Chapter 20
Psychological Resources for Well-Being Among Octogenarians, Nonagenarians, and Centenarians: Differential Effects of Age and Selective Mortality

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Abstract Research on the young old indicates that psychological processes associated with the maintenance of subjective well-being are effective despite declining health and age-related social losses. In this chapter, we examine the robustness of this system in the oldest old. We divided the first wave cross-sectional sample of the Chinese Longitudinal Healthy Longevity Study (CLHLS) into two subsamples: 2-year survivors ($N = 4{,}006$) and 2-year drop-outs ($N = 4{,}799$). Psychological resources for well-being were measured by seven items (5-point response scale). Selectivity analyses and multiple regression analyses were conducted. Despite constraints in objective life conditions, long-lived individuals showed reasonably high levels of psychological resources for well-being. Age-cohort differences were small. Selective mortality and individual differences in life-history and life-context factors accounted for substantial amounts of variance. Individual differences were primarily associated with engagement in life, cognitive functioning, and health. The efficacy of this psychological system is vulnerable to losses and is associated with survival in the oldest old.

Keywords Age difference, Attrition sample, Centenarian, Chinese oldest old, Cohort difference, Cross-sectional sample, Engagement in life, Fourth age, Mortality, Nonagenarian, Objective life conditions, Octogenarian, Psychological resources, Sample selectivity, Structural equation, Subjective well-being, Successful aging, Survivor sample

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20.1 Introduction

Gerontologists have long been interested in processes linked to the malleability of aging and the determinants of survival into very old age. Research has tended to focus primarily on biogenetic mechanisms and risk factors, but there is increasing consideration given to the interactive role of social, environmental, behavioral, and psychological factors (e.g., Seeman et al. 2004; Vaupel et al. 1998). Such a multilevel and multifaceted perspective on longevity coincides with the proposals of several models of successful aging (e.g., Baltes 1987; Baltes and Baltes 1990; Rowe and Kahn 1987, 1997; Strawbridge et al. 2002). Although these models suggest slightly different sets of components and processes, there is general agreement that two central outcomes of successful aging are a sense of personal well-being and a healthy long life.

Much is known about the characteristics and processes of aging successfully among individuals aged 60–80 years (e.g., Baltes and Smith 2003; Rowe and Kahn 1997). Among contemporary generations of the young old in many countries, there are high levels of physical and mental health, cognitive fitness, and engagement in productive, social, and solitary leisure activities, healthy lifestyles and subjective well-being (e.g., Antonucci et al. 2002). Little is known about the constellations of these characteristics in the oldest old (aged 80+). Advanced old age (the Fourth Age) has been described as a phase of life unlike earlier periods of the lifespan (e.g., Baltes and Smith 2003; Smith 2001; Suzman et al. 1992). It is associated with high levels of comorbidity as well as increased risks of dementia, need-for-care, and institutionalization. It is thus important to ask whether very long-lived persons have the psychological capacity to sustain a sense of personal well-being and, hence, to age successfully. Furthermore, are there differences in the profile of psychological resources for well-being observed in octogenarians, nonagenarians, and centenarians?

We examine these questions in the context of a cross-sectional sample from the first wave of the Chinese Longitudinal Healthy Longevity Study (CLHLS: Zeng et al. 2002). This study is unique in that it consists of a representative sample of the oldest old stratified by age and gender, meaning that it provides a context for age- and gender-comparative analyses within the oldest old. Furthermore, each participant was assessed individually with a standardized protocol in a face-to-face interview.

20.2 Psychological Resources for Well-Being

Depending on the researcher's method and theoretical stance, data about personal well-being can serve as an indicator of perceived current life status, an evaluation of life up-to-the-present, and/or as an estimate of the psychological resources that an individual could use to adapt to future challenges (e.g., Diener et al. 1999; Ryff 1995; Lawton 1991). In the research we report in this chapter, we adopt the latter approach.

We examine two sets of psychological resources, which together facilitate and constrain the maintenance of well-being and thriving in old age and so contribute to healthy longevity. One set involves resources that enhance positive well-being (e.g., optimism, a sense of personal control, conscientiousness, and positive feelings about aging). The other set is linked to negative aspects of well-being (e.g., loneliness, negative emotions such as anxiety, and associating aging with a loss of self worth or competence). Each of these psychological resources has been shown to be a predictor of mortality in old age (e.g., Berkman 1988; Friedman et al. 1995; Seeman et al., 1987; Swan and Carmelli 1996). Maier and Smith (1999) and Levy et al. (2002), for example, reported that older individuals who evaluated their own experiences of aging in a positive way and maintained a high sense of self worth also lived longer. These authors assessed positive feelings about aging using a subset of items from the PGCMS (Lawton 1975). In both studies, the predictive effects of these items remained after statistically controlling for other indicators associated with mortality in old age (e.g., age, gender, SES, and health).

