specific sociodemographic, psychosocial, and behavioral determinants, in either univariate and/or multivariate analyses, as primary independent or correlated factors. They included age, gender, education, socioeconomic status (living in larger higher end housing type, or having little or no financial difficulty in paying medical bills), high levels of social network and support (being married, living with others, having someone to confide with, frequent visits or regular phone calls by children/relatives/friends, having someone to help when needed), religious/spiritual beliefs as a source of support/comfort, nonsmoking, nondaily alcoholic drinking, healthy eating, physical activities and exercise, good sleep, having time for leisure and low nutritional risk. Another primary hypothesis was that successful aging was associated in longitudinal analyses with subsequent better quality of life outcomes.<sup>6</sup>

We further demonstrated concurrent validity with secondary analyses that tested the hypothesis that

successful ageing defined as such was associated with variables representing physical functional substrates of well-being, which have been described in previous research to be significant correlates of health.<sup>7-9</sup> These included specific chronic medical conditions/illnesses (hypertension, dyslipidemia, diabetes, stroke, cardiac diseases, major eye disorders [cataract, glaucoma], musculoskeletal/motor disorders, gastric problems, respiratory problems), number of medical conditions/illnesses, body mass index, physical performance level (POMA), hearing problem, visual impairment, hospitalization, number of physician visits, use of multiple prescription drugs, use complementary/alternative medicine and vitamin supplements.

## METHODS

### Study Participants

This study formed part of the ongoing Singapore Longitudinal Aging Study (SLAS), a prospective community-based epidemiological cohort study of aging and health, which has been described previously.<sup>15</sup> The study was approved by the Institutional Review Board of National University of Singapore and participants signed written informed consent. Residents who were physically or mentally incapacitated to give informed consent or participate were excluded. During recruitment and baseline data collection between September 2003 and December 2004, all older adult residents aged  $\geq 55$  years ( $N = 2,804$ , 78% response rate) were identified by door-to-door census in South East Singapore for participation in the study. For the purpose of this study of successful aging, we performed cross-sectional analyses on the data of 1,281 Chinese participants, aged  $\geq 65$  years, who participated in the baseline interview. Longitudinal data analysis was performed for 865 participants who gave interviews at both baseline and follow-up 2 years later (31 died, 11 were unfit for reinterview, 170 were uncontactable, and 204 refused).

Participants underwent an extensive series of interviews, assessments, and tests at the study center. Structured interviews, physical performance tests, and clinical assessments were conducted by trained

nurses. The participants' successful aging status and risk factors were determined from baseline interviews, and their quality of life status was assessed at 2 years follow-up interviews.

### Definition of Successful Aging

Successful aging was operationally defined in terms of overall and physical health and well functioning, cognitive functioning and emotional well-being, social functioning, life engagement and life satisfaction, and a summary composite measure created across dimensions to form a dichotomous variable.

### Measurements

Physical health and functional well-being was defined by "good or excellent" self-reported health status and being independent in instrumental activities of daily living (IADL).<sup>16</sup>

Cognitive well functioning and emotional well-being was measured by performance of the Mini Mental State Examination (MMSE  $\geq 26$ ) and a paucity of depressive symptoms on the Geriatric Depression Scale (GDS  $< 5$ ). The Chinese version of the MMSE that was validated in Shanghai<sup>17</sup> and in Singapore<sup>18</sup> was used. In this Chinese older population, the MMSE has been shown to have high sensitivity (96%) and specificity (84%) in identifying DSM-IV criteria-based cases of dementia. Depressive symptoms were assessed using a cutoff of 5/6 on the locally validated Chinese version of the GDS, which has been shown to have high sensitivity and specificity in identifying major depressive disorder.<sup>19</sup>

Social functioning and active engagement in life activities was assessed using a validated questionnaire<sup>15</sup> on the level of participation (often or at least once a week) in at least one listed social or productive activities, including social, recreational, civic activities, voluntary work, and paid employment or business, and domestic activities.

