International Journal of Population Studies

RESEARCH ARTICLE

Concordance and discordance between objectively and subjectively measured successful aging and their linkages with mortality

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Abstract: Successful aging has extended from the biomedical-oriented model to the biomedical-and-psychosocial mixed model. However, few studies have investigated the subtypes of the joint classification between subjective (psychosocial-oriented) (SSA) and objective (biomedical-oriented) (OSA) measures to identify and distinguish different risk groups. This study aims to examine how concordance and discordance between SSA and OSA are associated with subsequent mortality based on five waves of a nationwide longitudinal survey in China from 2000 to 2011 with 30,948 sampled persons aged 65 and older. SSA was measured by absence of poor life satisfaction, poor self-rated health, and psychological distress, while OSA was measured by absence of disability, cognitive impairment, and chronic diseases. We then defined a variable with four subtypes of concordance and discordance from these two dichotomous variables: Type I (not-OSA & not-SSA), Type II (not-OSA & SSA), Type III (OSA & not-SSA) and Type IV (OSA & SSA). Types I and IV are concordance types, while Types II and III are discordance types. The results showed that a negative association between Type IV (SSA & OSA) and risk of mortality was universal over age groups and sexes. Compared to Type I (not-SSA & not-OSA), Type IV (SSA & OSA) has a 25–71% lower risk of mortality, depending on age group and sex, after controlling for a rich set of confounders. Concordance and discordance between OSA and SSA provide added power in predicting subsequent mortality. Public health programs should target those more vulnerable subtypes to promote successful aging.

Keywords: successful aging, subjective successful aging, objective successful aging, concordance, discordance, mortality, China

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Received: May 12, 2015; **Accepted:** June 28, 2015; **Published Online:** July 6, 2015

Citation: Gu D. (2015). Concordance and discordance between objectively and subjectively measured successful aging and their linkages with mortality. *International Journal of Population Studies*, vol.1(1): 29–41. http://dx.doi.org/10.18063/IJPS.2015.01.003.

1. Introduction

A growing body of literature in the last few decades has expanded the scope of successful aging and extended our understanding of successful aging (Cosco, Prino, Perales *et al*., 2014; Rowe and Kahn, 1997; 2015). About two decades ago, the definition of successful

aging mainly referred to absence of diseases and disability, maintenance of adequate cognitive and physical function, and ability to engage in social activities (Rowe and Kahn, 1997). This definition focused on physical, physiological, or cognitive functions, usually known as the biomedical model or objective successful aging (OSA). More and more researchers today, however, define successful aging as a biopsychosocial model that emphasizes components of psychological characteristics and resources, such as life satisfaction and well-being, capacity for personal development, mastery/growth, positive adaptation, social networks and support, integration and participation, or cultural components (Bowling and Dieppe 2005; Cosco, Prino, Perales *et al*., 2014; Rowe and Kahn, 2015). The new biopsychosocial version of successful aging includes not only objective components (i.e., OSA) but also subjective components (or called subjective successful aging, SSA) (Rowe and Kahn, 2015). Indeed, there is a consensus among the researchers that successful aging should be a multidimensional concept from both objective and subjective measures (Blazer, 2006; Bowling and Iliffe, 2006; Depp, Glatt, and Jeste, 2007; Feng, Son, and Zeng, 2015; Jeste, Savla, Thompson *et al*., 2013; Lewis, 2011, Phelan, Anderson, Lacroix *et al*., 2004; Rowe and Kahn, 2015; Young, Fan, Parrish *et al*., 2009).

Regardless of whether they are from the respondents' perspective or from the researchers' perspective, different definitions and metrics of successful aging could produce profound heterogeneity in the outcome of successful aging (Cosco, Prino, Perales *et al*., 2014). For instance, Strawbridge, Wallhagen, and Cohen (2002) reported that half of the older adults aged 65–99 rated themselves as aging successfully, whereas slightly more than one-third of the older adults evaluated themselves as aging unsuccessfully even though they met Rowe and Kahn's criteria. Bowling and Dieppe (2005) showed that when older adults were asked to provide their own definitions of successful aging, they put relatively greater emphasis on social integration and well-being compared to other components in the biomedical model. Montross, Depp, Daly *et al*. (2006) reported that 92% of a sample of 205 older community-dwelling people considered themselves to be aging successfully, even though a large majority of them either suffered from some chronic conditions or had some physical limitations. Von Faber and colleagues (2001) showed that the oldest-old (aged 85 or older) in the Netherlands typically viewed psychological well-being as the core component of successful aging. One study from the U.S. found that Japanese-American older adults were more likely to consider having a longevity gene as an important component to successful aging than their Caucasian counterparts, who were more likely to rate remaining in control over one's own decisions as important (Matsubayashi, Ishine, Wada *et al*., 2006). A meta-analysis based on twenty-seven major individual empirical studies on successful aging showed that the proportion of older adults considered to be aging successfully ranged from 0.4% to 95.0%, depending on the definition used (Depp and Jeste, 2006); another meta-analysis based on more than one hundred studies revealed a similar finding (Cosco, Prino, Perales *et al*., 2014). All of these findings indicate great inconsistencies and variations in successful aging measurements.

