Do hassles mediate between life events and mortality in older men? Longitudinal findings from the VA Normative Aging Study

Citation	Aldwin, C. M., Jeong, Y., Igarashi, H., Choun, S., & Spiro, A. (2014). Do hassles mediate between life events and mortality in older men?: Longitudinal findings from the VA Normative Aging Study. Experimental Gerontology, 59, 74-80. doi:10.1016/j.exger.2014.06.019
DOI	10.1016/j.exger.2014.06.019
Publisher	Elsevier
Version	Version of Record
Terms of Use	http://cdss.library.oregonstate.edu/sa-termsofuse

Experimental Gerontology 59 (2014) 74–80

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Do hassles mediate between life events and mortality in older men? Longitudinal findings from the VA Normative Aging Study ☆

Carolyn M. Aldwin [a,*], Yu-Jin Jeong [b], Heidi Igarashi [a], Soyoung Choun [a], Avron Spiro III [c,d]

[a] Oregon State University, United States
[b] Chonbuk National University, Republic of Korea
[c] VA Boston Healthcare System, United States
[d] Boston University Schools of Public Health and Medicine, United States

ARTICLE INFO

Article history:
Received 10 March 2014
Received in revised form 21 June 2014
Accepted 30 June 2014
Available online 1 July 2014

Section Editor: A. Simm

Keywords:
Stressful life events
Hassles
Mortality
Trajectories
Aging

ABSTRACT

We investigated whether hassles mediated the effect of life events on mortality in a sample of 1293 men (M_{age} = 65.58, SD = 7.01), participants in the VA Normative Aging Study. We utilized measures of stressful life events (SLE) and hassles from 1989 to 2004, and men were followed for mortality until 2010. For life events and hassles, previous research identified three and four patterns of change over time, respectively, generally indicating low, moderate, and high trajectories, with one moderate, non-linear pattern for hassles (shallow U curve). Controlling for demographics and health behaviors, we found that those with moderate SLE trajectories (38%) more likely to die than those with low SLE trajectories, HR = 1.42, 95% CI [1.16, 3.45]. Including the hassles classes showed that those with the moderate non-linear hassles trajectory were 63% more likely to die than those with low hassles trajectory, HR = 1.63, 95% CI [1.19, 2.23], while those with consistently high hassles trajectory were over 3 times more likely to die, HR = 3.30, 95% CI [1.58, 6.89]. However, the HR for moderate SLE trajectory decreased only slightly to 1.38, 95% CI [1.13, 1.68], suggesting that the two types of stress have largely independent effects on mortality. Research is needed to determine the physiological and behavioral pathways through which SLE and hassles differentially affect mortality.

1. Introduction

The adverse effects of stress on health have been accepted for the last few decades (Aldwin, 2011; Almeida et al., 2011; Cohen et al., 2007; Steptoe and Kivimäki, 2013). However, there are different ways of assessing stress, and relatively little work has been done to understand their interrelationships. In general, there are several ways of assessing stress in field settings (Aldwin, 2007). Trauma is generally reserved for events which involve serious threat or experience of death or serious injury, such as combat, natural disasters, and car accidents (Yamashita, 2011). Stressful life events (SLE) are major changes which have primarily adverse effects for individuals and their loved ones, such as deaths, divorces, or being laid off from work (Hatch and Dohrenwend, 2007; Holmes and Rahe, 1967). Hassles or daily stressors are relatively minor, everyday problems which are often linked to social roles and/or the built and natural environment, such as commuting problems, family arguments, or household repairs (DeLongis et al., 1988; Hay and Diehl, 2010). Finally, chronic role strain reflects on-going problems, generally linked to social roles, such as troubled marriages, poverty, or difficult jobs (Pearlin et al., 1996; Turner and Turner, 2005; Wheaton, 1996).

Early research sought to determine the relative strength of the association between various measures of stress and health. Lazarus and his colleagues (DeLongis et al., 1982; Kanner et al., 1981) argued that hassles were the better determinants of health outcomes, as they were more numerous and more likely to have immediate effects on health. Others argued that hassles were "contaminated" by personality factors such as neuroticism, and that life events were more objective (Dohrenwend et al., 1984; Schroeder and Costa, 1984). Aldwin et al. (1989) argued that life events and hassles were related — for example, a life event such as divorce could lead to more hassles with car repair, child care, and household maintenance. They utilized longitudinal

☆ Author's note: Carolyn M. Aldwin Heidi Igarashi and Soyoung Choun are in the Program in Human Development and Family Sciences, School of Social and Behavioral Health Sciences, Oregon State University, while Dr. Jeong is at the Department of Child Studies, Chonbuk National University, Jeonju, South Korea. Avron Spiro III is at the VA Boston Healthcare System and Boston University Schools of Public Health and Medicine. This study was funded by NIH grants R01 AG032037, AG002287, and AG018436, as well as a Merit Review and a Senior Research Career Scientist Award from the CSR&D Service, US Department of Veterans Affairs. The VA Normative Aging Study is a research component of the Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC) and is supported by VA CSP/ERIC. The views expressed in this paper are those of the authors and do not necessarily represent the views of the US Department of Veterans Affairs.

* Corresponding author.
E-mail address: Carolyn.Aldwin@oregonstate.edu (C.M. Aldwin).

http://dx.doi.org/10.1016/j.exger.2014.06.019
0531-5565/

data from the VA Normative Aging Study (NAS) to test the relationships among neuroticism, life events, hassles, and psychological health, and found that neuroticism was equally predictive of both life events and hassles; life events were predictive of hassles. Nonetheless, life events and hassles were both independently related to mental health, although part of the effect of life events on mental health was mediated through hassles. In this study, we examine the association between life events and hassles and test whether the effect of life events on mortality was mediated through hassles.