A well-functioning psychological system that is capable of adapting to new challenges should be characterized by a pattern of higher levels (i.e., maximization) of resources associated with positive well-being, and relatively low levels (i.e., minimization) on indicators of negative well-being (e.g., Taylor 1991; Kahneman et al. 1999; Baltes and Baltes 1990). Other patterns across these resources are indicative of acute or chronic stress and of less effective functioning. An individual adjusts his or her level of aspirations to the reality of present life conditions in order to protect the self against a loss of well-being and to maintain a sense of purpose in life. Together, these psychological processes contribute to a positive aura of well-being and to seemingly paradoxical observations that some subgroups of individuals report high life satisfaction in contexts of relatively poor objective life circumstances (i.e., the well-being paradox). To the extent to which a sense of well-being contributes to a long life, these psychological resources and processes of evaluating life experiences play a critical role.

Theoretically, as a function of enduring personality dispositions and other psychological resources, an individual's level of well-being is expected to be generally stable across the lifespan, with short-term fluctuations contingent on acute negative events. However, research has revealed that some components of well-being show different age associations from age 20–75 years (e.g., Diener et al. 1999; Mroczek and Kolarz 1998). Feelings of happiness show negative age correlations, while reports of life satisfaction either reveal no age trends or a small increase with age. In very old age, it is suggested that the increased risk of frailty, the accumulation of debilitating health conditions, functional impairments, and personal losses may increasingly place constraints on life satisfaction (Isaacowitz and Smith 2003; Kunzmann et al. 2000; Smith et al. 2002). Beyond age and health, other factors such as life history and social embeddedness as well as activities and engagement in life are expected to contribute to differences between individuals (George 2000; Kahneman et al. 1999; Lennartsson and Silverstein 2001; Menec 2003).

Using cross-sectional data from the first wave of the CLHLS, we examine age cohort and selectivity effects in the levels of psychological resources associated

with maximizing positive and minimizing negative well-being as well as predictors of individual differences in resource availability. Examination of age-related differences in the period of very old age is conceptually and methodologically complex because components of heterogeneity differ across age groups. Subgroups representing each decade (octogenarians, nonagenarians, and centenarians) reflect cohort differences in life history, differential amounts of cumulative age-related change, differential impact of selective mortality, and differential distance from death (e.g., Manton 1990). We adopt a strategy that provides partial insight into the possible effects of distance from death on functioning within and across age-cohort groups. To do this, we compare levels of functioning within age-cohort groups between those individuals who subsequently survived a further 2 years and continued to participate in the study with those who did not survive. Because the likelihood of 2-year survival is higher for octogenarians than for centenarians, we argue that selection effects found for centenarians provide strong evidence for the important role of psychological resources for aging successfully in the Fourth Age. Observed levels of psychological resources in centenarians reflect multiple selection effects. For some (unknown) reasons they are the positive outliers in terms of survival in their birth cohort. Observations among octogenarians are probably less select on these factors given that we do not know how many of them will live until age 100.

Based on the assumption that psychological resources contribute to healthy longevity, we hypothesize that we should observe selectivity differences in this sample such that individuals who subsequently survive for 2 years and continue in the second wave of data collection would show higher levels on psychological resources that maximize positive and minimize negative well-being. The effects are expected to be larger in centenarians than in octogenarians. Within the positively selected group of "2-year survivors," we expect to observe only minimal age cohort differences but substantial individual differences reflecting diversity in life history and present life conditions that are also linked to well-being.

20.3 Methods

20.3.1 Sample

We compare two nested subsamples from the first wave of the Chinese Longitudinal Healthy Longevity Study (CLHLS; N = 8,805): One subgroup survived for a further 2 years after baseline assessment and continued in the longitudinal study (1998–2000: $N = 4{,}006$), whereas the other subgroup dropped out after baseline ($N = 4{,}799$). The major reason underlying the definition of the two groups and then concentrating on the 2-year survivor subsample was to shed some light on the effects of sample selectivity on research findings in very old age.

Detailed information about the assessment battery of the total cross-sectional CLHLS sample is reported in Zeng and Vaupel (2002), and in Chap. 2 in this volume. The survey was conducted in 631 randomly selected counties and cities

of 22 provinces in which Han Chinese predominate. These provinces covered 85 percent of the total population in China (985 million persons). All centenarians from the selected areas who agreed to participate were included in the study. Based on gender and place of residence (i.e., living in the same street, village, city, or county) for a given centenarian, randomly selected octogenarians and nonagenarians were also sampled. This matched-recruitment procedure resulted in an over-sampling of the oldest old and older men at baseline. Records of the age of Han Chinese have been verified as accurate for cohorts born after 1893 (see Coale and Li 1991; Zeng et al. 2002). Interviews and basic health examinations were carried out at the participant's place of residence (i.e., private household or institution) by a doctor, nurse, or medical student.

Descriptive information for the 2-year survivor and attrition subsamples analyzed in this chapter is provided in Table 20.1. To be included in the 2-year survivor subgroup, participants had to provide valid data on at least one indicator of a resource for positive and negative well-being at baseline and the subsequent follow-up in 2000. The attrition sample consisted of participants who were available for testing at baseline only (primarily due to mortality) as well as those who provided missing psychological data at either occasion (baseline: 3–7 percent; 2000: 9–15 percent). Missing data were primarily due to poor hearing and vision, and severe cognitive impairment.

