

Research Article

Optimism and Longevity Beyond Age 85

Jeremy M. Jacobs, MBBS,^{1,2,*} Yoram Maaravi, MD,^{1,2} and Jochanan Stessman, MD^{1,2}

¹The Jerusalem Institute of Aging Research, Faculty of Medicine, Hebrew University of Jerusalem, Israel. ²Department of Geriatric Rehabilitation and the Center for Palliative Care, Hadassah Medical Center, Jerusalem, Israel.

*Address correspondence to: Jeremy M. Jacobs, MBBS, Department of Geriatric Rehabilitation and the Center for Palliative Care, Hadassah Medical Center, P.O. Box 24035, Mt Scopus, Jerusalem 91240, Israel. E-mail: jacobsj@hadassah.org.il

Received: October 30, 2020; Editorial Decision Date: February 11, 2021

Decision Editor: Anne B. Newman, MD, MPH, FGSA

Abstract

Background: Optimism is associated with health benefits and improved survival among adults older than 65 years. Whether or not optimism beyond age 85 continues to confer survival benefits is poorly documented. We examine the hypothesis that being optimistic at ages 85 and 90 is associated with improved survival.

Method: The Jerusalem Longitudinal Study (1990–2020) assessed comorbidity, depression, cognition, social and functional status, and 5-year mortality among a representative community sample, born during 1920–1921, at age 85 ($n = 1096$) and age 90 ($n = 533$). Overall optimism (Op-Total) was measured using a validated 7-item score from the Scale of Subjective Wellbeing for Older Persons. The 4 questions concerning positive future expectations (Op-Future) and 3 questions concerning positive experiences (Op-Happy) were also analyzed separately. We determined unadjusted mortality hazards ratios and also adjusted for gender, financial difficulty, marital status, educational status, activities of daily living dependence, physical activity, diabetes mellitus, hypertension, ischemic heart disease, cognitive impairment, and depression.

Results: Between ages 85–90 and 90–95 years, 33.2% (364/1096) and 44.3% (236/533) people died, respectively. All mean optimism scores declined from age 85 to 90, with males significantly more optimistic than females throughout. All measures of optimism (Op-Total, Op-Future, and Op-Happy) at ages 85 and 90 were significantly associated with improved 5-year survival from age 85 to 90 and 90 to 95, respectively, in both unadjusted and adjusted models. Findings remained unchanged after separately excluding depressed subjects, cognitively impaired subjects, and subjects dying within 6 months from baseline.

Conclusions: These findings support the hypothesis that being optimistic continues to confer a survival benefit irrespective of advancing age.

Keywords: Life orientation, Life skills, Positive expectations, Psychological well-being, Resilience

Positive psychological factors play a central role throughout the entire life span in healthy development, resilience, and ageing, with benefits observed across numerous domains of health, function, and longevity (1–4). Understanding the role that positive psychological elements play within the context of aging is an important challenge, the ramifications of which include the potential to improve health and well-being among older people. Recent research has often focused on psychosocial assets and life skills, such as emotional stability, conscientiousness, hope, self-efficacy, and social skills; eudaemonic factors, including the perception of meaning and purpose in life; and hedonic indicators such as experiences of enjoyment, happiness, and well-being (2,5–8). Among this broad range of potentially beneficial factors, optimism is among the most consistent to show numerous associations with positive health outcomes (9–11).

While optimism has been conceptualized in various ways, a widely accepted approach is that suggested by Scheier et al. (12,13). Viewed primarily as a dispositional trait, optimism is defined as a highly generalized expectancy that good things rather than bad things will happen. This generalized positive expectancy pertains more or less to the individual's entire life space and is expected to occur without particular regard to the person's actions.

Research has shown consistent health benefits associated with optimism and positive orientation to life among young and middle-aged populations, as well as the positive effect of optimism measured in the distant past on subsequent survival. Thus, for example, the Nun's Study described how optimism among young females in their early 20s was observed to predict longevity over the next half a century (14). Similarly, optimism measured during

midlife subjects from the Veterans Affairs Normative Aging Study (15) was found to influence subsequent survival beyond the age of 85. Rather than focusing on the effects of remote optimism measured in the past, more recent studies have investigated the effects of current optimism measured during older age itself, assessed among people older than 65 years. While the beneficial influence of optimism measured among adults aged between 70 and 80 has been observed in some studies (16,17), contradictory results also exist (7), and beyond the age of 85 years, literature is particularly sparse. Similarly, current measures of positive affect, enjoyment, and life skills among older people have also been assessed. Thus, for example, recent research from the English Longitudinal Study of Aging described the association between sustained enjoyment of life measured among older adults and reduced 4-year mortality; however, only 136 of the total 2264 study subjects were older than 80 years (5).

Research concerning optimism among people older than 80 years is further complicated by the rising frequency of depression among this population, and while the absence of depression is clearly not synonymous with positive attributes, nonetheless the presence of depression is a confounding factor that must be addressed when considering positive indicators such as optimism, happiness, and purpose to life (18).

Current consensus concerning optimism confirms its positive effect among younger and middle-aged people on lifestyle, behaviors, health, and longevity. While the positive effects upon survival of optimism at a young age upon subsequent older age are generally accepted, far less certainty exists concerning the influence of optimism among older people in general, and exceptionally old people in particular. Increasing age is often associated with a rising frequency of depression and a growing burden of comorbidity. Both these important aspects of aging are likely to play important confounding roles in understanding the relationship of optimism to health and longevity.

