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# Happy and Satisfied in Very Late Life? Findings from the Health and Retirement Study

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**Special Issue**: Happy People Live Longer: Positive Well-Being Contributes to Health and Longevity

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**Abstract**

This research aims to examine cross-sectional and longitudinal associations of positive subjective well-being among centenarians and near-centenarians in the Health and Retirement Study. Participants who eventually survived to age 98 or older (*N* = 516) were included. Study variables included demographic characteristics, health and activities of daily living (ADL) functioning, cognitive functioning, and positive well-being. Additionally, a smaller subsample (*n* = 192) of participants with supplemental leave-behind questionnaire (LBQ) data, some of whom (*n* = 30) were assessed across three comparative time points, were included to examine psychological well-being variables over time. In the full sample, approximately 86% and 81% of participants over or near the age of 100 reported enjoying their lives and being happy, respectively. Also in the full sample, better self-rated health (SRH) was associated with greater happiness/enjoyment. Results with the LBQ subsample (*n* = 192) identified that a) greater life satisfaction related to better SRH, b) better cognitive functioning related to greater optimism and purpose in life, and c) more educated and non-White participants tended to have greater purpose in life. Finally, for the longitudinal subsample, life satisfaction increased significantly while purpose in life decreased significantly as participants neared age

100. Implications for this study include a greater focus on developing interventions geared toward improving psychological well-being; specifically, increasing purpose in life and optimism, as well as focusing on improving happiness and life enjoyment.

**Keywords**
Life satisfaction; happiness; centenarians; optimism; purpose in life; subjective well-being; exceptional longevity; self-rated health

## 1. Introduction

Living long lives and living happy lives are not always synonymous. As the number of older adults continues to increase around the world, so too does the number of centenarians [1], with projections suggesting 20.1 million centenarians worldwide in 2100 [2]. Centenarians are individuals who embody exceptional longevity. The predicted life expectancy from birth for someone born in 1900 was 47.3 years across sex and ethnicity groups [3]. Thus, centenarians born in that year more than doubled their anticipated life expectancy. Although living exceptionally long lives is in itself extraordinary, it is not entirely clear whether centenarians hold positive views about their well-being, including life satisfaction, optimism, purpose in life, positive affect, and happiness.

Maintaining quality of life is an important goal for most people. As average longevity increases, it is important to examine the components that can contribute to improved well-being. Growing older and taking care of positive psychological well-being may help individuals maintain greater autonomy and help ease normative changes related to aging. It appears that those who reach maximum expected ages, such as centenarians, may experience success in exceptional longevity. However, it is unclear whether centenarians also maintain high levels of overall positive well-being and quality of life. Further, remaining optimistic and establishing a sense of purpose could play a role in longer lives with less morbidity. The purpose of this study was to understand aspects of subjective well-being that are vital to continue supporting positive aging and continued quality of life well into late life.

### *1.1 Theoretical Frameworks*

Important theoretical frameworks have influenced the current study. The Georgia adaptation model [4] and the developmental adaptation model [5, 6] are two frameworks with a focus on oldest-old adults and how they adapt well into later life years. The Georgia adaptation model shows individual characteristics and mental health linked to life satisfaction, also including adaptation components of environmental support, nutrition, behavioral skills, family longevity, and age [4]. The authors [6] explain the developmental adaptation model as an extension, adding the focus of distal and proximal events as they predict adaptation and well-being in later life. The current study utilizes these frameworks by identifying associations among distal variables like education, proximal variables like health conditions and marital status, and exploring the links between individual characteristics (e.g., demographics) and mental health as they relate to life satisfaction and happiness among oldest-old adults.

### *1.2 Positive Psychological Well-Being*

Across the world, studies have considered the link between certain aspects of positive well-being and longevity. In the current research, four important psychological well-being domains are evaluated: life satisfaction, optimism, purpose in life, and positive affect. Life satisfaction has been suggested to be linked with longevity [7]. Longitudinal research across 20+ years in Germany demonstrated that a ten percent increase in life satisfaction related to a four percent decrease in the probability of death [7]. Another study [8] extensively addressed the causal links between positive subjective well-being (i.e., life satisfaction, optimism, positive emotions, absence of negative emotions) and longevity and health. The authors discussed potential causal factors, such as whether the study sample was healthy. However, they confirmed the causal links between positive subjective well-being that influence health and all-cause mortality, positing how compelling the evidence is considering that living years of your life happy is "more enjoyable and experienced with better health" ([8] p. 32).

### *1.3 Life Satisfaction*

Life satisfaction is one positive psychological well-being variable important to examine in late life. A recent systematic review [9] exploring life satisfaction, positive affect, and happiness among centenarians and near-centenarians identified inconsistent results across 28 studies and several countries. For example, age group comparisons among samples in Italy [10], China [11], and Australia [12] revealed that centenarians and near-centenarians had higher life satisfaction than younger groups, but a study in the United States revealed the opposite: that younger groups had higher levels of life satisfaction than centenarians [13]. A New York City sample of centenarians and near-centenarians indicated that more than 60% of the sample reported moderate to very high life satisfaction [14]. In the Georgia Centenarian Study, life satisfaction was directly associated with positive and negative affect, as well as with cognitive functioning [15]. A Portuguese centenarian study reported that approximately 62% of centenarians indicated that they were satisfied with their lives and that self-rated health, the number of living children, and regular visits were associated with higher levels of life satisfaction [16]. Similarly, the New York City study [14] reported that subjective health, activities of daily living, and the number of children all predicted higher levels of life satisfaction. A study in the Netherlands [17] addressed that a subgroup of participants who eventually became centenarians had "on average a higher rating of life satisfaction at age 85" (p. 6) than those who did not become centenarians.

### *1.4 Optimism*

Optimism is another positive subjective well-being component that has been linked to longevity, with one study indicating that high levels of optimism were associated with an 11–15% longer lifespan on average [18]. Additionally, a mixed-methods study exploring positive psychological traits of centenarians and nonagenarians (individuals in their 90s) in rural southern Italy identified optimism as a qualitative theme related to exceptional longevity [19]. One participant explained, "I am always thinking for the best…[I was taught] to always face difficulties and hope for the best" (p. 3) [19]. Higher levels of optimism have been associated with fewer chronic diseases and premature death [20]. The link between optimism and survival was confirmed in a representative community

sample of adults 85 years old (*n* = 1,096) and 90 years old (*n* = 533) from the Jerusalem Longitudinal Study (1990-2020) [21]. Optimism had played a significant role in predicting survival after 5-year intervals for both age groups, after accounting for common mortality risk factors and depression [21]. Furthermore, optimism among centenarians can help build positive relationships that protect against loneliness in very late life [22]. Qualitative interviews with 16 centenarians in the United Kingdom identified "happiness and a good life" (p. 815) as one of six socio-emotional well-being topics important to centenarians [23]. The authors specified that the term "happy" was provided by the centenarians, not the researchers. They also discussed optimistic perspectives, with a centenarian explaining, "I've had a good life… I don't think of the bad times, you've got to think of the good times. Yes, I'm happy thinking about the good times" (p. 815) [23], demonstrating high levels of optimism. Similarly, centenarians in Japan showed positive attitudes, a "peaceful state of mind," happiness, and acceptance of how things were at their current age [24].