1.1. Life events and mortality

While life events are now widely accepted to have adverse effects on health (Almeida et al., 2011), the literature on stress and mortality is surprisingly inconsistent. Some studies have found a positive association between stressful life events and mortality (Lantz et al., 2005; Nielsen et al., 2008; Rosengren et al., 1993). Others have found no association (Maunsell et al., 2001), and still others found that stressful life events were inversely related to mortality (Hollis et al., 1990). Phillips et al. (2008) argued that the relationship between life events and mortality was confounded by the presence of health-related events in lists of stressful life events. Thus, omitting health-related items from stress measures when predicting mortality can avoid circularity.

Alternatively, it is possible that long-term patterns of stress may be a better predictor of mortality than single assessments (Kopp and Rethelyi, 2004; Pearlin et al., 1996). Aldwin et al. (2011) found four patterns of SLE change across 18 years among men in the NAS using latent class growth analysis. Three of four classes decreased over time, with the major difference among them being in the average level of stress, which were low, moderate, and high. However, one class showed increases in stress which peaked around age 70. When the stressful life events inventory was rescored deleting the two health-related items only three classes emerged (see Fig. 1a). Thus, health-related stressors may peak around age 70, although other types of stressors may decrease, probably as a function of declining social roles (Aldwin, 2011). However, we followed Phillips et al.'s (2008) suggestion that health-related stress items should not be included when predicting health outcomes. Thus, three classes, or patterns, of SLE change were then used to predict mortality. Interestingly, both the moderate and high classes had similar hazard ratios for mortality, compared to the low group, HRs = 1.41 and 1.37, respectively, suggesting that there may be a non-linear relationship between stressful life events and mortality.

1.2. Hassles and mortality

In addition to the work by Lazarus and his colleagues cited earlier, several other groups have shown that hassles have a greater impact on health than do life events (Jandorf et al., 1987; Stanley and Burrows, 2008; Weinberger et al., 1987). Several reviews have demonstrated the adverse effects of hassles and daily stressors on a variety of health outcomes (Almeida et al., 2011; Piazza et al., 2013; Zautra, 2003). However, most of the research on hassles or daily stressors utilizes proximal health outcomes such as biomarkers rather than disease onset or mortality. For example, daily stress was positively associated with inflammatory biomarkers (Gouin et al., 2012), which, in turn, were associated with the development of chronic diseases such as type 2 diabetes (Stringhini et al., 2013). However, there are very few studies of the direct effects of hassles or daily stressors on long-term health outcomes such as mortality.

In prior research with this sample, Aldwin et al. (2014) used latent class growth analysis to identify long-term patterns of hassles intensity ratings across 16 years and found four basic patterns (see Fig. 1b). Three (low, medium, and high) were basically stable over time, differing in their average level, but one large group of participants showed a shallow U-shaped curve, with hassles decreasing until about age 67 and then increasing thereafter. Jeong et al. (2012) examined the association of these patterns with mortality and found that this moderate nonlinear group had about a 30% increased risk of dying, compared to the low stable hassles intensity group.

1.3. Present study

The question remains as to whether life events and hassles are independent predictors of mortality, or whether the effect of life events is mediated through hassles. While life events are rare, hassles are ubiquitous, which may explain why the early studies cited above argued that hassles would have a more immediate and thus consequential impact on health. However, it makes sense that life events can have adverse

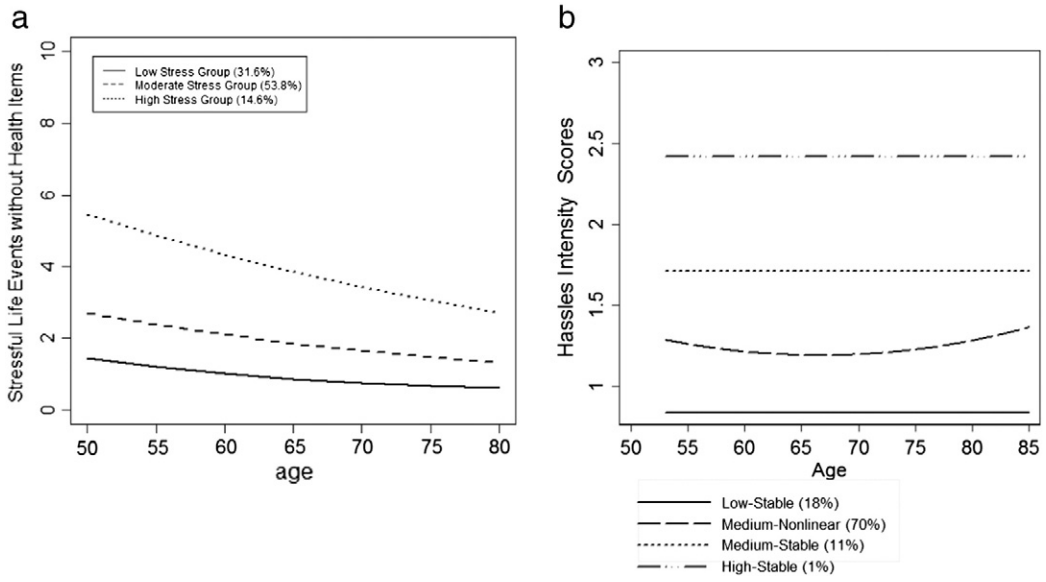

Fig. 1. Stress trajectory classes. Fig. 1a, Stressful Life Events Trajectory Categories, is from Aldwin, C.M., Molitor, N-.T., Spiro, A. III, Levenson, M.R., Molitor, J., & Igarashi, H. (2011). Do stress trajectories predict mortality in older men? Longitudinal findings from the VA Normative Aging Study. *Journal of Aging Research* http://www.hindawi.com/journals/jar/2011/896109/.

health effects in part because they can create more hassles (Aldwin et al., 1989). For example, a divorce is distressing in and of itself, but it can also create difficulties due to changes in economic status and housing, altered relationships with children and friends, and an increase in everyday maintenance tasks once shared by the spouse (see Cherlin et al., 2004). This can be especially true in later life, when resources to cope with problems can be limited. For example, younger individuals can bounce back more quickly from physical injuries such as a broken ankle. However, in older adults, bones heal more slowly. Balance problems can prevent them from effectively using crutches, further impairing mobility and making many activities of daily living, such as shopping or bathing more difficult (cf., Aldwin and Gilmer, 2012). Thus, it may be that life events result in problems that are more likely to spread across domains in later life (cf., Pearlin et al., 1981).