Thus, while survival benefits have been consistently associated with optimism measured in the past as well as current optimism among adults older than 65 years, it remains largely unknown if optimism among people older than 85 years continues to predict improved survival. In order to examine this issue, we performed a prospective study to examine the 5-year mortality associated with current levels of optimism measured at ages 85 and 90 among a representative study of community-dwelling people. Specifically, we aimed to test the hypothesis that optimism continues to predict survival despite increasing age, irrespective of rising comorbidity and independent of depression.

Method

Study Population

The present study examines data concerning optimism among subjects aged 85 and 90, who were enrolled at 2005 and 2010, respectively, as part of the Jerusalem Longitudinal Study (1990–2020), a prospective observational longitudinal study previously described (19,20). The sample frame is the birth cohort born June 1, 1920 through May 31, 1921, resident in Western Jerusalem all of whom were eligible for inclusion. There were no exclusion criteria. Subjects were randomly chosen from the national electoral register and, at the outset of the study in 1990, were aged 70, with repeated follow-up at ages 78, 85, 90, and 95 years in the years 1998, 2005, 2010, and 2015, respectively. In order to

maintain study sample size and to counteract the effects of mortality, the study sample was augmented at each subsequent phase with new subjects randomly recruited from the same birth cohort. No significant differences existed for either comorbidity or subsequent mortality rates among subjects enrolled at later stages. The study sample has been proven to be representative, as shown by similar morbidity, mortality, and hospitalization rates when comparing between study subjects, those who declined to enroll in the study, and those subjects from the birth cohort not approached (21,22). The study subjects underwent comprehensive assessment at each study phase: at age 85 or age 90, or at both age 85 and 90 for those subjects seen twice. Assessment included optimism and comorbidity, which were updated at each study assessment.

The total number of subjects enrolled in the Jerusalem Longitudinal Study at ages 85 and 90 was 1198 and 674, among whom optimism data were available for 1096/1198 (91.5%) and 533/674 (79.5%) subjects, respectively, and missing for 102/1198 (8.5%) and 141/674 (20.9%) subjects, respectively. Subjects with missing optimism data were excluded from the current study. Among the 1096 subjects whose assessment included measurement of optimism at age 85, 364 (33.2%) had died by age 90, and from the 732 remaining 90-year olds, a total of 396 (54.1%) agreed to participate in the study again at age 90 and completed a new optimism assessment. An additional 137 “new” subjects aged 90 from the same birth cohort were also enrolled and assessed for optimism. Thus, among the total of 533 subjects assessed for optimism at age 90, 74.3% (396) had also been previously assessed for optimism at age 85, and 25.7% (137) were new subjects without prior data. Participant, or legal guardians, provided informed consent. Proxy informants, with consent from legal guardians, were used in the case of extremely frail subjects unable to provide detailed factual information. Subjects received a summary of the personal data collected, with recommendations for their family physician if necessary. The Hadassah-Hebrew University Medical Center Institutional Review Board approved the study.

Measurements

Home assessment by study personnel, with structured interview, lasted 1.5 hours. Data collected included gender; marital status; education (years); financial status (self-reported difficulty getting through the month); body mass index (calculated as kg/height²); physical activity level (low activity being <4 h/wk vs active being ≥4 h/wk, or vigorous sports ≥2/wk) (23); loneliness (global subjective assessment as used in the Longitudinal Gothenburg population study of 70-year olds) (24); depression using the Short Geriatric Depression Scale, with a score of ≥2/5 considered positive screening for depression (25); self-rated health (good vs poor); 2 measures of functional status based on self-report, the first defined as dependence/independence on another person in performing ≥1 of 6 activities of daily living (ADLs; transferring, dressing, bathing, using the toilet, eating, and remaining continent), and the second measure defined as ease/difficulty in ≥1 of 6 ADLs (26); history of major diseases defined according to the *International Classification of Disease*, ninth edition (27) including ischemic heart disease; hypertension defined as treatment with antihypertensive medication, and/or sitting BP > 140 mm Hg systolic or >90 mm Hg diastolic; diabetes mellitus; chronic pain (defined as either joint or musculoskeletal pain of at least 3-month duration); and Mini-Mental State Examination (MMSE) score (28).

Optimism

Optimism, the independent study variable, was measured using the 7-item optimism subscale, taken from the previously validated Scale of Subjective Wellbeing for Older Persons (SSWO), developed by the University of Groningen, the Netherlands (16). Previously used to determine dispositional optimism by Giltay et al., the 7-item optimism subscale was identified through factor analysis of the 30-item SSWO, with a Cronbach $\alpha = .76$. The test-retest reliability coefficient was .76 (16). Responses for each of the 7 questions were rated as 0 (very rarely), 1 (occasionally), or 2 (often), with a maximum score of 14 and minimum of 0. The questions were as follows: (i) "I often feel that life is full of promises"; (ii) "I still have positive expectations concerning my future"; (iii) "There are many moments of happiness in my life"; (iv) "I do not make any more future plans" (opposite direction for score); (v) "Happy laughter often happens"; (vi) "I still have many goals to strive for"; and (vii) "Most of the time I am in good spirits." In addition to the total Optimism (Op-Total) score, we also grouped the questions into 2 subsets, one reflecting positive attitudes, goals, and expectations concerning the future (Op-Future) (questions i, ii, iv, and vi; total score 0–8) and the other subset reflecting positive ongoing experiences of happiness, laughter, and mood (Op-Happy) (questions iii, v, and vii; total score 0–6). Mortality analysis from age 85–90 and 90–95 was based according to the optimism score at ages 85 and 90, respectively. Assessment of optimism was by direct questioning of the study subjects themselves during the home visit by the research assistance. Proxy respondents were not included for assessment of study subject's optimism.