With few exceptions (Cernin, Lysack, and Lichtenberg, 2011; Pruchno, Wilson-Genderson, Rose *et al*., 2010), most studies have not looked into the subtypes of successful aging jointly classified by OSA and SSA. So far we have not found studies investigating how concordance or discordance between OSA and SSA is associated with mortality among older adults. This study aims to examine how concordance and discordance between SSA and OSA are associated with subsequent mortality among older adults from a large nationwide longitudinal survey in China. Developing subtypes of successful aging in terms of concordance and discordance between SSA and OSA and understanding their associations with subsequent mortality could help researchers better understand the differentials in meanings of successful aging defined objectively or subjectively, improve the ability of

service providers to offer people-centered programs, and benefit clinical programs that are oriented to enhance the health of older adults.

2. Methods

2.1 Study Sample

The data came from five waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) in 2000, 2002, 2005, 2008, and 2011. Started in 1998, the CLHLS is a national survey focusing on the oldest-old to investigate the determinants of health and longevity. The CLHLS is supported by an ongoing National Institute on Aging grant awarded to Duke University (USA) and Peking University (China). To avoid probable age exaggeration among ethnic minorities, the CLHLS only covered 22 Han-ethnicity dominated provinces in mainland China, which accounted for more than 80% of the population in the latest census.

The CLHLS aims to interview all centenarians in a randomly selected half of the counties/cities in 22 provinces. Age of each centenarian was validated from various sources as available, including birth certificates, genealogical documents, household booklets, and ages of their children and siblings (Zeng and Gu, 2008). For each centenarian interviewed, one nearby respondent from each of three age groups (ages 65–79, ages 80–89, and ages 90–99) with predesignated age and sex was randomly chosen to be interviewed based on a random code assigned to the centenarian. All information was obtained through in-home interviews and informed consent was obtained from each respondent. The accuracy of age reporting of centenarians and the data quality of other variables in the CLHLS are quite good (Gu, 2008; Gu and Dupre, 2008; Zeng and Gu, 2008). Detailed sampling procedures can be found elsewhere (Gu, 2008; Zeng and Gu, 2008).

The first wave (1998) of the CLHLS was not used in this study because the wording of the responses to questions related to distress in the 1998 wave was not the same as those in other waves. Furthermore, those who were lost to follow-up at a subsequent wave were dropped in the analysis because our focus is on mortality risk and because we do not know their survival status. This exclusion resulted in a final sample size of 30,948 respondents aged 65 and older with 49,218 observations. Figure 1 illustrates the sample distribution across waves.

2.2 Measurements

2.2.1 Measures of Objective Successful Aging

Objective successful aging (OSA) was defined by absence of any chronic disease, no functional disability, and no cognitive impairment. By contrast, a respondent was considered as not-OSA if he or she reported any of these three conditions. The CLHLS adopted a list of twenty diseases to measure comorbidity. An individual was coded as having no chronic conditions if he or she did not self-report any of the twenty disease conditions (e.g., heart diseases, stroke, diabetes, hypertension, cancers, cataracts, Parkinson's disease) at the time of the surveys. As 95% of these self-reported diseases were confirmed by physicians, chronic disease conditions are assumed to be reliable, although underreporting is still possible (Gu, 2014). Activities of daily living (ADL) were used as a proxy measure of physical function. A respondent was considered as ADL disabled if he or she needed assistance in performing any of six tasks (bathing, dressing, indoor transferring, toileting, eating, and continence) at the time of the surveys. Cognitive impairment was measured by the Chinese version of the Mini-mental Status Examination (MMSE), which includes six domains of cognition (orientation, reaction, calculation, short memory, naming, and language) with a total score of 30. The Chinese version of the MMSE was adapted from the