In previous work, we have shown that men in classes of moderate and high long-term levels of stressful life events had higher mortality (Aldwin et al., 2011). Similarly, men in classes of moderate and high hassles also had higher mortality (Jeong et al., 2012). Thus, the purpose of the present study was to examine whether the effect of life events on mortality was direct, or was mediated by hassles, after controlling for personality, demographics, and health behaviors. We included neuroticism as the personality measure in this study, given prior work showing that neuroticism predicts both life events and hassles (Aldwin et al., 1989). Based upon this prior study, we predict that hassles will be at least partial mediators of the effects of stress on mortality.

2. Methods

2.1. Sample and procedure

The VA Normative Aging Study (NAS) is a longitudinal study whose purpose is to examine normal aging processes in men. Between 1961 and 1970, it screened over 6000 men for good health and strong ties to the Boston area, eventually enrolling 2280 men who had no chronic illness or physical disability and ranging in age from 21 to 81 (Spiro and Bossé, 2001). In general, these men reflect the ethnic make-up of Boston in the 1960s (largely White), although they are slightly more likely to have a high school diploma and were mostly married at entry into the study (Spiro and Bossé, 2001).

In 1985, stressful life events were studied using a mail survey (Bossé et al., 1993). This was re-administered in 1988 and 1991. Response rates to NAS mail surveys typically exceed 80%. In 1989, psychosocial measures were included as part of the in-person examination. The stressful life events inventory was included in a packet of materials mailed shortly before the examination, and the men completed the Hassles and Uplifts Questionnaire (DeLongis et al., 1988) on the day of their examination. Completion rates were high: approximately 96% of the men completed these questionnaires (see Aldwin et al., 2011, 2014). On average, men in the sample had about three assessments on both stressful life events (M = 2.71, SD = 1.52, range = 0 to 6) and the hassles intensity measures (M = 2.82, SD = 1.33, range = 0 to 6).

Information on demographics, health behavior habits, and personality was obtained from other mail surveys or interviews conducted at approximately the same time as the initial hassles measures. Information on marital status, self-rated health, and personality was from the 1988 Social Support Survey (Bossé et al., 1993), while education status and alcohol consumption were from a 1986 mail survey (Butcher et al., 1991). Smoking status was assessed at the medical examination interview at the time the first hassle questionnaire was completed.

The present study includes 1293 men who reported having experienced any hassles at least once in 1989 or later. The mean age at the first hassles observation was 65.58, SD = 7.02, range = 53–85. The majority was European American; about two-thirds (60.76%) had some college education and most (88.48%) were married. Half of them (50.18%) were retired and either not working at all or working part-time.

2.2. Measures

2.2.1. Stressful life events

The Elders Life Stress Inventory (ELSI; Aldwin, 1990) is a 30-item dichotomous scale that taps personal and network events which middle-aged and older adults are likely to experience, such as caretaking for a parent or spouse, or divorce of a child. It focuses on events which happened in the past year. The construction of the ELSI utilized a nested strategy — that is, multiple items of increasing severity were organized within a domain (e.g., marital problems, separation from spouse, divorce). The dichotomous version of the ELSI correlates highly ($r > 0.90$) with an earlier version which included stress ratings (see Aldwin, 1990, for details). The ELSI can be scored in two ways — all 30 items, and a version which omits the two health-related items, which was utilized in this study. Responses have a Poisson distribution (M = 1.59, SD = 1.18), with about 30% reporting no stress at any given assessment (Aldwin et al., 2011).

Aldwin et al. (2011) conducted a semi-parametric mixture-model analysis (Jones et al., 2001; Nagin, 1999) and identified three classes of age-related trajectories in the ELSI, all of which showed decreasing trends and differed primarily in their intercepts (high, medium, and low) and in the rate at which they decreased (see Fig. 1a). The results from this study showed that men in both the medium and high trajectories had increased (~50%) mortality risk, compared to those men in the low trajectory group, covarying neuroticism, demographics, and health behaviors.

2.2.2. Hassles

Hassles intensity scores were derived from the Hassles and Uplifts Scale (HUS; DeLongis et al., 1988). This measure includes 53 items that are rated for the extent to which it has been a hassle in the past month using a 4-point Likert scale (0 = *none or not applicable*, 1 = *somewhat*, 2 = *quite a bit*, and 3 = *a great deal*). The items are are samples of work, interpersonal, intrapersonal, and environmental stressors. The hassles items can be scored both in terms of exposure (i.e., a simple count of items) and intensity (mean item ratings of items rated over zero). Previous work (Jeong et al., 2012) showed that hassles intensity scores were most likely to be associated with increased mortality risk, so the current study focuses on those. Given that the mean score across all assessments was 1.28 (SD = .27) and the possible maximum value was 3, the sample reported a fairly low level of hassle intensity.

Aldwin et al. (2014) used a semi-parametric mixture-model (Jones et al., 2001) to determine patterns of change of hassles intensity with age. They identified four patterns (see Fig. 1b). Three of the patterns were relatively stable (high, medium, and low), but one pattern showed a shallow U-shaped curve, with hassles intensity decreasing until about age 67 and increasing thereafter. About 70% of the men were in this category. Controlling for personality, demographics, and health behaviors, the men in the non-linear medium and high groups were 1.4 to 2.0 times more likely to die (Jeong et al., 2012).

