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Supplemental Material

Table S1: Hazard ratios [95% confidence intervals] for the association between mortality risk and the mean level of life satisfaction over time, the standard deviation of life satisfaction over time, or their interaction[a] in models with and without time-dependent age

	Model 1[b]	Model 2[c]	Model 3[d]	Model 4[e]
Mean of life satisfaction	0.82**** [0.76, 0.89]	0.87*** [0.80, 0.95]	0.93† [0.86, 1.01]	0.93 [0.84, 1.02]
Mean of life satisfaction with time-dependent age	0.82**** [0.75, 0.88]	0.87*** [0.80, 0.95]	0.93† [0.86, 1.01]	0.93 [0.84, 1.02]
Standard deviation of life satisfaction	1.20**** [1.11, 1.29]	1.15*** [1.06, 1.24]	1.08† [1.00, 1.17]	1.08† [0.99, 1.18]
Standard deviation of life satisfaction with time-dependent age	1.20**** [1.11, 1.29]	1.15**** [1.06, 1.24]	1.08† [0.99, 1.17]	1.08† [0.99, 1.17]
Mean of life satisfaction * Standard deviation of life satisfaction[f]	0.92** [0.87, 0.97]	0.91*** [0.86, 0.96]	0.91*** [0.86, 0.96]	0.91*** [0.86, 0.96]
Mean of life satisfaction * Standard deviation of life satisfaction with time-dependent age	0.92*** [0.87, 0.97]	0.91*** [0.86, 0.95]	0.91*** [0.86, 0.95]	0.91*** [0.86, 0.95]

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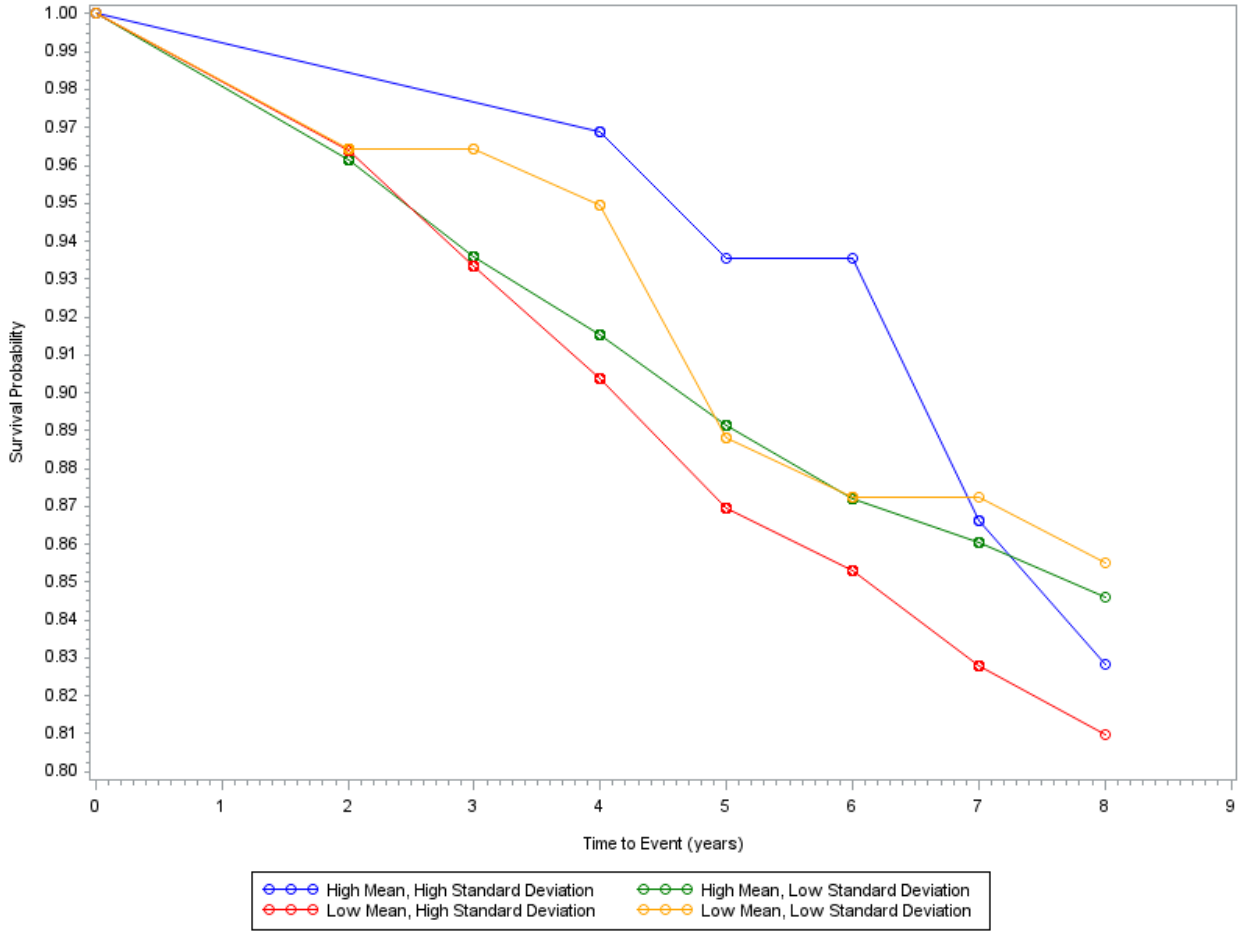

