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Original Research Report

Purpose in Life Among Centenarian Offspring

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Abstract

Objectives: Purpose in life (PIL), a feeling of meaning and direction in life, is associated with favorable health outcomes including lower mortality and reduced risk of disease, disability, and cognitive impairment. Since centenarian offspring have been shown to have long health spans we sought to examine whether they have higher PIL than individuals without familial longevity.

Method: We compared PIL scores from the Ryff Scales of Psychological Well-Being in centenarian offspring from the New England Centenarian Study (N = 361, mean age = 82.0 years) with 3 referent groups: spouses, birth cohort-matched referents, and Health and Retirement Study (HRS) participants.

Results: Logistic regression analyses adjusted for age, sex, education, and marital status indicated greater odds of high PIL among centenarian offspring compared with spouse (adjusted odds ratio [aOR] = 1.92, 95% confidence interval [CI] = 1.002–3.68, p = .049) and birth cohort referents (aOR = 2.64, 95% CI = 1.36–5.14, p = .004). Offspring had an almost 3 times greater odds of having high PIL than HRS participants (odds ratio [OR] = 2.93, 95% CI = 2.17–3.96, p < .0001).

Discussion: Higher PIL is associated with being an offspring of a long-lived parent and may play a role in the ability to delay age-associated illnesses and functional decline. Increasing purposefulness may be a target for interventions to promote healthy aging.

Keywords: Attitudes, Familial, Longevity, Mental health, Well-being

The centenarian population experienced a dramatic rise from 1980 to 2010 according to United States Census Bureau. The number of Americans living to 100 years or older increased during this time by 65%, almost doubling the total population increase of 36% (U.S. Census Bureau, 2012). There is concern that with the rising prevalence of long-lived individuals, there will be a growing burden of people with chronic diseases, a hypothesis put forth by Gruenberg (1977) and coined "failures of success." Certainly, there is some evidence that among the general population of the United States gains in life expectancy are being met by gains in years spent with a chronic disease and disability (Crimmins & Beltrán-Sánchez, 2011). In contrast, Fries' Compression of Morbidity Hypothesis suggested that as humans approach the limit of life span delays in disease onset will outweigh gains in survival resulting in compression of the time in which they experience diseases and associated disability toward the end of their lives

(Fries, 1980). Indeed, this appears to be true as a significant proportion of centenarians has been shown to delay or escape age-associated illnesses or to at least markedly delay the disability normally associated with them (Andersen, Sebastiani, Dworkis, Feldman, & Perls, 2012; Gellert et al., 2017; Ismail et al., 2016; Sebastiani et al., 2013; Terry, Sebastiani, Andersen, & Perls, 2008). Recent calls propose to assess compression of morbidity using indicators beyond the narrow outcomes of disease and disability prevalence such as subclinical disease, health care utilization, and psychosocial burden (Beltrán-Sánchez, Razak, & Subramanian, 2014). With favorable health and functional outcomes, centenarians and their family members provide insights into these and other determinants of healthy aging.

Centenarian Offspring

Studies indicate a substantial familial component to surviving to extreme old age (Hjelmborg et al., 2006; Perls et al., 2002; Sebastiani, Nussbaum, Andersen, Black, & Perls, 2016). Studies have also shown that centenarian offspring have similar healthy aging patterns to those found in their parents. They exhibit not only delayed onset of cardiovascular disease, hypertension, and diabetes, but also overall lower mortality than other members of their birth cohort (Adams, Nolan, Andersen, Perls, & Terry, 2008; Terry, Wilcox, McCormick, Lawler, & Perls, 2003; Terry, Wilcox, McCormick, Pennington, et al., 2004). As a significant proportion of centenarians may be in a period of terminal decline shown to begin three or more years before death in older adults (Cohen-Mansfield, Skornick-Bouchbinder, & Brill, 2017), centenarian offspring are a valuable model for studying the contributors to exceptional longevity and healthy aging earlier in the life course, particularly in relation to psychological factors that influence aging. Our studies found favorable personality traits such as lower neuroticism and higher extraversion among centenarian offspring in comparison with an age-matched control cohort (Givens et al., 2009) and these findings were later extended to the offspring generation of a study of families demonstrating clustering for exceptional survival, the Long Life Family Study (Andersen et al., 2013). It remains to be seen whether other psychosocial factors, such as indicators of well-being, may play a role in the ability of centenarian offspring to delay the onset of age-associated illnesses, functional decline, and mortality.

