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New Directions in Aging

Advancing Research on Psychosocial Stress and Aging with the Health and Retirement Study: Looking Back to Launch the Field Forward

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Abstract

Objectives: The Health and Retirement Study (HRS) was designed as an interdisciplinary study with a strong focus on health, retirement, and socioeconomic environment, to study their dynamic relationships over time in a sample of mid-life adults. The study includes validated self-report measures and individual items that capture the experiences of stressful events (stressor exposures) and subjective assessments of stress (perceived stress) within specific life domains.
Methods: This article reviews and catalogs the peer-reviewed publications that have used the HRS to examine associations between psychosocial stress measures and psychological, physical health, and economic outcomes.
Results: We describe the research to date using HRS measures of the following stress types: traumatic and life events, childhood adversity, caregiving and other chronic stressors, discrimination, social strain and loneliness, work stress, and neighborhood disorder. We highlight how to take further advantage of the longitudinal study to test complex biopsychosocial models of healthy aging.
Discussion: The HRS provides one of the most comprehensive assessments of psychosocial stress in existing population-based studies and offers the potential for a deeper understanding of how psychosocial factors are related to healthy aging trajectories. The next generation of research examining stress and trajectories of aging in the HRS should test complex longitudinal and mediational relationships, include contextual factors in analyses, and include more collaboration between psychologists and population health researchers.

Keywords: Aging, Measurement, Population health, Psychosocial, Stress

Experiencing stress is an unavoidable and integral part of life though adequately defining the experience is difficult. Here, we define stress as an emergent process in which a person responds to an external event or stimuli that is challenging; the existence of that event or stimuli (the exposure) can be differentiated from the person's anticipation and reaction to it (the response). Stressor exposures are experiences of events or stimuli that have the potential and likelihood of being threatening or challenging because its mere existence calls in to question the integrity of the organism (Wheaton, Young, Montazer, & Stuart-Lahman, 2013). A subjective stress response is the perception of being overwhelmed or taxed by the environmental conditions, often conceptualized as the perception that the demands of the situation outweigh one's resources to cope with it (Lazarus & Folkman, 1984). The Health and

Retirement Study (HRS) captures both stressor exposures and subjective stress responses across the lifespan and in a range of life domains (e.g. home life and work), providing one of the most comprehensive assessments of psychosocial stress in existing population-based studies.

The HRS was launched in 1992 to track the health, economics, and demographics of aging and the retirement process in aging adults in the United States (for further methodological and sample details see https://hrs.isr.umich.edu/documentation). In 2004, a new questionnaire was piloted to capture psychological, social, and lifestyle measures via a self-completed survey that were left with respondents after their in-person Core Interview. This survey is the Psychosocial and Lifestyle Questionnaire, which is also referred to as the "Leave Behind Questionnaire" because it was left for participants to self-complete after their in-person interview (see Smith, Ryan, Fischer, Sonnega, & Weir, 2017 for a complete description). Starting from 2006, this questionnaire is completed by participants every 4 years, though there are two subsamples that are sampled at different years. Specifically, a random 50% participants were sampled in 2006, and the other 50% in 2008—the original sample is then surveyed every 4 years (e.g. HRS subsample 1: 2006, 2010, 2014; HRS subsample 2: 2008, 2012, 2016). For a helpful figure describing this methodology and timeline of the Psychosocial and Lifestyle Questionnaire, see Figure 2 of Smith and colleagues (2017). Although most of the stress measures reviewed in this article were initially included in 2004, that is not true for all measures, as some were included in earlier waves and some were added later.

The HRS's multi-domain assessment of stressor exposure and stress responses, combined with the longitudinal design and the large sample size, creates the opportunity to test models that associate stress with aging-related outcomes such as health and economic well-being. The measurement of stress within the HRS can be categorized into the following types of stress: traumatic and stressful life events, childhood adversity, chronic stressors (i.e. caregiving and ongoing health problems), discrimination, social strain and loneliness, work stress, and neighborhood disorder. There is at least one measure within each of these categories in the HRS, with many of them added in 2006 via the Lifestyle Questionnaire. The measures of stress within the HRS include measures of stressor exposures (e.g. whether a trauma happened, like death of a child; Lifetime Trauma List), subjective or perceived stress (e.g. whether one feels lonely; UCLA Loneliness Scale), and a combination of the two (e.g. frequency of experiences of discrimination; Everyday Discrimination Scale). Social isolation and loneliness are conceptualized as types of "stress" because lacking supportive relationships increases an individual's psychological and physical risk from an evolutionary perspective (as there is safety in groups) and increases the effort needed to achieve goals (because there is no help from others in achieving them; Coan & Sbarra, 2015). Furthermore, the need to form and maintain positive, stable interpersonal relationships is argued to be a fundamental human motivation (Baumeister & Leary, 1995) and is a core component of nearly all models of optimal mental health functioning (e.g. Ryff & Singer, 1998).

