American Journal of Epidemiology

Vol. 173, No. 11
DOI: 10.1093/aje/kwr012
Advance Access publication:
March 31, 2011

Original Contribution

Is Positive Affect Associated With Survival? A Population-based Study of Elderly Persons

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Initially submitted July 6, 2010; accepted for publication January 11, 2011.

Study results on the association of positive affect with survival are conflicting. This disagreement potentially arises from poor control for health or negative affect and for the various age groups studied. The authors examined if positive affect predicts survival; whether this association is preserved after controlling for negative affect, socioeconomic status, lifestyle, and health; and whether this association varies with age. The study is set within the population-based Rotterdam Study (1997–2007) and included 4,411 participants aged 61 years or older, followed for on average 7.19 (standard deviation = 2.20) years. Positive affect was not consistently associated with survival across all ages. A significant interaction of positive affect with age on survival ($P = 0.02$) was found. Subsequent age stratification revealed that positive affect independently predicted survival in elderly persons aged <80 years (per affect score, hazard ratio = 0.96, 95% confidence interval: 0.93, 0.99) but not in those aged ≥80 years in fully adjusted models (hazard ratio = 1.00, 95% confidence interval: 0.96, 1.04). In the oldest old, the association was partly explained by differences in baseline health. In conclusion, the results suggest that there may be an association of positive affect with survival in the younger and middle old but not in the oldest old in whom perception of positive affect is more likely to be determined by health.

affect; aging; health; survival

Abbreviations: CES-D, Center for Epidemiologic Studies Depression; CI, confidence interval; HR, hazard ratio.

"Positive affect" is a mental health state that can be defined as pleasurable engagement with the environment and is characterized by happiness, joy, excitement, enthusiasm, or contentment (1). Positive affect is proposed to predict good health and has been associated with several determinants of survival, such as indicators of immune function. Studies showed that positive affect was related to a lower risk of the common cold (2) and less disability among patients with arthritis (3). In addition, positive affect reduced the risk of cardiovascular events, such as stroke (4, 5) and myocardial infarction (5–7).

The association between positive affect and survival has previously been studied and reviewed (1, 8, 9). The majority of studies found that positive affect was associated with lower mortality rates (10–15). However, some studies failed to find an association between positive affect and survival (16–18). These inconsistencies may arise from the different ways to account for indicators of baseline health status and other potential confounders among these studies. Several of these studies did not control for health status or relied solely on self-reported proxies for health (12). Controlling for health status is imperative for survival studies examining psychological risk factors, as health is a major confounder of the association between psychological risk factor and death. For example, people with poor health consistently have a lower level of positive affect and a higher degree of worry (1). Other potential confounders, which should be taken into account when considering the association between positive affect and survival, are socioeconomic status and lifestyle factors, as these are associated with survival (19, 20) and positive affect (8, 21). The association of positive affect with survival might also be confounded by

negative affect as characterized by, for example, fear, loneliness, and sadness. Negative affect is the key symptom of depression, which in turn is a risk factor for poor health and mortality (22–24).

The availability of validated and objective measures of positive affect and covariates in the Rotterdam Study allowed us to study the association between positive affect and survival while taking into consideration health status, negative affect, socioeconomic status, and lifestyle factors as possible confounders. In addition, we investigated possible age dependence given that the association of positive affect with survival is suggested to depend on the age range studied (1, 16).

MATERIALS AND METHODS

Design and case ascertainment

The current study was set within the Rotterdam Study, a population-based cohort designed to examine the onset of disease in older adults. A more detailed description is provided elsewhere (25). All participants aged 55 years or over in the Ommoord district of Rotterdam, the Netherlands, were invited to participate (1990–1993) (26). All participants engaged in a home interview and a subsequent visit to the research center for clinical assessments. During the third follow-up examination (1997–1999), screening with the Center for Epidemiologic Studies Depression (CES-D) Scale was added to the protocol. As such, this examination was used as the baseline for the current study. In this survey, 4,797 persons participated (79%), of whom 4,411 completed the CES-D Scale.