### *1.5 Purpose in Life*

Purpose in life is another psychological well-being variable relevant for centenarians. Purpose in life is a positive subjective well-being indicator addressed as a component of healthy aging and related to mortality risk reduction [25]. Purpose in life is defined as having a sense of direction or goals in life [26]. Literature indicates that the effect of having high levels of purpose in life among older adults is associated with better physical and psychosocial well-being [27]. A systematic review [27] revealed that greater levels of purpose in life were related to a decreased likelihood of mobility disabilities, better functional health, better self-report of health, and better cognitive health. Moreover, having a higher sense of purpose in life has been positively associated with optimism, positive affect, self-transcendence, and autonomy, and negatively associated with depression and fear of death. The findings also indicated that the level of purpose in life decreased with age; perhaps not due to age itself, but may be due to changes in social roles or losses in late adulthood [27].

A research gap for purpose in life is that limited studies include oldest-old adults or centenarians. A study investigated the purpose in life among centenarian offspring and noted that higher levels of purpose in life were associated with being the offspring of a long-lived parent [28]. A hermeneutic phenomenological study was conducted to understand lived experiences of how 19 centenarians perceive possible contributing factors to their advanced longevity [29]. One of the main themes that centenarians brought up was having a purpose or direction for the future, which connected to their love, passion, and social engagement in life.

### *1.6 Positive Affect*

Positive affect is another psychological well-being variable included in the current study. Results from the Georgia Centenarian Study suggested that centenarians had lower positive affect than octogenarians [30], and that positive affect decreased over time [31]. In contrast, a study in Rugao, China, noted that centenarians and near-centenarians had significantly higher positive affect than the younger control group (aged 60-69) [11]. However, cognitive, functional, and physical health impairments seemed to negatively impact positive affect more strongly for centenarians than for octogenarians [30]. Another study indicated that health measures significantly predicted levels of happiness [32]. A longitudinal analysis reported that positive affect decreased over time among

centenarians [33]. Interestingly, of the 28 studies included in the recent systematic review, only 6 studies examined *both* life satisfaction and positive affect [9], demonstrating a potential gap in the examination of both variables together. Furthermore, the systematic review detected no significant gender, ethnicity, residence type, or rurality demographic differences in centenarians' life satisfaction, nor any significant correlations with positive affect. Overall, good subjective health was consistently associated with high levels of satisfaction with life and positive affect, which may be due to centenarians potentially normalizing the more typical age-related health changes, which could encourage better subjective well-being [9].

### *1.7 Individual Characteristics*

Early life individual characteristics such as gender, marital status, or education may influence individuals in different ways throughout their lives. Gender and education are associated with subjective well-being in later life [34]. Among centenarians, there remains a gender discrepancy, as 85% to 90% of centenarians are women [35]. There may be gender differences in centenarians' positive psychological well-being. Additionally, it is important to consider the potential gender-related-roles that centenarians could have had in their earlier lives. For example, educational opportunities may have differed by gender when centenarians were young, suggesting a potential interaction between education and gender. Further, marital status or partnership may impact psychological well-being and physical health in later life.

### *1.8 Limitations in Centenarian Research*

Positive well-being research on large centenarian samples tends to be limited due to the exceptionality of their age. Further, there is difficulty collecting longitudinal data on centenarians due to attrition [32]. One longitudinal study examined mental health among 19 centenarians over six months, finding that positive affect decreased over time [33]. Due to the uniqueness of the exceptional longevity of centenarians, it has been more difficult to examine larger samples of centenarians in the United States related to positive psychosocial well-being. Thus, this study includes an exploratory approach examining psychological well-being changes over time among people at or near age 100.

One innovative study utilized a nationally representative sample of older Americans and explored long-term trajectories of cognitive function, disease, and disability among centenarian "survivors" (those that lived to age 100+) and "nonsurvivors" (those that died before age 100) [36]. Using the 1993–2010 waves of the Health and Retirement Study (HRS), the authors examined the health and functioning of centenarians in their years leading to age 100, encouraging researchers to examine similar trajectories [36]. The current study adds to their work by investigating positive well-being traits such as satisfaction and happiness in life among people who eventually lived to be 100 years old.

### *1.9 Current Study*

The current study explored subjective markers of positive well-being among eventual centenarians and near-centenarians in the HRS, with a focus on the years leading up to centenarian status. Therefore, the objective of this study was to examine the positive components of well-being

among individuals who eventually "survived" to become centenarians and near-centenarians (ages 98+). This age limit was designated in alignment with previous studies on centenarians [37]. This study provides data on quality of life utilizing both markers of psychological and physical well-being among centenarians and near-centenarians.

We asked three main research questions:

1. How does health relate to happiness and enjoyment at or near age 100?
   a. H1: We hypothesized that better health would be associated with higher levels of happiness and enjoyment at or near age 100.
2. How do positive psychological well-being variables (i.e., life satisfaction, optimism, purpose in life, and positive affect) relate to subjective and objective physical health markers, after accounting for individual demographic characteristics?
   a. H2: We hypothesized positive associations between psychological well-being and physical health after controlling for individual characteristics.
3. A secondary purpose of this study was to evaluate data from a smaller sample of centenarians and near-centenarians for whom data were available longitudinally and to examine their psychological well-being. Due to the limited information on changes over time in centenarian populations, it is unclear whether there are any significant changes among life satisfaction, optimism, purpose in life, and positive affect over time. We therefore used an exploratory approach to examine changes in positive psychological well-being among people at or near age 100.

## 2. Methods

### *2.1 Data and Sample*

Data for this study come from the Health and Retirement Study (HRS) [38]. Created in 1990, the HRS is a national longitudinal panel study of the economic, health, marital, and family status of approximately 20,000 people over 50 years of age and their spouses [39]. The HRS is sponsored by the National Institute on Aging and is conducted by the University of Michigan [40]. HRS core data are collected biennially from a nationally representative sample of older Americans. Study eligibility for the HRS is determined by a brief household screening, alongside geographic stratification and clustering. One respondent is randomly selected from the age-eligible household members; their romantic partner (if applicable) is also recruited [41]. African American and Hispanic households are oversampled at approximately twice the rate of White households in proportion to the US population [41]. Respondents must be community dwelling for at least the first wave of data collection; if respondents move to other senior living accommodations over time, the interviews are conducted in the new residence [41].

Baseline interviews are conducted face-to-face in respondents' homes; interviews take approximately three hours to complete. Until 2004, biennial follow-up interviews were conducted via phone for respondents under the age of 80; older participants were offered in-person interviews. In 2006, the HRS began implementing a mixed-mode approach, where a random half of the sample participates in follow-up interviews via phone and the remaining half completes in-person interviews with enhanced biophysical measures [41]. The in-person random half also completes a supplemental leave-behind questionnaire (LBQ; also started in 2006), which collects additional

psychosocial and lifestyle data. Consistent with before, adults aged 80 and over are always offered in-person follow-up interviews [41].

Recent waves in the HRS are particularly interesting as they include information on a sample of exceptional survivors (aged 98 and older), allowing us to track various health, well-being, and psychosocial components of individuals before they reached nearly 100 years of age. Thus, using HRS data from 1992 to 2020 (15 waves total), we selected only the individuals who eventually made it to age 98 or older. Given that not all participants became centenarians/near-centenarians at the same time, a variable was created to include participants' last available data point at age 98 or older. This method was repeated for all study variables that were collected during core interviews (every 2 years).