2.2.3. Mortality

The NAS maintains detailed information on vital status, using several procedures to acquire this information. These include supplemental questionnaires to NAS participants and regular mailings of birthday cards; next of kin and postal authorities typically inform us if the NAS participant is deceased (see Spiro and Bossé, 2001). In addition, the NAS conducts routine checks for death records through the Social Security Administration, as well as the Department of Veterans Affairs, and death certificates are obtained. We examined the vital status of the men between 1990 and 2010.

2.2.4. Covariates

Covariates included education, marital status, self-rated health, and smoking and drinking status. Four categories for education were utilized: 1 = *less than high school*, 2 = *high school or equivalent*, 3 =

some college or college degree, and 4 = *beyond college*. The NAS men are fairly well educated; only 2% did not complete high school, while 37% completed high school. Those who had some college or graduated were the largest group (45%), and 16% had at least some graduate education. In the survival analyses, the reference category was high school education.

Most of the men (88.48%) were married, with very few reporting being divorced, widowed, or never married. Thus, this variable was dichotomized (0 = *non-married*; 1 = *married*).

Self-reported health status was assessed using a single Likert scaled item, where 1 = *very poor* and 5 = *excellent*. On average, the NAS men rated their health as "good" (M = 4.11; SD = .69).

Health behaviors included alcohol consumption and smoking status. Alcohol consumption status was trichotomized, with 1 = *non-drinker* (15%), 2 = *light/moderate drinker* (64%) and 3 = *heavy drinker* (21%). Because the relationship between alcohol consumption and mortality in the NAS follows a J-shaped curve (De Labry et al., 1992), light/moderate drinkers were the reference category.

Smoking status was assessed at the first medical exam at which hassles were assessed. It was dichotomized into: 0 = *not currently smoking* and 1 = *currently smoking* (32%).

Neuroticism was measured using the Eysenck Personality Inventory (EPI-Q; Floderus, 1974). The neuroticism subscale consists of nine dichotomous items; if a participant completed 7 or 8 items we multiplied the mean of the valid items by 9. The mean neuroticism score in this sample was 2.95 (SD = 2.22). The reliability of the neuroticism measure with nine dichotomously-scored items was .71, estimated using the Kuder–Richardson Formula 20 (KR20) (Carmines and Zeller, 1979).

2.2.5. Analyses

We used Baron and Kenny's (1986) procedure to assess mediation effects. First, we established bivariate relations among the predictor variable (i.e. SLE trajectory class) and mortality, the mediating variable (i.e., hassles intensity trajectory class) and mortality, and then between the predictor and mediator variables. We then calculated two Cox proportional hazards models in *Stata 13* (StataCorp, 2013). The first model contained the covariates and the life event classes, while the second model added the hassles classes. Note that age was not included in these analyses as a covariate, because the trajectories for both life events and hassles utilized age as the denominator, that is, they measured change in stress by age, effectively including it in the analysis. For the Cox proportional hazard model, we used multiple imputations for handling nonresponse bias (Vinnard et al., 2013). This method imputes missing values with non-missing values in covariates and auxiliary variables and then generates multiple completed datasets. Afterwards, the estimates of a model are pooled from the multiple datasets. In this study, we generated completed datasets. In generating imputed datasets, we added mortality status (0 = *alive*; 1 = *dead*) and employment status in 1988 (1 = *retired*; 2 = *retired but worked part-time*; 3 = *retired but worked full-time*; 4 = *part-time worker*; 5 = *full-time worker*) as auxiliary variables.

3. Results

Of the 1293 men alive in 1989, 553 (43%) were deceased by 2010. We first present the unadjusted bivariate relationships between these variables, and then the Cox proportional hazards models.

3.1. Bivariate analyses

Mortality varied by both stressful life events (SLE) trajectory classes and hassles intensity trajectory classes. The first half of Table 1 presents the relations among the SLE trajectory classes and mortality. As can be seen, only about a third (36.3%) of those in the low SLE trajectory class had died, while the numbers for the moderate and high SLE trajectory classes were closer to half: 47.9% and 44.9%, respectively. This difference was highly significant, $\chi^2(2, N = 1199) = 13.75$, $p < .001$.

Table 1
Mortality by stress trajectory category.

	Yes (%)	Total	
SLE Trajectory Class			
Low stress	144 *(36.3)*	397	
Moderate stress	319 *(47.9)*	666	
High stress	61 *(44.9)*	136	
Total	524 *(43.7)*	1,199	$\chi^2(2, N = 1{,}199) = 13.75, p = .001$
Hassles Intensity Class			
Low stable	45 *(28.7)*	157	
Medium stable	47 *(46.1)*	102	
Medium nonlinear	452 *(44.3)*	1,020	
High stable	9 *(64.3)*	14	
Total	553 *(42.8)*	1,293	$\chi^2(3, N = 1{,}293) = 16.86, p = .001$

Note: SLE = Stressful Life Event.

Similar patterns were seen for the hassles intensity trajectory classes. As shown in the bottom half of Table 1, the low hassles class had the lowest mortality rate (28.7%). In the two medium classes, slightly less than half had died, while in the high hassles intensity class, 64.3% had died, $\chi^2(3, N = 1293) = 16.86$, $p < .001$.