Positive and negative affect measurement

The CES-D Scale is a widely used, standardized, self-report instrument for measuring current depressive symptoms and the identification of potential cases of depressive disorders. This measure has been validated in multiple populations (27). It consists of 20 items indicating mood and feelings experienced in the past week. Responses are scored on a 4-point scale with descriptive anchor points: 0—"rarely or none of the time (0–1 day)"; 1—"some or a little of the time (1–2 days)"; 2—"occasionally or a moderate amount of the time (3–4 days)"; and 3—"most or all of time (5–7 days)." A previous factor analysis of the CES-D Scale showed that the scale has 4 underlying factors: interpersonal relations, somatic problems, negative affect, and positive affect (27, 28). The positive and negative affect subscales have previously been used in population-based studies of mortality (11, 13). Confirmatory factor analysis confirmed these 4 factors, with a comparative fit index of 0.967 and a root mean square error of approximation of 0.038. The positive affect factor consists of 4 items related to positive affect, and these items are presented in Table 1. For the present analyses, the scores from the individual items were summed and used as a continuous variable, providing a potential score range from 0 to 12. The negative affect subscale consists of 7 items (also presented in Table 1.) and was used as a continuous variable with a score range from 0 to 21. Positive affect and negative affect were significantly correlated ($P = 0.00$); the correlation coefficient between the affect scores was 0.63.

Table 1. CES-D Scale Items for Positive and Negative Affect, the Rotterdam Study, 1997–2007

Positive affect
• I felt that I was just as good as other people.
• I felt hopeful about the future.
• I was happy.
• I enjoyed life.
Negative affect
• I felt that I could not shake off the blues even with the help of my family or friends.
• I felt depressed.
• I thought my life had been a failure.
• I felt fearful.
• I felt lonely.
• I had crying spells.
• I felt sad.

Abbreviation: CDS-D, Center for Epidemiologic Studies Depression.

Mortality assessment

Mortality was assessed through continuous monitoring of the municipal address files and computerized reports from general practitioners provided upon the death of a participant. Mortality follow-up was completed until January 1, 2007. From the group of 4,411 participants, 1,287 mortality events were observed, with a completeness of follow-up of 99.11%. The mean observed number of person-years was 7.19 (standard deviation = 2.20).

Covariate assessment

All covariates were assessed at baseline. Marital status was categorized into single, married, widowed, or divorced. The highest education achieved was recorded and categorized as elementary, lower secondary, higher secondary, or tertiary. Current occupational status was recorded as unemployed or employed. Smoking status was coded in categories as never, former, and current smoker. Alcohol use was coded as never, former, and current alcohol drinker. Height and weight were measured, and body mass index was calculated as weight (kg)/height $(m)^2$ and used as a continuous variable. The current exercise level was coded as nonexerciser and exerciser. Disability status was assessed by calculating the Disability Index Score (29) from the validated Stanford Health Assessment Questionnaire (30) and categorized as no disability (score, 0–0.5), moderate disability (score, 0.6–1), or severe disability (score, >1). Information on prevalent chronic disease at baseline (stroke, myocardial infarction, heart failure, and several types of cancer, i.e., prostate, breast, colon, and lung) was obtained from general practitioners' files. Two research physicians coded events and, in the case of disagreement, a medical

Table 2. Baseline Characteristics of the Study Population and Univariate Cox Regression Predicting Survival ($n = 4{,}411$), the Rotterdam Study, 1997–2007

Variable	Descriptive Statistics			Univariate Model	
	No.	%	Mean (SD)	HR	95% CI
General					
Sex					
Male	1,795	40.7		1.00	Referent
Female	2,616	59.3		0.71	0.63, 0.80
Age, years			72.74 (7.28)	1.11	1.10, 1.12
Affect					
Positive affect[a]			10.3 (2.62)	0.93	0.91, 0.95
Negative affect[a]			2.8 (4.85)	1.05	1.03, 1.07
Socioeconomic					
Employment					
Unemployed	4,216	95.6		1.00	Referent
Employed	195	4.4		0.39	0.26, 0.58
Marital status					
Married	2,819	63.9		1.00	Referent
Single	246	5.6		1.20	0.94, 1.52
Widowed	1,127	25.5		1.82	1.62, 2.05
Divorced	219	5.0		1.00	0.76, 1.32
Education					
Elementary	2,137	48.4		1.00	Referent
Lower secondary	742	16.8		0.80	0.68, 0.94
Higher secondary	1,144	25.9		0.85	0.75, 0.98
Tertiary	388	8.8		0.72	0.57, 0.89
Lifestyle					
Exercise					
Nonexerciser	2,947	66.8		1.00	Referent
Exerciser	1,464	33.2		0.56	0.49, 0.64

Table continues

specialist was consulted. Variables for prevalent diseases were coded as ''0'' when participants never had the disease and as ''1'' when a participant had the disease in the past or has the disease at baseline. Systolic blood pressure of the right brachial artery was measured twice by a trained research assistant with a random-zero sphygmomanometer after the subjects had rested for 5 minutes. For analyses, the mean of the 2 blood pressure measurements was calculated.