Outcomes

Death was the primary outcome throughout the study period from 2005 to 2015. Mortality data were obtained from review of all obligatory notifications of death issued by the Ministry of Interior. This provided 100% surveillance of mortality data for subjects in Israel.

Statistical Analysis

Descriptive statistics were performed using *t* test for continuous variables among the study population at both ages 85 and 90. Optimism was examined as a continuous variable. Means with *SD* and median optimism scores were determined. A multivariate linear regression was performed to assess the cross-sectional association between the optimism score and other demographic, social, and functional variables. The multivariate model included all variables with $p < .2$ from preliminary explanatory models. Mortality during follow-up periods from ages 85–90 and 90–95 years was examined as a function of optimism assessed at ages 85 and 90, respectively, using Cox proportional hazard models to determine unadjusted and adjusted mortality hazard ratios (HRs) after controlling for gender, financial status, marital status, educational status, functional status, physical activity, diabetes mellitus, hypertension, ischemic heart disease, cognitive impairment, and depression. Unadjusted and adjusted HRs were determined separately for the Op-Total, Op-Happy, and Op-Future scores. We also determined gender-adjusted tertiles for optimism and examined the association with mortality in Kaplan–Meier survival curves. As a sensitivity analysis, we repeated the multivariate model for mortality including only participants with a MMSE of >18 . Since "terminal decline" in the period of time preceding death may be reflected in deteriorating function across numerous domains, and to address possible reverse causality, analyses were also repeated after omitting subjects dying within the 6 months of follow-up. Furthermore, after excluding all subjects who screened

positive for depression, all analyses were repeated among the remaining sample of subjects free from depression. In order to examine the possible difference between study subjects enrolled once at age 90, compared to those enrolled twice at both age 85 and 90, we repeated the Cox proportional hazard models comparing HRs for mortality from age 90–95 associated with optimism at age 90, comparing the 396 subjects (assessed at ages 85 and 90) to the 137 new subjects (assessed only at age 90). The overall trend of the association between optimism and mortality was similar between the 2 groups; however, results were not significant among the 137 "new" subjects, due to lack of sample size. All *p*-values were 2-tailed and $p < .05$ was considered significant. The sample size was sufficient to achieve a power of 80% with an alpha coefficient of .05. Data storage and analysis were performed using SAS version 9.1e (SAS Institute, Inc., Cary, NC).

Results

Full data concerning optimism among the total sample were available for 1096 and 533 subjects at ages 85 and 90, respectively. At ages 85 and 90, 29.6% (324/1096) and 54.8% (292/533) of subjects, respectively, were identified as depressed, and after excluding these depressed subjects from the sample, there remained 772 and 241 subjects free from depression at ages 85 and 90, respectively. Among the total sample between ages 85–90 and 90–95, a total of 33.2% (364/1096) and 44.3% (236/533) died, compared to 27.5% (212/772) and 34.9% (84/241), respectively, among subjects free from depression. Baseline characteristics are shown in Table 1 for the total sample as well as the subjects free from depression at ages 85 and 90, with similar characteristics observed between both groups. With increasing age, subjects were more frequently single, less physically active, dependent in ADL, yet less likely to report self-reported financial difficulty. Loneliness and self-rated health remained stable despite increasing age, as did the prevalence of hypertension, ischemic heart disease, diabetes, chronic pain, and cognitive impairment. The mean optimism scores for the total study sample and for nondepressed subjects alone are presented in Figure 1, and individual means for Op-Total, Op-Future, and Op-Happy according to gender among the total sample and separately for nondepressed subjects are presented separately in Supplementary Table S1. All measures of optimism declined between ages 85 and 90, with a largest decrease observed for Op-Future. While similar trends were observed for males and females, nonetheless male scores were significantly higher than females at all points of measurements. A similar pattern of results was observed among nondepressed subjects, among whom optimism scores were consistently higher than among the total sample. As shown in the Table 2, significant differences were observed in total optimism score according to gender, widow, married status, educational level, and monetary problems at both ages 85 and 90. Multivariate models examined the cross-sectional association between the increasing Op-Total score and numerous baseline characteristics among the total sample. Higher optimism was significantly associated both at ages 85 and 90 with male gender, being married, lower levels of loneliness, improved self-rated health, lower depression, less dependency in ADL (at age 85 only), and better cognitive status (at age 90 only) (Supplementary Table S2).