The scope of this review focuses on psychosocial stressors to add to the body of research identifying how acute or chronic psychological and social difficulties shape aging trajectories. Psychosocial stressors can be external stressor exposures such as witnessing violence and can also be internally generated stressors, such as perceiving a threat or ruminating on a past event (see Figure 1 in Epel et al., 2018). Both of the processes—stressor exposures and subjective stress appraisals—can elicit biological responses (e.g. an inflammatory response) similar to what occurs after a biological insult like an infection. Despite similar biological responses between psychosocial stress and biological insults, however, the fundamental experiences of each are hugely different. Thus, we decided to not cover infection or other physiological external exposures that in some literatures are considered "stressors" because that is beyond the scope of our goal of contributing to the understanding of how psychosocial stress in particular influences aging. For a more complete description of the theoretical and empirically known links between psychosocial stress and biological aging as well as a detailed description of psychosocial stress measurement, see Epel and colleagues (2018).

Despite these strengths, the number of peer-reviewed manuscripts that have taken advantage of the stress measures in HRS remains small compared to all publications using this publically available data. Only 5% of all studies published on the HRS have primary hypotheses based on measures of stressor exposure or stress response. This percentage is calculated by dividing the number of studies that used stress measures by the total number of publications in the HRS online bibliography since 2006 (when psychosocial items were added to HRS) until May 31, 2018 (i.e. 225/4,263 × 100 = 5.30%). The purpose of this article was to catalogue existing peer-reviewed publications that have used these measures to describe how the HRS has been used thus far to examine stress and aging, and to highlight areas that warrant more comprehensive exploration. We conclude with recommendations for the next generation of studies that will use the HRS to examine how psychosocial factors influence trajectories of aging. We take a qualitative instead of quantitative approach to summarizing results to provide the needed context for the primary purpose of the article—describing how to use HRS to move the field of stress science forward.

Methods

We searched for manuscripts that examined associations between stress measures and aging outcomes in the HRS that were published online before May 1, 2018. As part of a previous project, our team had identified scales that capture components of stress exposure or response in the HRS

by reviewing every item at every assessment point. Each measure is described in detail in one product of this project, the HRS Stress Harmonization User Manual, which can be found along with the downloadable data at the Gateway to Global Aging project website (www.g2aging.org). We conducted a literature search by identifying all peer-reviewed studies using the HRS that included one or more of these stress measures in their primary hypotheses. We used the HRS online bibliography tool, PubMed, and GoogleScholar to identify the publications.

Overall, there are 225 unique published studies that conducted analyses with at least one stress measure in their primary hypotheses using the HRS data. The results, including a summary of each study by outcome category, from this literature search are presented in Table 1 and Supplementary Tables 1–7. The majority of studies focused on the stress categories of loneliness, work stress, and discrimination; the top five most commonly used scales were the UCLA-R Loneliness Scale (n = 33 studies; Russell, Peplau, & Cutrona, 1980), the Everyday Discrimination Scale (n = 33 studies; Williams, Yan Yu, Jackson, & Anderson, 1997), a measure capturing ongoing chronic stressors (n = 23 studies; Troxel, Matthews, Bromberger, & Sutton-Tyrrell, 2003), items capturing social support and social strain (n = 23), and the Job Demands and Control Scale (n = 22; Karasek et al., 1998).

The outcomes used in these studies can be organized into six categories: cognitive function (e.g. episodic memory and cognitive impairment), economic outcomes (e.g. wealth, debt, income, disability, financial risk-taking, and retirement plans), physical health (e.g. self-reported morbidity, mortality, self-rated health, activities of daily living, and physician visits), health behaviors (e.g. smoking, alcohol consumption, and sleep), biomarkers of disease (e.g. blood pressure and telomere length), and psychological well-being (e.g. depressive symptoms and life satisfaction). We also included studies that presented descriptive statistics of stress measures by demographic category. Nearly one-third of studies reported on psychological outcomes (n = 73) and on physical health (n = 71) outcomes. Thirty-six studies examined the impact of stress on health biomarkers of disease (14%), 26 on health behaviors (10%), 25 on variation across demographic groups (10%), 16 on economic outcomes (6%), and 11 on cognitive function (4%). The most frequently studied outcomes overall were depressive symptoms, blood pressure, alcohol consumption, mortality, and self-reported physical health. Of note, studies that included multiple outcome categories were counted twice and thus although there were 225 unique studies, 258 are listed in Table 1 and used as the basis of the percentages described in this paragraph.

Results

In the following section, we describe what stress measures and outcomes have been the focus of publications from the HRS. We provide a high-level description of study results, with detailed descriptions of each study provided in Supplementary Materials. In-text citations are included when needed to clarify the sentence or there were less than three studies to support that statement, and otherwise refer to the Supplementary Materials for specific citations.