Overall positive life satisfaction was determined using a self-reported Life Satisfaction Scale comprising four questions that assessed the subjects' interest in life, happiness, loneliness, and general ease of living, which has been shown to predict mortality.<sup>20</sup> Respondents rated whether they find life "interesting or boring," "happy or sad," or "easy or hard" on a

5-point Likert scale (such as 1 = "very interesting" to 5 = "very boring"), or "lonely" (3-point Likert scale: 1 = not at all, 2 = fairly lonely, 3 = very lonely). The total summed score ranges from 4 to 18, with the lowest decile (score <11) indicating a positive life satisfaction.

### Risk Factors, Correlates, and Outcomes of Successful Aging

Potential risk factors of successful aging included gender, age, education, housing status, marital status, living arrangement, social network and support, financial status, spirituality, smoking, alcohol, watch what I eat, exercise, good sleep, leisure time, and nutritional risk. Physical health and functional status included specific chronic medical illnesses and the number of comorbidities, disabilities in instrumental activities of daily living, body mass index (BMI), gait and balance, and hearing and visual impairment were regarded as physical functional substrates of overall well-being and correlates of successful aging. Quality of life was considered as an outcome variable in the analysis.

Sociodemographic data included age, gender, ethnicity, and education. Financial well-being and security was measured by two variables: one variable determined the grade of housing accommodation according to public or private sector and floor space (number of rooms), which has been shown in numerous studies to be highly correlated to income and financial status; the second variable determined to what extent (1 = not at all or little, 2 = to some extent, 3 = to a great extent) the respondent was limited by financial resources to pay for needed health care.

Spirituality was assessed by an item that asked the respondent "to what extent are your religious or spiritual beliefs a source of support and comfort to you (1 = not at all or little, 2 = to some extent, 3 = to a great extent)?"

Social network and support was assessed by six items marital status (being married versus single, divorced, widowed), living arrangements (living with others versus living alone), having someone to confide with, regular visits at least once a week by children/relatives/friends in the last year, and regular phone calls at least once a week by children/relatives/friends in the last year, and having some-

one to help when needed (to some or a great extent).<sup>21</sup> Good social network and support was determined by three or more positive responses to the six items.

"Health behaviors" included smoking (current smokers versus ex-smokers and nonsmokers) and alcohol drinking (daily drank at least one alcoholic drink), and the reported frequency with which the respondents "watch what you eat," "performed physical activities or exercises," "have good sleep," "have time for leisure or relaxation" (never = less than once a month, sometimes = once a month or more but less than once a week, or often = once a week or more).

*Health Status.* Subjects were asked to report the presence in the 12 months prior to the interview of any of a list of 16 specified and other physician-diagnosed medical conditions. This was corroborated with their self-report of relevant surgical operations or procedures and physical identification of medications they currently took for their illnesses. Diagnoses of diabetes and hypertension were verified by the positive identification of medications, as well as fasting blood glucose and blood pressure. The number of chronic medical conditions was summed and categorized as "none, one or two, and three or more."

*Healthcare Use.* This included information on the frequency of hospitalization and physician visits in the 12 months period prior to the interview, vitamin and mineral supplements, and complementary and alternative medicine (CAM) use, determined by a detailed checklist of "nutriceuticals."

The nutritional risk status of the respondents was assessed by the Nutrition Screening Initiative (NSI) checklist<sup>22</sup> of 10 questions (Yes/No) on behaviors and circumstances that increase the risk of poor nutrition (having an illness or condition that made me change the kind and/or amount of food I eat; eat fewer than two meals per day; eat few fruits or vegetable or milk products (less than once a day); having three or more drinks of beer, liquor or wine almost every day; having tooth or mouth problems that make it hard for me to eat; do not always have enough money to buy the food I need; eat alone most of the time; take three or more different prescribed or over-the-counter drugs a day; without wanting, have lost or gained 10 pounds (4 kg) in the last 6 months; always physically unable to shop, cook and/or feed



myself). The weighted summed scores were used to categorize participants with no or low nutritional risk (score of 0–2) or moderate-to-high nutrition risk (score of 3 or more).