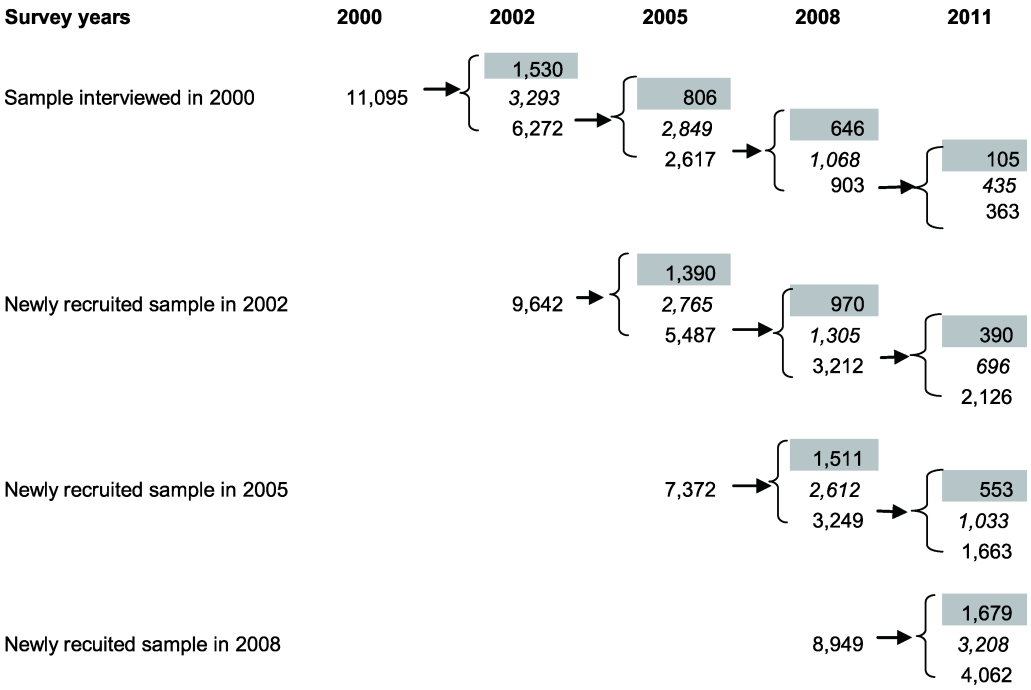


Figure 1. Structure of sample by survey year, initial interview year, and survival status at a follow-up wave.
Note: (1) Figures highlighted in grey were the losses to follow-up and they are excluded from the present study. Figures in italic font were deceased persons who died before a follow-up. All other figures were either newly recruited samples at a survey or survivors in a follow-up wave. (2) The total valid number of individuals who have at least one follow-up interview was 30,948 (=11,095−1,530+9,642−1,390+7,372−1,511+8,949−1,679).

original MMSE version proposed by Folstein, Folstein and McHugh (1975). A respondent was coded as cognitively impaired if his/her MMSE score was 23 or lower at the interview (Gu, 2008).

2.2.2 Measures of Subjective Successful Aging

Subjective successful aging (SSA) was defined as the absence of self-rated poor health, self-rated poor life satisfaction, and distress. A person was coded as not-SSA if he or she reported any of these three conditions. The CLHLS collected data on self-rated health and self-rated life satisfaction with five categories: very good, good, so-so, poor, and very poor. We re-coded the last two categories as poor condition, and the first three as good condition. Distress was measured by the following three proxy variables: (1) Do you feel fearful or anxious? (2) Do you feel lonely and isolated? and (3) Do you feel useless? Each question has five response options: always, often, sometimes, rare, almost never or never. A respondent was coded as having distress if he or she answered any of the three questions with often or always. Missing values were imputed by assuming that individuals with the same demographics, socioeconomic conditions, and health conditions (such as disability, chronic conditions, and cognitive function) shared the same distress. The results were very similar between imputed and not-imputed data.

2.2.3 Concordance and Discordance of OSA and SSA

The above two dichotomous variables of OSA and SSA were jointly grouped into a single variable with four types: concordance in terms of not-OSA & not-SSA (Type I), discordance in terms of not-OSA & SSA (Type II), discordance in terms of OSA & not-SSA (Type III), and concordance in terms of OSA & SSA (Type IV). These four categories were coded from 1 to 4, respectively.

2.2.4 Mortality Risk

Mortality risk is the dependent variable of this study. To analyze mortality risk, we em-

ployed survival analysis techniques with time between any two adjacent surveys (in terms of days) as the exposure length, and survival status (surviving vs. dead) at the end of the period of the two adjacent surveys as an event. The dates of the interviews were recorded for each wave. For those who died between two adjacent waves, the dates of death were collected from officially issued death certificates whenever available; the next-of-kin and the local residential committee were consulted when a death certificate was not available. The quality of mortality data in the CLHLS is high (Gu and Dupre, 2008).

2.2.5 Controls

To obtain robust results, we controlled several sets of covariates that are shown in the literature to be associated with mortality (Wen and Gu, 2011); the covariates included demographics, socioeconomic status, and health practice. Demographics included age, residence (urban vs. rural), and ethnicity (Han vs. non-Han). Sex was not considered as a covariate since all analyses were stratified by sex. Socioeconomic status included years of schooling (0, 1–6, and 7+), primary lifetime occupation (professional/administration (white collar) vs. others), and economic independence measured by whether the respondent has retirement wage/pension or own earnings (yes vs. no). Family support was measured by co-residence with children (yes vs. no) and marital status (currently married vs. unmarried). Health practice was measured by currently smoking (yes vs. no), currently consuming alcohol (yes vs. no), and regularly exercising (yes vs. no). The sample characteristics are presented in Table 1.