We also found a significant relationship between the SLE and hassles intensity trajectory classes, $\chi^2(6, N = 1199) = 56.87$, $p < .001$. As can be seen in Table 2, the majority of the men were in the medium nonlinear class, a confirmed age-related pattern (see Aldwin et al., 2014). However, examining relative differences among the classes was instructive. For example, those in the low SLE class were more likely to be in the low hassles intensity group (20.65%), but only 2% were in the high hassles trajectory group. These two cells contributed the most to the overall chi-square, 18.9 and 12.0, respectively, *ps* < .001. Similarly, those in the middle stable class were also diversely distributed, with only 4% of the men in this class also in the low SLE trajectory class, while 16% were in the high stable SLE trajectory class. The chi-square contributions for these cells were also relatively high, 8.6 and 10.3, respectively, *ps* < .01, indicating that they also differed significantly from chance.

Thus, the predictor, mediator, and outcome variables were all correlated with each other, satisfying Baron and Kenny's (1986) requirements for examining mediation effects.

3.2. Mediation analyses

We computed two Cox proportional hazards models to examine our hypothesis that hassles mediated the effects of SLE on mortality. The first examined the effects of the SLE trajectory classes on mortality, controlling for demographics, health behaviors, and neuroticism. The second model added the hassles trajectory classes. As can be seen in Table 3, most of the covariates were significant predictors of mortality. Having at least some college education, being married, and better self-rated health were protective for mortality, HRs = 0.74

Table 2
Associations among SLE and hassles intensity trajectory classes.

SLE trajectory classes	Hassles intensity trajectory classes				
	Low	Medium	Medium nonlinear	High	Total
Low	82	16	293	6	397
%	*20.65*	*4.03*	*73.8*	*1.51*	*100*
Moderate	69	61	528	8	666
%	*10.36*	*9.16*	*79.28*	*1.2*	*100*
High	3	22	111	0	136
%	*2.21*	*16.18*	*81.62*	*0*	*100*
Total	154	99	932	14	1199

Note: SLE = stressful life events.
$\chi^2(6, N = 1199) = 56.87$, $p < .001$.

Table 3
Cox regression models predicting mortality (N = 1293).

	Model 1				Model 2			
	HR	*p*	95%	CI	HR	*p*	95%	CI
Covariates								
Below high school	0.89	0.72	0.47	1.68	0.93	0.83	0.49	1.77
College	0.74	0.01	0.60	0.91	0.74	0.01	0.59	0.91
Postgrad	0.84	0.23	0.64	1.12	0.83	0.19	0.63	1.09
Married	0.67	0.00	0.52	0.87	0.68	0.00	0.52	0.88
Smoking status	0.95	0.57	0.79	1.14	0.97	0.75	0.80	1.17
Nondrinker	1.30	0.04	1.01	1.67	1.28	0.06	0.99	1.65
Heavy drinker	1.23	0.09	0.97	1.55	1.23	0.08	0.97	1.55
Self-rated health	0.72	0.00	0.64	0.81	0.71	0.00	0.63	0.80
Neuroticism	1.00	0.95	0.95	1.04	0.99	0.70	0.95	1.04
SLE classes								
Moderate	1.42	0.00	1.16	1.73	1.38	0.00	1.13	1.68
High	1.22	0.25	0.87	1.70	1.18	0.33	0.84	1.67
Hassles classes								
Medium-stable					1.34	0.18	0.88	2.05
Medium-nonlinear					1.63	0.00	1.19	2.23
High stable					3.30	0.00	1.58	6.89

(95% CI [0.60, 0.91]), 0.67 (95% CI [0.52, 0.87]) and 0.72 (95% CI [0.64, 0.81]), respectively. In other words, those with some college education were 26% less likely to die, compared to those with just a high school education, while marriage conferred a 33% mortality benefit. For every increase in self-reported health rating, a 28% decrease in mortality was seen. In contrast, being a non-drinker was associated with a 30% increased risk in mortality, HR = 1.30, 95% CI [1.01, 1.67], while being a heavy drinker was only marginally associated, HR = 1.23, 95% CI [0.97, 1.55]. For the life events classes, the moderately high stressful life events class was associated with a 42% increase in mortality risk, HR = 1.42, 95% CI [1.16, 1.73], compared to those with consistently low stressful life events.

As can be seen in Model 2 in Table 3, two of the hassles trajectory classes were significantly associated with increased risk of mortality. Compared to those with low hassles class, those with medium nonlinear class had a 63% higher mortality risk, HR = 1.63, 95% CI [1.19, 2.23], while those with stable high hassles patterns were over three times as likely to die, HR = 3.30, 95% CI [1.58, 6.89].

Comparing the HR for the medium SLE trajectory class between the two models revealed only a slight decrease, 1.42, 95% CI [1.16, 1.73] to 1.38, 95% CI [1.13,1.68]. Thus, it appears that SLE and hassles intensity trajectory classes had largely independent effects on mortality.

4. Discussion

We examined whether hassles intensity trajectory classes mediated the effect of SLE trajectory classes on mortality, controlling for demographics, health behaviors, and neuroticism. We found that men in the moderate SLE trajectory class had a 40% higher mortality risk than those with a low trajectory of stressful life events. Those in the medium non-linear and chronically high hassles intensity classes were 63% and over three times as likely to die, respectively, compared to those in the low hassles intensity trajectory class. Contrary to expectations, the effects of the two different kinds of stress on mortality were largely independent. Thus, one's pattern of experiencing major life events and perceiving one's every-day life as stressful both have harmful effects on health.

There are a few possible explanations for why the effects of SLE and hassles trajectory classes on mortality were independent. The first possibility is that there may be different pathways through biomarkers or behaviors for the two types of stressors. However, our reading of the literature does not support this interpretation, as both life events and daily stressors appear to be related to biomarkers such as inflammatory factors (see Almeida et al., 2011; Epel et al., 2007; Gouin et al., 2012). To our knowledge, no one has explicitly compared whether these two types of stress affect biomarker pathways similarly, when assessing humans in a field setting.