The full sample of eventual centenarians and near-centenarians with demographic and health functioning data that were drawn from 15 waves in the HRS included 516 participants. Time invariant variables across waves included gender, ethnicity, and highest education achieved. There were 399 women (77.3%) and 117 men (22.7%). Ethnicity in the full sample included 425 participants (82.4%) who identified as White, 79 participants (15.3%) who identified as African American or Black, and 12 participants (2.3%) self-selecting in another ethnicity category. For the highest education achieved in the full sample, 237 participants (45.9%) completed less than a high school degree, 127 participants (24.7%) received a high school diploma or equivalent GED, 87 participants (16.9%) completed some college, and 65 participants (12.6%) received a college degree or higher. Age and marital status were two variables that differed by wave, so baseline scores (wave 2, 1992) were used. The average age at wave 2 in the full sample was 84.09 years (*SD* = 7.62, *n* = 516). There were 506 participants with wave 2 marital status responses: 178 people (35.2%) were married, 2 people (.4%) were partnered, 23 people (4.5%) were separated/divorced, 295 people (58.3%) were widowed, and 8 people (1.6%) never married.

The second group of analyses was conducted on a subsample of participants who had supplementary psychological well-being data from the LBQ that began in 2006. Due to the year that this questionnaire began, the number of centenarians and near-centenarians that could be included was limited. For example, some participants were born in 1890, so it would be highly unlikely for any of those people to still be alive in 2006 at age 116. Thus, the analyses with these additional psychological well-being variables had fewer participants. Of the full centenarian sample, there were 192 participants with LBQ data on optimism, purpose in life, life satisfaction, and positive affect in waves 8 and 9 (2006 and 2008). The average age of this sample in 2006 (wave 8) was 91.17 (*SD* = 3.71), ranging from 85 to 104 years.

The last set of analyses included participants who had data on the LBQ psychological well-being scales (i.e., life satisfaction, optimism, purpose in life, and positive affect) consistently across waves 8/9 (2006 and 2008), 10/11 (2010 and 2012), and 12/13 (2014 and 2016). There were 30 participants with three data points from the LBQ, with an average age at wave 12 (2014) of 95.77 (*SD* = 2.42).

### *2.2 Measures*

#### 2.2.1 Happiness/Enjoyment

The Center of Epidemiologic Studies of Depression (CES-D) scale [42] includes several items asking participants whether they felt certain ways, coded as yes (1) or no (0). One subscale in the CES-D represents “positive affect” [43], consisting of two items: “enjoyed life” and “felt happy.”

These two items were asked in each wave of the HRS. The subscale assesses participants' happiness and life enjoyment and is henceforth referenced to as "happiness/enjoyment." Possible scores for happiness/enjoyment ranged from 0 to 2. Cronbach's alpha reliability was 0.69 in both 2006 and 2008.

#### 2.2.2 Self-Rated Health

One item measured self-reported health, stating "Would you say your health is excellent, very good, good, fair, or poor?" Self-rated health in the current study ranged from poor (1) to excellent (5), with higher scores indicating better self-rated health.

#### 2.2.3 Functional Impairment

Functional health impairment was another physical health variable included in this study, measured by activities of daily living (ADL). The ADL impairment summary score measured whether participants had difficulty (difficulty = 1, no difficulty = 0) with bathing, eating, and dressing, aligning with previous suggestions for a 3-item ADL difficulty index [44]. High scores indicated difficulty with activities of daily living or functional impairment, and possible scores ranged from 0 to 3. Reliability was 0.73 at wave 3.

#### 2.2.4 Health Conditions

Health conditions was measured via the sum of indicators on whether a doctor had ever told respondents that they ever had a specific disease/condition [39]. Disease included high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, psychiatric problems, and arthritis [39]. Higher scores indicate worse health/more disease(s). This measure was included as an objective measure of physical health, as noted by the respondents' doctor(s).

#### 2.2.5 Cognitive Functioning

A total cognition score in the HRS was created by summing the total recall and mental status indicators, including measures like immediate and delayed word recall, serial 7s test, counting backward, naming tasks, and vocabulary questions [39]. A couple of items for cognitive functioning changed after wave 2. Reliability at wave 3 was 0.70.

#### 2.2.6 Life Satisfaction

Life satisfaction was measured with the Satisfaction with Life Scale [45-47]. The measure consisted of five items: "In most ways my life is close to ideal," "The conditions of my life are excellent," "I am satisfied with my life," "So far, I have gotten the important things I want in life," and "If I could live my life again, I would change almost nothing." Item responses for life satisfaction ranged from *strongly disagree* to *strongly agree*, with high scores indicating high life satisfaction. The summary average scores of the five items were computed, indicating that the average of the five items were computed and then that average was multiplied by 5 to create a comparable scaling score. Reliability was 0.87 in 2006 and 0.84 in 2008.

### 2.2.7 Optimism

Optimism was measured with the Life Orientation Test-Revised (LOT-R), which assesses dispositional optimism and has demonstrated acceptable predictive and discriminant validity [48]. The LOT-R in the HRS includes six items. Following a similar structure to previous HRS studies [49] and literature supporting the unidimensional use of this scale [50], the three negatively worded items were recoded, and all six items were averaged into one composite score assessing optimism, with higher scores indicating more optimism. Six response categories ranged from *strongly disagree* (1) to *strongly agree* (6). The possible scores for optimism ranged from 6 to 36. Reliability was 0.71 in 2006 and 0.68 in 2008.

### 2.2.8 Purpose in Life

Purpose in life was measured with the Purpose in Life scale which evaluates one dimension of psychological well-being [45, 51, 52]. Seven items evaluated purpose in life in the HRS: three positively worded items and four negatively worded items. The negatively worded items were recoded, and all seven items were averaged into one composite score assessing purpose in life, with higher scores indicating greater purpose in life. There were six response options, ranging from strongly disagree (1) to strongly agree (6). The possible scores for purpose in life ranged from 7 to 42. Reliability was 0.67 in 2006 and 0.72 in 2008.

### 2.2.9 Positive Affect

The current study includes positive affect as a component of positive psychological well-being. In 2006, positive affect was measured with six items from the MIDUS study which asked how often participants felt: cheerful, in good spirits, extremely happy, calm and peaceful, satisfied, and full of life over the past 30 days [45], with responses ranging from *all of the time* (5) to *none of the time* (1). In 2008 and onward, positive affect was measured with 13 items asking about the degree to which participants felt: determined, enthusiastic, active, proud, interested, happy, attentive, content, inspired, hopeful, alert, calm, and excited [45]. Responses were recoded into *not at all* (1), *a little* (2), *moderately* (3), *quite a bit* (4), and *very much* (5). Possible scores for positive affect in 2006 ranged from 6 to 30, and from 2008 onwards possible scores ranged from 13 to 65. Due to the non-comparable scores for positive affect in 2006, only positive affect scores starting in 2008 were used. Reliability was 0.92 in 2008.

### 2.2.10 Demographic Characteristics

Several demographic characteristics were included in the current study, including age (continuous), education (*less than high schoo*l, *GED*, *high school graduate*, *some college*, and *college degree and above*), gender (*male* and *female*), marital status (*married*, *partnered*, *separated*, *divorced*, *widowed*, and *never married*), ethnicity (*White*, *African American/Black*, and *Other*). For analyses, marital status and ethnicity were binary coded: marital status was coded as 1 = *married or partnered*, 0 = *not married or partnered*; ethnicity was coded into 1 = *White*, 0 = *not White*.

### *2.3 Analytic Procedure*

Frequency and descriptive analyses were conducted on all study variables (baseline, last available data point, and LBQ baseline). Bivariate correlations were conducted at participants' last available data point (at age 98 or older) with core variables (i.e., age, gender, ethnicity, marital status, education, ADL impairment, self-rated health, sum of health conditions, cognitive status, happiness, life enjoyment, and the happiness/enjoyment subscale). Another bivariate correlation was conducted at the LBQ baseline (2006/2008) for all study variables. Additionally, t-tests were conducted to test for group differences in study variables by gender.