Purpose in Life

Psychological well-being is an important component of successful aging (Cosco, Prina, Perales, Stephan, & Brayne, 2013; Phelan, Anderson, LaCroix, & Larson, 2004). One proposed facet of well-being stems from work of Frankl (1963) describing the will to find meaning as the primary motivation in life. Also termed "purpose in life" and defined as a feeling of meaning and direction in one's life (Ryff, 1989), this facet has recently garnered significant attention due to its association with favorable health and survival outcomes including protective physiological and cognitive health benefits. A recent meta-analysis of the literature found that high purpose in life was associated with a 17% less risk for all-cause mortality as well as cardiovascular events, including myocardial infarction, cardiac death, and stroke even after adjustment for sociodemographic, health, and functional status covariates (Cohen, Bavishi, & Rozanski, 2016). A study of women aged 85 years and older found that those with PIL scores in the highest quartile had significantly reduced odds of disability, incident disease, and mortality compared with those scoring in the lowest quartile (Zaslavsky et al., 2014). Another study of adults found that higher purpose in life scores predicted better health as measured by biomarkers 10 years later (Zilioli, Slatcher, Ong, & Gruenewald, 2015).

The potential contributions of purpose in life to healthy aging also extend to preservation of cognitive function. Greater purpose in life has been associated with higher cognitive test scores (Lewis, Turiano, Payne, & Hill, 2017; Windsor, Curtis, & Luszcz, 2015) and a lower risk of cognitive impairment and Alzheimer's disease over follow-up (Boyle, Buchman, Barnes, & Bennett, 2010). In a neuropathological study, premorbid higher purpose in life was associated with an almost 50% reduced odds of having cerebral infarcts (Yu et al., 2015). Additionally, in the psychological domain, higher PIL has been associated with fewer depressive symptoms (Chow & Ho, 2012; Hedberg, Gustafson, Alex, & Brulin, 2010) and with greater life satisfaction (Ardelt & Edwards, 2016).

Several biological pathways have been proposed as playing roles in how PIL might affect health. Lower levels of the pro-inflammatory factor, cytokine interleukin-6 receptor, were associated with higher PIL scores even after adjusting for sociodemographics and risk factors suggesting an immune protection (Friedman, Hayney, Love, Singer, & Ryff, 2007). Furthermore, individuals with higher PIL scores had a reduced inflammatory response (Thoma et al., 2017) and better recovery (Fogelman and Canli, 2015) following a psychosocial stressor. These studies suggest that having a sense of purpose may contribute to better adaptation and regulation to negative emotional responses, protecting against negative events that may be harmful to health.

In addition to biologic buffers, purpose in life has been linked to health benefits driven by behavior modifications. Higher purpose in life has been linked to increased likelihood of seeking preventative health measures, such as mammograms, pap smears, and prostate examinations (Kim, Strecher, & Ryff, 2014) and not smoking (Konkolÿ Thege, Bachner, Martos, & Kushnir, 2009). Alternatively, low PIL may represent a psychological variable related to harmful health-related behaviors. Patients with poorly controlled type II diabetes were more likely to have low purpose in life scores than diabetes patients with acceptable glycemic levels (Rasmussen et al., 2013).

Study Objectives and Hypotheses

The elucidation of psychosocial factors that are associated with healthy aging may provide valuable opportunities for public health interventions, such as programs designed to bolster feelings of well-being. Since purpose in life is associated with lower mortality and decreased risk of cardiovascular events, traits that have been seen among the adult children of centenarians, we sought to examine purposefulness among centenarian offspring. We hypothesized that centenarian offspring would have higher purpose in life in comparison with three referent groups without familial longevity: their spouses, age-matched individuals with average parental longevity, and a nationally representative sample matched for sociodemographic variables.

Method

Study Participants

The New England Centenarian Study (NECS) at Boston Medical Center and Boston University School of Medicine is a worldwide, longitudinal study of extreme survival among centenarians and their family members (Sebastiani & Perls, 2012). The current study used data from the offspring generation. The referent cohorts consist of (a) spouses of centenarian offspring and (b) septuagenarian referents who are the offspring of at least one parent from the same birth cohort as the centenarians but who died at the age of 73 (Terry et al., 2003). Offspring and referent participants complete questionnaires for sociodemographic, medical history, physical function, and family tree information and provide a blood sample at enrollment. Participants then complete annual follow-ups by mail or telephone to update medication use, medical history, and physical function information. Additionally, they complete a brief cognitive test biennially. All participants provided written informed consent at the time of study enrollment. The Boston University Medical Campus and Boston Medical Center Institutional Review Board approved the research protocol.

The Health and Retirement Study (HRS) is a longitudinal study of health, retirement, and aging in a nationally representative sample of more than 30,000 individuals in the United States over the age of 50 (Sonnega et al., 2014). It is conducted by the University of Michigan and sponsored by the National Institute on Aging. Participants were interviewed every 2 years beginning in 1992, with new cohorts continually added to keep the population representative. Starting in 2006, HRS used a mixed-mode design for follow-up with half of the sample receiving an enhanced face-to-face interview including the psychosocial questionnaire. The half-samples alternate waves so that the enhanced interview for each participant is conducted every 4 years for longitudinal analysis. For this study, we used data from the subset of HRS participants who completed an enhanced face-to-face interview in 2014 (N = 9,554).