2.2.6 Analytical Strategy

The Weibull parametric survival function was applied because some of the variables violated the proportionality assumption required by the Cox proportional hazard model. As noted early, respondents who were lost to follow-up were excluded because we did not know their survival information. Other alternative approaches such as imputing the survival information, treating them as right-censored, or treating them as a specific category yielded similar results. In the original design, several sequential models were conceived to examine how the association between concordance/discordance of OSA and SSA was changed in the presence of different covariates that included demographics, socioeconomic status and family support, and health practice. However, because the results of the sequential models are very close to each other, we only presented the results from the final model that includes all covariates (the results from the sequential models are available upon request). The proportion of missing values for all variables in the analysis was less than 2%. To reduce possible bias due to missing values in the analysis and inferences, we employed multiple imputation techniques for all variables. We did not apply sampling weights to the regression models because the CLHLS weight variable was unable to reflect the national population distributions with respect to variables other than age, sex, and urban/rural residence (Wen and Gu, 2011)

We also performed additional tests to examine improved predictive power of concordance and discordance of OSA and SSA for mortality risk (controlling for all covariates in the analysis) by performing two alternative models that treated OSA and SSA as two independent variables. All analyses were performed using STATA 13.0.

3. Results

Table 1 presents the sample distribution for study variables and covariates by sex. One interesting result in Table 1 is that it is more common to be in objectively poor health, but subjectively good health (Type II) (18.7% for women and 21.4% for men), rather than the other way around (Type III) (3.9% for women and 7.9% for men); it is much more common to be in both objectively and subjectively poor health (75.0% for women and 64.4%

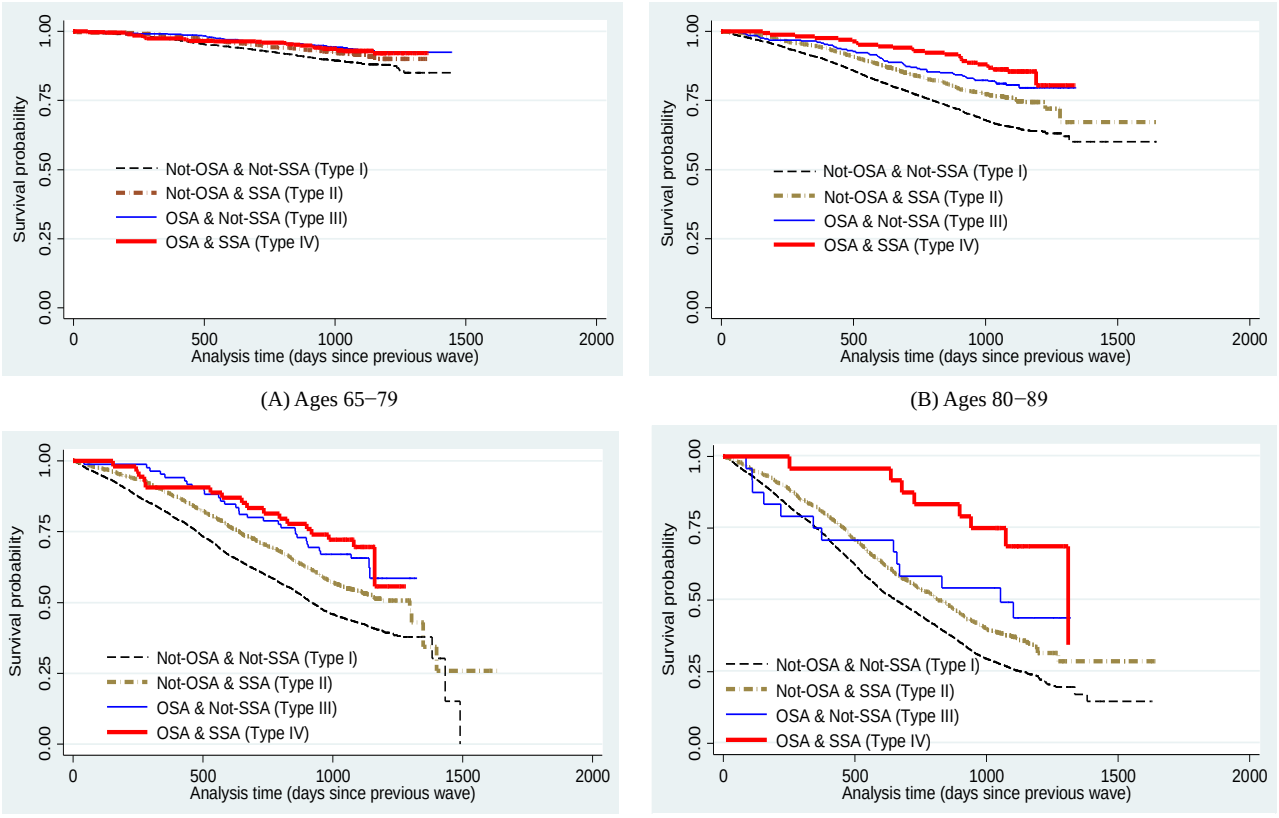
Table 1. Sample distribution of variables in the study, CLHLS 2000–2008