Table 20.1 Differences on demographic, physical-functioning, and psychological characteristics for subsamples of the CLHLS participants who survived two years after baseline (*S*; $N = 4006$) or dropped out (*A*; $N = 4799$) across the three age cohorts

	80–89 years		90–99 years		100–105 years	
	S	*A*	*S*	*A*	*S*	A
N	2,239	1,289	1,216	1,797	551	1,713
% Women	51^a	47^a	55^a	58^a	81^a	79^a
% City	43^a	49^b	38^a	36^a	24^a	29^a
% No school education	56^a	53^a	66^a	70^a	82^a	85^a
% No spouse	69^a	73^b	87^a	90^b	98^a	97^a
Number of children alive	5.23^a	4.89^a	5.27^a	5.20^a	5.32^a	5.62^a
% Poor hearing	3^a	11^b	10^a	29^b	18^a	47^b
% Poor vision	7^a	12^b	12^a	26^b	23^a	42^b
ADL (max = 12)	11.68^a	10.99^b	11.18^a	9.93^b	10.62^a	8.53^b
Engagement in life (max = 16)	4.01^a	3.29^b	2.78^a	1.83^b	2.03^a	1.12^b
MMSE (max = 23)	20.17^a	18.85^b	18.27^a	15.28^b	15.99^a	12.15^b
Word fluency (foods)	11.29^a	10.52^b	9.39^a	7.26^b	7.32^a	5.47^b
Life satisfaction (max = 5)	3.90^a	3.88^a	3.92^a	3.83^b	3.93^a	3.87^a
Self-rated health (max = 5)	3.74^a	3.54^b	3.70^a	3.48^b	3.70^a	3.46^b

Total $N = 8805$. *S* = 2-year survivor subsample, *A* = attrition (drop-out sample). ADL, activities of daily living; MMSE, mini-mental state examination. Higher scores on ADL, engagement in life, MMSE, and word fluency indicate higher functioning. Within age cohorts, indices with different superscripts are significantly different between the samples at $p < .01$ or below. For statistically significant differences between the age cohorts, see text.

20.3.2 Measures

Psychological resources. Our research includes indicators of psychological resources associated with positive and negative aspects of well-being. Resources for positive well-being were measured using four items: *Optimism* ("I always look on the bright side of things"), *Conscientiousness* ("I like to keep my belongings neat and clean"), *Sense of personal control* ("I can make my own decisions concerning my personal affairs"), and *Positive feelings about aging* ("I am just as happy now as when I was younger"; item from the PGCMS; Lawton 1975). To assess negative aspects of well-being, the following three items were used: *Neuroticism* ("I often feel fearful or anxious"), *Loneliness* ("I often feel lonely or isolated"), and *Perceived loss of self-worth* ("The older I get, the more useless I feel"; item from the PGCMS; Lawton 1975). Responses were recorded on a 5-point scale (1—describes me very well; 5—does not describe me at all). To have both sets of resources scored in the same direction, all responses on items for positive well-being were reverse coded. As a consequence, high scores on resources against negative well-being reflect low neuroticism, low loneliness, and high self-worth.

Structural characteristics of the resource indicators of maximizing positive and minimizing negative well-being were evaluated using structural equation modeling techniques. Table 20.2 contains the standardized factor loadings, their levels of statistical significance and standard errors, as well as the communalities for the measurement model of well-being. This model produced bivariate correlations

Table 20.2 Standardized factor loadings and communalities for the measurement model of psychological resources for well-being

Indicator	Factor loading	*T*	SE	R^{2a}
Resources for positive well-being				
1. I always look on the bright side of things.	0.64 (0.65)	32.24 (48.74)	0.02 (0.01)	0.41 (0.42)
2. I like to keep my belongings neat and clean.	0.53 (0.53)	27.38 (40.85)	0.01 (0.01)	0.28 (0.28)
3. I can make my own decisions concerning my personal affairs.	0.45 (0.42)	23.58 (32.55)	0.02 (0.01)	0.21 (0.18)
4. I am just as happy now as when I was younger.	0.54 (0.54)	27.91 (41.63)	0.02 (0.01)	0.29 (0.29)
Resources against negative well-being				
1. I often feel fearful or anxious.$^{+}$	0.62 (0.61)	29.93 (43.96)	0.02 (0.01)	0.38 (0.37)
2. I often feel lonely or isolated.$^{+}$	0.75 (0.75)	33.40 (49.64)	0.02 (0.01)	0.56 (0.56)
3. The older I get, the more useless I feel.$^{+}$	0.43 (0.43)	23.05 (33.67)	0.02 (0.01)	0.19 (0.18)

$N = 4006$. In parentheses, indices for the total sample ($N = 8805$).

$^{+}$ Scores were recoded so that high scores represent higher well-being-associated resources.

[a] Communality (R^2) = 1—standardized residual variance. Communality indicates the proportion of variance each single indicator explains of its associated latent factor: Squared multiple correlations.

between the positive and negative factors of well-being and found them to be of moderate size both in the total cross-sectional CLHLS sample (N = 8,805: r = 0.34) and in the restricted subsample of 2-year survivors (N = 4,006: r = 0.33). This specified model showed acceptable fit with the data in the total sample (N = 8,805: RMSEA = 0.061, NFI = 0.94, CFI = 0.94) as well as in the 2-year survivor subsample (N = 4,006: RMSEA = 0.054, NFI = 0.95, CFI = 0.95). As can be seen in Table 20.2, all factor loadings were reasonable, which also indicates that the fit between the model specified and the current data set is acceptable.