Cognitive Functioning

Eleven studies examined the relationship between stress and cognitive functioning. Cognitive function is assessed over the phone using a mini-mental state exam that assessed memory (e.g. immediate and delayed recall of words) and general mental status (count backward as quickly as possible from 86). The items in the HRS cognitive battery were adapted from the Telephone Interview of Cognitive Status (Brandt, Spencer, & Folstein, 1988). A full description of the cognitive functioning measures in the HRS was written by Ofstedal, Fisher, and Herzog (2005) and a critique of them is provided by Lachman and Spiro (2002). A chief critique of the battery is that it is heavily focused on knowledge and orientation items, and thus may be most useful for identifying those with some degree of cognitive impairment, whereas having limited sensitivity to capture the range of cognitive functioning in non-impaired adults.

Despite the potential lack of sensitivity of the cognitive outcomes, results from several studies have found associations between greater stress exposure and/or perceptions and worse cognitive function. Specifically, reporting greater job strain and lower job control 10 years before retirement was negatively associated with episodic memory at retirement, and an accelerated rate of cognitive decline over 18 years (Andel et al., 2015; Fisher et al., 2014). Loneliness predicted accelerated cognitive decline over time, measured by a composite score of time orientation, semantic memory, working memory, and immediate and delayed recall (Ayalon, Palgi, Avidor, & Bodner, 2016; Donovan et al., 2017). Chronic stress from spousal caregiving was associated with lower cognitive functioning measured by a composite score of time orientation, semantic memory, working memory, immediate recall, and delayed recall (Pertl, Lawlor, Robertson, Walsh, & Brennan, 2015). Early-life adversity was associated with a steeper decline in working memory over a 12-year period (i.e. decline in immediate recall and delayed recall scores; Zhang, Hayward, & Yu, 2016). Of note, there are no published studies testing the relationship between discrimination, or neighborhood stressors, and cognitive functioning, suggesting that these may be areas left for exploration.

Economic Outcomes

Sixteen studies examined the relationship between stress and economic outcomes. Economic outcomes are financial risk-taking, social security disability insurance, retirement

Table 1. Number of Health and Retirement Study (HRS) Publications by Outcome Category and Stress Measure

		Outcomes							
Stress domains	Scales	Cognitive function	Economic	Physical health	Health behaviors	Biomarkers of disease	Psychological well-being	Descriptive	Total
Traumatic and life events	Lifetime Trauma List (Krause, Shaw, & Cairney, 2004)	0	1	1	0	3	3	1	10
	Social Readjustment Rating Scale (Holmes & Rahe, 1967)	0	0	0	0	0	0	0	0
	Event History Questionnaire (Turner, Wheaton, & Lloyd, 1995)	0	0	1	1	3	4	1	10
Chronic stress	Caregiving items (source unknown)	1	2	3	2	1	5	1	15
	Ongoing chronic stressors (Troxel et al., 2003)	0	1	5	4	2	11	1	24
Childhood adversity	Maternal warmth items (Rossi, 2001)	0	0	0	0	0	0	0	0
	Childhood adversity (3 Lifetime Trauma List items)	0	0	1	0	2	1	0	4
	Childhood adversity (7 Event History Questionnaire items)	1	0	0	0	1	1	1	4
	Childhood health status (source unknown)	1	0	3	1	0	1	0	6
	Childhood socioeconomic status (source unknown)	1	0	4	1	0	1	0	7
Discrimination	Everyday discrimination (Williams et al., 1997) (Kessler, Mickelson, Williams, & Kessler, 1999)	0	1	10	2	8	7	3	31
	Major Lifetime Discrimination (Williams et al., 1997)	0	0	3	0	1	1	3	8
	Work Discrimination Scale (Williams et al., 1997)	0	1	0	0	1	0	0	2
Social strain	UCLA Loneliness Scale–revised (Russell et al., 1980)[a]	3	0	9	3	3	12	3	33
	CES-D Scale (single item on loneliness; Radloff, 1977)	0	1	3	1	0	1	3	9
	Social Network Index (Turner, Frankel, & Levin, 1983)	0	0	5	2	3	5	1	16

Table 1. *Continued*

Stress domains	Scales	Outcomes							
		Cognitive function	Economic	Physical health	Health behaviors	Biomarkers of disease	Psychological well-being	Descriptive	Total
	Social support and social strain (Schuster, Kessler, & Aseltine, 1990)	2	0	6	3	3	8	1	23
Work stress	Job demands and control (Karasek et al., 1998)	2	6	5	1	1	6	2	23
	Work/life tension (MacDermid et al., 2000)	0	1	0	0	0	1	0	2
	Work discrimination (Williams et al., 1997)	0	0	0	0	1	0	0	1
	Effort–reward imbalance (Siegrist et al., 2004)	0	1	2	0	0	3	1	7
	Work social support (Eisenberger, Stinglhamber, Vandenberghe, Sucharski, & Rhoades, 2002; Haynes, Wall, Bolden, Stride, & Rick, 1999)	0	1	1	0	0	1	1	4
Neighborhood characteristics	Neighborhood physical disorder (Cagney et al., 2009)	0	0	1	3	1	1	1	7
	Perceived social cohesion (Cagney et al., 2009)	0	0	3	1	1	0	1	6
	Perceived neighborhood safety (single item; source unknown)	0	0	2	1	0	0	0	3
	Economic/social/built environment (for a theoretical source see Taylor, Repetti, and Seeman [1997])	0	0	2	0	1	0	0	3
Total		11	16	71	26	36	73	25	258