The second explanation is that hassles and life events are simply different sources of stress, both of which are harmful to health. Although related, they are still sufficiently different aspects of stress and are able to contribute independently to mortality. This would be more in accord with the original Selye (1956) hypothesis that stress has similar effects on physiology, regardless of its source.

There are some interesting aspects of the data which need to be addressed. First, it is interesting that the SLE and hassles intensity trajectory classes showed similar but nonetheless divergent patterns. As can be seen in Table 2, the percentage of men with low hassles intensity trajectories decreased with the increase in the number of life events, from 21% for the "low–low" to 2% for the "high–low group." In contrast, the percent of men with moderate hassles intensity quadrupled with increasing life events, from 4% from the "low–medium" group to 16% from the "high–medium." This supports Pearlin et al.'s (1981) observation of stressors spreading across domains. At higher levels of hassles stress, however, the effect was surprisingly less pronounced. For example, the moderate non-linear hassles intensity class did increase with stress levels, but only from 74% to 82%, while the chronically high hassles showed little relationship with life events. In part, the number of men in this group was too low (n = 14) to draw firm conclusions. Nonetheless, it was interesting that there were no men who had both high levels of life events and high levels of hassles. Perhaps that was because men who have very high levels of stress from multiple sources do not survive into later life. Or perhaps the very high levels of hassles intensity scores reflect ongoing chronic strain, and for men who are overwhelmed, the demands of daily living may be less likely to make major changes in their lives.

The second interesting finding was the nonlinear relation between stress level and mortality. For hassles intensity, the HR doubled from 1.61 to 3.3 going from the medium to the high hassles intensity group. However, this should be interpreted with caution, given the small sample size in the highest group. For the SLE trajectory classes, those in the moderate class were 41% more likely to die than those in the low SLE class, but those in the high class were not significantly different from the low class, contrary to Aldwin et al.'s (2011) findings. This may be due to a couple of possibilities. First, the sample size in this study was smaller, due to the focus on hassles trajectories, dropping from 210 men in the high SLE group in the earlier paper to 136 men in this study, and so we may not have had the power to accurately assess hazard ratios in this group. Further, the HR was reduced to 1.23 while in the earlier study it was 1.49. In the earlier study we examined mortality from 1986 onward, while in this study we tracked mortality from 1990 onward, as hassles were not measured until 1989. Thus, those who had experienced earlier mortality in the high SLE trajectory groups were not included in this study.

There are a number of limitations to this study. First, the sample included only men, most of European-American descent, and results may differ in samples with women and greater ethnic diversity. There is evidence to suggest that there are complex patterns of gender differences in vulnerability to and responses to stress, which may vary by pre- or post-menopausal status in women (Almeida et al., 2011; Prather et al., 2009). Similarly, there are also complex patterns of stress vulnerability and resilience in different ethnic groups, including differences in exposure and reactivity (Jackson et al., 2010; Keane et al., 1996). Thus, it is likely that we have underestimated the effects of stress on mortality that might be seen in a more diverse sample.

In addition, we only tested one potential mediator, hassles, and it is possible that there may be bidirectional relationships. For example, it is possible that high levels of hassles may lead to life events, as when chronic marital role strain results in divorce. However, the relative independence of life events and hassles in predicting mortality suggests that

this may not be of central importance relative to the question we are addressing. The same cannot be said, however, for the issue of causal directionality between stress and mortality. While we did eliminate the health items from the life events scale, the hassles scale did not have any items which were specifically health related. It is possible that those in poor health had more problems with activities of everyday living, resulting in more hassles and higher mortality. However, the fact that we controlled for self-rated health mitigates this possibility.

Further, in any analysis of longitudinal data, there is always a dialectic between including every possible covariate and sample size. While we judiciously used multiple imputation to maintain our sample size, it is possible that different sets of covariates might have altered the results. Understanding the relationships among stress, biomarkers, morbidity and mortality is of particular importance, especially considering biomarkers that are affected by stress, such as cholesterol levels, blood pressure, and inflammatory processes (cf., Juster et al., 2010; Steptoe and Kivimäki, 2013). Rather than covarying out biomarkers, however, we feel that it is more important to understand how stress-linked biomarker and changes in these biomarkers may mediate the relationship between stress and mortality, and we are currently exploring this approach.

Nonetheless, we believe that this study is important in that it is the first study to show that stressful life events and hassles have independent effects on mortality. Understanding the long-term patterns of stress over time provides better predictive value than studies which have a single assessment of stress. Future research should address the issue of why these effects are largely independent, perhaps by contrasting their effects on different biomarker pathways.

References

Aldwin, C.M., 1990. The elders life stress inventory (ELSI): egocentric and nonegocentric stress. In: Stephens, M.A.P., Crowther, J.H., Hobfoll, S.E., Tennenbaum, D.L. (Eds.), Stress and Coping in Later Life Families. Hemisphere, New York, pp. 49–69.

Aldwin, C.M., 2007. Stress, Coping, and Development: An Integrative Perspective, 2nd ed. Guilford Press, New York.

Aldwin, C.M., 2011. Stress and coping across the lifespan. In: Folkman, S. (Ed.), Oxford Handbook of Stress, Health, & Coping. Oxford University Press, New York, pp. 15–24.

Aldwin, C.M., Gilmer, D.F., 2012. Health, Illness and Optimal Aging: Biological and Psychosocial Perspectives, 2nd ed. Springer, New York, NY.

Aldwin, C.M., Levenson, M.R., Spiro Ill, A., Bossé, R., 1989. Does emotionality predict stress? Findings from the Normative Aging Study. J. Pers. Soc. Psychol. 56, 618–624.

Aldwin, C.M., Molitor, N.-T., Spiro III, A., Levenson, M.R., Molitor, J., Igarashi, H., 2011. Do stress trajectories predict mortality in older men? Longitudinal findings from the VA Normative Aging Study. J. Aging Res. 1–10. http://dx.doi.org/10.4061/2011/896109.