Individual difference correlates. To examine cross-disciplinary correlates of individual differences in the psychological resources for well-being, we entered six sets of measures into regression models. A first set contained sociodemographic characteristics including gender (1 = men, 2 = women), education (0 = no education, 1 = attended school), and place of residence (1 = urban, 2 = rural). A second set of correlates included in the analyses comprised measures of functional health such as Activities of Daily Living (ADL) and sensory functioning. ADL represents the number of basic activities (i.e., getting out of bed, dressing, toileting, bathing, and eating) in which participants' reported needing assistance (max 12 = no assistance needed on six activities; Katz et al. 1963). Sensory functioning was indicated by a vision test (1 = the participant could see a break in a circle on a cardboard sheet and distinguish where the break was located, 2 = can not see) and by the interviewers' rating of the participant's ability to hear (1 = can hear, 2 = cannot hear). Third, self-rated health was measured using an item that is standard in the literature and that has often been shown to be a valid predictor of functioning and mortality among older people (for review, see Idler and Benyamini 1997): "How would you rate your health at present?" The response format ranged from 1 = very good to 5 = very bad.

The fourth set of correlates involved indicators of cognitive functioning. Two measures were used. An age-adjusted 23-item Chinese version of the Mini-Mental State Examination (MMSE; Folstein et al. 1975) assessed the facets orientation, registration, attention and calculation, recall, and language and movement. The second measure of cognitive functioning assessed verbal fluency. Participants were required to name as many kinds of food as possible within 60 s. This is a standard task in many intelligence tests.

The last fifth and sixth sets of correlates reflected social embeddedness and active engagement in life. Quantitative measures of social integration were available including whether the participant's spouse was alive and the number of children alive. Engagement in life was measured using a summed score of a list of eight activities. Participants were asked to indicate whether they performed the following eight activities regularly: Housework, grow vegetables and other field work, garden work, read newspapers or books, raise domestic animals, play cards and/or mah-jong, watch TV and/or listen to the radio, and religious activities. Due to the coding scheme (0 = never, 1 = sometimes, 2 = regularly), the maximum score was 16.

Mortality information was obtained in 2000 in interviews with relatives, caregivers, and community authorities. Mortality status was available for N = 7,938 and (partly) missing for N = 867. Of those for whom mortality status was recorded,

41 percent (N = 3,247) were deceased by 2000. Among the survivors (N = 4691), 85 percent (N = 4,006) provided valid data on resource indicators for well-being.

20.4 Results

Results are reported in three main sections. In a first section, we compare the profiles of psychological resources for positive and against negative well-being of octogenarians, nonagenarians, and centenarians in the 2-year survivor sample (N = 4,006). In a second step, selectivity analyses are carried out to examine the extent to which positive sample selectivity contributed to these findings. Here, we contrast the survivor sample against the attrition sample (N = 4,799). In a third step, multiple regression analyses are undertaken to examine a number of cross-disciplinary factors as potential individual difference correlates of subjective well-being among long-lived individuals.

20.4.1 Profiles of Well-Being in Advanced Old Age

Table contains descriptive statistics for the three age cohorts on the indicators of psychological resources for positive well-being and against negative well-being. Overall, participants in the three age cohorts had relatively high potential for well-being. For example, the mean for centenarians on the optimism item was 3.91, nonagenarians = 3.95, and octogenarians = 3.97. Statistically significant differences between the three age cohorts of long-lived individuals were found on personal control, ($F_{2,3,918}$ = 11.4, $p < .000$), loneliness ($F_{2,3,953}$ = 6.3, $p < .01$), and self-worth ($F_{2,3,940}$ = 14.8, $p < .000$). On average, centenarians reported lower self-worth, greater loneliness, and less control over their lives than did octogenarians. As a result, centenarians had somewhat lower levels on the composite measures of resources for positive well-being ($F_{2,4,003}$ = 7.7, $p < .000$) and against negative well-being ($F_{2,4,003}$ = 11.0, $p < .000$). Although statistically significant, these differences were small amounting to 0.18 SD units for both sets of resources. The maximum difference between centenarians and octogenarians was on self-worth, but this reflected only 0.25 SD units. In sum, results from this 2-year survivor subsample of the CLHLS suggest that, on average, individuals are able to maintain relatively high well-being into advanced old age, and that there are cross-sectional differences between various cohorts of long-lived individuals, but they are small.