Body Mass Index (BMI) was calculated from weight and height ( $\text{kg}/\text{m}^2$ ) and used to categorize participants as underweight ( $\text{BMI} < 18.5$ ), healthy range ( $\text{BMI} 18.5\text{--}22.9$ ), overweight or obese ( $\text{BMI} \geq 23.0$ ), based on the revised cut-offs for Asian adult population, as recommended by the World Health Organization.<sup>23</sup>

The Performance-Oriented Mobility Assessment (POMA) of balance and gait was used to determine the mobility status of participants.<sup>24</sup> Sitting and standing balance (one leg, semitandem and tandem, heel, toe), as well as gait from walking down and back 10 m were each assessed on a three-point Likert scale (0,1,2). The summed score from the balance and gait scores (0 to 35), with higher scores denoting better mobility, was used.

Hearing impairment was determined by the whisper test at arm's length,<sup>25</sup> whereas visual impairment was defined by a logMAR score above 0.6 (equivalent to Snellen score worse than 20/80) in at least one eye.<sup>26</sup>

Quality of life status was determined at baseline and 2-year follow-up using the Chinese version of the Medical Outcomes study 12-item Short Form.<sup>27</sup> The SF-36 has been previously validated for use in Singaporeans.<sup>28</sup> Scores of the 12 items were summarized in two weighted summary scales: the Mental Component Summary (MCS) score and the Physical Component Summary (PCS) score. Scores range from 1 to 100, with lower scores indicating poorer health status.

### Statistical Analyses

Successful aging was analyzed as the dependent variable in logistic regression models that included demographic, psychosocial, and behavioral variables as predictors. Variables representing physical and functional substrates of well-being were analyzed as correlates of successful aging in separate models. The association of successful aging as an independent variable with SF-12 MCS and SF-12 PCS quality of life scores at baseline and 2 years follow-up as the continuous dependent variable was analyzed using multiple regression models and analysis of variance.

Adjusted odds ratio (OR) and 95% confidence intervals (CI) and adjusted means were calculated from regression coefficient estimates, controlling for other covariables. The level for statistical significance was set at 0.05.

## RESULTS

We interviewed 1,281 Chinese elderly, aged 65 or older, with mean age of 72.1 year (SD 5.8); 60% were women and 67% had primary education or below. Among them, 61.2% were found to be cognitively and emotionally well functioning; 47.9% were reportedly physically healthy and independent; 78.4% reported high social functioning; and 88.2% reported positive life satisfaction. Overall, 28.6% met the multidimensional criteria for successful aging (Table 1).

Table 2 compares sociodemographic, psychosocial, and behavioral factors among seniors showing successful ( $N = 366$ ) and unsuccessful aging ( $N = 915$ ). Successfully aging respondents were significantly younger, better educated, were more likely to live in higher-end housing facilities, had better social network and support, were more likely to report religious and/or spiritual beliefs being a source of support and comfort, and having fewer financial difficulties. Successfully aging seniors more frequently reported having regular physical activities or exercise and little or no nutritional risk. Smoking, alcohol drinking, "watching what I eat" and having time for leisure were not found to be significantly

**TABLE 1. Prevalence of Successful Aging in Chinese Elderly Aged 65+**

	Prevalence
Total sample size at baseline	1,281
1. Physical health and well functioning	47.9
Good or excellent self-reported health status	64.6
Independent in instrumental ADL	67.1
2. Cognitive and emotional well functioning	61.2
MMSE $\geq 26$	68.1
GDS $< 5$	87.0
3. High social functioning and active life engagement	78.4
Engaged in at least one social activities	82.8
Engaged in at least one productive activities	90.7
4. High life satisfaction (score $< 11$ )	88.2
Successful aging <sup>a</sup>	28.6

*Note:* Values are in % unless otherwise stated.