Aldwin, C.M., Jeong, Y.-J., Igarashi, H., Spiro III, A., 2014. Do hassles and uplifts change with age? Longitudinal findings from the VA Normative Aging Study. Psychol. Aging 29, 57–71. http://dx.doi.org/10.1037/a0035042.

Almeida, D.M., Piazza, J., Stawski, R.S., Klein, L.C., 2011. The speedometer of life: stress, health and aging, In: Schaie, K.W., Willis, S.L. (Eds.), Handbook of the Psychology of Aging, 7th ed.Elsevier, Oxford, pp. 191–206. http://dx.doi.org/10.1016/8978-0-12-380882-0.00012-7.

Baron, R.M., Kenny, D.A., 1986. The moderator–mediator variable distinction in social psychological research: conceptual, strategic and statistical considerations. J. Pers. Soc. Psychol. 51, 1173–1182.

Bossé, R., Aldwin, C.M., Levenson, M.R., Spiro III, A., Mroczek, D.K., 1993. Change in social support after retirement: longitudinal findings from the Normative Aging Study. J. Gerontol. Psychol. Sci. 48, P210–P219.

Butcher, J.N., Aldwin, C.M., Levenson, M.R., Ben-Porath, Y.S., Spiro III, A., Bossé, R., 1991. Personality and aging: a study of the MMPI-2 among older men. Psychol. Aging 6, 361–370.

Carmines, E.G., Zeller, R.A., 1979. Reliability and Validity Assessment. Sage Publications, Thousand Oaks, CA.

Cherlin, A.J., Burton, L.M., Hurt, T.R., Purvin, D.M., 2004. The influence of physical and sexual abuse on marriage and cohabitation. Am. Sociol. Rev. 69, 768–789. http://dx.doi.org/10.1177/000312240406900602.

Cohen, S., Janicki-Deverts, D., Miller, G.E., 2007. Psychological stress and disease. Am. Med. Assoc. 298, 1685–1687.

De Labry, L.O., Glynn, R.J., Levenson, M.R., Hermos, J.A., LoCastro, J.S., Vokonas, P.S., 1992. Alcohol consumption and mortality in an American male population: recovering the U-shaped curve — findings from the Normative Aging Study. J. Stud. Alcohol 53, 25–32.

DeLongis, A., Coyne, J.C., Dakof, G., Folkman, S., Lazarus, R.S., 1982. Relationship of daily hassles, uplifts, and major life events to health status. Health Psychol. 1, 119–136.

DeLongis, A., Folkman, S., Lazarus, R., 1988. The impact of daily stress on health and mood: psychological and social resources as mediators. J. Pers. Soc. Psychol. 54, 486–495.

Dohrenwend, B.S., Dohrenwend, B.P., Dodson, M., Shrout, P.E., 1984. Symptoms, hassles, social support, and life events: problem of confounded measures. J. Abnorm. Psychol. 93, 222–230.

Epel, E.S., Burke, H.M., Wolkowitz, O.M., 2007. The psychoneuroendocrinology of aging: anabolic and catabolic hormones. In: Aldwin, C.M., Spiro III, A., Park, C. (Eds.), Handbook of Health Psychology and Aging. Guilford Press, New York, pp. 119–141.

Floderus, B., 1974. Psychological factors in relation to coronary heart disease and associated risk factors. Nord. Hyg. Tidskr. Suppl. 6.

Gouin, J.-P., Glaser, R., Malarkey, W., Beversdorf, D., Kiecolt-Glaser, J., 2012. Childhood abuse and inflammatory responses to daily stressors. Ann. Behav. Med. 44, 287–292. http://dx.doi.org/10.1007/s12160-012-9386-1.

Hatch, S.L., Dohrenwend, B.P., 2007. Distribution of traumatic and other stressful life events by race/ethnicity, gender, SES and age: a review of the research. Am. J. Community Psychol. 40, 313–332. http://dx.doi.org/10.1007/s10464-007-9134-z.

Hay, E.L., Diehl, M., 2010. Reactivity to daily stressors in adulthood: the importance of stressor type in characterizing risk factors. Psychol. Aging 25, 118–131. http://dx.doi.org/10.1037/a0018747.

Hollis, J.F., Connett, J.E., Stevens, V.J., Greenlick, M.R., 1990. Stressful life events, type A behavior, and the prediction of cardiovascular and total mortality over six years. J. Behav. Med. 13, 263–280.

Holmes, T.H., Rahe, R.H., 1967. The social readjustment scale. J. Psychosom. Res. 11, 213–218.

Jackson, J.J., Knight, K.M., Rafferty, J.A., 2010. Race and unhealthy behaviors: chronic stress, the HPA axis, and physical and mental health disparities over the life course. Am. J. Public Health 100, 933–939. http://dx.doi.org/10.2105/AJPH.2008.143446.

Jandorf, L., Deblinger, E., Neale, J.M., Stone, A.A., 1987. Daily versus major life events as predictors of symptom frequency: a replication study. J. Gen. Psychol. 113, 205–218.

Jeong, Y., Aldwin, C.M., Igarashi, H., Spiro III, A., 2012. Trajectories of hassles and uplifts in relation to mortality: the VA Normative Aging Study. Poster Presentation at the Annual Meeting of the Gerontological Society of America, San Diego, CA (November).

Jones, B.L., Nagin, D.S., Roeder, K., 2001. A SAS procedure based on mixture models for estimating developmental trajectories. Sociol. Methods Res. 29, 374–393.

Juster, R.-P., McEwen, B.S., Lupien, S.J., 2010. Allostatic load biomarkers of chronic stress and impact on health and cognition. Neurosci. Biobehav. Rev. 35, 2–16. http://dx.doi.org/10.1016/j.neubiorev2009.10.002.