A linear regression analysis was conducted on the happiness/enjoyment subscale using predictors of demographic characteristics (age, gender, ethnicity, education, and marital status), ADL impairment, self-rated health, cognitive status, and the sum of health conditions. Finally, four repeated measures analyses of variance (ANOVAs) were conducted on LBQ life satisfaction, optimism, purpose in life, and positive affect across three time points. To represent the full sample at each time point, responses from each pair of waves were combined: waves 8 and 9 (2006 and 2008), waves 10 and 11 (2010 and 2012), and waves 12 and 13 (2014 and 2016). The ANOVA analyses examined changes in mean scores of the four subjective well-being variables across the repeated time points.

Pairwise deletion and individual mean substitution were used for all analyses. Individual mean substitution was only conducted for scales with less than 20% missing data.

IRB approval was received (03/22/2022) through the Iowa State University IRB committee approval process (Study 22-087).

## 3. Results

Descriptive results (Table 1) demonstrated that 86.4% of participants reported that they enjoyed their lives at their last available data point. Similarly, 81.6% of participants reported being happy at their last available data point. About half of the sample (53%) reported that their health was good, very good, or excellent at their last available data point on or after the age of 98.

**Table 1** Descriptive information for study variables.

| Variable | *n* | *M* | *SD* | % |
|---|---|---|---|---|
| Age (baseline, 1992) | 516 | 84.09 | 7.62 | |
| Gender | | | | |
| Male | 117 | -- | -- | 22.7% |
| Female | 399 | | | 77.3% |
| Ethnicity | | | | |
| White | 425 | | | 82.4% |
| Black/African American | 79 | -- | -- | 15.3% |
| Other | 12 | | | 2.3% |

| | | | | |
|---|---|---|---|---|
| Education | | | | |
| Less than high school | 237 | | | 45.9% |
| High school or GED equivalent | 127 | -- | -- | 24.7% |
| Some college | 87 | | | 16.9% |
| College degree or above | 65 | | | 12.6% |
| Marital Status (baseline, 1992) | | | | |
| Married | 178 | | | 35.2% |
| Partnered | 2 | | | 0.4% |
| Separated/Divorced | 23 | -- | -- | 4.5% |
| Widowed | 295 | | | 58.3% |
| Never Married | 8 | | | 1.6% |
| ADL Impairment (LADP) | 294 | 1.71 | 1.18 | |
| Sum of Health Conditions (LADP) | 295 | 2.65 | 1.38 | |
| Cognition (LADP) | 108 | 12.04 | 5.59 | |
| Self-Reported Health (LADP) | | 2.62 | 1.17 | |
| 1. Poor | 59 | | | 20.2% |
| 2. Fair | 78 | | | 26.7% |
| 3. Good | 88 | | | 30.1% |
| 4. Very good | 48 | | | 16.4% |
| 5. Excellent | 19 | | | 6.5% |
| Enjoyed Life (LADP) | | | | |
| 1. Yes, enjoyed life | 108 | -- | -- | 86.4% |
| 0. No, did not enjoy life | 17 | | | 13.6% |
| Happy (LADP) | | | | |
| 1. Yes, felt happy | 102 | -- | -- | 81.6% |
| 0. No, not happy | 23 | | | 18.4% |
| Happiness/Enjoyment (LADP) | 125 | 1.68 | 0.62 | |
| Life Satisfaction, w8/9 (2006/2008) | 196 | 23.79 | 6.79 | |
| Optimism, w8/9 (2006/2008) | 193 | 26.52 | 5.85 | |
| Purpose in Life, w8/9 (2006/2008) | 184 | 29.26 | 6.71 | |
| Positive Affect, w9 (2008) | 89 | 43.26 | 11.26 | |

*Note*. LADP = last available data point, after participants were at least 98 years or older. ADL impairment: higher scores indicate more impairment. Life satisfaction, optimism, purpose in life, and positive affect were coded such that high scores indicate good well-being. Leave-Behind Questionnaires (LBQ) conducted biannually, such that half of potential HRS respondents were eligible on off years, so to represent responses from the full sample, waves were combined to represent individual time points (e.g., 2006 and 2008 as one time point; see methods for more information). Only wave 9 of positive affect was used due to inconstant items in wave 8. Percentages may not add up to exactly 100% due to rounding.

Correlation results of functioning at the last available data point (Table 2) identified that self-rated health significantly related to enjoyment ($r[123] = 0.22$, $p < 0.05$), happiness ($r[123] = 0.30$, $p < 0.001$), and the happiness/enjoyment subscale ($r[123] = 0.32$, $p < 0.001$), such that better subjective health related to being happy, enjoying life, and having more happiness/enjoyment at

participants' last available data point. Self-rated health was inversely related to health conditions ($r$[292] = -0.21, $p$ < 0.001) and ADL impairment ($r$[291] = -0.26, $p$ < 0.001), such that people with good subjective health tended to have fewer health conditions and less functional health impairment, as expected. Enjoyed life and felt happy at last data points were positively correlated to one another ($r$[123] = 0.41, $p$ < 0.001), suggesting that people who felt happy tended to also report enjoying their lives.

**Table 2** Correlation table of functioning at last available data point (aged 98+).

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age, w2 | 1 | | | | | | | | | | | |
| 2. Gender (female) | -0.03 | 1 | | | | | | | | | | |
| 3. Ethnicity(White) | 0.01 | -0.03 | 1 | | | | | | | | | |
| 4. Marital (partnered), w2 | -0.31*** | -0.41*** | 0.15** | 1 | | | | | | | | |
| 5. Education | -0.22*** | -0.05 | 0.24*** | 0.19*** | 1 | | | | | | | |
| 6. ADL impairment (LADP) | 0.09 | 0.16** | -0.01 | -0.05 | -0.09 | 1 | | | | | | |
| 7. SRH (LADP) | 0.02 | -0.08 | 0.13* | -0.02 | 0.05 | -0.26*** | 1 | | | | | |
| 8. Health conditions (LADP) | -0.25*** | 0.06 | -0.04 | 0.15* | -0.04 | 0.19** | -0.21*** | 1 | | | | |
| 9. Cognitive status (LADP) | 0.04 | -0.22* | 0.28** | 0.11 | 0.24* | -0.11 | 0.08 | -0.09 | 1 | | | |
| 10. Enjoyed (LADP) | 0.07 | 0.02 | -0.13 | -0.03 | -0.06 | -0.10 | 0.22* | 0.01 | -0.01 | 1 | | |
| 11. Happy (LADP) | 0.10 | 0.13 | 0.03 | 0.02 | -0.08 | -0.03 | 0.30*** | -0.06 | -0.04 | 0.41*** | 1 | |
| 12. Happiness/Enjoyment (LADP) | 0.10 | 0.09 | -0.06 | -0.00 | -0.08 | -0.07 | 0.32*** | -0.04 | -0.03 | 0.82*** | 0.86*** | 1 |

*Note.* LADP = last available data point, after participants were at least 98 years or older. Marital = marital status. Gender, ethnicity, and marital status were binary coded. SRH = self-rated health, coded as high scores = good health. Education = higher scores indicate more education. ADL impairment = activities of daily living impairment, where high scores = functional impairment. Health conditions = higher scores indicate more health issues/conditions. Cognitive status = high scores indicate good cognitive status. Baseline (w2) is wave 2, collected in 1992. The sample size for these correlations ranged from $n$ = 105-516. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