Subjects with lowest tertiles of optimism (adjusted for gender) at both age 85 and again at age 90 had significantly higher mortality from age 85–90 (log rank $p < .0001$) and 90–95 (log rank $p < .0001$), respectively, as shown in Kaplan–Meier survival curves

Table 1. Baseline Characteristics at Ages 85 and 90 of the Total Study Population and Nondepressed Subjects

	Total Sample		Nondepressed	
	Age 85	Age 90	Age 85	Age 90
N	1096	533	767	231
Gender				
Female	54.2% (594)	56.7% (302)	49.8% (382)	50.6% (117)
Marital status				
Not married	56.5% (617)	70.4% (373)	50.6% (387)	64.3% (148)
Married	43.5% (476)	29.6% (157)	49.4% (378)	35.7% (82)
Years of education				
<12	54.8% (601)	52.7% (281)	49.3% (378)	42.9% (99)
Monetary problems				
Yes	17.6% (193)	13% (69)	12.3% (94)	4.3% (10)
BMI (kg/m ²)				
<25	32.2% (335)	48.5% (176)	33.1% (244)	51.5% (101)
25–30	43.4% (451)	38.3% (139)	44.4% (328)	35.2% (69)
>30	24.4% (253)	13.2% (48)	22.5% (166)	13.3% (26)
Physically active				
Yes	67.1% (729)	18.4% (97)	76% (577)	29.3% (67)
Feels alone				
Yes	38% (415)	39.9% (210)	25% (191)	19.8% (45)
Depressed				
Yes	29.7% (324)	55.8% (292)		
Self-rated health				
Poor	35.2% (383)	41.2% (215)	22% (167)	20.4% (46)
Good	64.8% (704)	58.8% (307)	78% (593)	79.6% (179)
ADL difficulty				
Yes	85.6% (925)	74% (239)	83.4% (635)	56.7% (80)
ADL dependency				
Yes	35.3% (382)	48.6% (157)	25.1% (191)	26.2% (37)
Hypertension				
Yes	72.8% (798)	72.4% (381)	70.8% (543)	65% (147)
Diabetes				
Yes	20.9% (229)	19.4% (102)	18.3% (140)	14.6% (33)
Mini-Mental State Examination				
0–18	10.1% (111)	9.9% (53)	6.5% (50)	3.5% (8)
19–24	13.3% (146)	13.7% (73)	9.6% (74)	8.2% (19)
>24	76.6% (839)	67% (357)	83.8% (643)	84.4% (195)
Missing		9.4% (50)		3.9% (9)
Chronic pain				
Yes	56.7% (621)	23.3% (124)	50.4% (391)	23.4% (59)
Heart disease				
Yes	38% (416)	28.5% (150)	34.8% (270)	23% (53)

Note: ADL = activities of daily living; BMI = body mass index.

(Figure 2). We also examined mortality from 90 to 95 among the 396 subjects for whom optimism was measured at both age 85 and again at 90. A total of 184/396 subjects died between 90 and 95, and the HR for mortality from 90 and 95 associated with optimism level at 85 was 0.935 (95% CI: 0.9–0.97), $p < .001$, compared to 0.887 (95% CI: 0.85–0.93), $p < .001$ associated with optimism at age 90. Among these 396 subjects, we also compared survival curves from age 90 to 95 for subjects whose optimism level had remained the same or increased (74/396, 18.6%), versus those with a small decline of 0–5 points (197/396, 49.7%), versus those with a large decline of >5 points (125/396, 31.6%). No differences were observed between the groups (log rank $p = .36$).

Cox proportional hazard analyses determined HRs for mortality associated with a unit change in optimism over a follow-up period from 85 to 90 and 90 to 95 among the total sample, firstly unadjusted and subsequently adjusted for gender, financial

difficulty, marital status, educational status, ADL dependence, physical activity status, diabetes mellitus, hypertension, ischemic heart disease, cognitive impairment, and depression. The results of separate models which separately examined Op-Total, Op-Happy, and Op-Future at ages 85 and 90 are presented in Figure 3, which shows a forest plot of the HRs. Higher scores in all 3 measures of optimism was significantly associated with reduced likelihood of mortality at ages 85 and 90, in both unadjusted and adjusted models. No meaningful changes to the results were observed after excluding subjects with MMSE $\leq 18/30$ from the multivariate analysis for mortality. Similarly, in order to address possible reverse causality, subjects dying within the first 6 months of follow-up were removed from the analyses, again with no meaningful differences in the findings. The multivariate analysis was repeated for males and females separately. The magnitude of the association between optimism and mortality was similar between the

overall population and these subpopulations, although this effect was statistically significant among only male participants, probably due to a small number of events.

We performed the same multivariate analysis for mortality among the sample of nondepressed subjects. The direction, magnitude, and significance of the HRs associated with Op-Total, Op-Happy, and Op-Future was largely unchanged, as shown in the forest plot of HRs in [Supplementary Figure S1](#). Full detailed results of the Cox proportional hazards models among the total sample and among nondepressed subjects are shown in [Supplementary Tables S3 and S4](#), respectively.