Kanner, A.D., Coyne, J.C., Schaefer, C., Lazarus, R.S., 1981. Comparison of two modes of stress measurement: daily hassles and uplifts versus major life events. J. Behav. Med. 4, 1–39.

Keane, T.M., Kaloupek, D.G., Weathers, F.W., 1996. Ethnocultural considerations in the assessment of PTSD. In: Marsella, A.J., Friedman, M.J., Gerrity, E.T., Scurfield, R.M. (Eds.), Ethnocultural Aspects of Posttraumatic Stress Disorder: Issues, Research, and Clinical Applications. American Psychological Association, Washington, DC, pp. 183–205. http://dx.doi.org/10.1037/10555-007.

Kopp, M.S., Rethelyi, J., 2004. Where psychology meets physiology: chronic stress and premature mortality — the Central-Eastern European health paradox. Brain Res. Bull. 62, 351–367.

Lantz, P.M., House, J.S., Mero, R.P., Williams, D.R., 2005. Stress, life events, and socioeconomic disparities in health: results from the Americans' Changing Lives Study. J. Health Soc. Behav. 46, 274–288.

Maunsell, E., Brisson, J., Mondor, M., Verreault, R., Deschênes, L., 2001. Stressful life events and survival after breast cancer. Psychosom. Med. 63, 306–315.

Nagin, D.S., 1999. Analyzing developmental trajectories: a semiparametric, group-based approach. Psychol. Methods 4, 139–157.

Nielsen, N.R., Kristensen, T.S., Schnohr, P., Grønbaek, M., 2008. Perceived stress and cause-specific mortality among men and women: results from a prospective cohort study. Am. J. Epidemiol. 168 (5), 481–491. http://dx.doi.org/10.1093/aje/kwn157.

Pearlin, L.I., Lieberman, M.A., Menaghan, E.G., Mullan, J.T., 1981. The stress process. J. Health Soc. Behav. 22, 337–356.

Pearlin, L.I., Aneshensel, C.S., Mullan, T., Whitlatch, C.J., 1996. Caregiving and its social support, In: Binstock, R.H., George, L.K. (Eds.), Handbook of Aging and the Social Science, 4th ed.Academic Press, San Diego, CA, pp. 283–302.

Phillips, A.C., Der, G., Carroll, D., 2008. Stressful life-events exposure is associated with 17-year mortality, but it is health related events that prove predictive. Br. J. Health Psychol. 13, 647–657.

Piazza, J.R., Charles, S.T., Sliwinski, M.J., Mogle, J., Almeida, D.M., 2013. Affective reactivity to daily stressors and long-term risk of reporting a chronic physical health condition. Ann. Behav. Med. 45 (1), 110–120. http://dx.doi.org/10.1007/s12160-012-9423-0.

Prather, A.A., Carroll, J.E., Fury, J.M., McDade, K.K., Ross, D., Marsland, A.L., 2009. Gender differences in stimulated cytokine production following acute psychological stress. Brain Behav. Immun. 23, 622–628.

Rosengren, A., Orth-Gomér, K., Wedel, H., Wilhelmsen, L., 1993. Stressful life events, social support, and mortality in men born in 1933. Br. Med. J. 307, 1102–1105.

Schroeder, D.H., Costa, P.T., 1984. Influence of life event stress on physical illness: substantive effects or methodological flaws? J. Pers. Soc. Psychol. 46, 853–863. http://dx.doi.org/10.1037/0022-3514.46.4.853.

Selye, H., 1956. The Stress of Life. McGraw-Hill, New York, NY.

Spiro III, A., Bossé, R., 2001. The Normative Aging Study, In: Maddox, G. (Ed.), Encyclopedia of Aging, 3rd ed.Springer, New York, pp. 744–746.

Stanley, R.O., Burrows, G.D., 2008. Psychogenic heart disease, stress and the heart: a historical perspective. Stress. Health 187, 181–187. http://dx.doi.org/10.1002/smi.

StataCorp, 2013. Stata Statistical Software: Release 13. StataCorp LP, College Station, TX.

Steptoe, A., Kivimäki, M., 2013. Stress and cardiovascular disease: an update on current knowledge. Annu. Rev. Public Health 34, 337–354. http://dx.doi.org/10.1146/annurev-publhealth-031912-114452.

Stringhini, S., Batty, G.D., Bovet, P., Shipley, M.J., Marmot, M.G., Kumari, M., Tabak, A.G., Kivima, M., 2013. Association of life course socioeconomic status with chronic inflammation and type 2 diabetes risk: the Whitehall II Prospective Cohort Study. PLoS Med. 10, e1001479. http://dx.doi.org/10.1371/journal.pmed.1001479.

Turner, H.A., Turner, R.J., 2005. Understanding variations in exposure to social stress. Health 9, 209–240.

Vinnard, C., Wileyto, E.P., Bisson, G.P., Winston, C.A., 2013. First use of multiple imputation with national tuberculosis surveillance system. Epidemiol. Res. Int. 1–6. http://dx.doi.org/10.1155/2013/875234.

Weinberger, M., Hiner, S.L., Tierney, W.M., 1987. In support of hassles as a measure of stress in predicting health outcomes. J. Behav. Med. 10, 19–31.

Wheaton, B., 1996. The nature of chronic stress. In: Gottlieb, B.H. (Ed.), Coping With Chronic Stress. Plenum, New York, pp. 343–374.

Yamashita, J., 2011. A Review of Psychosocial Assessments for Disaster Mental Health Studies. 4 (6), 560–567. http://dx.doi.org/10.1037/a0025952 (Nov 2012).

Zautra, A.J., 2003. Emotions, Stress and Health. Oxford University Press, New York.