The second correlation table (Table 3) includes core data (wave 8, 2006) alongside LBQ data (waves 8/9, 2006/2008) of the four psychological well-being variables. Due to noncomparable items, positive affect scores were only included from 2008, which limited the sample size for that variable. There were several notable correlations to highlight. Optimism demonstrated significant positive associations with life enjoyment ($r$[184] = 0.18, $p < 0.05$), happiness ($r$[184] = 0.22, $p < 0.01$), the happiness/enjoyment subscale ($r$[182] = 0.22, $p < 0.01$), life satisfaction ($r$[192] = 0.21, $p < 0.01$), purpose in life ($r$[181] = 0.39, $p < 0.001$), positive affect ($r$[89] = 0.39, $p < 0.001$), and cognitive status ($r$[186] = 0.17, $p < 0.05$). This suggests that optimistic people tend to also be in better cognitive health and have better overall quality of life on various psychological well-being measures. Furthermore, results suggested that participants with greater purpose in life tended to have better cognitive functioning ($r$[177] = 0.28, $p < 0.001$), higher educational achievement ($r$[184] = 0.24, $p < 0.01$), be more optimistic (r[181] = 0.39, $p < 0.001$), have greater positive affect ($r$[81] = 0.59, $p < 0.001$), and be younger in age (r[182] = -0.15, $p < 0.05$). Significant correlations with age suggested that older participants at wave 8 tended to be not partnered (r[318] = -0.18, $p < 0.01$), more ADL impaired (r[317] = 0.43, $p < 0.001$), have more health conditions (r[318] = 0.15, $p < 0.01$), rate their health as lower (r[318] = -0.19, $p < 0.001$), have worse cognitive functioning (r[270] = -0.46, $p < 0.001$), and have lower purpose in life (r[182] = -0.15, $p < 0.05$). However, nonsignificant associations with age were also notable, suggesting that participants' age at wave 8 did not significantly relate to their concurrent levels of happiness, enjoyment, life satisfaction, optimism, or positive affect. In addition, positive affect at wave 8 related concurrently to happiness/enjoyment (r[80] = 0.25, $p < 0.05$) and cognitive status (r[83] = 0.23, $p < 0.05$), suggesting that more positive affect related to greater happiness/enjoyment and better cognitive status. Also, greater satisfaction with life positively correlated with better subjective health (r[194] = 0.31, $p < 0.001$), life enjoyment (r[187] = 0.22, $p < 0.01$), and the enjoyment/happiness subscale (r[185] = 0.18, $p < 0.05$).

**Table 3** Correlation table of study variables at wave 8/9 (2006/2008).

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age, w8 | 1 | | | | | | | | | | | | | | | |
| 2. Gender (female) | -0.03 | 1 | | | | | | | | | | | | | | |
| 3. Ethnicity(White) | -0.06 | -0.03 | 1 | | | | | | | | | | | | | |
| 4. Marital (partnered), w8 | -0.18** | -0.39*** | 0.13* | 1 | | | | | | | | | | | | |
| 5. Education | -0.09 | -0.05 | 0.24*** | 0.17** | 1 | | | | | | | | | | | |
| 6. ADL impairment, w8 | 0.43*** | 0.06 | -0.02 | -0.10 | -0.16** | 1 | | | | | | | | | | |
| 7. Good SRH, w8 | -0.19*** | 0.04 | 0.06 | 0.01 | 0.25*** | -0.35*** | 1 | | | | | | | | | |
| 8. Health conditions, w8 | 0.15** | 0.11* | -0.02 | -0.06 | -0.11 | 0.23*** | -0.27*** | 1 | | | | | | | | |
| 9. Cognitive status, w8 | -0.46*** | -0.05 | 0.31*** | 0.12 | 0.42*** | -0.25*** | 0.24*** | -0.11 | 1 | | | | | | | |
| 10. Enjoyed, w8 | -0.01 | 0.17** | -0.03 | -0.05 | -0.08 | -0.04 | 0.15* | 0.01 | -0.06 | 1 | | | | | | |
| 11. Happy, w8 | -0.11 | 0.14* | 0.05 | -0.09 | -0.09 | -0.07 | 0.08 | 0.07 | -0.05 | 0.55*** | 1 | | | | | |
| 12. Happiness/enjoyment, w8 | -0.08 | 0.17** | 0.03 | -0.10 | -0.11 | -0.06 | 0.12 | 0.04 | -0.07 | 0.84*** | 0.92*** | 1 | | | | |
| 13. Life satisfaction, w8/w9 | -0.02 | 0.08 | 0.11 | -0.05 | 0.03 | 0.03 | 0.31*** | -0.14 | 0.13 | 0.22** | 0.14 | 0.18* | 1 | | | |
| 14. Purpose in life, w8/w9 | -0.15* | -0.09 | -0.14 | 0.15 | 0.24** | -0.03 | 0.10 | -0.02 | 0.28*** | 0.06 | 0.02 | 0.07 | 0.14 | 1 | | |
| 15. Optimism, w8/w9 | -0.08 | 0.12 | -0.05 | -0.02 | 0.09 | 0.05 | 0.10 | 0.01 | 0.17* | 0.18* | 0.22** | 0.22** | 0.21** | 0.39*** | 1 | |
| 16. Positive affect, w9 | -0.18* | -0.01 | 0.00 | 0.01 | 0.15 | -0.03 | 0.09 | -0.14 | 0.23* | 0.18 | 0.18 | 0.25* | 0.07 | 0.59*** | 0.39*** | 1 |

*Note*. w8 = wave 8, 2006. w9 = wave 9, 2008. Marital = marital status. Gender, ethnicity, and marital status were binary coded. Education was coded as higher scores indicate more education. Good SRH = good self-rated health; high scores indicate good health. ADL impairment = activities of daily living impairment; high scores indicate functional impairment. Health conditions = higher scores indicate more health issues or conditions. Cognitive status = high scores indicate good cognitive status. Wave 8 began the collection of the leave-behind questionnaire (LBQ) items from half of the sample, with the other half responding at wave 9. Thus, wave 8 and wave 9 responses were used for LBQ life satisfaction, optimism, and purpose in life; sample size ranging from 181-196. Only wave 9 (2008) of positive affect was used because wave 8 had noncomparable items; sample size of 89 participants. Demographic/health correlations were conducted with LBQ baseline (wave 8 = 2006). The sample size for the demographics and other well-being variables at wave 8 ranged from $n$ = 262-516. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

We were also interested in examining whether there were any gender or partnership differences among eventual centenarian survivors on health and well-being markers at wave 8. Four significant gender group differences were identified. Women centenarian survivors reported enjoying their lives ($t$[71.719] = -2.077, $p$ = 0.041), being happy ($t$[78.380] = -1.980, $p$ = 0.051), and having both life enjoyment/happiness ($t$[72.183] = -2.247, $p$ = 0.028) significantly more than men did. However, women also had significantly more health conditions compared to men ($t$[316] = -1.998, $p$ = 0.047). No significant gender differences were identified among functional health impairment, self-rated health, or cognitive status. We also tested for partnered vs. non-partnered group differences in the health and well-being markers at wave 8. Because partnership status differed by wave, we used participants' partnership status at wave 8 to show contemporaneous group differences. One significant group difference was identified. People who were partnered at wave 8 had significantly fewer functional health impairments than people who were non-partnered ($t$[69.615] = 2.046, $p$ = 0.045). No significant group differences were observed among self-rated health, health conditions, cognitive status, life enjoyment, happiness, or the happiness/life enjoyment subscale.

Linear regression results (Table 4) demonstrated that self-rated health at participants' last available data point (aged 98 or older) positively predicted happiness/enjoyment at their last available data point, over and above the effects of demographic characteristics, cognitive status, the sum of health conditions, and ADL impairment, β = 0.35, $p$ < 0.001. This suggests that centenarians and near-centenarians who reported good health at or after the age of 98 tended to also score high in happiness/enjoyment, indicating that they were happy and enjoyed their lives much of the time.