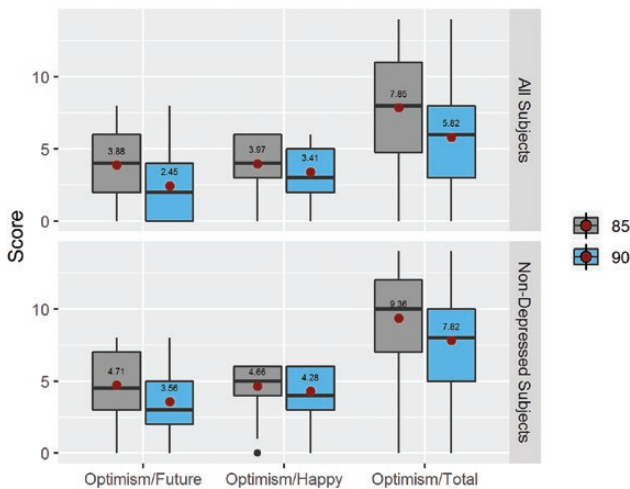


Figure 1. Optimism score among the total sample and among nondepressed subjects.

Note: Mean score is written and also marked by the red dot; median score is displayed as the central line in each box; upper and lower interquartile range is shown as the upper and lower lines of each box.

Discussion

The primary finding to emerge from this study was the significant association between optimism and survival, irrespective of advancing age. Higher levels of optimism measured at both ages 85 and 90 remained a significant predictor of reduced subsequent 5-year mortality, after adjusting not only for common mortality risk factors, but also for depression. The finding was robust, being observed after separately excluding subjects with depression, cognitive impairment, or early mortality within the first 6 months of follow-up. Not only the overall measure of optimism, but also the optimism subscales concerning experienced happiness and future orientation were both independent predictors of mortality, both at ages 85 and 90, and among both men and women alike.

The results of this study add to the existing body of literature concerning the positive effects of optimism on survival among young and middle-aged people. Not only are our findings in keeping with similar effects observed among people up to age 80, but they also provide new evidence to support the hypothesis that the positive effect of optimism is independent of age. Indeed, our study supports the novel finding that the positive influence of being optimistic extends beyond 90 years of age.

The measure of optimism used in our study was used by Giltay et al. (16), who examined a sample of people with a mean age 75 followed over 9 years in the Arnhem Elderly Study in the Netherlands. Optimism was independently associated with survival after adjusting for cardiovascular risk factors; however, depression was neither reported nor adjusted for in the study. It was observed that questions concerning future plans and goals had greatest significant discrimination among men, compared to the question concerning moments of happiness among women. Using a 4-item optimism scale, exclusively focused on positive orientation concerning future expectancies, Giltay et al. also described the protective effect on survival and cardiovascular risk during 15-year follow-up, after adjusting for depression among men (mean age 71) in the Zutphen Elderly Study (17). Depression was also adjusted for in a recent study which merged data from the Nurses' Health Study (2004–2014) and the

Table 2. Mean Optimism Score According to Baseline Characteristics

Variable	Age 85			Age 90		
	N	Mean Optimism (SD)	p-Value	N	Mean Optimism (SD)	p-Value
Total sample	1096	7.85 (4.26)		533	5.80 (3.65)	
Gender						
Male	502	8.44 (4.14)	<.001	231	6.28 (3.68)	.01
Female	594	7.35 (4.29)		302	5.46 (3.59)	
Widow						
Yes	561	7.14 (4.25)	<.001	339	5.43 (3.59)	.002
No	532	8.6 (4.13)		192	6.45 (3.63)	
Married						
Yes	476	8.81 (4.03)	<.001	157	6.76 (3.55)	<.001
No	617	7.12 (4.28)		373	5.39 (3.61)	
Education						
≤12 y	601	7.15 (4.28)	<.001	281	4.93 (3.38)	<.001
>12 y	495	8.71 (4.07)		252	6.8 (3.68)	
Financial difficulty						
Yes	193	6.06 (4.13)	<.001	69	3.59 (3.19)	<.001
No	902	8.24 (4.14)		460	6.17 (3.6)	
Ever smoked						
Yes	432	8.07 (4.09)	.215	113	6.34 (3.1)	.648
No	643	7.75 (4.34)		251	6.51 (3.59)	

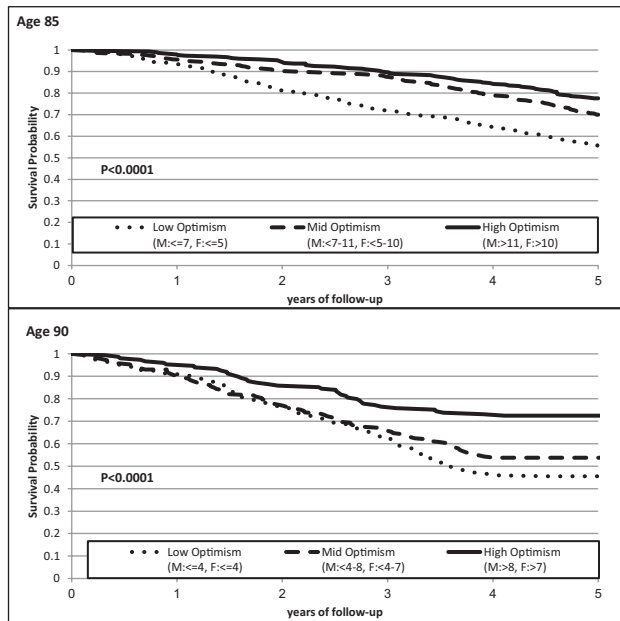


Figure 2. Kaplan–Meier survival curves from age 85–90 and 90–95 according to optimism tertiles at ages 85 and 90, respectively.