20.4.2 Sample Selectivity

To examine the effects of sample selectivity on the present findings about preserved well-being in very old age, participants from the 2-year survivor subsample of the CLHLS (s; $N = 4{,}006$) were contrasted against the total cross-sectional sample

Table 20.3 Descriptive statistics of resource indicators for positive well-being and for the lack of negative well-being across the three age cohorts at baseline assessment

Indicator	80–9 years ($N = 2{,}239$)	90–9 years ($N = 1{,}216$)	100–05 years ($N = 551$)
Resources for positive well-being			
1. I always look on the bright side of things.	3.97^{a} (0.80)	3.95^{a} (0.78)	3.91^{a} (0.85)
2. I like to keep my belongings neat and clean.	4.11^{a} (0.68)	4.07^{a} (0.68)	4.03^{a} (0.76)
3. I can make my own decisions concerning my personal affairs.	3.64^{a} (1.02)	$3.54^{a,b}$ (0.99)	3.42^{b} (1.05)
4. I am just as happy now as when I was younger.	3.40^{a} (1.05)	3.36^{a} (1.05)	3.32^{a} (1.09)
Composite	3.78^{a} (0.60)	$3.73^{a,b}$ (0.61)	3.67^{b} (0.68)
Resources against negative well-being			
1. I often feel fearful or anxious.$^{+}$	3.70^{a} (0.82)	3.66^{a} (0.82)	3.67^{a} (0.84)
2. I often feel lonely or isolated.$^{+}$	3.67^{a} (0.84)	3.57^{b} (0.85)	$3.58^{a,b}$ (0.89)
3. The older I get, the more useless I feel.$^{+}$	3.10^{a} (0.99)	$3.00^{a,b}$ (1.00)	2.85^{b} (1.02)
Composite	3.49^{a} (0.66)	3.40^{b} (0.68)	3.37^{b} (0.70)

N = 4006. Means and standard deviations shown in parentheses. $^{+}$ Scores were recoded so that high scores represent higher well-being-associated resources. Indices with different superscripts are significantly different between the age cohorts at $p < .01$ or below. Response format for the items ranges from 1 to 5.

($N = 8{,}805$). Following a procedure used by Lindenberger et al. (2002), effect sizes for sample selectivity were computed as the normed difference between the two nested samples: selectivity = $(M_s - M_{\text{total sample}})/\text{SD}_{\text{total sample}}$. Effects are expressed in SD units. It has to be noted that the effect size is a descriptive measure that is derived directly from the group level, so that there is no variance associated with it. For that reason, it is not possible to apply significance tests. Overall, only 15 percent of baseline participants who were eligible for repeated assessment were not willing or capable to do so. The majority of baseline participants who did not take part a second time were deceased. As a consequence, total selectivity was *not* separated into a mortality-associated component and an experimental component because the mortality component was the major source of drop-out.

In a first set of selectivity analyses, sample differences on the composite scores for the two sets of resources were determined. In a second set of analyses, sample differences in demographic, physical-functioning, and psychological characteristics were examined because these variables were used in a subsequent step as potential individual difference covariates of well-being.

Sample differences in psychological resources. The results of the selectivity analyses are shown in Fig. 20.1. From Panel A of Fig. 20.1, it can be seen that the

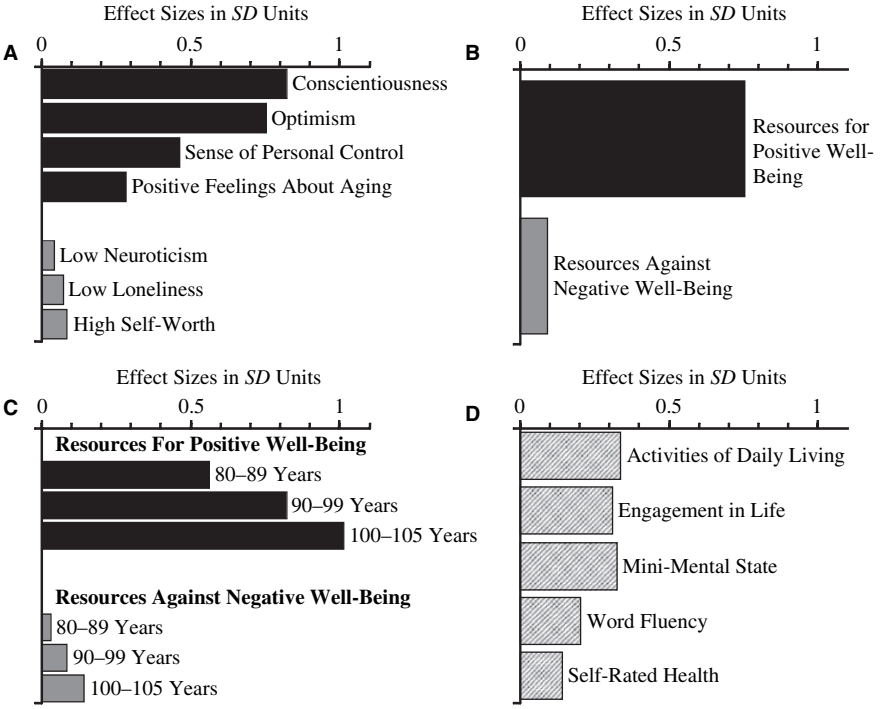

Fig. 20.1 Selectivity effects in the 2-year survivor sample of the CLHLS (N = 4,006) relative to the total CLHLS sample (N = 8,805) for variables assessed at baseline
Note: *Panel A*: Selectivity effects on the single psychological resource indicators for positive well-being (conscientiousness, optimism, sense of personal control, and positive feelings about aging) and against negative well-being (neuroticism, loneliness, and perceived loss of self-worth). *Panel B*: Selectivity effects on the composite measures of resources for positive well-being and resources against negative well-being. *Panel C*: Selectivity effects on resources for positive well-being and against negative well-being separately for the three age cohorts of octogenarians, nonagenarians, and centenarians. *Panel D*: Selectivity effects for individual difference correlates of well-being.