**Table 4** Linear regression results on happiness/enjoyment at age 98 and older.

| **Variables** | ***B*** | ***SE*** | **β** |
|---|---|---|---|
| Age, w2 | 0.01 | 001 | 0.14 |
| Gender (female) | 0.26 | 0.16 | 0.18 |
| Ethnicity (White) | -0.16 | 0.17 | -0.10 |
| Education | -0.03 | 0.04 | -0.06 |
| Marital status (partnered), w2 | 0.18 | 0.15 | 0.14 |
| Cognitive status (LADP) | 0.00 | 0.01 | 0.01 |
| Sum of health conditions (LADP) | 0.02 | 0.05 | 0.04 |
| Good SRH (LADP) | 0.18 | 0.05 | 0.35*** |
| ADL impairment (LADP) | -0.02 | 0.05 | -0.03 |

*Note.* LADP = last available data point, after participants were at least 98 years or older. Baseline (wave 2, 1992) characteristics were used for age and marital status. Gender, ethnicity, and marital status were binary coded. Education coded such that high scores indicate more education. Cognitive status = high scores indicate good cognitive status. Sum of health conditions = higher scores indicate more health issues/conditions. Good SRH = good self-rated health; high scores indicate good health. ADL Impairment = activities of daily living impairment; high scores indicate impairment. Analytic sample size = 96 participants. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

Table 5 presents multiple linear regression analyses on the LBQ subjective well-being variables of life satisfaction, optimism, purpose in life, and positive affect at LBQ baseline (2006/2008). Results demonstrated that greater levels of life satisfaction related to good self-rated health, $\beta = 0.33$, $p < 0.001$, yet also to greater ADL impairment, $\beta = 0.17$, $p < 0.05$. Results for optimism demonstrated that older adults who were more optimistic tended to also have higher levels of cognitive functioning, $\beta = 0.20$, $p < 0.05$. Purpose in life significantly related to ethnicity, education, and cognitive status, such that people who were not White, more educated, and those with high cognitive status tended to have higher levels of purpose in life, $\beta = -0.28$, $p < 0.001$, $\beta = 0.17$, $p < 0.05$, and $\beta = 0.28$, $p < 0.01$, respectively. Positive affect did not significantly relate to any of the demographic or functioning variables. To test for possible gender by education interaction effects, the four linear regressions were tested with the addition of a 'gender x education' interaction term in the regression block. The interaction term did not significantly predict any of the four LBQ subjective well-being variables.

**Table 5** Linear regression results on psychological subjective well-being variables at wave 8/9 (2006/2008).

| | **Life Satisfaction** (*n* = 180) | | | **Optimism** (*n* = 177) | | | **Purpose in Life** (*n* = 168) | | | **Positive Affect^** (*n* = 74) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | ***B*** | ***SE*** | **β** | ***B*** | ***SE*** | **β** | ***B*** | ***SE*** | **β** | ***B*** | ***SE*** | **β** |
| Age, w8 | 0.04 | 0.13 | 0.03 | -0.03 | 0.12 | -0.02 | -0.08 | 0.13 | -0.05 | -0.31 | 0.34 | -0.13 |
| Gender (female) | 0.98 | 1.24 | 0.06 | 1.79 | 1.12 | 0.13 | -0.66 | 1.24 | -0.04 | -5.55 | 3.27 | -0.21 |
| Ethnicity (White) | 1.44 | 1.32 | 0.08 | -0.19 | 1.19 | -0.13 | -4.96 | 1.32 | -0.28*** | -2.13 | 3.47 | -0.07 |
| Education | -0.44 | 0.36 | -0.10 | 0.15 | 0.32 | 0.04 | 0.77 | 0.36 | 0.17* | 0.68 | 0.95 | 0.09 |
| Marital (partnered), w8 | -0.35 | 1.51 | -0.02 | 0.48 | 1.36 | 0.03 | 2.01 | 1.51 | 0.11 | -3.83 | 3.97 | -0.12 |
| Cognitive status, w8 | 0.13 | 0.11 | 0.11 | 0.20 | 0.10 | 0.20* | 0.33 | 0.11 | 0.28** | 0.35 | 0.28 | 0.18 |
| Sum of health conditions, w8 | -0.50 | 0.37 | -0.10 | 0.08 | 0.34 | 0.02 | 0.11 | 0.37 | 0.02 | -0.83 | 0.98 | -0.10 |
| Good SRH, w8 | 2.12 | 0.49 | 0.33*** | 0.50 | 0.45 | 0.09 | 0.21 | 0.49 | 0.03 | -0.30 | 1.30 | -0.03 |
| ADL impairment, w8 | 1.14 | 0.56 | 0.17* | 0.78 | 0.50 | 0.13 | 0.74 | 0.56 | 0.11 | 1.36 | 1.19 | 0.12 |

*Note*. ^ = Positive affect did not have comparable items in wave 8 (2006), so only wave 9 (2008) was used in the analysis. Wave 8 (2006) demographic characteristics and health variables were used since the outcome LBQ variables were asked to half the sample at wave 8 (2006) and to the other half at wave 9 (2008). Marital = marital status. Gender, ethnicity, and marital status were binary coded. Education coded such that high scores indicate more education. ADL impairment = Activities of daily living impairment; high scores indicate impairment. Good SRH = good self-rated health; high scores indicate good health. Sum of health conditions = high scores indicate more health issues or conditions. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

Four repeated measures ANOVA analyses on LBQ variables at waves 8/9 (2006/2008), 10/11 (2010/2012), and 12/13 (2014/2016) were conducted (Table 6). The ANOVA on life satisfaction demonstrated significant linear results, $F(1, 29) = 5.33$, $p < 0.05$, indicating that average life satisfaction scores steadily increased across time points: $M = 25.60$ at wave 8/9, $M = 26.70$ at wave 10/11, and $M = 27.71$ at wave 12/13. ANOVA results for purpose in life across three LBQ time points were also significant, $F(1, 27) = 5.02$, $p < 0.05$, with average scores of 32.06 at wave 8/9, 31.36 at wave 10/11, and 28.67 at wave 12/13. ANOVA results for optimism across three time points were not significant across time points, $F(1, 28) = 1.87$, $p = 0.182$. Average optimism scores were 29.52 at wave 8/9, 27.76 at wave 10/11, and 28.02 at wave 12/13. The ANOVA for positive affect could only include two time points (wave 10/11 and wave 12/13) since the first LBQ wave (2006) used different items than in 2008 onwards. Results for positive affect over two time points were not significant, $F(1, 31) = 0.002$, $p = 0.964$, with mean scores of 45.63 at wave 10/11 and 45.42 at wave 12/13.