Note: M = male; F = females. The age-adjusted optimism scores for the low, mid, and high optimism tertile are shown for males and females within the legend.

Mortality model for All Subjects						
Variable	Age	Model	n/N	HR	CI 95%	P-val
Opt/Total	85	Unadjusted	364/1095	0.926	(0.9 - 0.95)	<0.001
		Adjusted	352/1055	0.955	(0.93 - 0.98)	0.003
	90	Unadjusted	236/533	0.915	(0.88 - 0.95)	<0.001
		Adjusted	91/227	0.91	(0.84 - 0.98)	0.013
Opt/Happy	85	Unadjusted	364/1095	0.87	(0.83 - 0.91)	<0.001
		Adjusted	352/1055	0.936	(0.88 - 0.99)	0.032
	90	Unadjusted	236/533	0.86	(0.8 - 0.92)	<0.001
		Adjusted	91/230	0.821	(0.71 - 0.95)	0.01
Opt/Future	85	Unadjusted	364/1095	0.895	(0.86 - 0.93)	<0.001
		Adjusted	352/1056	0.937	(0.9 - 0.98)	0.005
	90	Unadjusted	236/533	0.868	(0.82 - 0.92)	<0.001
		Adjusted	91/230	0.897	(0.8 - 1)	0.049

Figure 3. Mortality hazard ratios associated with increased optimism score over a follow-up period from 85 to 90 and 90 to 95, among the total study sample.

Note: Hazards ratios were adjusted for gender, financial status, marital status, educational status, functional status, physical activity, diabetes mellitus, hypertension, ischemic heart disease, cognitive impairment, and depression.

Veterans Affairs Normative Aging Study (1986–2016), and confirmed the association of remote optimism at a much younger age with exceptional longevity, which they defined as survival beyond age 85 (15). In contrast, the Rotterdam Study found that the protective effect of positive affect on survival observed among subjects aged over 60 years was no longer significant beyond age 80, leading the authors to suggest that the potential benefits of positive affect were neutralized by the increasing comorbid burden that inevitably accompanies increasing age (7). In contrast to these studies, our findings are based on current measures of both optimism and depression at ages 85 and 90, and replicate the findings among subjects free from depression (18).

Understanding the mechanism by which optimism influences health and survival is beyond the scope of this study. Nonetheless, it stands to reason that the health-promoting behaviors associated with optimism, which have been repeatedly observed among younger populations, may also take effect irrespective of increasing age (9–11,29,30). Recent research to emerge from the oncology literature provide evidence to support the psychoneuroimmunological basis for hopefulness and suggest its mediating role in improving oncological outcomes. Accordingly, it has been suggested that hope can be a therapeutic target, and interventions to increase patients' level of hopefulness are currently being assessed (31). The widely accepted definition by Snyder et al. (32) of hope conceptualizes hope as a goal-oriented cognitive construct, involving pathway thinking (ways to achieve ones goals), in conjunction with agency thinking (concerning one's ability and motivation to move along the pathways). In contrast optimism, by definition, is a dispositional state whereby ones generalized expectation are positive, both concerning the future and present, and generally unrelated to any action on behalf of the individual. While clearly a different theoretical concept, it is nonetheless likely that the 7-item measure of optimism used in this study may also have been influenced by the subject's degree of hope, particularly in the future-oriented subset of questions. Additionally, it is likely that optimism and hope coexist and are perhaps associated one with the other. Whether interventions aimed at promoting hope might also influence optimism is unknown.

It might be suggested that the health and survival benefits associated with current levels of optimism at age 85 or 90 in actual fact reflect an accumulation of the many years of a long life lived as an optimist. Although we lack data from the distant past to either confirm or disprove this proposition, nonetheless it remains a fact that current optimism at age 85 and over indeed predicts survival and, as such, may serve perhaps as a proxy measure for past optimism. Current notions concerning “terminal decline” in the period of time preceding death indicate that numerous domains of physical, cognitive, affective, and functional performance may begin to deteriorate at differing rates and trajectories (33,34). Our findings were unchanged after removing subjects whose optimism score was assessed within 6 months of death, thus suggesting that optimism in our population was largely uninfluenced by the possibility of a decline due to the proximity to death.

Among the strengths of our study is the fact that all data were collected face to face during home visits, which in all likelihood increased the accuracy and quality of the data collection. Furthermore, the number of homebound people among the study sample population at ages 85 and 90 years rises from 18% to 40%, respectively (35), and home visits ensured the inclusion of homebound people who would otherwise be excluded from research of this nature. A limitation which deserves mention is the need for caution when applying our findings to other populations from other countries and cultures. However, our sample has previously been found to share very similar characteristics at age 85 with similar cohorts (36,37), and the study sample itself has been found to be representative of the local population itself. Another limitation worthy of note was the lack of information among the study subjects concerning earlier-life processes (such as employment trajectories and accumulation of wealth), which could affect both the level of optimism in later life and longevity. Their influence on our findings was not directly accounted for among the subjects of this study.