	Women	Men
# of individuals	18,029	12,919
# of observations (2000–2008)	28,130	21,088
2000	5,536	4,029
2002	7,831	5,887
2005	7,012	5,337
2008	7,751	5,835
# of individuals died between the 2000 and 2011 waves	11,594	7,670
% OSA [a]	6.32	14.21
% SSA [a]	21.13	27.71
Concordance & discordance [a]		
% Not-OSA, Not-SSA (Type I)	74.95	64.40
% Not-OSA, SSA (Type II)	18.73	21.39
% OSA, Not-SSA (Type III)	3.92	7.89
% OSA, SSA (Type IV)	2.40	6.32
Covariates [a]		
% Ages 65-79	17.99	27.61
% Ages 80-89	23.34	33.60
% Ages 90-99	27.43	27.80
% Ages 100+	31.24	10.98
% Urban	43.16	45.00
% Han ethnicity	93.57	94.08
% Currently married	15.39	47.54
% Coresidence with children	74.31	59.79
% Years of schooling (0)	84.75	37.94
% Years of schooling (1–6)	12.45	45.86
% Years of schooling (7+)	2.90	16.19
% White collar occupation	2.27	12.85
% Economic independence	14.17	40.34
% Current smoking	6.89	34.57
% Current alcohol consumption	11.71	32.19
% Doing regular exercise	22.55	37.70

Note: a, The percentage distribution was based on the pooled dataset among # of individuals from 2000 to 2008.

for men), rather than in objectively and subjectively good health (2.4% for women and 6.3% for men).

Figures 2 and 3 present the Kaplan-Meier survival functions by age group for women and men, respectively. It is apparent that those who were both OSA and SSA (i.e., Type IV) have the highest survival probability across four age groups for both women and men, while those who were both not-OSA and not-SSA (i.e., Type I) had the lowest survival probability. For those who were OSA, the survival difference between subgroups of SSA and not-SSA (i.e., Type IV versus Type III) in most cases is relatively small; for those who were SSA, the survival difference between its subgroups of OSA and not-OSA (i.e., Type IV versus Type II) is relatively pronounced. These results indicate that OSA likely has a greater power in predicting subsequent mortality.



(A) Ages 65−79

(B) Ages 80−89

(C) Ages 90−99

(D) Ages 100+

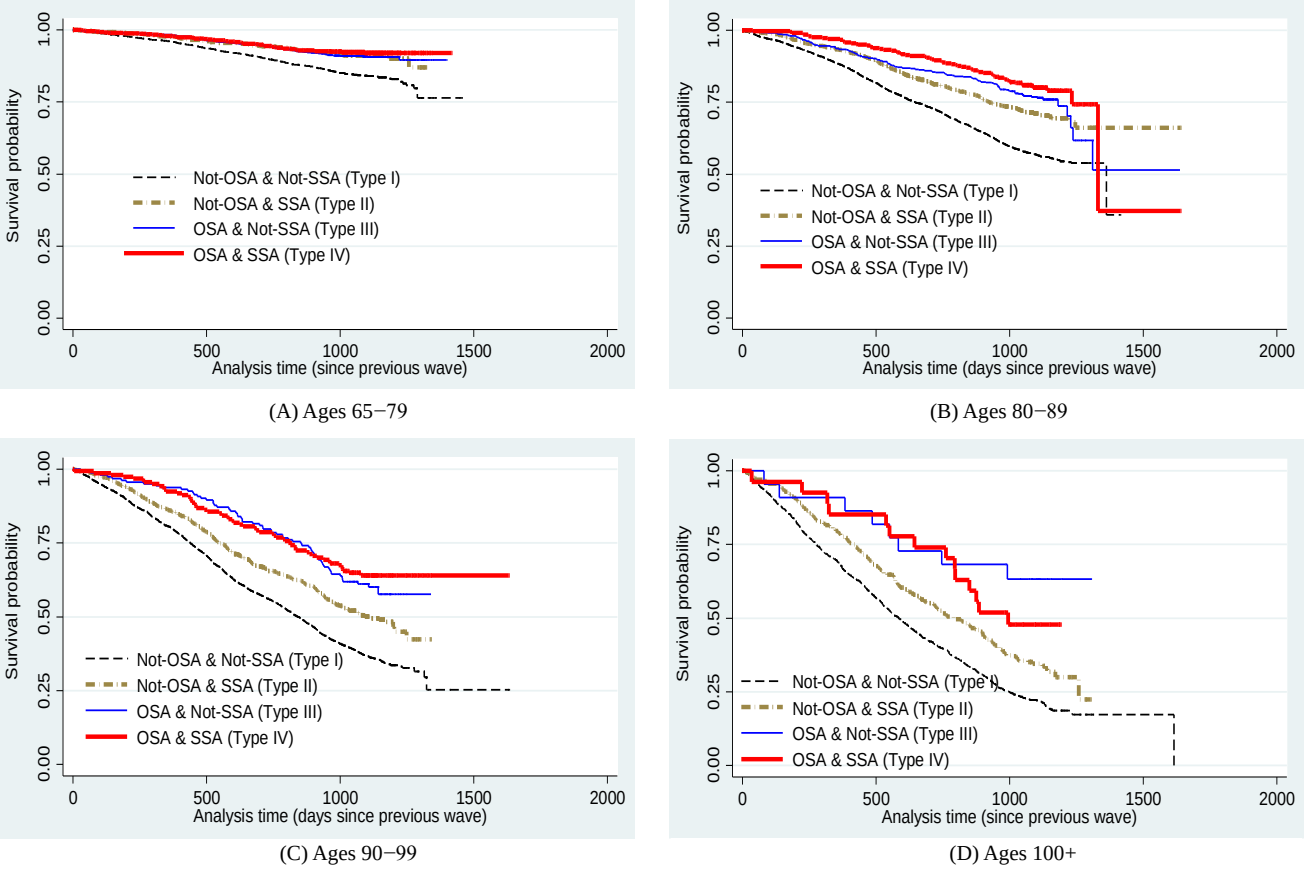
Figure 2. Kaplan-Meier survival function at follow-up by age group at a wave — women