Figure S1. Survival curves for the four most extreme groups: high mean/high standard deviation; high mean/low standard deviation; low mean/high standard deviation; low mean/low standard deviation.

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First approach: Is terminal decline evident?

Following previous studies (e.g., Gerstorf, Ram, Rocke, Lindenberger, & Smith, 2008), we used multilevel modeling to determine whether terminal decline was evident in our sample. Results indicated that there was a larger negative slope for time (years, centered around study entry) among those who died versus survived (Table S2), controlling for age. Thus, the fixed-effect coefficient for time suggests that life satisfaction is slightly reduced as time passes, but that this downward trend is more pronounced (i.e., of greater magnitude) among those who died. This indicates that there is some terminal decline in our sample.

Table S2. *Multilevel models of life satisfaction over years in study and survivor status.*

Fixed effects	Estimate	Standard error
Age	0.019**	0.002
Time	-0.034**	0.004
Survivor status, where 1 = died	-0.176*	.069
Time * Survivor status	-0.0878**	.014
Random effects		
Intercept	1.52**	0.04
Time slope	0.14**	0.0008
Intercept-slope covariance	-0.064**	.005
Residual	1.10**	0.01

Note. $N = 4458$ who provided 33,669 observations.
*$p \leq .01$, **$p \leq .0001$

Second approach: What is the terminal decline's magnitude of effect?

Among those who died, we evaluated the magnitude of terminal decline by centering time around the year of death rather than study entry. This permitted us to quantify the change in life satisfaction as a function of time to death (i.e., terminal decline). Life satisfaction declined as death approached (Table S3). (A quadratic term for time was tested in another model, but was not statistically significant.) The time parameter accounted for a very small amount of within-person variance in life satisfaction (by comparison with a model without a time parameter; residual variance declined from 1.7525 to 1.6086, or 8%).

Table S3. *Multilevel models of life satisfaction over time to death in deceased participants.*

Fixed effects	Estimate	Standard error
Time	-0.104**	0.017
Random effects		
Intercept	2.57**	0.26
Time slope	0.19**	0.04
Intercept-slope covariance	0.03*	0.01
Residual	1.61**	0.06

Note. $N = 546$ who provided 2,526 observations.
*$p \leq .01$, **$p \leq .0001$

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Third approach: How does variability in the detrended residual of life satisfaction compare to variability in the raw life satisfaction score?