In conclusion, we found that optimism at ages 85 and 90 is associated with improved 5-year survival, irrespective of rising comorbidity and independent of depression. It yet remains to be discovered whether or not therapeutic interventions aimed at improving levels of optimism among older people may influence resilience and health.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Table S1. Optimism score by gender among the total sample, and among nondepressed subjects.

Table S2. Cross-sectional multivariate models for the association between the optimism score and other demographic, social, and functional variables among the total study sample.

Tables S3. Cox proportional hazards models: all study subjects.

Tables S4. Cox proportional hazards models: nondepressed subjects.

Figure S1. Mortality hazard ratios associated with increased optimism score over a follow-up period from 85 to 90 and 90 to 95, among nondepressed subjects.

Funding

This work was supported by funds from the Ministry of Senior Citizens, the Ministry of Labor and Social Affairs of the State of Israel, the Bituach Leumi National Insurance Institute of Israel, and Eshel-the Association for the Planning and Development of Services for the Aged in Israel. The sponsors had no role in the study design, data analysis, preparation, or approval of the manuscript.

Conflict of Interest

None declared.

Acknowledgments

We acknowledge Ms. Aliza Rozenberg (MA) and Mr. Hananel Giat (BA) for their statistical consultation.

Author Contributions

J. Stessman and J. M. Jacobs had full access to all study data and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: J. Stessman, J. M. Jacobs, and Y. Maaravi; acquisition of data: J. Stessman, J. M. Jacobs, and Y. Maaravi; analysis and interpretation of data: J. M. Jacobs and J. Stessman; drafting of the first manuscript and critical revision of the manuscript for important intellectual content: J. M. Jacobs, J. Stessman, and Y. Maaravi; statistical analyses: J. Stessman; and administrative, technical, or material support: J. Stessman.

References

1. Woods NF, Rillamas-Sun E, Cochrane BB, et al. Aging well: observations from the Women's Health Initiative Study. *J Gerontol A Biol Sci Med Sci*. 2016;71(suppl. 1):S3–S12. doi:10.1093/gerona/glv054
2. Steptoe A, Wardle J. Life skills, wealth, health, and wellbeing in later life. *Proc Natl Acad Sci USA*. 2017;114(17):4354–4359. doi:10.1073/pnas.1616011114
3. Cosco TD, Howse K, Brayne C. Healthy ageing, resilience and wellbeing. *Epidemiol Psychiatr Sci*. 2017;26(6):579–583. doi:10.1017/S2045796017000324
4. Kubzansky LD, Boehm JK, Segerstrom SC. Positive psychological functioning and the biology of health: positive psychology and biology. *Soc Pers Psychol Compass*. 2015;9(12):645–660. doi:10.1111/spc3.12224
5. Zaninotto P, Wardle J, Steptoe A. Sustained enjoyment of life and mortality at older ages: analysis of the English Longitudinal Study of Ageing. *Br Med J*. 2016;355:i6267. doi:10.1136/bmj.i6267
6. Steptoe A, de Oliveira C, Demakakos P, Zaninotto P. Enjoyment of life and declining physical function at older ages: a longitudinal cohort study. *Can Med Assoc J*. 2014;186(4):E150–E156. doi:10.1503/cmaj.131155
7. Krijthe BP, Walter S, Newson RS, Hofman A, Hunink MG, Tiemeier H. Is positive affect associated with survival? A population-based study of elderly persons. *Am J Epidemiol*. 2011;173(11):1298–1307. doi:10.1093/aje/kwr012
8. Tilvis RS, Laitala V, Routasalo P, Strandberg TE, Pitkala KH. Positive life orientation predicts good survival prognosis in old age. *Arch Gerontol Geriatr*. 2012;55(1):133–137. doi:10.1016/j.archger.2011.06.030
9. Rasmussen HN, Scheier MF, Greenhouse JB. Optimism and physical health: a meta-analytic review. *Ann Behav Med*. 2009;37(3):239–256. doi:10.1007/s12160-009-9111-x
10. Avvenuti G, Baiardini I, Giardini A. Optimism's explicative role for chronic diseases. *Front Psychol*. 2016;7:295. doi:10.3389/fpsyg.2016.00295
11. Boehm JK, Chen Y, Koga H, Mathur MB, Vie LL, Kubzansky LD. Is optimism associated with healthier cardiovascular-related behavior? Meta-analyses of 3 health behaviors. *Circ Res*. 2018;122(8):1119–1134. doi:10.1161/CIRCRESAHA.117.310828
12. Chang EC, ed. *Optimism and Pessimism: Implications for Theory, Research and Practice*. American Psychological Association; 2000. doi:10.1037/10385-000
13. Scheier MF, Carver CS. Dispositional optimism and physical health: a long look back, a quick look forward. *Am Psychol*. 2018;73(9):1082–1094. doi:10.1037/amp0000384
14. Danner DD, Snowdon DA, Friesen WV. Positive emotions in early life and longevity: findings from the nun study. *J Pers Soc Psychol*. 2001;80(5):804–813. doi:10.1037/0022-3514.80.5.804
15. Lee LO, James P, Zevon ES, et al. Optimism is associated with exceptional longevity in 2 epidemiologic cohorts of men and women. *Proc Natl Acad Sci USA*. 2019;116(37):18357–18362. doi:10.1073/pnas.1900712116
16. Giltay EJ, Geleijnse JM, Zitman FG, Hoekstra T, Schouten EG. Dispositional optimism and all-cause and cardiovascular mortality in a prospective cohort of elderly Dutch men and women. *Arch Gen Psychiatry*. 2004;61(11):1126–1135. doi:10.1001/archpsyc.61.11.1126
17. Giltay EJ, Kamphuis MH, Kalmijn S, Zitman FG, Kromhout D. Dispositional optimism and the risk of cardiovascular death: the Zutphen Elderly Study. *Arch Intern Med*. 2006;166(4):431–436. doi:10.1001/archinte.166.4.431
18. Martín-María N, Caballero FF, Olaya B, et al. Positive affect is inversely associated with mortality in individuals without depression. *Front Psychol*. 2016;7:1040. doi:10.3389/fpsyg.2016.01040
19. Stessman J, Cohen A, Ginsberg GM, et al. The Jerusalem seventy-year-old longitudinal study. I: description of the initial cross-sectional survey. *Eur J Epidemiol*. 1995;11:675–684. doi:10.1007/BF01720302
20. Jacobs JM, Cohen A, Bursztyn M, Azoulay D, Ein-Mor E, Stessman J. Cohort profile: the Jerusalem longitudinal cohort study. *Int J Epidemiol*. 2009;38:1464–1469. doi:10.1093/ije/dyn252
21. Cohen A, Stessman J, Ginsberg GM, et al. The Jerusalem seventy year olds longitudinal study. II: background results from the initial home interview. *Eur J Epidemiol*. 1995;11(6):685–692. doi:10.1007/BF01720303
22. Jacobs JM, Maaravi Y, Cohen A, Bursztyn M, Ein-Mor E, Stessman J. Changing profile of health and function from age 70 to 85 years. *Gerontology*. 2012;58(4):313–321. doi:10.1159/000335238
23. Stessman J, Hammerman-Rozenberg R, Cohen A, Ein-Mor E, Jacobs JM. Physical activity, function, and longevity among the very old. *Arch Intern Med*. 2009;169:1476–1483. doi:10.1001/archinternmed.2009.248
24. Stessman J, Rottenberg Y, Shimshilashvili I, Ein-Mor E, Jacobs JM. Loneliness, health, and longevity. *J Gerontol A Biol Sci Med Sci*. 2014;69(6):744–750. doi:10.1093/gerona/glt147