Table 2 summarizes hazard ratios for each subtype of concordance and discordance of OSA and SSA. As a conventional practice in which OSA and SSA were treated as two independent variables and simultaneously included in the regression models (Panels A and B), these two variables were significant predictors of subsequent mortality risk in all age groups and in both sexes (except for women aged 65–79), even when covariates were present. Overall, the mortality risk differences between OSA and not-OSA were greater than those between SSA and not-SSA, especially at the oldest-old ages.

Once these two variables were combined into a single variable with four categories, the mortality risk differences across four categories was more distinctive and informative. We summarize the major findings from Panels C to F in Table 2 as follows.

Firstly, in the cases of not-OSA (the first row in Panel C), SSA was associated with 21–31% lower mortality risk in four age groups in women (i.e., Type II (Not-OSA & SSA) versus Type I (not-OSA & not-SSA)). Among men, the subtype II (Not-OSA & SSA) was associated with 24–40% lower mortality risk compared to the subtype I (not-OSA & not-SSA). Furthermore, among women who were not-OSA, the greatest difference in mortality risk between SSA and not-SSA was found in octogenarians (i.e., ages 80–89), whereas in male counterparts the greatest difference was found in the youngest age group (i.e., ages 65–79).

Secondly, in the cases of not-SSA, compared to not-OSA, the reduced mortality risks for OSA in non-centenarian women (i.e., Type III versus Type I, the second row in Panel C) were around 37–43%. In men, reduced mortality risks for OSA compared to not-OSA were 41−49% in the three younger age groups. Unlike female centenarians, the reduced mortality risk of OSA for male centenarians compared to not-OSA was 64%.



(A) Ages 65−79

(B) Ages 80−89

(C) Ages 90−99

(D) Ages 100+

Figure 3. Kaplan-Meier survival function at follow-up by age group at a wave — men

Table 2. Mortality risk of concordance and discordance between OSA and SSA by sex and age group, CLHLS 2000–2008 to 2002–2011

	Women				Men			
	Ages 65–79	Ages 80–89	Ages 90–99	Ages 100+	Ages 65–79	Ages 80–89	Ages 90–99	Ages 100+
Panel A								
OSA versus not-OSA	0.71**	0.57***	0.60**	0.50**	0.68***	0.57***	0.58***	0.54**
Panel B								
SSA versus not-SSA	0.87	0.70***	0.75***	0.77***	0.70***	0.69***	0.77***	0.74***
Panel C: (not-OSA & not-SSA is the reference group)								
Not-OSA & SSA	0.79+	0.69***	0.74***	0.77***	0.60***	0.67***	0.76***	0.73**
OSA & Not-SSA	0.63**	0.57***	0.57**	0.63	0.59***	0.53***	0.53***	0.36**
OSA & SSA	0.75	0.41***	0.50**	0.29***	0.57***	0.44***	0.50***	0.56*
Panel D								
OSA & SSA versus OSA & not-SSA	1.19	0.71	0.87	0.45+	0.96	0.83	0.95	1.55
Panel E								
OSA & SSA versus not-OSA & SSA	0.94	0.58**	0.67	0.37**	0.95	0.65**	0.66**	0.77
Panel F								
OSA & SSA versus others	0.83	0.44***	0.53*	0.30***	0.68**	0.50***	0.55***	0.62+