Questionnaire

We measured purpose in life using the HRS version of the seven question purpose in life scale of the Ryff Psychological Well-Being Scale (Smith, Ryan, Fisher, Sonnega, & Weir, 2017) retaining the same wording and coding. Participants from the New England Centenarian study were mailed the PIL questionnaire in June 2016. Those who did not return the questionnaire within 1 month were called to complete it by telephone. In the HRS analysis, we used data from the 2014 wave of interviews (Health and Retirement Study, 2016). Items are based on a six-point Likert scale with answers ranging from strongly disagree to strongly agree. The Cronbach coefficient for internal consistency of the scale has been reported as α = .77 for the HRS 2014 wave (Smith et al., 2017). Some questions are positively phrased such as "I enjoy making plans for the future and working to make them a reality" which are coded from one to six. Negatively worded questions such as "My daily activities often seem trivial and unimportant to me" are reverse coded. See the Supplementary Appendix for all items included in the scale. All scores are averaged to create a composite purpose in life index with a high score indicating greater purpose. Questionnaires with more than three missing items were considered invalid and removed from the analysis. Among the NECS cohorts one questionnaire was missing five items and thus was removed from the analysis and nine questionnaires (2%) missing one item were retained in the analysis. HRS had a response rate of 79% for the Psychosocial and Lifestyle Questionnaire in 2014. Among the HRS cohort, questionnaires missing 4 (N = 17, 0.2%), 5 (N = 4, 0.1%), 6 (N = 6, 0.1%), and 7 (N = 128, 1.7%) items were omitted from the analysis. Included in the set of valid HRS questionnaires for the potential matching set, 205 (2.7%) were missing one item, 42 (0.6%) were missing two items, and 17 (0.2%) were missing three items.

Analysis

We used independent t-tests for continuous variables and chi-square tests for categorical variables to assess differences in participant characteristics between NECS offspring and referents. We used Fisher's exact test to compare rare events.

PIL score was non-normally distributed, with skewness of −1.14 (SE = 0.11) and kurtosis of 1.27 (SE = 0.21), and did not have outliers. We conducted a linear regression analysis to model the relationship of offspring status and PIL score adjusted for age, sex, education (stratified as less than high school, high school, and college), and marital status. We then attempted six different transformations of the data (i.e., logarithm, square root, cube root, scaled scores, power, multiplicative inverse) but were unable to normalize the data, with absolute skewness ranging from 0.55 to 5.38 (moderately to highly skewed) and kurtosis ranging from −0.58 to 48.3. Due to the inability to normalize the PIL scores through transformation, we conducted two types of analyses. In one analysis, we used the nonparametric Wilcoxon Rank Sum

test to compare the medians for each cohort. This analysis does not allow for adjustment by sociodemographic variables known to relate to purpose in life scores including age, education, and marital status. Therefore, in the next analysis, we categorized scores into high and low PIL using the top quartile cutpoint and used logistic regression to estimate the odds ratio for high PIL scores between offspring and spouse referents and between offspring and septuagenarian referents adjusted for age, sex, education, and marital status. We restricted the sample to non-Hispanic, whites because this comprised 98% of the offspring sample.

To further understand differences in PIL between NECS offspring and various referent cohorts and to address limitations caused by the small sample sizes of the NECS referent cohorts, we performed an additional analysis in which we matched each NECS offspring to two respondents in the 2014 wave of HRS based on age, sex, education, marital status, and race using the matching algorithm implemented in the functions Optmatch and pairmatch in R (Hansen & Klopfer, 2006). The HRS potential match set included 3,307 non-Hispanic, white participants within the age range of the NECS participants (65–96 years). Six NECS offspring were missing marital status and thus could not be matched to the HRS sample. Another 22 NECS offspring were a complete match for only one HRS referent rather than the required two matches and were removed from the analysis. We used generalized estimating equations (GEE) to compare the continuous PIL score and a conditional logistic regression to estimate the odds of high PIL scores among NECS offspring and HRS referents. Analyses were performed in R 3.3.2 and in SAS 9.4 (SAS Institute, Cary, NC).

Results

NECS Offspring and NECS Referents

We had an overall response rate of 92%. Nonresponders included participants who were unable to be contacted (N = 25), recently deceased (N = 11), cognitively impaired (N = 7), and those who refused due to current life circumstances (N = 2). The Cronbach's coefficient for the seven items of the PIL scale was α = .76.

Table 1 summarizes the characteristics of 361 offspring, 72 spouse referents, and 87 septuagenarian referents who completed the questionnaire. Offspring were older, less likely to be married, and more likely to be divorced or widowed than spouse referents. There were no significant demographic differences between offspring and the septuagenarian referents. Thirtty percent 30% of the offspring, 21% of the spouse referents, and 14% of the septuagenarian referents had high PIL using a top quartile cutpoint of 5.85.

Nonparametric analysis using the continuous data for PIL score did not show a significant difference in the distribution of PIL score between centenarian offspring and spousal controls (Z = –0.9, p = .3518), but showed a significant difference between centenarian offspring and septuagenarian referents (Z = -2.9, p = .0032). The linear regression analysis adjusted for age, sex, education, and marital status using the continuous PIL score found similar results (Supplementary Table 1).