The contribution of terminal decline was assessed in the second approach (above) using the following multilevel model:

$LS_{ij} = \beta_{0j} + \beta_{1j} * \text{Years before death} + e_{ij}$

That is, life satisfaction (LS) for person j at year i is a function of an intercept (predicted life satisfaction at study entry), an effect of years before death, and a within-person residual. Further,

$\beta_{0j} = \gamma_{00} + U_{0j}$
$\beta_{1j} = \gamma_{10} + U_{1j}$

That is, the intercept and slope of time for life satisfaction for each person j is a function of the average intercept and slope across the sample (i.e., the fixed effects) and that person's random effects or deviation from the fixed effect.

This model can be rewritten by substitution as:

$LS_{ij} = \gamma_{00} + U_{0j} + (\gamma_{10} + U_{1j}) * \text{Years before death} + e_{ij}$

In this model, e_{ij} is the detrended residual in life satisfaction after the effects due to both total (γ_{10}) and individual (U_{1j}) time slopes – including terminal decline – are taken out. Using this formulation, we output the random effects parameters (U_{0j} and U_{1j}) from the model and solved for e_{ij}. We found both the within-subject standard deviation and variance of e_{ij} were highly correlated with the within-subject standard deviation and variance of the raw life satisfaction score (both rs > .98). Therefore, although there was time-structured variance in life satisfaction among the individuals who died (consistent with terminal decline), it would have contributed very little to the total intraindividual variability that was identified in our original models.

Fourth approach: Does the variability in the detrended residual of life satisfaction predict risk of mortality?

We next tested whether variability in the detrended residual in life satisfaction (e_{ij}) would predict mortality in our Cox proportional hazards regression models. Using the standard deviation of the detrended residual rather than the standard deviation of the raw score effectively removes variability due to terminal decline from the total variability. For individuals who died, we substituted the standard deviation of this detrended residual in life satisfaction for the original standard deviation in life satisfaction. Results for variability in life satisfaction remained completely consistent with our primary findings. In the age-adjusted model with the main effect of variability (i.e., no interaction term included), greater variability in detrended life satisfaction was associated with increased risk of mortality (HR = 1.13, 95% CI [1.05, 1.22], p = .002). However, this was qualified by an interaction with mean life satisfaction. When the mean of life satisfaction, the variability in detrended life satisfaction, and their interaction were included

together, results were consistent with our primary findings, regardless of the covariates that were included (age-adjusted: HR = 0.91, 95% CI [0.86, 0.96], $p = .0004$). Thus, our primary conclusions were maintained even when removing the effect of terminal decline on variability among those who died.

Fifth approach: Is baseline life satisfaction associated with reduced risk of mortality?

We examined whether level of life satisfaction assessed at the first study wave (and therefore the least likely to be subject to terminal decline as it is the furthest available point from death) was associated with mortality risk. Higher levels of life satisfaction assessed during the first wave of the study were associated with reduced risk of mortality (age-adjusted: HR = 0.95, 95% CI [0.90, 1.00], $p = .03$). Most participants (71.78%) contributed 9 years worth of data to analyses and the average number of years contributed by all participants was 7.78 ($SD = 2.23$, minimum = 2, maximum = 9). The average number of years contributed among those who died was 4.75. Given that these exceed the typical period in which terminal decline is expected to occur (approximately 4 years; Gerstorf et al., 2008), it is unlikely that our findings are due primarily to reverse causality. Note that because a single assessment of life satisfaction is less reliable than the mean, this analysis underestimates the true effect of stable individual differences in life satisfaction. Nonetheless, this analysis replicates our original findings.

Summary

Although we found evidence of terminal decline in our sample, its magnitude was small. In addition, variability in the detrended residual of life satisfaction was highly correlated with variability in the raw score of life satisfaction. Furthermore, when variability in the detrended residual was substituted for variability in the raw score, primary findings regarding mortality risk were maintained. Findings regarding mortality risk were also maintained when considering baseline life satisfaction (the farthest point from death). Taken together, these sensitivity analyses support the robustness of our primary findings and indicate that our results cannot be fully explained by terminal decline.

References

Gerstorf, D., Ram, N., Rocke, C., Lindenberger, U., & Smith, J. (2008). Decline in life satisfaction in old age: Longitudinal evidence for links to distance-to-death. *Psychology and Aging, 23*, 154–168.