Note: The total number of publications listed in the table exceeds the unique number of publications because some manuscripts had outcomes that fell into more than one category. Citations for scales were taken from the HRS Psychosocial and Lifestyle Questionnaire 2006–2010 Documentation Report Core Section LB, which also provides details on each item's wording, response scale, and scoring (Smith et al., 2017), though not all scales listed here were included in that report given that some measures were administered in previous study waves. CES-D = Center for epidemiological studies depression scale.

[a]In the 2008 and 2010 waves, there were eight additional loneliness items added from Hughes, Waite, Hawkley, and Cacioppo (2004).

plans, household income, accumulated wealth, assets, debts, and expenditures. Trauma exposure, discrimination, loneliness, chronic stress, and work stress were each associated with a variety of financial behaviors such as less frequent risk-taking in investments, lower probability of applying for social security disability insurance, earlier retirement plans, and lower household wealth and household income. Although educational level may be the most important contextual factor for determining economic well-being outcomes across the lifespan, there is tremendous variance within education level; these studies indicate that stressor exposure is also associated with economic well-being and

the HRS data could be used to further examine the extent to which stressful experiences across the lifespan influence economic outcomes.

Physical Health

Seventy-one studies examined the relationship between stress and physical health. Physical health outcomes are self-reported health, self-reported illness diagnoses, physician visits, overnight hospital visits, functional impairment, and mortality. Reporting greater traumatic event exposure, early adversity, discrimination, loneliness, work stress, neighborhood physical disorder, and lower neighborhood safety were associated with greater health care utilization, worse self-reported health and functioning, and greater risk of disease diagnosis and mortality. Associations between stress measures and physical health outcomes have been well-studied in HRS, providing epidemiological evidence for associations between greater stress across the lifespan and increased disease risk. These studies provide the basis for examining the "off-diagonals"—the people who have similar exposures but do not develop the risk factors or disease, as well as pathways by which stressor exposure "gets under the skin" to influence disease states.

Health Behaviors

Twenty-six studies examined the relationship between stress and health behaviors. The specific health behaviors are sleep, alcohol use, smoking, and physical activity. Reporting greater trauma exposure, work stress, every day and lifetime discrimination, loneliness, neighborhood physical disorder, and lower neighborhood safety were each associated with worse health behaviors. In this set of studies, and the broader literature, health behaviors can act as mechanistic mediators linking stress exposures to worse outcomes over time. For example, Latham and Williams (2015) found that barriers to physical activity partially mediated the association between neighborhood physical disorder and recovery from mobility limitations over 2 years in a subsample of older adults from the HRS. Identifying physical activity as a significant reason neighborhood disorder slows physical recovery from an injury or disease helps direct intervention development. Importantly, there are no published studies on the relationship between early adversity and health behaviors using HRS data despite health behaviors being a proposed pathway linking stress in childhood to chronic illness in adulthood. The relationship between stress and health behaviors is an understudied and critical pathway in determining aging outcomes. The HRS should be used to examine life-course relations between stress exposures (both childhood and adulthood events), health behaviors, and aging outcomes.

Biomarkers

Thirty-six studies examined the relationship between stress and biomarkers. The biomarkers are blood pressure, glycemic control, C-reactive protein (CRP), telomere length, and conserved transcriptional response to adversity (CTRA) gene expression. Everyday discrimination, adult trauma exposure, and childhood adversity were associated with higher levels of circulating CRP; CRP is a marker of inflammation, and chronically high inflammation is predictive of cardiovascular disease risk (e.g. Wirtz & von Känel, 2017). Greater loneliness was associated with upregulation of genomic pattern indicative of a conserved CTRA, and loneliness moderated the relationship between APoE24 and cognitive functioning. This genomic profile is characterized by an upregulation of pro-inflammatory genes and downregulation of innate antiviral and antibody-related genes in peripheral blood leukocytes (Cole, 2013). Greater childhood adversity, everyday and lifetime discrimination, and marital disruption (i.e. divorce and separation) were related to shorter telomere length. Telomeres are DNA–protein complexes that cap chromosomal ends with shorter telomeres indicate fraying of the chromosomal cap. Telomere length is used as a biomarker of cellular aging and positively associated with psychosocial stress (Epel et al., 2004). Higher lifetime discrimination, chronic stress, loneliness, and work stress were each associated with higher resting blood pressure cross-sectionally, and some studies showed prospective relationships (e.g. Birditt, Newton, Cranford, & Ryan, 2016; Mezuk, Kershaw, Hudson, Lim, & Ratliff, 2011). The biomarker outcomes are a more recent addition to the HRS, and data are starting to be well used. Further analyses on biomarkers can address both how stress and economic factors shape biomarkers, and how well biomarkers predict disease and mortality. Most of the manuscripts using the stress variables in the HRS have been published in the last 2 years, coinciding with the release of biomarker data. The increasing number of stress and health focused publications provides support for the generative potential of this rich, publicly available biopsychosocial data source.