<sup>a</sup>Combined criteria (1 and 2 and 3 and 4).

**TABLE 2. Associations of Sociodemographic, Psychosocial, and Behavioral Determinants of Successful Aging in Chinese Elderly Aged 65 Years or Older**

	Nonsuccessful Aging	Successful Aging	Chi-squared Test	df	p	Multivariate Analysis			
						Adjusted OR (95% CI)	Wald Test	df	p
Total sample size	915	366							
Age, yr, mean (SD)	72.9 (6.1)	69.7 (4.2)	9.2	1,279	<0.001	0.90 (0.88-0.93)	45.8	1	<0.001
Female	59.2	62.3	1.0	1	0.31	1.37 (1.02-1.85)	4.4	1	0.04
More than 6 years of education	26.1	51.6	76.5	1	<0.001	2.31 (1.71-3.10)	29.9	1	<0.001
Housing type: larger (>3 rooms) public/private housing	59.5	76.2	32.0	1	<0.001	1.41 (1.03-1.93)	4.6	1	0.03
Social network and support									
Being married (versus single, divorced, widowed)	65.6	71.9	4.6	1	0.032				
Living with others (versus living alone)	91.1	92.1	0.3	1	0.56				
Having someone to confide with	92.2	98.1	15.5	1	<0.001				
Frequent visits by children/ relatives/friends	73.6	77.2	1.8	1	0.18				
Having regular phone calls by children/relatives/ friends	78.7	86.2	9.5	1	0.002				
Having someone to help when needed	88.3	96.2	18.7	1	<0.001				
Having 3 or more of the factors above	87.5	93.7	10.4	1	0.001				
"No or little" financial difficulty in paying medical bills	49.0	53.2	1.8	1	0.18				
Religious/spiritual beliefs source of support/ comfort to great extent	21.6	32.5	16.5	1	<0.001	1.64 (1.22-2.22)	10.4	1	0.001
Non or ex-smokers (versus current smokers)	92.0	94.5	2.5	1	0.12				
Alcoholic drink daily	6.3	9.0	2.8	1	0.09				
Watch what I eat (often or sometimes)	64.8	68.0	1.2	1	0.28				
Physical activities and exercise (often or sometimes)	69.7	83.9	27.3	1	<0.001	1.90 (1.35-2.68)	13.4	1	<0.001
Good sleep (often or sometimes)	71.9	75.4	1.6	1	0.20				
Time for leisure (often or sometimes)	60.6	60.7	0.01	1	0.99				
No or low nutritional risk (NSI score <3)	59.7	77.0	34.3	1	<0.001	2.16 (1.60-2.92)	25.3	1	<0.001

*Notes:* Values are in % unless otherwise stated. Independent t-test for mean and  $\chi^2$  test for proportion. The full model includes all other variables shown in previous tables. For clarity, only significant correlates of successful aging were shown in this table. Similar results were obtained in stepwise selection models.

different between successful and nonsuccessful aging seniors.

In multivariate analyses, the significant independent determinants of successful aging were younger age, female gender, higher-end housing, better education, physical activities and exercise, having reli-

gious and/or spiritual beliefs as a source of support/comfort, and low or no nutritional risk.

There were significant differences in health status and health care use between successful and nonsuccessful aging seniors (Table 3). Successful aging respondents reported significantly fewer chronic med-

**TABLE 3. Physical Health Status and Healthcare Use Correlates of Successful Aging in Chinese Elderly Aged 65 Years or Older**