Statistical analyses

We used analysis of variance for continuous/dichotomous variables and the chi-square test for categorical variables to describe the associations of positive affect with the covariates. For this, we used positive affect categorically with participants scoring low on positive affect (positive affect score, 0–7), medium (positive affect score, 8–11), or high (positive affect score, 12).

The association between positive affect and survival was evaluated by using Cox proportional hazards models. The proportional hazards assumption was assessed for all predictors by using time-dependent interaction terms. Cancer prevalence violated the proportional hazards assumption and, hence, we used heavy side functions (31) for this variable, such that the survival follow-up time was stratified according to <5 years and ≥ 5 years.

Univariate, age- and sex-adjusted, and fully adjusted analyses were conducted. For the fully adjusted analyses, covariates were clustered into different domains: affect, socioeconomic, lifestyle, and health status at baseline. Stepwise Cox regression analyses were conducted, such that these covariate domains were added sequentially and cumulatively to the age- and sex-adjusted model to determine if positive affect remained associated with survival after controlling for each subsequent domain of variables. To assess a dose-response relation, we used positive affect categorically as described above.

The positive affect $\times$ age interaction on survival was tested by separately adding a multiplicative term of these variables into the fully adjusted model. Because the estimate of the interaction term of positive affect with age on survival departed from a multiplicative effect, we stratified by

Table 2. Continued

Variable	Descriptive Statistics			Univariate Model	
	No.	%	Mean (SD)	HR	95% CI
Smoker					
Never	1,529	34.7		1.00	Referent
Past	2,161	49.0		0.95	0.84, 1.07
Current	721	16.3		1.23	1.05, 1.43
Alcohol use					
Never	503	11.4		1.00	Referent
Past	344	7.8		1.51	1.21, 1.87
Current	3,564	80.8		0.81	0.69, 0.96
Body mass index, kg/m^2			26.82 (3.97)	0.97	0.96, 0.99
Health status					
Disability status					
None	2,937	66.6		1.00	Reference
Moderate	748	17.0		1.90	1.64, 2.19
High	726	16.5		3.76	3.31, 4.26
Prevalent disease					
Myocardial infarction	512	11.6		1.86	1.61, 2.15
Heart failure	261	5.9		3.37	2.86, 3.97
Stroke	196	4.4		2.66	2.19, 3.23
Dementia	172	3.9		2.96	2.42, 3.62
Cancer	244	5.5		1.86	1.53, 2.27
Systolic blood pressure, mm Hg			143.5 (21.30)	1.01	1.00, 1.01

Abbreviations: CES-D, Center for Epidemiologic Studies Depression; CI, confidence interval; HR, hazard ratio; SD, standard deviation.

[a] For positive affect and negative affect, the hazard ratio is expressed per unit change on the CES-D Scale.

10-year age groups to illustrate the effect within age groups. The positive affect × health status interaction was tested by separately adding a multiplicative term of these variables into a fully adjusted model, including health status (dichotomous) instead of the separate variables concerning health status at baseline. Health status was defined as 0 when participants were free of any prevalent disease that is accounted for in the analysis and had no disabilities and as 1 when otherwise. In additional analyses, we also stratified by health status.

RESULTS

Baseline characteristics are presented in Table 2. The median age of the sample was 71.9 years with an age range of 61.2–102.4 years. Compared with those having low positive affect, participants with high positive affect were significantly younger ($P < 0.01$), more likely to be male ($P < 0.01$), higher educated ($P < 0.01$), more likely to be employed ($P = 0.007$), more likely to be married ($P < 0.01$), less likely to smoke ($P < 0.01$), and more likely to drink alcohol ($P < 0.01$). Moreover, persons with high positive affect scores were less likely to be disabled ($P < 0.01$), more likely to exercise ($P < 0.01$), and less likely to have baseline prevalence of stroke ($P < 0.01$) or heart failure ($P < 0.01$). There were no significant differences in body mass index, baseline prevalence of myocardial infarction or cancer, and systolic blood pressure.