Psychological Well-being

Seventy-three studies reported positive relationships between stressor exposures and/or subjective stress and psychological well-being. The psychological outcomes in these studies are negative affect-related outcomes (i.e. depressive symptoms, hopelessness, anxiety, anger, and loneliness), positive well-being outcomes (i.e. mastery, life satisfaction, eudaimonia, optimism, sense of control, and conscientiousness), as well as self-reported mental health diagnosis, daily emotional experiences, marital relationship quality, and presenteeism (workers who are sick but still working). The most commonly used measures of stress were the UCLA Loneliness Scale, ongoing chronic stressors, social support and social strain, and the Job Demands and

Control scale. One of the key outcomes has been depressive symptoms, with studies showing that across various stress measures, higher reported stress in these categories was significantly associated with higher depressive symptoms at the same time point, and prospectively. A further thorough review is needed to look for converging and diverging results, what results suggest in terms of stress-resilience traits, and to use these findings to advance theoretical models of healthy aging.

Discussion

There are several recommendations we offer for the next generation of scientists who want to use HRS to test associations between stress measures and aging outcomes. The overarching need is to test more complex models of stress and aging trajectories, especially when using health as an outcome. The majority of the studies reviewed relied on a simplistic model of stress and health, testing and reporting linear associations between a handful of stress measures and a single domain of health. The first problem with this approach is that it ignores reciprocal relationships between predictor and outcome. As a simplistic example, although divorce may predict an increase in depressive symptoms, the alternative may be equally true, that an increase in depressive symptoms may predict divorce. The HRS offers the opportunity to test temporal dynamics between stressors and outcomes because of its longitudinal design though only a fraction of the over 200 papers reviewed here were longitudinal studies (for a nice example of how to take advantage of the longitudinal measurement see Queen, Butner, Berg, and Smith [2019]). The currently published articles also commonly describe potential pathways between predictors and outcomes without testing those pathways despite the availability of data to do that. Longitudinal analyses (and mediation models) should be more routinely used to test hypothesized paths between stress and aging outcomes. One potential difficulty in examining longitudinal trajectories is that for some psychosocial constructs, specific items and/or response scales were changed between waves. This happened rarely, and more often than not, items were added instead of taken away (details of these changes are described in Smith et al., 2017). For instances when response scales were changed, efforts should be made to harmonize across waves, which can be done on an item-by-item basis.

Furthermore, the context of a person's life has largely been ignored in these linear models of stress and aging despite knowledge that contextual factors influence the impact of stress. For example, there is compelling evidence that clinical diagnoses (e.g. depression and posttraumatic stress disorder), experiences of historical stress (e.g. history of traumatic events and adverse childhood events), current chronic stress (e.g. caregiving for an ill spouse), and developmental or life course stages act as background contextual factors that influence the effect of current stressor exposure on aging outcomes (Epel et al., 2018). These contextual factors need to be included in hypotheses of stress or accounted for in statistical models not merely by controlling for them, but also by testing them as moderators or mediators, or using them as exclusion criteria. For example, Sabbath, Mejía-Guevara, Noelke, and Berkman (2015) demonstrated that the association between cumulative work stress across the lifespan and mortality risk in women the HRS varied by family circumstances (marital status) because work stress is experienced alongside family and relationship circumstances. As another example, in longitudinal analyses of the HRS, Bucciol and Zarri (2015) found that experiencing a traumatic event predicted decreases in financial risk taking behavior for many years after the trauma, and that the type of trauma influenced how long the decreased financial risk taking lasted. The HRS offers an opportunity for researchers to test complex biopsychosocial models of health, and to consider how individual-level (and group-level) contextual factors influence aging trajectories. Researchers need to make conscious efforts to integrate literature from psychological (both health psychology and, importantly, social psychology), social epidemiological, and biological sciences to integrate findings and avoid building silos of understanding that are not situated within cross-disciplinary research fields.

Another recommendation is to move beyond single items or single constructs of stress in hypotheses and analytic models, and instead to examine underlying constructs of stressor exposure that may be responsible for its toxic effects on health. For example, Dickerson and Kemeny (2004) identified social evaluative threat (being negatively evaluated by others) as a core component of acute stress tasks that evoke a physiological stress response. Few other core components of stress have been empirically tested, though in theoretical models, several components have been suggested to be responsible for what makes stressors of various types toxic. These components include feeling physically and/or psychologically unsafe (Brosschot, Verkuil, & Thayer, 2018), uncertainty (Grupe & Nitschke, 2013), perseverative cognitions (Brosschot, Pieper, & Thayer, 2005), and when demands of the stressor outweigh available resources (Lazarus & Folkman, 1984). One or several of these core components may be the common denominator underlying experiences of stress that makes it harmful to health and well-being.