We next analyzed differences in high PIL score, between centenarian offspring and the two types of controls. Adjusting for age, sex, educational attainment, and marital status, the offspring had a 92% greater significant odds of high PIL compared with spouse referents (adjusted odds ratio [aOR] = 1.92, 95% confidence interval [CI] = 1.002–3.68, p = .0493) as shown in Table 2. Age was independently associated with high PIL and each additional year of age resulted in a 5% decreased odds of high PIL. After adjusting for age, sex, educational attainment, and marital status offspring had higher odds of high PIL compared to septuagenarian referents (aOR = 2.64, 95% CI = 1.36–5.14, p = .0041). Additionally each year of age was associated with a 6% decreased odds of high PIL. There were no significant interactions of participant type with age, sex, education, or marital status.

NECS Offspring and HRS Referents

Table 3 displays the demographic characteristics of the NECS offspring and HRS referents matched on age, sex, educational attainment, and marital status who provided the data used in the second analysis. The Cronbach's coefficient of the PIL scale among the HRS respondents included in the analysis was α = .75. The top quartile cutoff for high PIL was 5.43 which classified 41% of NECS offspring and 19% of HRS referents as having high PIL. Offspring had a 193% increased odds of having high PIL than HRS

Table 1. Participant Characteristics for New England Centenarian Study Offspring and Referents

	Offspring	Spouse referents	Septuagenarian referents
N	361	72	87
Age, mean (*SD*)	82.0 (6.6)	80.1 (7.2)*	82.2 (5.4)
% Female	64.0	57.0	52.9
Education			
% Less than high school	0.3	0	0
% High school	15.2	12.5	20.7
% College	84.5	87.5	79.3
Marital status			
% Married	53.0	82.9***	60.7
% Divorced	8.7	0[a]**	4.8
% Widowed	33.8	17.1**	32.1
% Never married	4.5	0[a]	2.4
Purpose in life, median (IQR)	5.28 (4.57, 5.85)	5.28 (4.50, 5.71)	5.14 (4.14, 5.42)

Note: Offspring were the referent group; *SD* = standard deviation; IQR = interquartile range.

[a]Fisher's exact test used due to low cell count. *p < .05. **p < .01. ***p < .0001.

Table 2. Independent Predictors of High Purpose in Life Score Among Offspring (*N* = 361) and Spousal (*N* = 72) and Septuagenarian (*N* = 87) Referent Participants

	Spouse referents		Septuagenarian referents	
	aOR (95% CI)	*p*-Value	aOR (95% CI)	*p*-Value
Offspring	1.92 (1.002–3.68)	.049	2.64 (1.36–5.14)	.004
Age (years)	0.95 (0.92–0.98)	.003	0.94 (0.91–0.97)	<.001
Sex (female)	0.72 (0.45–1.15)	.173	0.79 (0.49–1.27)	.332
Education				
College	1.00 (reference)	—	1.00 (reference)	—
High school	1.04 (0.56–1.94)	.973	0.74 (0.39–1.41)	.975
<High school	<0.001 (<0.001–>999.99)	.973	<0.001 (<0.001–>999.99)	.974
Marital status				
Never married	1.00 (reference)	—	1.00 (reference)	—
Divorced	2.33 (0.53–10.15)	.261	1.55 (0.40–6.01)	.528
Married	1.72 (0.47–6.33)	.418	1.31 (0.41–4.27)	.649
Widowed	2.12 (0.56–8.05)	.269	1.40 (0.42–4.70)	.582

Note: aOR = adjusted odds ratio; CI = confidence interval.

referents (odds ratio [OR] = 2.93, 95% CI = 2.17–3.96, $p < .0001$). Comparison of the continuous PIL score among offspring and HRS referents using GEE also yielded significant differences ($\beta = 0.63$, 95% CI = 0.52–0.75, $p < .0001$).

Discussion

This is the first study to examine purpose in life among centenarian offspring. Results were consistent with our hypothesis that centenarian offspring would have higher levels of purpose in life when compared with a birth cohort-matched referent group and a nationally representative referent cohort matched on age, sex, education, and marital status. However, these differences were reduced when we compared offspring with their spouses. In line with our results, a study of community-dwelling oldest old individuals found higher PIL among nonagenarians and centenarians when compared with octogenarians (Bondevik & Skogstad, 2000). Together these findings suggest that purposefulness is associated with familial longevity.

A unique aspect of the current study is the comparison with three distinct referent groups. The first referent group consisted of the spouses of centenarian offspring. Offspring had an almost two times higher likelihood of having high PIL using a top quartile cutpoint than their spouses albeit with a modest level of significance due to the relatively small sample size of the spouse referent group. Additionally the results were not replicated using a nonparametric analysis of the overall PIL score. Due to assortative mating, spouses tend to be both phenotypically, in terms of health and psychological profiles (Di Castelnuovo, Quacquaruccio, Donati, de Gaetano, & Iacoviello, 2009; Galbaud du Fort, Kovess, & Boivin, 1994), and genetically (Sebastiani, Gurinovich, Bae, Andersen, & Perls, 2017; Sebro, Peloso, Dupuis, & Risch, 2017) more similar than unrelated individuals. Thus, these results warrant further investigation to determine whether larger samples of spouse pairs with and without familial longevity consistently show different levels of purpose in life.