Positive affect and survival

In the univariate analyses (Table 2), positive affect was a significant predictor of survival, such that a higher positive affect was associated with a lower risk of mortality (hazard ratio (HR) = 0.93, 95% confidence interval (CI): 0.91, 0.95; $P < 0.001$). The estimated effect of negative affect on survival was only significant when modeled univariately (HR = 1.05, 95% CI: 1.03, 1.07; $P < 0.001$). When positive affect was added to the analysis, the estimated effect of negative affect was no longer significant (HR = 1.01, 95% CI: 0.98, 1.03).

Age- and sex-adjusted and multivariate analyses are presented in Table 3. Adjustment for age and sex had little effect on the association between positive affect and survival (HR = 0.95, 95% CI: 0.93, 0.97; $P < 0.001$). A similar finding was present for the first step of the adjusted model that added socioeconomic variables. When lifestyle

Table 3. Stepwise Cox Regression Models Predicting Survival ($n = 4,411$), the Rotterdam Study, 1997–2007

Covariates	Baseline Model[a]			Negative Affect[b]			Socioeconomic[b]			Lifestyle[b]			Health Status[b]		
	HR	95% CI	*P* Value	HR	95% CI	*P* Value	HR	95% CI	*P* Value	HR	95% CI	*P* Value	HR	95% CI	*P* Value
General															
Sex															
Male	1.00	Referent		1.00	Referent		1.00	Referent		1.00	Referent		1.00	Referent	
Female	0.55	0.49, 0.62	<0.01	0.55	0.49, 0.61	<0.01	0.52	0.46, 0.59	<0.01	0.54	0.47, 0.62	<0.01	0.53	0.46, 0.61	<0.01
Age	1.12	1.11, 1.12	<0.01	1.11	1.11, 1.12	<0.01	1.11	1.10, 1.12	<0.01	1.11	1.10, 1.12	<0.01	1.09	1.08, 1.10	<0.01
Affect															
Positive affect[c]	0.95	0.93, 0.97	<0.01	0.96	0.93, 0.98	<0.01	0.96	0.93, 0.98	<0.01	0.97	0.95, 0.99	0.01	0.98	0.96, 1.01	0.13
Negative affect[c]				1.01	0.98, 1.03	0.51	1.01	0.98, 1.03	0.70	1.01	0.98, 1.03	0.63	0.99	0.97, 1.02	0.66
Socioeconomic statistics															
Employment															
Unemployed							1.00	Referent		1.00	Referent		1.00	Referent	
Employed							0.75	0.50, 1.13	0.17	0.76	0.51, 1.15	0.19	0.80	0.53, 1.21	0.29
Marital status															
Married							1.00	Referent		1.00	Referent		1.00	Referent	
Single							0.83	0.58, 1.18	0.30	0.80	0.56, 1.15	0.22	0.85	0.66, 1.09	0.19
Widowed							0.91	0.68, 1.21	0.51	0.95	0.71, 1.26	0.73	1.05	0.91, 1.22	0.48
Divorced							1.02	0.76, 1.36	0.90	1.01	0.76, 1.35	0.93	1.01	0.76, 1.34	0.95
Education															
Elementary							1.00	Referent		1.00	Referent		1.00	Referent	
Lower secondary							1.12	0.90, 1.41	0.32	1.04	0.82, 1.30	0.77	1.00	0.85, 1.18	0.96
Higher secondary							1.06	0.82, 1.38	0.64	1.00	0.77, 1.29	1.00	0.99	0.86, 1.14	0.91
Tertiary							1.08	0.85, 1.38	0.51	1.05	0.83, 1.34	0.67	0.99	0.78, 1.25	0.92
Lifestyle															
Exercise															
Nonexerciser										1.00	Referent		1.00	Referent	
Exerciser										0.70	0.62, 0.80	<0.01	0.75	0.66, 0.86	<0.01
Smoker															
Never										1.00	Referent		1.00	Referent	
Past										0.57	0.48, 0.68	<0.01	1.04	0.90, 1.20	0.60
Current										0.58	0.50, 0.68	<0.01	1.72	1.44, 2.04	<0.01