Categorizing and analyzing stress measures within these underlying constructs (e.g. threat of physical harm) instead of by life domain (e.g. work stress and relationship strain) may improve predictive models. For example, Palgi, Shrira, Ben-Ezra, Shiovitz-Ezra, and Ayalon (2012) classified traumatic events into self- and other-oriented events (e.g. being personally abused vs death of child), and then examined how these two types of events were differentially associated with loneliness in a subset of older adults from the HRS. As an example for future work, items that capture whether someone felt that they were physically in danger at different points across their lifespan could be selected

from a variety of stress measures such as a traumatic life events scale that asks about witnessing violence or being deployed in the military, a neighborhood measure that asks about sense of safety in the community, and a childhood adverse events measure that captures whether they were being physically abused in childhood. A composite of these "threat of physical harm" items could then be created and tested.

Alternatively, it has been proposed that it may be the accumulation of stressor exposures and accumulation of heightened stress responses across the lifespan that is most predictive of worse aging trajectories, regardless of the type of stressor exposures. Despite the potential to develop cumulative measures both across domains of stress and across the lifespan in the HRS, we are only aware of one study that has attempted this. Puterman and colleagues (2016) found that a cumulative measure of lifespan stress—adding up a range of severe financial, traumatic, and social exposures—predicted 6% greater odds of shorter telomere length, with most of the effect driven by stressful childhood events (Puterman et al., 2016).

As part of a National Institute on Aging sponsored effort to improve stress measurement in studies of aging, an initial typology of stress measures has been developed as a way to help researchers categorize and communicate the types of stress exposure and stress response measures they are using (see https://stresscenter.ucsf.edu/ for the latest version of this Stress Typology document). This outlines the characteristics of stressor exposures (e.g. timescale of the stressor, the life period in which it occurred, and the assessment window of the measurement tool used) that may be particularly impactful to health as well as the psychological and behavioral responses (e.g. appraisals and perceptions of the situation, and affective, emotional, and cognitive responses to it). Using the descriptive language presented in the typology when describing HRS stress-related publications would allow easier comparison of results both within HRS and between HRS families of studies.

Researchers should also move beyond the stress-disease lens to explore stress resilience factors. Although there is a solid body of work documenting relations between various stress exposures to these outcomes, most of this work examines main effects, and there is a tremendous amount of variance to be explained to show why highly exposed people stay healthy. The HRS offers an opportunity to explore under what circumstances people remain resilient to stress exposures. A separate body of literature has demonstrated that positive psychological constructs such as life satisfaction, optimism, mastery, purpose in life, and positive affect are positively related to better health outcomes in the HRS. For example, Sutin, Stephan, and Terracciano (2018) found that after controlling for traditional risk factors, purpose in life was associated with a 30% decreased risk of dementia incidence. However, interestingly, other positive psychosocial constructs were not related to dementia risk. Insights from these studies about when and for whom psychological resources are relevant for aging outcomes should be incorporated into models and analyses examining relationships among stress exposure and aging outcomes. There is also an opportunity to examine measures of positive health beyond just the absence of disease such as with outcomes such as subjective well-being, physical functioning, and perceived health status. Whether there is also a "resilient biomarker profile" is unknown, as healthy functioning may be the norm, with unhealthy functioning resulting in detectable alterations, though this may be explored in the HRS.

Finally, with the international cohorts that have modeled their study design and assessments on the HRS, there is the opportunity to explore cross-cultural questions about stress exposure (e.g. see Robinson, Sutin, & Daly, 2017; Tiedt, 2013). Future studies should conduct cross-cultural analyses of stress and aging outcomes using the HRS families of studies and harmonized data available at the Gateway to Global Aging Data website (g2aging.org). This provides an opportunity to test what is universal versus cultural about stress and aging. These studies are the Mexico Health and Aging Study (MHAS), English Longitudinal Study of Ageing (ELSA), the Survey of Health, Ageing, and Retirement in Europe (SHARE), the Costa Rican Longevity and Healthy Aging Study (CRELES), Korean Longitudinal Study of Aging (KLoSA), Japanese Study of Aging and Retirement (JSTAR), The Irish Longitudinal Study on Ageing (TILDA), China Health and Retirement Longitudinal Study (CHARLS), and the Longitudinal Aging Study in India (LASI).

To adequately take advantage of the opportunity the HRS affords to examine these complex relationships, it is important for psychological scientists who did not receive training in biostatistics and epidemiological methods to learn the specific methods for dealing with the complex issues present in working with large cohort studies. This includes considering and using survey weights, handling dropout over time, and using recent statistical tools for testing causal inference. Learning these new techniques is essential so that psychological scientists can contribute meaningfully to the broader social sciences body of work examining trajectories of aging in large cohort studies. These skills can be learned through coursework, workshops or seminars, and collaborating with population scientists.