	Nonsuccessful Aging	Successful Aging	Test Statistic	df	p
Self-reported chronic medical conditions/illnesses					
Hypertension	67.2	57.4	11.0	1	0.001
Dyslipidemia	59.8	59.3	0.03	1	0.87
Diabetes	24.0	12.3	22.0	1	<0.001
Stroke	6.0	1.1	14.4	1	<0.001
Cardiac diseases:	13.9	6.0	15.7	1	<0.001
Ischemic heart disease/IHD	8.9	4.6	6.6	1	0.01
Atrial fibrillation	1.6	0.3	4.0	1	0.05
Heart failure	6.9	2.2	11.0	1	0.001
Major eye disorders (cataract, glaucoma, etc.)	48.7	42.9	3.6	1	0.06
Musculoskeletal/motor disorders <sup>a</sup>	22.1	18.9	1.6	1	0.20
Gastric problems	3.1	2.2	0.7	1	0.39
Respiratory problems <sup>b</sup>	38.4	27.3	14.0	1	<0.001
Number of medical conditions/illnesses					
None	5.5	7.9	23.5	1	<0.001
One or two	36.7	49.2			
Three or more	57.8	42.9			
Body Mass Index (kg/m <sup>2</sup> )					
Underweight (<18.5)	7.8	4.1	6.3	1	0.04
Healthy range (18.5–22.9)	38.3	42.5			
Overweight and obese (≥23)	53.9	53.4			
POMA <sup>c</sup> score, mean (SD)	30.8 (5.0)	33.0 (2.1)	8.1	1268	<0.001
Hearing problem	3.9	3.0	0.6	1	0.42
Visual impairment <sup>d</sup>	34.6	19.2	29.0	1	<0.001
Hospitalization (≥1) in past year	5.5	3.0	3.6	1	0.06
Number of physician visits in past year, mean (SD)	5.0 (6.2)	3.8 (5.2)	3.5	1279	0.001
Use of multiple (≥5) prescription drugs	19.5	7.7	27.0	1	<0.001
Use complementary/alternative medicine	36.0	44.8	8.3	1	0.004
Use vitamin supplements	36.6	44.0	6.0	1	0.02

Note: Values are in % unless otherwise stated; Independent t-test for mean and  $\chi^2$  test for proportion.

<sup>a</sup>Arthritis, knee or back pain, hip fracture, osteoporosis.

<sup>b</sup>Asthma, COPD, Chronic bronchitis (cough up with phlegm on most days for 3 consecutive months in past yr), spirometric-based FEV1/FVC <0.7.

<sup>c</sup>Performance-oriented mobility assessment for balance and gait; maximum possible score = 35, higher score denoting better function.

<sup>d</sup>Visual impairment: very low visual acuity of log MAR >0.6 (Snellen 20/80).

ical problems, fewer numbers of medical illnesses, and had better POMA scores of mobility. They showed similar proportions of overweight and obesity, more normal weight, and fewer underweight. Visual impairment was less frequent in successful aging respondents, but there were no significant differences in hearing impairment. Successful aging seniors reported fewer physician visits, less multiple (≥5) prescription drugs use, and more alternative medicine or vitamins use.

Compared with seniors who did not participate in the follow-up interviews, participants with follow-up data showed better baseline ratings on IADL performance ( $p < 0.001$ ), GDS scores ( $p = 0.05$ ), MMSE scores ( $p < 0.001$ ), SF-12 MCS ( $p = 0.002$ ), and PCS scores ( $p = 0.02$ ) (data not shown). In this group of followed up participants, baseline successful aging status was found to be significantly associated

with better scores of the SF-12 quality of life at baseline and at 2 years in both cross-sectional and longitudinal analyses (Table 4).

## DISCUSSION

The data in this study supported the construct and predictive validity of a proposed multidimensional model and operational definition of successful aging in Chinese seniors. It demonstrated good convergent validity with concurrent health status and health care use parameters and predicted subsequent levels of quality of life. By virtue of its broad multidimensional construct, successful aging was shown to be associated with a multiplicity of demographic, environmental, psychosocial, and behavioral determi-

**TABLE 4. Associations of Successful Aging With Quality of Life in Chinese Elderly Aged 65+ (Cross-Sectional and Longitudinal Analyses)**