Alcohol use						
Never	1.00	Referent		1.00	Referent	
Past	1.04	0.87, 1.23	0.69	1.28	1.02, 1.60	0.03
Current	1.30	1.09, 1.55	<0.01	1.10	0.92, 1.31	0.31
Body mass index, kg/m^2	0.99	0.97, 1.01	0.16	0.98	0.96, 0.99	<0.01
Health status						
Disability status						
None				1.00	Referent	
Moderate				1.52	13.28, 1.74	<0.01
High				2.62	2.16, 3.19	<0.01
Prevalent disease						
Myocardial infarction				1.23	1.06, 1.44	0.01
Heart failure				1.58	1.33, 1.88	<0.01
Stroke				1.54	1.26, 1.89	<0.01
Dementia				1.92	1.55, 2.37	<0.01
Cancer						
<5 years of follow-up				13.87	10.26, 18.75	<0.01
≥5 years of follow-up				0.79	0.60, 1.04	0.09
Systolic blood pressure, mm Hg				1.00	1.00, 1.00	0.61

Abbreviations: CES-D, Center for Epidemiologic Studies Depression; CI, confidence interval; HR, hazard ratio.
[a] The baseline model is adjusted for sex, age, and positive affect.
[b] In addition to all variables included in previous models.
[c] For positive affect and negative affect, the hazard ratio is expressed per unit change on the CES-D Scale.

variables were added in the next step of the adjusted model, the association of positive affect with survival was attenuated but remained significant (HR = 0.97, 95% CI: 0.95, 0.99; $P = 0.01$). However, when health status was entered into the final step of the adjusted model, positive affect no longer predicted survival (HR = 0.98, 95% CI: 0.96, 1.01; $P = 0.13$). In the fully adjusted model, in addition to age and sex, smoking status, exercise, alcohol usage, prevalence of myocardial infarction, stroke, dementia, heart failure, and cancer were all significantly associated with survival.

Interaction of positive affect with age and health status

We observed a significant interaction of positive affect with age in the fully adjusted model ($P_{\text{interaction}} = 0.02$). Subsequent age stratification was conducted to determine if there was a differential association between positive affect and survival within each age stratum, and results are presented in Table 4. Age- and sex-adjusted models revealed that positive affect was associated with survival in each age group stratum. For adults aged under 70 years, positive affect remained a significant predictor of survival even when fully adjusted (HR = 0.92, 95% CI: 0.86, 0.98; $P = 0.01$). In this association, there was a dose-response relation between positive affect and mortality. In the younger old, the hazard ratio of a medium score for mortality was 0.72 (95% CI: 0.45, 1.13) compared with those scoring low. Participants scoring high had a hazard ratio for mortality of 0.59 (95% CI: 0.37, 0.92) in the fully adjusted analyses (age, sex, negative affect, socioeconomic status, lifestyle, and baseline health status). For adults aged 70–80 years, positive affect was a significant predictor of survival after controlling for negative affect, socioeconomic status, and lifestyle, but the addition of health status to this model rendered the association insignificant (HR = 0.97, 95% CI: 0.94, 1.07; $P = 0.11$). For adults aged >80 years, positive affect did not predict survival after controlling for negative affect, socioeconomic status, and lifestyle factors (HR = 0.97, 95% CI: 0.94, 1.01; $P = 0.16$).

To further illustrate and investigate this association, we also dichotomized the 3 age strata, contrasting the oldest old at baseline (>80 years) with the middle and younger-old persons (≤80 years). Positive affect was significantly associated with survival after controlling for all covariates in the younger and middle-old persons (≤80 years of age: HR = 0.96, 95% CI: 0.93, 0.99; $P = 0.01$), whereas in the oldest-old persons, the association was not significant after adjustment for covariates (HR = 1.00, 95% CI: 0.96, 1.04; $P = 0.79$).

Positive affect did not significantly interact with health status on survival ($P_{\text{interaction}} = 0.61$) in a model including age, sex, negative affect, socioeconomic variables, lifestyle variables, and health status (dichotomous). When we additionally stratified by health status, the fully adjusted association of positive affect with survival was not statistically significant in any of the 6 strata. In participants healthy at baseline, the hazard ratio of positive affect on survival in the younger old was 0.94 (95% CI: 0.85, 1.04) and, in the middle old, it was 0.96 (95% CI: 0.89, 1.04). In the small group of oldest old, the point estimate was a hazard ratio of 1.06 (95% CI: 0.94, 1.20). In participants with a prevalent disease or disabilities at baseline, the hazard ratio of positive affect on survival was 0.93 (95% CI: 0.86, 1.01) in the younger old, 0.90 (95% CI: 0.95, 1.03) in the middle old, and 0.96 (95% CI: 0.92, 1.00) in the oldest old.