An important limitation of this review (and one not unique to this area of research) is that the published articles focused on positive results, reporting few analyses that resulted in null associations. This is not to say that no null associations were reported. For example, Andel and colleagues (2015) reported that job strain was not significantly associated with episodic memory performance in employed adults in the years before retirement (though it was associated with worse episodic memory at retirement and the following years). It is likely that null associations such as this are under reported, especially if there is not a positive result to highlight in parallel with the null association. This tendency to not report null effects severely

limits our ability to move the science forward, diluting our understanding of the impact of stress and ability to advance models and theories. We attempted to find null results that had not been published by contacting all authors who had published articles using stress variables and asking for any analyses that they did not publish; this approach was not fruitful. Moving forward, we encourage all scientists to preregister their hypotheses and to publish null findings in peer-reviewed journals. For a further discussion of this and other important best practices to improve the scientific study of psychology and aging, see Isaacowitz (2018).

Conclusion

The HRS data offers a rich resource for critically evaluating models and theories of how stress exposures and responses across the lifespan influence aging. Existing peer-reviewed publications have demonstrated significant associations between stress variables and aging-related outcomes in the HRS. Researchers can take further advantage of the stress data by examining longitudinal trajectories, testing mediation and moderation, and testing more complex hypotheses about stress and aging. By using the HRS data at its potential, and through collaborations between psychological and population scientists, fundamental questions about how and when stressor exposure and perceptions of stress influence negative and positive trajectories of aging can be answered.

Supplementary Material

Supplementary materials are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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References

Andel, R., Infurna, F. J., Hahn Rickenbach, E. A., Crowe, M., Marchiondo, L., & Fisher, G. G. (2015). Job strain and trajectories of change in episodic memory before and after retirement: Results from the Health and Retirement Study. *Journal of Epidemiology and Community Health*, **69**, 442–446. doi:10.1136/jech-2014-204754

Ayalon, L., Palgi, Y., Avidor, S., & Bodner, E. (2016). Accelerated increase and decrease in subjective age as a function of changes in loneliness and objective social indicators over a four-year period: Results from the Health and Retirement Study. *Aging & Mental Health*, **20**, 743–751. doi:10.1080/13607863.2015.1035696

Baumeister, R., & Leary, M. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, **117**, 497–529. doi:10.1037/0033-2909.117.3.497

Birditt, K. S., Newton, N. J., Cranford, J. A., & Ryan, L. H. (2016). Stress and negative relationship quality among older couples: Implications for blood pressure. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **71**, 775–785. doi:10.1093/geronb/gbv023

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview for cognitive status. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, **1**, 111–118. Retrieved from: https://journals.lww.com/cogbehavneurol/toc/1988/00120#-912709229

Brosschot, J. F., Pieper, S., & Thayer, J. F. (2005). Expanding stress theory: Prolonged activation and perseverative cognition. *Psychoneuroendocrinology*, **30**, 1043–1049. doi:10.1016/j.psyneuen.2005.04.008

Brosschot, J. F., Verkuil, B., & Thayer, J. F. (2018). Generalized unsafety theory of stress: Unsafe environments and conditions, and the default stress response. *International Journal of Environmental Research and Public Health*, **15**, 464. doi:10.3390/ijerph15030464

Bucciol, A., & Zarri, L. (2015). The shadow of the past: Financial risk taking and negative life events. *Journal of Economic Psychology*, **48**, 1–16. doi:10.1016/j.joep.2015.02.006

Cagney, K. A., Glass, T. A., Skarupski, K. A., Barnes, L. L., Schwartz, B. S., & Mendes de Leon, C. F. (2009). Neighborhood-level cohesion and disorder: Measurement and validation in two older adult urban populations. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **64**, 415–424. doi:10.1093/geronb/gbn041

Coan, J. A., & Sbarra, D. A. (2015). Social baseline theory: The social regulation of risk and effort. *Current Opinion in Psychology*, **1**, 87–91. doi:10.1016/j.copsyc.2014.12.021

Cole, S. W. (2013). Social regulation of human gene expression: Mechanisms and implications for public health. *American Journal of Public Health*, **103**(Suppl. 1), S84–S92. doi:10.2105/AJPH.2012.301183

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, **130**, 355–391. doi:10.1037/0033-2909.130.3.355

Donovan, N. J., Wu, Q., Rentz, D. M., Sperling, R. A., Marshall, G. A., & Glymour, M. M. (2017). Loneliness, depression and cognitive function in older U.S. adults. *International Journal of Geriatric Psychiatry*, **32**, 564–573. doi:10.1002/gps.4495

Eisenberger, R., Stinglhamber, F., Vandenberghe, C., Sucharski, I. L., & Rhoades, L. (2002). Perceived supervisor support: Contributions to perceived organizational support and employee retention. *Journal of Applied Psychology*, **87**, 565–573. doi:10.1037/0021-9010.87.3.565