Note: (1) Figures are hazard ratios from the parametric Weibull regression. Hazard ratios are based on models controlling for age, urban-rural residence, ethnicity, education, lifetime primary occupation, economic independence, current marital status, co-residence with children, currently smoking, alcohol consumption at present, and doing regular exercise. (2) Panels A and B are from conventional regressions where both SSA and OSA are two independent variables and are simultaneously included in the regressions. Results in Panels C, D, and E are from the same regression with a different category as the reference, while Panel F is from a different regression where the first three categories are pooled together. (3) +p<0.1, *p<0.05, **p<0.01, ***p<0.001.

Thirdly, in women, when compared to Type I (the concordance of not-OSA & not-SSA type), Type IV (the concordance of OSA & SSA type, the third row in Panel C) had 25–71% lower risk of mortality. The corresponding figures in men were 43–56%. These reduced ratios were significant except for male centenarians.

Fourthly, in the case of OSA (Panel D), the survival difference between SSA and not-SSA (i.e., Type IV versus Type III) was non-significant for both women and men across four age groups, which is consistent with the Kaplan-Meier findings in Figures 2 and 3 where no factors were controlled for.

Fifthly, for those who were SSA, the difference in mortality risk between OSA and not-OSA (i.e., Type IV versus Type I) was significant in some age groups (Panel E). For women, the difference was significant in octogenarians and centenarians, whereas for men it was significant in octogenarians and nonagenarians.

Sixthly, in Panel F the subtype of SSA & OSA was associated with lower mortality risk for both women and men in all age groups (except women ages 65–79) compared to all other types combined. In women, compared to their counterparts who were either not-OSA or not-SSA or both not-OSA & not-SSA (i.e., Types I, II, and III were combined into one category), those who were OSA & SSA (Type IV) had a 47–70% lower ratio of mortality in three age groups above age 80. In men, Type IV was associated with 32–50% lower ratio of mortality.

4. Discussion

Prior research suggested that objective measurements and self-rating tools can be used together to refine the classification of successful aging (Cernin, Lysack, and Lichtenberg, 2011; Pruchno, Wilson-Genderson, Rose *et al*., 2010). In this study, with a large nationally representative sample focusing on the oldest-old, we showed how objectively and subjectively measured indicators of successful aging can be used jointly to construct different mortality-predictive subtypes among Chinese older adults, a group that is understudied in the existing literature of successful aging. Subjectively measured successful aging indicators reflect respondents' own feelings and likely include some conditions that are unobserved by researchers or medical personnel. Therefore, the distinctive subtypes from the joint classification of objectively and subjectively measured indicators of successful aging are expected to have added value to better predict subsequent mortality.

Literature has shown that objectively-defined and subjectively-rated successful aging measurements could differentiate survivorship in the overall population whether they are used alone or both are simultaneously presented in the model (Stenholm, Koster, Valkeinen *et al*., 2015; Brown, Thompson, Zack *et al*., 2015; Diener and Chan, 2011); our results confirm these findings. However, our approach has extra value for distinguishing subpopulations in terms of mortality risk. Specifically, our findings revealed that when older adults were not-OSA, there was a significant difference in mortality risk between SSA and not-SSA (i.e., Type II versus Type I). This is also true that when older adults were not-SSA, there was a significant difference in mortality between OSA and not-OSA (i.e., Type III versus Type I). The difference in the latter scenario was likely greater than the difference in the former scenario. However, when older adults were OSA, there was no difference in mortality risk between SSA and not-SSA (i.e., Type IV versus Type III); and when older adults were SSA, the lower mortality risk associated with OSA versus not-OSA (i.e., Type IV versus Type I) was not universal across age groups.

Overall, the findings of the current study about differential mortality risk across subtypes of successful aging suggest that the added value of concordance and discordance between OSA and SSA is important not only for those who are both OSA and SSA, but

also for those who are not-OSA or not-SSA. Our findings are novel in that older adults who are not-OSA or not-SSA constitute meaningful subtypes in distinguishing subsequent mortality risk that previous studies have inadequately examined. We argue that the combined use of both types of objectively measured successful aging and subjective (self-rated) successful aging is preferable, which echoes the recent calls on the understanding of successful aging by some researchers (Rowe and Kahn, 2015).