DISCUSSION

Positive affect was found to predict survival in older adults in univariate analyses, such that a higher level of positive affect provides a protective effect against survival. This association remained after controlling for age, sex, negative affect, socioeconomic status, and lifestyle factors but was not significant anymore after controlling for health status. However, we did find a significant age-dependent association of positive affect with survival. For the younger old adults, a more positive affect was related to reduce mortality, while in the oldest-old persons a positive affect was not associated with survival after adjustment for socioeconomic status, lifestyle, and health.

Several previous studies reported a better survival of persons with more positive affect (1, 8, 9, 12–14, 17, 32, 33). Positive affect was associated with survival in a population-based study in 2,282 older individuals by Ostir et al. (13), even after controlling for age, sex, baseline medical conditions, body mass index, smoking, drinking, sociodemographics, and negative affect. However, this study had a limited follow-up time of 2 years. A smaller study of 660 older individuals with 23 years of follow-up by Levy et al. (32) also reported positive affect to be associated with survival after controlling for age, sex, socioeconomic status, and baseline health status. Interestingly, a large study by Kaplan and Camacho (16) including 6,928 individuals with a wide age range (16–94 years) observed no association between happiness and survival after 9 years of follow-up. Although they did not study age interaction, this may suggest that the association of positive affect with survival is inconsistent across age ranges. In addition, some evidence for an age interaction in elderly persons has been reported in a small study of 421 individuals by Parker et al. (15). Here, life satisfaction was significantly associated with survival in the younger old (75–85 years) but not in the older old (≥85 years). Our results also suggest that the association of positive affect with survival is inconsistent across age ranges and is based on a large sample, considerable follow-up time, and controlled for multiple well-assessed confounders. This suggests that not only control for confounders but also age range accounts for inconsistencies in published results.

We additionally checked whether the association of positive affect with survival was modified by health status. However, it is likely that this analysis is underpowered. For example, only 175 persons (85 cases) among the very old with a mean follow-up of 6.94 years contributed person-time to the healthy stratum. All results should therefore be interpreted cautiously.

In general, several mechanisms have been suggested to explain the association of positive affect with survival. One potential mechanism is better health behavior (34). People with a higher positive affect are more inclined to watch their weight, are more perceptive of symptoms of

Table 4. Cox Regression Analyses of Positive Affect and Survival Within Age Group Strata ($n = 4,411$), the Rotterdam Study, 1997–2007

	No.	Model 1[a]			Model 2[b]			Model 3[c]		
		HR	95% CI	*P* Value	HR	95% CI	*P* Value	HR	95% CI	*P* Value
Age continuous										
Positive affect[d]	4,411	0.89	0.84, 0.95	<0.01	0.91	0.85, 0.97	<0.01	0.92	0.86, 0.98	0.01
Age	4,411	2.28	1.74, 2.99	<0.01	2.24	1.70, 2.96	<0.01	1.73	1.31, 2.28	<0.01
Positive affect × age		1.03	1.00, 1.06	0.03	1.03	1.00, 1.06	0.03	1.03	1.00, 1.06	0.02
Age group strata										
Positive affect, <70 years	1,798	0.90	0.86, 0.94	<0.01	0.91	0.86, 0.97	<0.01	0.92	0.86, 0.98	0.01
Positive affect, 70–80 years	1,866	0.95	0.92, 0.98	<0.01	0.96	0.93, 1.00	0.04	0.97	0.94, 1.07	0.11
Positive affect, >80 years	747	0.96	0.93, 0.99	0.01	0.97	0.94, 1.01	0.16	1.00	0.96, 1.04	0.79

Abbreviations: CES-D, Center for Epidemiologic Studies Depression; CI, confidence interval; HR, hazard ratio.
[a] Adjusted for age and sex.
[b] Adjusted for age, sex, negative affect, lifestyle, and socioeconomic factors.
[c] Adjusted for age, sex, negative affect, lifestyle, socioeconomic factors, and baseline health status.
[d] For positive affect, the hazard ratio is expressed per unit change on the CES-D Scale.