Table 3. Participant Characteristics for New England Centenarian Study Offspring and Health and Retirement Study Referents

	NECS offspring	HRS referents
N	333	666
Age, mean (*SD*)	81.7 (6.5)	81.1 (6.8)
% Female	62.8	62.8
Education		
% Less than high school	0.3	0.3
% High school	15.3	15.3
% College	84.4	84.4
Marital status		
% Married	54.7	54.7
% Divorced	7.5	7.5
% Widowed	35.7	35.7
% Never married	2.1	2.1
Purpose in life, median (IQR)	5.28 (4.57, 5.85)	4.57 (3.86, 5.17)

Note: SD = standard deviation; IQR = interquartile range.

One limitation of using the spouses of centenarian offspring as a referent group is that they are significantly younger and are more likely to be married than the centenarian offspring and both age and marital status are known to be associated with psychological well-being (Koren & Lowenstein, 2008; Shapiro & Keyes, 2008). Therefore, we analyzed differences in PIL among a second referent group consisting of offspring of parents from the same birth cohort as the parents of the centenarian offspring but who died approximately

30 years earlier than the centenarians. We found that centenarian offspring had an even greater likelihood of high PIL in comparison with this birth cohort specific referent group.

A possible source of selection bias for the birth cohort referent group is that their deceased parents were identified using the Massachusetts death registry and were therefore also highly likely to live in Massachusetts. So we sought to examine whether our findings would generalize to a referent group selected from a nationally representative sample, the HRS. Centenarian offspring were almost three times as likely to have high PIL as the HRS referents which is an even greater likelihood than the comparison between offspring and the two other referents groups.

Age appears to have a small but significant negative association with PIL in both cross-sectional (Karasawa et al., 2011) and longitudinal studies (Springer, Pudrovska, & Hauser, 2011). In our study each year of age imparted a 5%–6% reduced likelihood of having high PIL. This is consistent with a meta-analysis of PIL which found that age explained 1.7% of the variability in PIL scores among participants age 70 years and older (Pinquart, 2002).

Although this study provides valuable support for the potential role of purpose in life in longevity, there are several limitations to acknowledge. The first limitation is that NECS participants included in this analysis are non-Hispanic whites with a high level of education and therefore the results presented here may not be generalizable to other groups of people with familial longevity who have different sociodemographic characteristics.

The small sample size of the referent groups from the NECS is also a limitation. Although the effect size of the difference between offspring and spouses is substantial, the findings are limited by the small sample size as indicated by the marginal level of significance. Consistency of the results in a larger sample of spouses would increase confidence in the findings.

Another limitation of the study is the temporal fluctuations in PIL and our measurement of the construct at only one time point. It was our experience that some respondents refused to answer the questionnaire due to recent negative life events (e.g., death of a spouse) because they felt it would not be a true reflection of their usual feeling of PIL. This raises the important point that we do not know whether purpose in life scores reflect only an individual's current state of purposefulness or his or her mean lifetime purposefulness. A longitudinal study of PIL in men over 3 years found significant interindividual change but did not find significant change in the sample as a whole (Hill, Turiano, Spiro, & Mroczek, 2015). Certainly one would suspect that sustained purposefulness across a lifetime would have a greater impact upon survival and maintenance of good health than purposefulness at a specific time point. Moreover, as also suggested by Pinquart (2002), we find it likely that there is a bidirectional relationship between PIL and health status such that in addition to the buffer effect that high PIL may impart against negative health outcomes, better health and functional status may also promote higher PIL. Individuals without age-related diseases, disabilities, pain, or frailty may score higher on the PIL scale because it is easier to engage in meaningful activities. If the directionality is such that better health status leads to greater purposefulness then it would not be surprising that centenarian offspring, a group of healthy agers, would have higher PIL scores. As our data are cross-sectional, we are unable to infer directionality of the relationship between PIL and health and survival and therefore only report on the association between higher PIL scores and familial longevity.

Our next steps will include collecting repeated measures of PIL in this cohort. Longitudinal measures in the centenarian offspring cohort and the referent groups will allow us to better understand whether high purpose is sustained or periodic among centenarian offspring and perhaps impart insight regarding the directionality of the PIL and healthy aging relationship. We will also be able to investigate the relationship of PIL and resilience to various stressors including changes in social support networks, occupation, and environment as well as the onset of disease and disability. Additionally, future studies are needed to investigate the association of PIL with other health and psychosocial correlates such as presence of age-related illnesses and functional impairments, income and financial resources, retirement status, leisure activities, social networks, personality, depression, and other measures of subjective well-being in this cohort to better understand the role of PIL in familial longevity.