	Adjusted Mean (SE)		Test Statistic	df	p
	Nonsuccessful Aging	Successful Aging			
Crosssectional analysis (N = 1,281)					
Physical well-being score (PCS-SF12)	46.8 (0.35)	50.8 (0.44)	70.8	1,1274	<0.001
Mental well-being score (MCS-SF12)	53.3 (0.40)	56.1 (0.50)	28.5	1,1274	<0.001
Longitudinal analysis (N=865)					
Physical well-being score (PCS-SF12)	48.8 (0.37)	50.0 (0.46)	5.8	1,856	0.02
Mental well-being score (MCS-SF12)	56.1 (0.38)	57.6 (0.47)	7.9	1,856	0.005

Notes: Test: ANOVA; Higher scores denote better quality of life. Models were adjusted for age, education, gender, medical comorbidities; and the longitudinal models were adjusted for length of follow-up, and their respective baseline score. Test statistic was quoted from the adjusted models.

nants, notably more in numbers and strength of association than those shown in studies that used restricted biomedical and physical functional definitions of successful aging.

Studies using a biomedical model of successful aging generally reported a lack of association with gender, income, education, and marital status.<sup>9</sup> Our results are in good concordance with two studies both of Chinese elderly in Hong Kong and Shanghai,<sup>11,12</sup> which also used multidimensional criteria including cognitive functioning, affective status, and productive involvement. Both studies identified the factors most related to successful aging to be socio-demographic such as younger age, gender, education, being married, financial well-being, and leisure activities. Also, recent focus group studies of older adults<sup>4</sup> have shown that they place less emphasis on factors such as longevity, genetics, absence of disease or disability, function and independence, but more emphasis on psychosocial factors as keys to successful aging. A significant observation is that positive attitude and adaptation strategies often compensated for impaired physical health, and furthermore, active social engagement required a foundation of security and stability.<sup>4</sup>

In consonance with this lay model of successful aging, we found that education, better housing, better social network and support, spirituality, and nutrition were salient factors associated with successful aging. The importance of spirituality was particularly worth noting, given that religious and/or spiritual beliefs play positive roles in mental and psychosocial well-being,<sup>14</sup> but it is rarely studied. Among behavioral factors, the associations of non-smoking and physical activities and exercises are not unexpected, but the positive association of nutri-

tional risk status with successful aging is worth noting and has been investigated in very few studies.<sup>13</sup>

These observations are of great relevance to geriatric psychiatry because it implies that care providers should begin to help seniors age successfully beyond a limited sphere of attention to physical and mental health needs and encompass a broader range of activities directed at social, behavioral, and spiritual needs. This calls for a holistic care model for the aged with interfacing of activities and care in the community and possibly within the framework of a population-based program of multifaceted interventions. Future research should be directed at empirical validation of a multidimensional framework for understanding and promoting successful aging.

There are presently no consensus and no uniform operational criteria to define successful aging. Terms such as active aging, healthy aging, productive aging, and positive aging are sometimes used synonymously and interchangeably, but carry different nuances of meaning and emphasis, especially when used as policy slogans. Successful aging and active or healthy aging are semantically the closest, one incorporating the notion of attainment of complete well-being, and the other, the notion of desired behavioral performance.

Whether a given set of operational criteria can universally tap the contents of successful aging is arguable. There may also be domain variations among multidimensional models of successful aging depending on the interventional perspectives and framework. Studies vary in the way constituents of successful aging are used as precursors or outcomes. Thus, alike some studies, we have considered life satisfaction to be a component of successful aging, but this was used as a predictor in other studies.<sup>29</sup>



In some studies, participation in leisure activities was not included as a defining component of successful aging, but was found to “predict” successful aging.<sup>14,30</sup>