magnitude of sample selectivity was 0.82 SD units for conscientiousness (i.e., the 2-year survivor subsample was higher on this resource), 0.75 SD units for optimism, 0.46 SD units for control, 0.28 SD units for positive feelings about aging, 0.04 SD units for neuroticism, 0.07 SD units for loneliness, and 0.08 SD units for self-worth. Panel B of Fig. 20.1 illustrates that composite selectivity effects for resources linked to positive well-being (0.75 SD units) were much stronger than selectivity effects for lack of negative well-being (0.09 SD units). According to statistical convention (e.g., Cohen 1977), observed selectivity corresponds to medium effects for measures of positive well-being and to small effects for measures of lack of negative well-being.

Panel C of Fig. 20.1 displays sample selectivity effects for well-being separately for the three age cohorts. In both sets of resources, the positive selectivity effects tended to be stronger among the older cohorts. For resources linked to positive well-being, the magnitude of total sample selectivity was 0.56 SD units for

octogenarians, 0.82 SD units for nonagenarians, and 1.01 SD units for centenarians. Again, based on Cohen 's criteria 1977), the selectivity effects among octogenarians represent medium effects and among nonagenarians and centenarians correspond to large effects. For resources against negative well-being, effects were small: Sample selectivity was 0.03 SD units for octogenarians, 0.08 SD units for nonagenarians, and 0.14 SD units for centenarians.

Sample differences in individual difference correlates of well-being. An additional set of selectivity analyses examined sample differences in demographic, physical-functioning, and psychological characteristics. Panel D of Fig. 20.1 shows sample selectivity effects for those covariates that were available as continuous measures, which allowed the calculation of effect size estimates of selectivity analogous to those reported for well-being. The magnitude of total sample selectivity was 0.34 SD units for Activities of Daily Living, 0.31 SD units for engagement in life, 0.32 SD units for the Mini-Mental State Examination, 0.20 SD units for word fluency, and 0.14 SD units for subjective health. By convention (e.g., Cohen 1977), selectivity effects for the covariates of well-being examined here were small.

Table 20.1 provides additional information about all correlates between the CLHLS participants in the 2-year survivor subsample ($N = 4{,}006$) and the attrition subsample ($N = 4{,}799$), separately for the three age cohorts. There were no or only marginally significant sample differences in terms of gender distribution, place of residency, school education or not, availability of a spouse, and life satisfaction. For example, the lack of differences in life satisfaction across the samples as well as across the age cohorts indicates that life satisfaction represents but one and probably not the most sensitive indicator of successful aging (Kahneman et al. 1999). Substantive selectivity differences were found for the ratio of participants who were impaired in hearing and vision, and with regard to ADL, engagement in life, MMSE, word fluency, and self-rated health. These differences unequivocally indicate the positive selection of the 2-year survivor subsample. For example, among the centenarians who continued participation in the CLHLS, only 23 percent were found to be visually impaired as compared with 42 percent among those centenarians who were only available for testing once.

Table 20.1 also shows pronounced age-related differences. In both samples, the ratio of women over men increased drastically over the age cohorts, reflecting the higher mortality rates for men, chi-square ${\chi^2}_{2,N=4,006} = 169.4$, $p < .000$; ${\chi^2}_{2,N=4,799} = 357.6$, $p < .000$. Among the octogenarians, there was an almost equal distribution of gender, whereas the ratio was 4:1 for women among centenarians. In a similar vein, it was found that the older the CLHLS participants, the less likely they were to live in an urban area (chi-square ${\chi^2}_{2,N=4,006} = 61.8$, $p < .000$; ${\chi^2}_{2,N=4,799} = 126.3$, $p < .000$), to have had school education (${\chi^2}_{2,N=4,006} = 140.6$, $p < .000$; ${\chi^2}_{2,N=4,799} = 360.3$, $p < .000$), to have a spouse (${\chi^2}_{2,N=4,006} = 276.0$, $p < .000$; ${\chi^2}_{2,N=4,799} = 423.9$, $p < .000$), to have relatively well-preserved hearing (${\chi^2}_{2,N=4,006} = 186.4$, $p < .000$; ${\chi^2}_{2,N=4,799} = 451.0$, $p < .000$) and vision (${\chi^2}_{2,N=4,006} = 133.7$, $p < .000$; ${\chi^2}_{2,N=4,799} = 331.2$, $p < .000$), to be restricted in ADL ($N = 4{,}006$: $F_{2,4,003} = 122.7$, $p < .000$; $N = 4{,}799$: $F_{2,4,791} = 249.8$, $p < .000$) and engagement in life ($N = 4{,}006$: $F_{2,4,002} = 197.8$, $p < .000$; $N = 4{,}799$:

$F_{2,4,788} = 422.9$, $p < .000$), and to be cognitively fit on the MMSE ($N = 4{,}006$: $F_{2,3,991} = 261.8$, $p < .000$; $N = 4{,}799$: $F_{2,4,190} = 416.6$, $p < .000$) as well as in terms of word fluency ($N = 4{,}006$: $F_{2,3,371} = 76.9$, $p < .000$; $N = 4{,}799$: $F_{2,3,540} = 213.0$, $p < .000$). In contrast, there were no or only minimal differences between the three age cohorts in terms of life satisfaction ($N = 4{,}006$: $F_{2,3,994=}0.7$, $p > .10$; $N = 4{,}799$: $F_{2,4,201} = 2.1$, $p > .10$) and self-rated health ($N = 4{,}006$: $F_{2,3,998} = 1.0$, $p > .10$; $N = 4{,}799$: $F_{2,4,201} = 3.0$, $p = .051$). The large majority of the sample was either living alone or living together with other household members, but not in nursing homes, and this was the case both for the total cross-sectional CLHLS sample ($N = 202$, 4.2 percent) and in the restricted positively selected sample of 2-year survivors ($N = 221$, 5.5 percent).

20.4.3 Regression Analyses

Multiple regression analyses were undertaken to examine a number of cross-disciplinary factors as potential correlates of subjective well-being among long-lived individuals. The effect of chronological age was covaried by entering age in a first step. This was followed by blockwise entry of the covariates. Intercorrelations among the constructs entered into the regression analyses are provided in the Appendix (see Table 20.5).

Results of the final age-partialed models of hierarchical regression analyses predicting the availability of resources for positive well-being and against negative well-being are displayed in Table 20.4. Analyses indicated that the linear

Table 20.4 Final age-partialed models from hierarchical regression analyses to predict resources for positive well-being and against negative well-being in the 2-wave sample of the Chinese Longitudinal Healthy Longevity Study

	Resources for positive well-being			Resources against negative well-being		
Unique predictors	*B*	SE	*β*	*B*	SE	*β*
Men/women	0.03	0.02	0.02	−0.11***	0.03	−0.08***
Urban/rural	−0.18***	0.02	0.15***	−0.07**	0.02	−0.05**
No school/school	−0.01	0.02	−0.01	0.03	0.03	0.02
Number of children alive	0.01**	0.00	0.05**	0.01*	0.00	0.03*
Poor vision/good vision	0.06	0.03	0.03	−0.05	0.04	−0.02
Poor hearing/good hearing	0.01	0.04	0.00	−0.10*	0.05	−0.04*
ADL	−0.02**	0.01	−0.05**	0.02*	0.01	0.05**
Engagement in life	0.03***	0.00	0.14***	0.00	0.01	0.01
Mini-Mental State	0.02**	0.00	0.16***	0.01*	0.00	0.05*
Word fluency	0.01***	0.00	0.07***	0.01***	0.00	0.08***
Self-rated health	0.21***	0.01	0.28***	0.15***	0.02	0.17***
R^2	0.21			0.10		
F	74.10			29.41		
d*f*	12,3353			12,3353		
p <	0.000			0.000		

$N = 4006$.

* $p < .05$; ** $p < .01$; *** $p < .001$.

combination of the covariates accounted for 21 percent of the variance in resources for positive well-being, F (12, 3,353) = 27.41, $p < .000$, and 10 percent of the variance in resources against negative well-being, $F(12, 3{,}353) = 29.35$, $p < .000$. According to statistical convention (Cohen 1977), the effect of resources for positive well-being was of medium size and the effect of resources against negative well-being was small.

Unique positive predictors of resources for positive well-being were living in the city, being socially embedded (as indexed by the number of children alive), preserved functional health (Activities of Daily Living), engagement in life, cognitive fitness (Mini-Mental State, word fluency), and self-rated health. As expected, the largest standardized beta weight was found for subjective health (beta $\beta = 0.28$), but beta weights of the Mini-Mental State ($\beta = 0.16$), living in the city ($\beta = 0.15$), and engagement in life ($\beta = 0.14$) were also considerable. Being a man, living in the city, having higher social integration, preserved functioning (good hearing, ADL), cognitive fitness, and higher self-rated health uniquely predicted higher resources against negative well-being. Again, the beta weights for subjective health were largest ($\beta = 0.17$) for this dimension, whereas all other beta weights were rather small (ranging from $\beta = 0.08$ for word fluency to $\beta = -0.04$ for hearing).

20.5 Discussion

Our findings point to the existence of the well-being paradox in this Chinese sample of the oldest old. Despite constraints in objective life conditions (e.g., functional health), long-lived individuals showed reasonably high levels of psychological resources linked to the capacity of well-being. Differences between the three age cohorts of octogenarians, nonagenarians, and centenarians were present, but were relatively small. Selective mortality and individual differences in life-history and life-context factors accounted for substantial amounts of variance in the potential for well-being.

Overall, our analyses suggest that psychological processes associated with maximizing positive and minimizing negative well-being remain reasonably intact in advanced old age. Even among centenarians, the psychological system associated with sustaining well-being appears to be functional. At the same time, however, these results need to be interpreted in the context of the sample selectivity effects we report. Selectivity leads to an underestimation of actual losses associated with age-related change at the population level of the remaining portion of a given birth cohort in very old age. This is so because the less functional individuals in an age group are more likely to drop out. In addition, selectivity indicates that distance from death is associated with less efficacy of the psychological system linked to well-being. In future work, it will be important to more thoroughly attempt to separate the effects age-associated processes from mortality-associated processes.