Conclusion

Centenarian offspring demonstrated significantly higher purpose in life scores when compared to individuals without familial longevity. Higher purpose in life as a component of psychological well-being may be contributing to their healthy aging profiles, including the ability to delay mortality and cardiovascular-related events. Additionally, screening for feelings of purposefulness may help to identify individuals at risk for less healthy aging and interventions aimed at increasing one's purposefulness may promote healthy aging.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None declared.

References

Adams, E. R., Nolan, V. G., Andersen, S. L., Perls, T. T., & Terry, D. F. (2008). Centenarian offspring: Start healthier and stay healthier. *Journal of the American Geriatrics Society*, **56**, 2089–2092. doi:10.1111/j.1532-5415.2008.01949.x

Andersen, S. L., Sebastiani, P., Dworkis, D. A., Feldman, L., & Perls, T. T. (2012). Health span approximates life span among many supercentenarians: Compression of morbidity at the approximate limit of life span. *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences*, **67**, 395–405. doi:10.1093/gerona/glr223

Andersen, S. L., Sun, J. X., Sebastiani, P., Huntly, J., Gass, J. D., Feldman, L.,…Perls, T. T. (2013). Personality factors in the Long Life Family Study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **68**, 739–749. doi:10.1093/geronb/gbs117

Ardelt, M., & Edwards, C. A. (2016). Wisdom at the end of life: An analysis of mediating and moderating relations between wisdom and subjective well-being. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **71**, 502–513. doi:10.1093/geronb/gbv051

Beltrán-Sánchez, H., Razak, F., & Subramanian, S. V. (2014). Going beyond the disability-based morbidity definition in the compression of morbidity framework. *Global Health Action*, **7**, 24766. doi:10.3402/gha.v7.24766

Bondevik, M., & Skogstad, A. (2000). Loneliness, religiousness, and purpose in life in the oldest old. *Journal of Religious Gerontology*, **11**, 5–21. doi:10.1300/J078v11n01_03

Boyle, P. A., Buchman, A. S., Barnes, L. L., & Bennett, D. A. (2010). Effect of a purpose in life on risk of incident Alzheimer disease and mild cognitive impairment in community-dwelling older persons. *Archives of General Psychiatry*, **67**, 304–310. doi:10.1001/archgenpsychiatry.2009.208

Chow, E. O., & Ho, H. C. (2012). The relationship between psychological resources, social resources, and depression: Results from older spousal caregivers in Hong Kong. *Aging & Mental Health*, **16**, 1016–1027. doi:10.1080/13607863.2012.692769

Cohen, R., Bavishi, C., & Rozanski, A. (2016). Purpose in life and its relationship to all-cause mortality and cardiovascular events: A meta-analysis. *Psychosomatic Medicine*, **78**, 122–133. doi:10.1097/PSY.0000000000000274

Cohen-Mansfield, J., Skornick-Bouchbinder, M., & Brill, S. (2017). Trajectories of end of life: A systematic review. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*. doi:10.1093/geronb/gbx093

Cosco, T. D., Prina, A. M., Perales, J., Stephan, B. C., & Brayne, C. (2013). Lay perspectives of successful ageing: A systematic review and meta-ethnography. *BMJ Open*, **3**(6), e002710. doi: 10.1136/bmjopen-2013–002710

Crimmins, E. M., & Beltrán-Sánchez, H. (2011). Mortality and morbidity trends: Is there compression of morbidity? *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **66**, 75–86. doi:10.1093/geronb/gbq088

Di Castelnuovo, A., Quacquaruccio, G., Donati, M. B., de Gaetano, G., & Iacoviello, L. (2009). Spousal concordance for major coronary risk factors: A systematic review and meta-analysis. *American Journal of Epidemiology*, **169**, 1–8. doi:10.1093/aje/kwn234

Fogelman, N., & Canli, T. (2015). 'Purpose in Life' as a psychosocial resource in healthy aging: An examination of cortisol baseline levels and response to the Trier Social Stress Test. *NPJ Aging and Mechanisms of Disease*, **1**, 15006. doi:10.1038/npjamd.2015.6

Frankl, V. E. (1963). *Man's search for meaning: An introduction to logotherapy*. Boston: Beacon Press.

Friedman, E. M., Hayney, M., Love, G. D., Singer, B. H., & Ryff, C. D. (2007). Plasma interleukin-6 and soluble IL-6 receptors are associated with psychological well-being in aging women. *Health Psychology*, **26**, 305–313. doi:10.1037/0278-6133.26.3.305

Fries, J. F. (1980). Aging, natural death, and the compression of morbidity. *The New England Journal of Medicine*, **303**, 130–135. doi:10.1056/NEJM198007173030304

Galbaud du Fort, G., Kovess, V., & Boivin, J. F. (1994). Spouse similarity for psychological distress and well-being: A population study. *Psychological Medicine*, **24**, 431–447. doi:10.1017/S0033291700027409