illness, engage more often in sport, and tend to be moderate with smoking and drinking (8). It is also been suggested that people with higher positive affect make better health-relevant choices in life because they are more open to the world and are more self-confident (35). Therefore, people with a higher positive affect may live longer, but this may not be directly due to positive affect but due to a healthy lifestyle and protective health behavior. Although we cannot exclude this possibility in the present study, we were able to adjust for some of these factors, such as body mass index, exercise, smoking status, and alcohol use to limit confounding because of lifestyle and health behavior. Another possible mechanism is a direct effect of positive affect, possibly through favorable biologic responses, including low cortisol levels, faster cardiovascular stress recovery, and reduced inflammation resilience to infection (2, 34, 36–39). Why increased levels of positive affect might be beneficial in the younger old, in particular, requires further research. We adjusted for health status as measured by several variables, but this may mean that we corrected for the consequences of positive affect in younger years. To some extent, good health may be the result of positive affect. On the other hand, prior research suggested that life satisfaction and quality of life in the oldest old are strongly determined by the absence or presence of chronic diseases (40). Therefore, we posit that the perception of happiness in the oldest old is largely determined by health status.

As several mechanisms could explain the association of positive affect with survival, covariate selection for the analysis was especially important. One other study reporting an association between positive affect and survival did not report the association upon adjustment for sociodemographic variables and perceived health (17). Disregarding age dependence, our fully adjusted model also suggests that positive affect was not associated with survival if the effects of other variables are accounted for. However, the inclusion of some variables in our fully adjusted model may be considered as overadjustment. ''Overadjustment'' refers to the inclusion of mediators of the association between happiness and survival in the model (41). Our study population consists of older people, and it is plausible that prior happiness determined baseline health, so any assessment of baseline health could reflect the consequences of a prior positive affect. With the current design, it is not possible to completely solve this issue. Hence, we can only reason the most likely causal pathway (42). We argue that the covariates in the present study are independently associated with survival and are not, or only to a small extent, mediators of the association between positive affect and survival.

A different observation was on the limited impact of negative affect on survival. In the present analysis, negative affect was inversely associated with survival only in the univariate analysis, in the younger old. In contrast, positive affect was a predictor of survival even after adjustment for negative affect, in some analyses. Therefore, our results suggest that the positive affect component in the CES-D Scale is a more powerful predictor of survival than negative affect. This is in line with other survival studies. Although many studies report either positive affect or negative affect, few studies analyzed both positive and negative affect. One study of 4,162 community-dwelling elders showed that only positive affect was a predictor of survival, not the other factors of the CES-D Scale, independent of age, sex, race, civil status, education, cognitive impairment, and functional impairment (10). Further, a survival study of 2,282 Mexican Americans showed that positive affect was a predictor of survival even independent of negative affect along with age, sociodemographic variables, and prevalence of some chronic diseases (13). Finally, a study on cytokines reported that positive affect, not negative affect, was associated with increased infection-induced proinflammatory cytokines and thereby resilience to infections (39). This is interesting, because this suggests that positive affect (and not negative affect) has beneficial health effects, while negative affect is considered to be the key symptom of depressive disorder that in itself is a major risk factor for health risks and survival (22–24).

The present study has several strengths, such as the sample size and the population-based approach utilized. Further,

the current analyses considered multiple confounders related to negative affect, lifestyle, socioeconomics, and health that were assessed by trained interviewers or clinicians and, in the case of prevalent disease status, adjudicated through revision of medical records. On the other hand, this study is based on a single measurement of positive affect, derived from the CES-D Scale. Single measurements are criticized on the grounds that they are affected by recall bias and the dominant influences of current state (37). However, in older adults, positive affect is considered a stable characteristic that is unlikely to vary over time (43).

In conclusion, the current study suggests that the association of positive affect with survival is not consistent over the age range studied. In the younger old, positive affect did significantly predict survival independent of negative affect and health. In the oldest old, the association of positive affect with survival might be moderated by differences in health status.

ACKNOWLEDGMENTS

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The Rotterdam Study is supported by the Erasmus Medical Centre and Erasmus University Rotterdam, as well as by the Netherlands Organization for Scientific Research and the Netherlands Organization for Health Research and Development (ZonMw). S. W. is funded by the Network for Studies on Pensions, Aging, and Retirement (NETSPAR) theme, ''Living Longer in Good Health.'' R. S. N. was supported by a postdoctoral research grant on healthy aging from Unilever Corporate Research, United Kingdom, and the work of H. T. was supported by a grant from the Netherlands Organization for Scientific Research (VICI 017-106-370).

The sponsors had no role in the design or conduct of the study; in the collection, management, analysis, or interpretation of the data; or in the preparation, review, or approval of the paper.

Conflict of interest: none declared.

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