Given that different criteria are used to define successful aging in various studies, there is also debate about the appropriate cutoff points in measures used. The reported prevalence of successful aging in publications therefore varies widely and cannot be meaningfully compared. Previous studies that have also used maximum/optimum cutoff scores based on various biomedical and other models<sup>6,26</sup> have variously reported the prevalence of successful aging at between 16% and 34%. Our operational criteria used to define successful aging, based on the maximum score (4/4) for the proposed model, was similarly restrictive, and it generated a prevalence figure within the range of these reported figures. There is arguably a universal case for a less restrictive definition and criteria because seniors may still consider themselves to be aging well because of their transcendental experience of positive psychological and social well-being despite deteriorating health and physical functioning.<sup>10</sup> This will increase the distribution of successful aging to a majority of the population, but the appropriate normative level requires further investigation and consensus.<sup>31</sup>

Several other limitations in this study should be noted. The use of some measures and cutoffs such as MMSE  $\geq 26$  and GDS  $< 5$  does not identify successfully aging participants who are at the highest level of cognitive and emotional functioning and well-being. Furthermore, because education is also known to be associated with MMSE performance in this population, the prevalence of successful aging in less

educated seniors may be underestimated as a result. Nevertheless, by using stratified MMSE cutoffs according to educational levels, education remained a significant determinant of successful aging. Another limitation was that although the SF-36 was previously validated for use in the local population, we have used the SF-12 version in this study. There was likely bias from loss to follow-up in the longitudinal analysis; participants in the follow-up study tended to be in better health and functioning. Because of their better aging profile, the observed association with quality of life may be underestimated. The number of medical comorbidities was not based on self-report of medical conditions. Nevertheless, previous research has shown that self-report of most chronic illnesses are valid and useful for research.<sup>32,33</sup> The strengths of the study include the large, population-based sample and the use of a multiplicity of measures that are less often present in other studies.

## CONCLUSION

In contrast to studies based on more restricted biomedical definitions of successful aging that showed a preponderance of health-related determinants, this study identified more demographic, psychosocial, and behavioral determinants including nutrition and spirituality in a multidimensional construct of successful aging among Chinese elderly populations.

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## References

1. Rowe JW, Kahn RL: Successful aging. *Gerontologist* 1997; 37: 433–440
2. Bowling A, Dieppe P: What is successful aging and who should define it? *BMJ* 2005; 331:1548–1551
3. Montross LP, Depp C, Daly J, et al: Correlates of self-rated successful aging among community-dwelling older adults. *Am J Geriatr Psychiatry* 2006; 14:43–51
4. Reichstadt J, Depp CA, Palinkas LA, et al: Building blocks of successful aging: a focus group study of older adults' perceived contributors to successful aging. *Am J Geriatr Psychiatry* 2007; 15:194–201
5. Von Faber M, Bootsma-van der Wiel A, van Exel E, et al: Successful aging in the oldest old: who can be characterized as successfully aged? *Arch Intern Med* 2001; 161:2694–2700
6. Bowling A, Iliffe S: Which model of successful ageing should be used? Basel, Switzerland findings from a British longitudinal survey of ageing. *Age Ageing* 2006; 35:607–614
7. Depp CA, Glatt SJ, Jeste DV: Recent advances in research on successful or healthy aging. *Curr Psychiatry Rep* 2007; 9:7–13
8. Schoenfeld DE, Malmrose LC, Blazer DG, et al: Self-rated health and mortality in the high-functioning elderly—a closer look at healthy individuals: MacArthur field study of successful aging. *J Gerontol* 1994; 49:109–115
9. Depp CA, Jeste DV: Definitions and predictors of successful aging: a comprehensive review of larger quantitative studies. *Am J Geriatr Psychiatry* 2006; 14:6–20
10. Phelan EA, Anderson LA, LaCroix AZ, et al: Older adults' views of