Gellert, P., von Berenberg, P., Oedekoven, M., Klemt, M., Zwillich, C., Hörter, S., … Dräger, D. (2017). Centenarians differ in their comorbidity trends during the six years before death compared to individuals who died in their 80s or 90s. *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences*. doi:10.1093/gerona/glx136

Givens, J. L., Frederick, M., Silverman, L., Anderson, S., Senville, J., Silver, M.,…Perls, T. T. (2009). Personality traits of centenarians' offspring. *Journal of the American Geriatrics Society*, **57**, 683–685. doi:10.1111/j.1532-5415.2009.02189.x

Gruenberg, E. M. (1977). The failures of success. *The Milbank Memorial Fund Quarterly. Health and Society*, **55**, 3–24. doi:10.2307/3349592

Hansen, B. B., & Klopfer, S. O. (2006). Optimal full matching and related designs via network flows. *Journal of Computational and Graphical Statistics*, **15**, 1–19. doi:10.1198/106186006X137047

Health and Retirement Study. (2016). *HRS 2014 Core* [public use dataset]. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI.

Hedberg, P., Gustafson, Y., Aléx, L., & Brulin, C. (2010). Depression in relation to purpose in life among a very old population: A five-year follow-up study. *Aging & Mental Health*, **14**, 757–763. doi:10.1080/13607861003713216

Hill, P. L., Turiano, N. A., Spiro, A. III, & Mroczek, D. K. (2015). Understanding inter-individual variability in purpose: Longitudinal findings from the VA Normative Aging Study. *Psychology and Aging*, **30**, 529–533. doi:10.1037/pag0000020

Hjelmborg, J. V., Iachine, I., Skytthe, A., Vaupel, J. W., McGue, M., Koskenvuo, M., … Christensen, K. (2006). Genetic influence on human lifespan and longevity. *Human Genetics*, **119**, 312–321. doi:10.1007/s00439-006-0144-y

Ismail, K., Nussbaum, L., Sebastiani, P., Andersen, S., Perls, T., Barzilai, N., & Milman, S. (2016). Compression of morbidity is observed across cohorts with exceptional longevity. *Journal of the American Geriatrics Society*, **64**, 1583–1591. doi:10.1111/jgs.14222

Karasawa, M., Curhan, K. B., Markus, H. R., Kitayama, S. S., Love, G. D., Radler, B. T., & Ryff, C. D. (2011). Cultural perspectives on aging and well-being: A comparison of Japan and the United

States. *International Journal of Aging & Human Development*, **73**, 73–98. doi:10.2190/AG.73.1.d

Kim, E. S., Strecher, V. J., & Ryff, C. D. (2014). Purpose in life and use of preventive health care services. *Proceedings of the National Academy of Sciences of the United States of America*, **111**, 16331–16336. doi:10.1073/pnas.1414826111

Konkolÿ Thege, B., Bachner, Y. G., Martos, T., & Kushnir, T. (2009). Meaning in life: Does it play a role in smoking? *Substance Use & Misuse*, **44**, 1566–1577. doi:10.1080/10826080802495096

Koren, C., & Lowenstein, A. (2008). Late-life widowhood and meaning in life. *Ageing International*, **32**, 140–155. doi:10.1007/s12126-008-9008-1

Lewis, N. A., Turiano, N. A., Payne, B. R., & Hill, P. L. (2017). Purpose in life and cognitive functioning in adulthood. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*, **24**, 662–671. doi:10.1080/13825585.2016.1251549

Perls, T. T., Wilmoth, J., Levenson, R., Drinkwater, M., Cohen, M., Bogan, H.,…Puca, A. (2002). Life-long sustained mortality advantage of siblings of centenarians. *Proceedings of the National Academy of Sciences of the United States of America*, **99**, 8442–8447. doi:10.1073/pnas.122587599

Phelan, E. A., Anderson, L. A., LaCroix, A. Z., & Larson, E. B. (2004). Older adults' views of "successful aging"—How do they compare with researchers' definitions? *Journal of the American Geriatrics Society*, **52**, 211–216. doi:10.1111/j.1532-5415.2004.52056.x

Pinquart, M. (2002). Creating and maintaining purpose in life in old age: A meta-analysis. *Ageing International*, **27**, 90–114. doi:10.1007/s12126-002-1004-2

Rasmussen, N. H., Smith, S. A., Maxson, J. A., Bernard, M. E., Cha, S. S., Agerter, D. C., & Shah, N. D. (2013). Association of HbA1c with emotion regulation, intolerance of uncertainty, and purpose in life in type 2 diabetes mellitus. *Primary Care Diabetes*, **7**, 213–221. doi:10.1016/j.pcd.2013.04.006

Ryff, C. D. (1989). Happiness is everything, or is it—Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, **57**, 1069–1081. doi:10.1037/0022-3514.57.6.1069

Sebastiani, P., Gurinovich, A., Bae, H., Andersen, S. L., & Perls, T. T. (2017). Assortative mating by ethnicity in longevous families. *Frontiers in Genetics*, **8**(186). doi:10.3389/fgene.2017.00186