Successful aging, especially SSA, is an adaptive process that results in older adults maintaining a perception of well-being and life satisfaction (Romo, Wallhagen, Yourman *et al*., 2013); our approach of exploratory classification of successful aging and findings on the associations between subtypes of successful aging and subsequent mortality may be useful for care and service provisions in both clinical settings and community service programs, policy-making, and the individual's better adaptation. For example, the joint classification of OSA and SSA may benefit clinicians by encouraging a patient-centered definition of successful aging; clinicians could develop intervention programs or treatment plans that help older adults to develop positive adaptations (Phelan, Anderson, Lacroix *et al*., 2004). Integration of older adults' subjective rating of successful aging may improve the ability of health service providers to identify appropriate types of interventions and person-centered service programs to improve the experience of successful aging. From a policymaking perspective, although prevention of functional/capacity decline and interventions are still important to achieve successful aging, more resources should be invested in understanding and supporting those who live in poor objectively measured health to help them adapt and maintain a positive feeling of satisfaction. From older adults' perspective, the joint classification enables them to know their own state condition in terms of OSA and SSA so that they can make better adaptations by themselves to maintain a subjective feeling of satisfaction, to optimize functional domains that are appropriate and important to them, and thus age successfully (Baltes and Baltes, 1990).

The strength of the present study is the joint classification of OSA and SSA into different subtypes, that is, concordance and discordance of OSA and SSA based on a large nationwide sample. Previous efforts at characterizing specific successful aging subtypes are mainly limited by sample sizes and cross-sectional nature (Cernin, Lysack, and Lichtenberg, 2011; Pruchno, Wilson-Genderson, Rose *et al*., 2010), which prevent researchers from fully distinguishing different successful aging subtypes by age and sex, and examining the associations between these subtypes and mortality. With the world's largest sample of very old adults, we are fortunate to be able to conduct such research and provide empirical results for the first time. Furthermore, we have extended previous work (Cernin, Lysack, and Lichtenberg, 2011; Pruchno, Wilson-Genderson, Rose *et al*., 2010) by using a longitudinal dataset to examine associations between successful aging subtypes and subsequent mortality in several different age groups of older adults for both men and women. However, whether our findings about the associations between concordance and discordance of OSA and SSA and subsequent mortality still hold or whether these findings are robust across different populations deserves further examinations. As individuals with different health conditions may value components of successful aging differently and the subjective ratings of successful aging can also vary by culture, further studies including self-rated priorities of different domains of successful aging as well as differences in priorities in dissimilar cultural settings are clearly needed to shed some light on the psychological process of subjectively measured successful aging of respondents (Carr, Gibson, and Robinson, 2001; Feng, Son, and Zeng, 2015; Phelan, Anderson, Lacroix *et al*., 2004; von Faber, Bootsma-van der Wiel, van Exel *et al*., 2001).

The following limitations should be taken into account when interpreting our results. Firstly, due to unavailable information on subjectively defined domains of successful ag-

ing, such as self-prioritized importance of economic conditions, family support, or longevity gene in determining successful aging (Phelan, Anderson, Lacroix *et al*, 2004; Matsubayashi, Ishine, Wada *et al*., 2006), we only used subjective measures that are closely related to psychological well-being or the quality of life that are available in the CLHLS. Future research should include more psychological and social factors in classifying concordance and discordance of OSA and SSA. Secondly, we only constructed four subtypes for the variable of concordance and discordance of OSA and SSA based on two dichotomous variables. Although it provided more information on successful aging than OSA or SSA alone, this classification is very crude, and mainly exploratory. A more sophisticated classification is needed to further identify or distinguish different groups of older people in clinical or community settings to prioritize patient-specific care and services. In the meantime, there is still a long way to adequately incorporate the notion of successful aging classification in public healthcare systems to monitor and manage population health beyond specific diseases and conditions.

Despite the limitations discussed above, our findings underscore the bio-psychosocial model of successful aging that identifies subtypes that appear to represent distinct groups with regard to concordance and discordance between objective and subjective measures of successful aging. We believe that the use and further exploration of joint classification of objectively and subjectively measured successful aging could help to better understand mortality risk-differentiated groups of successful aging, both objectively and subjectively.

Conflict of Interest and Funding

No conflict of interest has been reported by the author. The author also wishes to make a disclaimer that the views expressed in this paper are solely those of his own and do not reflect those of the United Nations.

Acknowledgements

This article is based on a publicly available dataset derived from an ongoing project of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The CLHLS is supported by R01 AG023627-01 (Yi Zeng, principal investigator) awarded to Duke University. The CLHLS is also supported by the United Nations Population Fund (UNFPA), the China Natural Science Foundation, the China Social Sciences Foundation, the Hong Kong Research Grants Council, and the Max Planck Institute for Demographic Research, which provided support for international training. Thanks also go to two anonymous reviewers and Professor Bernardo Lanza Queiroz, Professor Jesscia Sautter, and Professor Melanie S. Brasher for their helpful comments.

Ethics Statement

Ethics approval was obtained from the Institutional Review Board at Duke University Medical Center, the Division of Social Sciences, Peking University, and the National Bureau of Statistics of China.

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