**Table 6** Psychological well-being over time.

| **Scales** | **Mean (*SD*)** | | | ***F*-value** | ***n*** |
|---|---|---|---|---|---|
| | Wave 8/9 (2006/2008) | Wave 10/11 (2010/2012) | Wave 12/13 (2014/2016) | | |
| Life Satisfaction | 25.60 (4.75) | 26.70 (7.15) | 27.71 (7.06) | **5.33**$^{*}$ | 30 |
| Optimism | 29.52 (5.14) | 27.76 (6.62) | 28.02 (5.38) | 1.87 | 29 |
| Purpose in Life | 32.06 (1.26) | 31.36 (1.12) | 28.67 (1.17) | **5.02**$^{*}$ | 28 |
| Positive Affect^ | -- | 45.92 (1.67) | 45.85 (1.70) | 0.00 | 32 |

*Note*. ^ = Positive affect was only analyzed from wave 10/11 to wave 12/13 since the positive affect scale used in 2006 was not consistent with all other time points. $^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

## 4. Discussion

The purpose of this study was to examine positive subjective well-being (e.g., happiness, life enjoyment, life satisfaction, optimism, purpose in life, and positive affect) of individuals drawn from different waves of the Health and Retirement Study (HRS) who would eventually become centenarians or near-centenarians (aged 98+). Three major findings were obtained in this study: 1) there was a positive association between happiness/enjoyment and self-rated health at centenarians' and near-centenarians' last available data points (age 98 or older); 2) there were positive associations between self-rated health and psychological well-being among happiness, life enjoyment, and life satisfaction; 3) longitudinally, life satisfaction scores significantly increased and purpose in life significantly decreased over three time points among centenarian and near-centenarian survivors.

This sample comes from a longitudinal nationally representative study in the United States that allows an opportunity to explore a variety of attributes among eventual centenarians and near-

centenarians. We were interested in exploring three main research questions: 1) How does health functioning relate to happiness and enjoyment at or near age 100? 2) How do life satisfaction, purpose in life, optimism, and positive affect relate to physical health functioning variables after accounting for personal characteristics? 3) Using an exploratory approach in a smaller longitudinal subsample, can we examine whether different psychological well-being variables (i.e., purpose in life, life satisfaction, positive affect, and optimism) change over time among people who are at or near age 100?

### *4.1 Characteristics of Eventual Centenarians in the HRS*

Descriptive results demonstrated that the self-ratings of well-being among centenarians and near-centenarians are generally very positive. Findings suggest that most participants at or near age 100 declared their life to be happy and enjoyable much of the time. This is consistent with past research [53] where over 70% of centenarians reported that they felt happy mostly. It is important to note that most centenarians and near-centenarians were happy and enjoyed their lives even after nearly 100 years, suggesting the exceptional outlook of these long-lived individuals, even as they may experience health conditions or environmental changes surrounding their exceptional longevity.

Women who were not married or partnered reported more ADL impairments at their last available data point and tended to have worse cognitive status than men. Older adults who were White tended to be married/partnered, more educated, and had better self-rated health and cognitive status at their last data point than non-White individuals. There may be a systemic role, such as health disparities, in these associations. No baseline demographic characteristics played a significant role in whether participants indicated to be happy or enjoy their life at or around age 100. Perhaps, at the end of a long life, people become more homogeneous with regard to personal (demographic) characteristics.

Secondary correlation results with the supplemental LBQ data from 2006/2008 revealed positive associations between self-rated health and higher scores of life satisfaction among eventual centenarians and near-centenarians. Additionally, greater optimism related to greater life enjoyment, happiness, life satisfaction, purpose in life, positive affect, and better cognitive functioning. Eventual centenarians with greater purpose in life tended to be younger, more educated, more cognitively healthy, more optimistic, and had higher levels of positive affect. Better cognitive functioning tended to be found among participants who were younger, White, more educated, optimistic, less functionally impaired, and who had better self-rated health and greater purpose in life. Happiness/enjoyment at wave 8 related positively to higher levels of life satisfaction, optimism, positive affect, and being female.

As with most centenarian studies, there was an imbalance in the number of men and women, in that there were more female than male centenarian survivors [54]. Even so, significant gender differences were able to be computed in the current study at wave 8. Women centenarian survivors reported being happy, enjoying their life, and having both life enjoyment and happiness more often than men in the current study. However, women centenarian survivors also reported more health conditions than men did. This is consistent with past studies [55, 56] in which women generally reported more health issues or morbidities than men. Reasons for this may be due to women being more averse to taking health risks and being more likely to go to the doctor when a health issue

arises. In addition, women who attend doctor's appointments more regularly may have more opportunities to receive health diagnoses from their medical professional. It is interesting to note that health conditions differed significantly by gender in this study, but other physical health markers like functional health and self-rated health did not. Perhaps that is because the health conditions variable is an objective marker of health, as participants shared diagnoses received from a doctor, whereas functional health and self-rated health are subjective. However, other centenarian studies reported gender differences on all health-related variables with women reporting more health issues [56]. Additionally, partnership group differences were obtained among eventual centenarians and near-centenarians. People who were partnered had fewer ADL impairments than people who were not partnered. Perhaps partnered individuals encourage each other and feel more supported in endeavors to stay active and involved in different activities. Non-partnered older adults may not receive that support and encouragement toward remaining active in their daily lives. This should be further explored in future studies.

### *4.2 Research Question 1: Happiness, Life Enjoyment, and Health*

The first hypothesis was that health functioning would positively relate to happiness and life enjoyment at or near age 100. This hypothesis was supported through bivariate correlations and linear regression analysis. Centenarians who were happy and who enjoyed their lives most of the time also tended to report that they were in good health, after accounting for demographic characteristics. There are potential bidirectional effects here. It may be that centenarians who were happy viewed their health in a better light, or people who rated their health as good overall felt happy that they had made it to such an exceptionally advanced age in relatively good health.

### *4.3 Research Question 2: Positive Psychological Well-Being and Health*

The second hypothesis was that better overall psychological well-being would be associated with better subjective physical health, such that people who feel that they are in good health may also rate their psychological well-being as high. In addition to the larger analytic sample, supplemental wave 8/9 regressions tested demographic characteristics and three physical health markers on outcomes of life satisfaction, optimism, purpose in life, and positive affect. This hypothesis was partially supported. Results suggested that better self-rated health and more ADL impairment related to better life satisfaction. This is partially consistent with another study [14] that had identified positive associations between good subjective health and life satisfaction among centenarians in the Fordham Centenarian Study. In the current study, the positive association between functional health impairment and life satisfaction may be due to a suppressor effect. It is also perhaps mediated by social connections; older adults facing functional impairment likely receive help from their social supports, and those social supports may in turn add to their increased life satisfaction. Social connections are important for people throughout the life span. It is no surprise then that social resources are vital for the positive well-being, adaptation, and survival of centenarians [57]. We encourage future studies to also differentiate between types of social supports (e.g., friends, family) that may impact psychological well-being among centenarians, as the exceptional age of centenarians may make it such that centenarians outlive some of their supports [58]. The important role of social connections contributing to centenarians' psychological health and overall well-being should be further explored in future studies.

Our results demonstrated that better cognitive status related to higher levels of optimism and purpose in life, holding all other variables constant. Perhaps people with greater cognitive abilities have an easier time being more optimistic and finding greater purpose in their lives, though bidirectionality is possible. It may be that people who are more optimistic and who feel more purpose in their lives tend to be more active and engaged with life, which may play a role in their good cognitive status. Finally, eventual centenarians and near-centenarians who were not White and those with more education tended to have more purpose in life. Another study [59] confirmed these associations in their study with older adults. Positive affect did not relate to any of the wave 8 demographic or functioning variables.

Although not significant, we had also examined whether there were interaction effects between gender and education in predicting the four psychological well-being outcomes. In centenarians' early lives, women were less likely to be highly educated. Thus, it was important to assess whether the interaction of gender and education would have an impact on centenarian survivors' later life psychological well-being.

### *4.4 Research Question 3: Longitudinal Examination of Centenarians' Psychological Well-Being*

The third research question was a longitudinal exploration of changes among a subset of centenarians and near-centenarians who had three data points. Mean changes over time in life satisfaction, optimism, positive affect, and purpose in life demonstrated two important longitudinal findings: a) life satisfaction increased over time, and b) purpose in life decreased over time as participants moved closer to becoming centenarians. The increase in life satisfaction may be due to participants moving closer to "centenarian status," feeling unique thinking about their new centenarian "title" as a kind of reward marker, potentially boosting their life satisfaction. Interestingly, no differences in life satisfaction were reported across two time points (~20 months) after achieving centenarian status in the Georgia Centenarian Study [15].