Sebastiani, P., Nussbaum, L., Andersen, S. L., Black, M. J., & Perls, T. T. (2016). Increasing sibling relative risk of survival to older and older ages and the importance of precise definitions of "aging," "life span," and "longevity". *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences*, **71**, 340–346. doi:10.1093/gerona/glv020

Sebastiani, P., & Perls, T. T. (2012). The genetics of extreme longevity: Lessons from the new England centenarian study. *Frontiers in Genetics*, **3**, 277. doi:10.3389/fgene.2012.00277

Sebastiani, P., Sun, F. X., Andersen, S. L., Lee, J. H., Wojczynski, M. K., Sanders, J. L.,…Perls, T. T. (2013). Families enriched for exceptional longevity also have increased health-span: Findings from the Long Life Family Study. *Frontiers in Public Health*, **1**, 38. doi:10.3389/fpubh.2013.00038

Sebro, R., Peloso, G. M., Dupuis, J., & Risch, N. J. (2017). Structured mating: Patterns and implications. *PLoS Genetics*, **13**, e1006655. doi:10.1371/journal.pgen.1006655

Shapiro, A., & Keyes, C. (2008). Marital status and social well-being: Are the married always better off? *Social Indicators Research*, **88**, 329–346. doi:10.1007/s11205-007-9194-3

Smith, J., Ryan, L., Fisher, G., Sonnega, A., & Weir, D. (2017). *HRS Psychosocial and Lifestyle Questionnaire 2006–2016*. Ann Arbor, MI: Survey Research Center, Institute for Social Research, University of Michigan.

Sonnega, A., Faul, J. D., Ofstedal, M. B., Langa, K. M., Phillips, J. W., & Weir, D. R. (2014). Cohort profile: the Health and Retirement Study (HRS). *International Journal of Epidemiology*, **43**, 576–585. doi:10.1093/ije/dyu067

Springer, K. W., Pudrovska, T., & Hauser, R. M. (2011). Does Psychological well-being change with age? Longitudinal tests of age variations and further exploration of the multidimensionality of Ryff's model of psychological well-being. *Social Science Research*, **40**, 392–398. doi:10.1016/j.ssresearch.2010.05.008

Terry, D. F., Sebastiani, P., Andersen, S. L., & Perls, T. T. (2008). Disentangling the roles of disability and morbidity in survival to exceptional old age. *Archives of Internal Medicine*, **168**, 277–283. doi:10.1001/archinternmed.2007.75

Terry, D. F., Wilcox, M., McCormick, M. A., Lawler, E., & Perls, T. T. (2003). Cardiovascular advantages among the offspring of centenarians. *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences*, **58**, M425–M431. doi:10.1093/gerona/58.5.M425

Terry, D. F., Wilcox, M. A., McCormick, M. A., Pennington, J. Y., Schoenhofen, E. A., Andersen, S. L., & Perls, T. T. (2004). Lower all-cause, cardiovascular, and cancer mortality in centenarians' offspring. *Journal of the American Geriatrics Society*, **52**, 2074–2076. doi:10.1111/j.1532-5415.2004.52561.x

Thoma, M. V., Gianferante, D., Hanlin, L., Fiksdal, A., Chen, X., & Rohleder, N. (2017). Stronger hypothalamus-pituitary-adrenal axis habituation predicts lesser sensitization of inflammatory response to repeated acute stress exposures in healthy young adults. *Brain, Behavior, and Immunity*, **61**, 228–235. doi:10.1016/j.bbi.2016.11.030

U.S. Census Bureau. (2012). *2010 Census Special Reports, Centenarians: 2010 (C2010SR-03)*. Washington, DC: U.S. Government Printing Office. Retrieved from https://www.census.gov/prod/cen2010/reports/c2010sr-03.pdf

Windsor, T. D., Curtis, R. G., & Luszcz, M. A. (2015). Sense of purpose as a psychological resource for aging well. *Developmental Psychology*, **51**, 975–986. doi:10.1037/dev0000023

Yu, L., Boyle, P. A., Wilson, R. S., Levine, S. R., Schneider, J. A., & Bennett, D. A. (2015). Purpose in life and cerebral infarcts in community-dwelling older people. *Stroke*, **46**, 1071–1076. doi:10.1161/STROKEAHA.114.008010

Zaslavsky, O., Rillamas-Sun, E., Woods, N. F., Cochrane, B. B., Stefanick, M. L., Tindle, H.,…LaCroix, A. Z. (2014). Association of the selected dimensions of eudaimonic well-being with healthy survival to 85 years of age in older women. *International Psychogeriatrics*, **26**, 2081–2091. doi:10.1017/S1041610214001768

Zilioli, S., Slatcher, R. B., Ong, A. D., & Gruenewald, T. L. (2015). Purpose in life predicts allostatic load ten years later. *Journal of Psychosomatic Research*, **79**, 451–457. doi:10.1016/j.jpsychores.2015.09.013