25. Hoyl MT, Alessi CA, Harker JO, et al. Development and testing of a five-item version of the Geriatric Depression Scale. *J Am Geriatr Soc*. 1999;47(7):873–878. doi:10.1111/j.1532-5415.1999.tb03848.x
26. Stessman J, Hammerman-Rozenberg R, Maaravi Y, Cohen A. Effect of exercise on ease in performing activities of daily living and instrumental activities of daily living from age 70 to 77: the Jerusalem longitudinal study. *J Am Geriatr Soc*. 2002;50(12):1934–1938. doi:10.1046/j.1532-5415.2002.50603.x
27. World Health Organization. *International Classification of Diseases, Ninth Revision (ICD-9)*. Geneva, Switzerland: World Health Organization; 1977.
28. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189–198. doi:10.1016/0022-3956(75)90026-6
29. Warner LM, Schwarzer R, Schüz B, Wurm S, Tesch-Römer C. Health-specific optimism mediates between objective and perceived physical functioning in older adults. *J Behav Med*. 2012;35(4):400–406. doi:10.1007/s10865-011-9368-y
30. Diener E, Chan MY. Happy people live longer: subjective well-being contributes to health and longevity: health benefits of happiness. *Appl Psychol Health Well Being*. 2011;3(1):1–43. doi:10.1111/j.1758-0854.2010.01045.x
31. Corn BW, Feldman DB, Wexler I. The science of hope. *Lancet Oncol*. 2020;21(9):e452–e459. doi:10.1016/S1470-2045(20)30210-2
32. Snyder CR, Rand KL, Sigmon DR. Hope theory: a member of the positive psychology family. In: Gallagher MW, Lopez SJ, eds. *Hope Theory*. Oxford University Press; 2017. doi:10.1093/oxfordhb/9780199399314.013.3
33. Gerstorf D, Ram N. Inquiry into terminal decline: five objectives for future study. *Gerontologist*. 2013;53(5):727–737. doi:10.1093/geront/gnt046
34. Cohen-Mansfield J, Cohen R, Skornick-Bouchbinder M, Brill S. What is the end of life period? Trajectories and characterization based on primary caregiver reports. *J Gerontol A Biol Sci Med Sci*. 2018;73(5):695–701. doi:10.1093/gerona/glx195
35. Jacobs JM, Hammerman-Rozenberg A, Stessman J. Frequency of leaving the house and mortality from age 70 to 95. *J Am Geriatr Soc*. 2018;66(1):106–112. doi:10.1111/jgs.15148
36. Collerton J, Davies K, Jagger C, et al. Health and diseases in 85 year olds: baseline findings from the Newcastle 85+ Cohort Study. *Br Med J* 2009;399:b4904. doi:10.1136/bmj.h4904
37. Westendorp RG. Leiden Research Program on Ageing. *Exp Gerontol*. 2002;37(5):609–614. doi:10.1016/s0531-5565(02)00007-4