We defined two sets of psychological resources that contribute to sustaining well-being by maximizing positive aspects of life (e.g., conscientiousness, optimism, personal control, and a positive perception of aging) and minimizing negative

aspects (dealing with loneliness, maintaining self worth, and regulation of anxiety). The idea that personal well-being is multidimensional and that it reflects a positive balance of cognitive evaluations of life and emotional experience is well-established in the literature (e.g., Diener et al. 1999; Kahneman et al. 1999; Lawton 1991). Our definition of psychological resources and processes associated with well-being, however, was constrained by the items included in the CLHLS. Investigating well-being in the oldest old was not the primarily goal of the CLHLS.

Nevertheless, the seven items available in the survey do indicate key psychological resources that have been previously been highlighted in the gerontological literature as predictors of well-being and longevity, and our findings are theory consistent. Conscientiousness, for example, which was predictive of longevity in the Terman sample (Friedman et al. 1995) indicates a responsible well-organized lifestyle and a degree of self-discipline needed to deal with all the challenges of a long life. Optimism and a sense of personal control over the things that happen in one's life add positive future-oriented motivational resources to a conscientious lifestyle and probably ensure some aspects of variety to life routines and activities (see also Maruta et al. 2000). Minimization of anxiety, fear, and loneliness have been shown to have positive effects on the immune system (e.g., Kiecolt-Glaser et al., 2002), to reduce stress, and to foster well-being and health (e.g., Ryff and Singer 1998). Finally, the two items in the CLHLS which assess whether individuals perceive that, despite getting older, they have maintained a degree of happiness and sense of self-worth, were extracted from a PGCMS subscale (Lawton 1975) previously found to predict survival in the Berlin Aging Study (Maier and Smith 1999) and in the Ohio Longitudinal Study of Aging (Levy et al. 2002).

The limitations of the CLHLS data on psychological functioning are more than outweighed by its strengths. On the limitation side, one would have wished to have available a more comprehensive measurement battery to index not only psychological resources linked to well-being but also status on multiple components of well-being. Additional cognitive measures sensitive to average and higher levels of cognitive functioning (i.e., beyond the level of functioning assessed by the MMSE) would have allowed us to better differentiate individuals in terms of average and successful aging.

In terms of its strengths, the CLHLS offers a unique data set with large subgroup sizes at the oldest old ages to shed light on the differential impact of advanced age and selectivity. Furthermore, the CLHLS comprises a partially *representative* sample of octogenarians, nonagenarians, and centenarians in a non-Western country. As a consequence, the longitudinal data provide insight into the definition and mechanisms underlying the effects linked to social and economic status as well as technological and political changes. We also want to highlight the surprising similarity between our findings in these Chinese data about correlates of individual differences in the availability of resources for sustaining well-being and results from other countries (see Antonucci et al. 2002). This lends support to theories about successful aging and speaks to the universal nature of contributing factors including psychological resources, health, social integration, and engagement in life. The CLHLS provides a wealth of opportunities for future analyses to test hypotheses

about determinants of longevity and life quality among the oldest old and also to distinguish sources of heterogeneity in this period of life (e.g., biological, social, age-related, and death-related). Such future work will further our understanding of how individuals age differently at the end of life.

Appendix

Table 20.5 Intercorrelations among the constructs entered INTO hierarchical regression analyses to predict resources for positive well-being and against negative well-being in the 2-wave sample of the Chinese Longitudinal Healthy Longevity Study

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Resources for positive well-being	–												
2. Resources against negative well-being	0.21[a]	–											
3. Age	−0.7	−0.9	–										
4. Men/women	−0.7	−1.4	0.17	–									
5. Urban/rural	−2.0	−0.8	0.13	0.3	–								
6. No school/school	0.12	0.13	−1.9	−5.4	−1.9	–							
7. Number of children alive	0.09	0.07	−1.2	−1.6	0.2	0.13	–						
8. Poor vision/good vision	−1.0	−1.1	0.18	0.13	0.06	−1.1	−0.7	–					
9. Poor hearing/good hearing	−1.0	−1.0	0.21	0.10	0.05	−1.2	−0.6	0.18	–				
10. ADL	0.08	0.13	−2.4	−1.3	.01	0.10	0.05	−2.5	−2.3	–			
11. Engagement in life	0.25	0.13	−3.3	−1.6	−1.4	0.28	0.12	−2.7	−1.6	0.28	–		
12. Mini-Mental State	0.27	0.18	−3.5	−2.7	−1.3	0.30	0.13	−.32	−.37	0.32	0.36	–	
13. Word fluency	0.19	0.16	−2.1	−1.4	−0.9	0.19	0.08	−1.3	−1.6	0.16	0.25	0.34	–
14. Self-rated health	0.34	0.23	−0.3	−1.0	−0.4	0.10	0.05	−1.2	−1.1	0.19	0.19	0.23	0.16

$N = 4006$.

[a] The correlation at the manifest level is somewhat lower than those reported from the LISREL models carried out at the latent level. Correlations that were not significantly different from zero at $p < .01$ or below, in italics.

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