- "successful aging"—how do they compare with researchers' definitions? *J Am Geriatr Soc* 2004; 52:211–216
11. Chou KL, Chi I: Successful aging among the young-old, old-old, and oldest-old Chinese. *Int J Aging Hum Dev* 2002; 54:1–14
  12. Li C, Wu W, Jin H, et al: Successful aging in Shanghai, China: definition, distribution and related factors. *Int Psychogeriatr* 2006; 18:551–563
  13. Gaudreau P, Morais JA, Shatenstein B, et al: Nutrition as a determinant of successful aging: description of the Quebec longitudinal study Nuage and results from cross-sectional pilot studies. *Rejuvenation Res* 2007; 10:377–386
  14. Crowther MR, Parker MW, Achenbaum WA, et al: Rowe and Kahn's model of successful aging revisited: positive spirituality—the forgotten factor. *Gerontologist* 2002; 42:613–620
  15. Niti M, Yap KB, Kua EH, et al: Physical, social and productive leisure activities, cognitive decline and interaction with APOE-epsilon 4 genotype in Chinese older adults. *Int Psychogeriatr* 2008; 20:237–251
  16. Lawton MP, Brody EM: Assessment of older persons: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969; 9:179–186
  17. Katzman R, Zhang MY, Ouang-Ya-Qu Wang ZY, et al: A Chinese version of the Mini-Mental State Examination; impact of illiteracy in a Shanghai dementia survey. *J Clin Epidemiol* 1988; 41:971–978
  18. Ng TP, Niti M, Chiam PC, et al: Ethnic and educational differences in cognitive test performance on mini-mental state examination in Asians. *Am J Geriatr Psychiatry* 2007; 15:130–139
  19. Lim pp, Ng LL, Chiam PC, et al: Validation and comparison of three brief depression scales in an elderly Chinese population. *Int J Geriatr Psychiatry* 2000; 15:824–830
  20. Koivumaa-Honkanen H, Honkanen R, Viinamäki H, et al: Self-reported life satisfaction and 20-year mortality in healthy Finnish adults. *Am J Epidemiol* 2000; 152:983–991
  21. Fratiglioni L, Wang HX, Ericsson K, et al: The influence of social network on the occurrence of dementia: a community-based longitudinal study. *Lancet* 2000; 355:1315–1319
  22. Posner BM, Jette AM, Smith KW, et al: Nutrition and health risks in the elderly: the nutrition screening initiative. *Am J Public Health* 1993; 83:972–978
  23. World Health Organization expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; 363:157–163
  24. Tinetti ME: Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc* 1986; 34:119–126
  25. Macphree GJ, Crowther JA, McAlpine CH: A simple screening test for hearing impairment in elderly patients. *Age Ageing* 1988; 17:347–351
  26. Duane's Clinical Ophthalmology. Edited by Tasman W, Jaeger EA. Philadelphia, Lippincott Williams & Wilkins, 2004
  27. Ware JE, Kosinski M, Keller SD: A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996; 34:220–233
  28. Thumbboo J, Fong KY, Machin D, et al: A community-based study of scaling assumptions and construct validity of the English (UK) and Chinese (HK) SF-36 in Singapore. *Qual Life Res* 2001; 10:175–188
  29. Vaillant GE, Mukamal K: Successful aging. *Am J Psychiatry* 2001; 158:839–847
  30. Garfein AJ, Herzog AR: Robust aging among the young-old, old-old, and oldest-old. *J Gerontol B Psychol Sci Soc Sci* 1995; 50:S77–S87
  31. Strawbridge WJ, Wallhagen MI, Cohen RD: Successful aging and well-being. Self-rated compared with Rowe and Kahn. *Gerontologist* 2002; 42:727–733
  32. Haapanen N, Miilunpalo S, Pasanen M, et al: Agreement between questionnaire data and medical records of chronic diseases in middle-aged and elderly Finnish men and women. *Am J Epidemiol* 1997; 145:762–769
  33. Kriegsman DM, Penninx BW, van Eijk JT, et al: Self-reports and general practitioner information on the presence of chronic diseases in community dwelling elderly. A study on the accuracy of patients' self-reports and on determinants of inaccuracy. *J Clin Epidemiol* 1996; 49:1407–1417