The decline in purpose in life over three time points may make more sense when considering the items for purpose in life. One recoded item in the scale asks participants whether they feel that they have done all that there is to do in their life. For the general aged 65+ older adult population, it makes sense that there is still a lot for them to achieve. Perhaps people who are nearly 100 years of age feel a sense of accomplishment with what they have been able to achieve, so this score may be lower. The scale also asks about making plans for the future and whether participants have a sense of what they are trying to accomplish in their lives. It may be that as individuals get closer to age 100 and seemingly toward the end of their life, they may be faced with less clarity as to future plans and what more they would like to accomplish. This is an opportunity for future research to examine and possibly adjust scales measuring purpose in life among oldest-old and centenarian populations, as it may look different than it does for the general population.

Our findings that life satisfaction increases while purpose in life decreases over time is interesting to address, especially when considering how it relates to the "well-being paradox." The well-being paradox suggests that although aging may bring about health issues and/or social losses, subjective well-being, such as life satisfaction, remains stable and may even increase in later life [60]. The maintenance or increase in life satisfaction over time has been identified in different studies with older adults [60-62]. This well-being paradox is consistent with our results that life satisfaction increased over time as participants neared centenarian age. Interestingly, purpose in life does not

seem to support the well-being paradox, as it decreased over time as participants neared centenarian age. In addition, a study [63] identified that centenarians who attributed faith to their longevity tended to have improved patterns of life satisfaction after 100 years of age. This association may suggest that spiritual connections could reflect underlying characteristics of gerotranscendence common among oldest old adults, and may help explain why centenarians develop greater satisfaction toward life over time.

Positive affect could only be measured at two time points because of inconsistent items and no significant change was noted. Previous studies have shown that positive affect decreased over time among a small sample of centenarians [33]. This longitudinal examination among eventual centenarians and near-centenarians was exploratory and preliminary; it is rare to have longitudinal data across 12 years for people who become centenarians. Due to the limited size of the longitudinal sample, caution needs to be taken in interpreting these findings. As more people continue to live to exceptional ages and the number of centenarians worldwide continues to grow, more longitudinal studies may become available.

The theoretical frameworks that complement the current study [4, 6] provided a focus on adaptation well into late life for oldest old adults. Incorporating the influence of individual characteristics and mental health linked with life satisfaction, alongside other adaptation qualities, allowed opportunities for examining both distal variables (e.g., education) and proximal variables (e.g., health conditions, marital status) among eventual centenarians and near-centenarians in the United States.

### *4.5 Limitations*

There are a number of limitations to note. All measures in this study were subjective self-reports of positive well-being and health, so objective measurements of positive well-being were not addressed. A limitation and opportunity for future researchers is to validate the positive subjective well-being scales among centenarian and near-centenarian populations [9]. One important limitation is the sample size due to the exceptionality of centenarians. The original sample size of 516 eventual centenarian participants was quite large but using supplemental LBQ variables limited the sample size to those with supplemental data in 2006 for the correlations and regressions, and further limited it to approximately 30 people with data across three waves. Although having three waves of centenarian and near-centenarian responses is notable, the limited sample size must be acknowledged. Another limitation is the generalizability of the data. Although the HRS is a nationally representative sample in the United States, it does not necessarily mean that this longevity sample is representative of centenarians across the United States. Additionally, people who respond to surveys are typically rate higher on overall well-being scales than people who do not respond to surveys. Another limitation is concerned with the lack of data regarding centenarians' early lives. For example, differences in gender among eventual centenarians may have played an integral role when individuals were younger. Individual factors such as gender may reflect influences in early life, which may have lasting impact into later life. This is an important area for further investigation within centenarian research.

### *4.6 Future Directions and Implications*

The findings reported in this study could be beneficial for gerontologists and geriatricians. Acknowledging the important role of positive well-being components (e.g., life satisfaction, purpose in life, positive affect, and optimism) may help promote overall well-being of oldest-old adults. Social deficits can negatively impact health impairment [32]. Further, positive subjective well-being is linked to physical health and longevity and should be considered desirable and beneficial [8].

The overall improvement of well-being is an important goal for health care providers. However, there is normative age-related decline in health and functioning for older adults. This limits the capacity/extent of biomedical interventions, especially in late life for improving well-being. The results of this study suggest that greater purpose in life and more optimism may mitigate cognitive decline and support well-being. This highlights the importance of maintaining psychological well-being in later life. However, results also demonstrated that purpose in life declines over time as participants near centenarian age. This creates an opportunity for future intervention research to examine pathways to improve the purpose in life among oldest-old adults.

Developing effective interventions toward improving purpose in life may be more difficult than those geared toward improving life satisfaction or happiness. Although feeling happy or satisfied may come from good experiences and/or positive social connections, there may be a more nuanced way of improving feelings of purpose in life for oldest-old adults. One option may be to offer intergenerational programming aimed at centenarians and near-centenarians, allowing for enhanced social interaction and engagement with others. This may also offer younger individuals opportunities to learn from centenarians, hearing their wisdom and sharing in their life experiences of living nearly 100 years [58].

There are many future directions for this area of study. First, it would be helpful to utilize a similar structure of examining eventual centenarians in the HRS by different subgroups (e.g., cultural, ethnic, regional, etc.). As the HRS is a nationally representative sample and utilizes oversampling of certain groups, this may allow for an extended examination of longevity in various groups across the United States. Additionally, the HRS provides opportunities to look at many variables that may be of interest to other researchers related to longevity, such as biomarkers among eventual centenarians or health vitals such as blood pressure and cholesterol. Second, future research can replicate this study's structure utilizing different longitudinal population surveys, such as the National Social Health and Aging Project (NSHAP) or the Survey of Health, Ageing, and Retirement in Europe (SHARE) project. Although the current waves of the NSHAP do not yet include centenarians, centenarians and near-centenarians will be included as the project continues. As the NSHAP and SHARE studies have similar structures to the HRS, this could be an important comparison project for researchers to take on.

### *4.7 Conclusions*

Overall, this study identified several important conclusions. First, centenarians and near-centenarians who reported being happy and enjoying their lives most of the time tended to also report being in better health. Second, centenarians and near-centenarians who reported being in better health tended to also report greater life satisfaction, after accounting for personal characteristics like demographics and cognitive status. Third, a subset of centenarians and near-centenarians with consistent data across three time points spanning 12 years demonstrated

significant longitudinal findings: a) life satisfaction significantly increased over time, and b) purpose in life significantly decreased over time. Exploring the processes and mechanisms related to exceptional longevity and psychological wellness may allow for continued improvement in the quality of later life. Ultimately, increasing our understanding of these relationships is vital to support positive aging. As the number of future centenarians continues to climb, focus must shift from improving the "life span" to expanding the emotional and physical "health span."

## Author Contributions

Rotem Arieli: Conceptualization, Methodology, Software, Formal Analysis, Data Curation, Writing – Original Draft, Writing – Review & Editing, Visualization. Gina Lee: Data Curation, Writing – Review & Editing. Yeon Ji Ryou: Data Curation; Writing – Review & Editing. Peter Martin: Conceptualization, Methodology, Validation, Data Curation, Writing – Review & Editing, Supervision.

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## Competing Interests

The authors have declared that no competing interests exist.

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