Epel, E., Blackburn, E. H., Lin, J., Dhabhar, F. S., Adler, N. E., Morrow, J. D., & Cawthon, R. M. (2004). Accelerated telomere shortening in response to life stress. *Proceedings of the National Academy of Sciences of the United States of America*, **101**, 17312–17315. doi:10.1073/pnas.0407162101

Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: A unified view of stress measurement for population science. *Frontiers in Neuroendocrinology*, **49**, 146–169. doi:10.1016/j.yfrne.2018.03.001

Fisher, G. G., Stachowski, A., Infurna, F. J., Faul, J. D., Grosch, J., & Tetrick, L. E. (2014). Mental work demands, retirement, and longitudinal trajectories of cognitive functioning. *Journal of Occupational Health Psychology*, **19**, 231–242. doi:10.1037/a0035724

Grupe, D. W., & Nitschke, J. B. (2013). Uncertainty and anticipation in anxiety: An integrated neurobiological and psychological perspective. *Nature Reviews. Neuroscience*, **14**, 488–501. doi:10.1038/nrn3524

Haynes, C. E., Wall, T. D., Bolden, R. I., Stride, C., & Rick, J. E. (1999). Measures of perceived work characteristics for health services research: Test of a measurement model and normative data. *British Journal of Health Psychology*, **4**, 257–275. doi:10.1348/135910799168614

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, **11**, 213–218. Retrieved from http://www.jpsychores.com/article/0022-3999(67)90010–4/pdf

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging*, **26**, 655–672. doi:10.1177/0164027504268574

Isaacowitz, D. M. (2018). Planning for the future of psychological research on aging. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **73**, 361–362. doi:10.1093/geronb/gbx142

Karasek, R., Brisson, C., Kawakami, N., Houtman, I., Bongers, P., & Amick, B. (1998). The Job Content Questionnaire (JCQ): An instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology*, **3**, 322–355. doi:org/10.1037/1076-8998.3.4.322

Kessler, R. C., Mickelson, K. D., Williams, D. R., & Kessler, R. C. (1999). The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. *Journal of Health and Social Behavior*, **40**, 208–230. doi:10.2307/2676349

Krause, N., Shaw, B. A., & Cairney, J. (2004). A descriptive epidemiology of lifetime trauma and the physical health status of older adults. *Psychology and Aging*, **19**, 637–648. doi:10.1037/0882-7974.19.4.637

Lachman, M., & Spiro, A. I. (2002). *Critique of Cognitive measures in the Health and Retirement Study (HRS) and the Asset and Health Dynamics Among Oldest Old (AHEAD) study*. Retrieved 27 April 2018, from http://hrsonline.isr.umich.edu/sitedocs/dmc/Lachman_hrscognitive.pdf

Latham, K., & Williams, M. M. (2015). Does neighborhood disorder predict recovery from mobility limitation? Findings from the Health and Retirement Study. *Journal of Aging and Health*, **27**, 1415–1442. doi:10.1177/0898264315584328

Lazarus, R., & Folkman, S. (1984). Coping and adaptation. In W. D. Gentry (Ed.), *The handbook of behavioral medicine* (pp. 282–325). New York, NY: The Guilford Press.

MacDermid, S., Barnett, R., Crosby, F., Greenhaus, J., Koblenz, M., Marks, S.,…Sabbatini-Bunch, L. (2000). *The measurement of work/life tension: Recommendations of a virtual think tank*. Boston, MA: Alfred P Sloan Foundation.

Mezuk, B., Kershaw, K. N., Hudson, D., Lim, K. A., & Ratliff, S. (2011). Job strain, workplace discrimination, and hypertension among older workers: The Health and Retirement Study. *Race and Social Problems*, **3**, 38–50. doi:10.1007/s12552-011-9041-7

Ofstedal, M. B., Fisher, G. G., & Herzog, A. R. (2005). *HRS/AHEAD documentation report: Documentation of cognitive functioning measures in the Health and Retirement Study*. Ann Arbor: Survey Research Center, University of Michigan.

Palgi, Y., Shrira, A., Ben-Ezra, M., Shiovitz-Ezra, S., & Ayalon, L. (2012). Self- and other-oriented potential lifetime traumatic events as predictors of loneliness in the second half of life. *Aging & Mental Health*, **16**, 423–430. doi:10.1080/13607863.2011.638903

Pertl, M. M., Lawlor, B. A., Robertson, I. H., Walsh, C., & Brennan, S. (2015). Risk of cognitive and functional impairment in spouses of people with dementia: Evidence from the Health and Retirement Study. *Journal of Geriatric Psychiatry and Neurology*, **28**, 260–271. doi:10.1177/0891988715588834

Puterman, E., Gemmill, A., Karasek, D., Weir, D., Adler, N. E., Prather, A. A., & Epel, E. (2016). Lifespan adversity and later adulthood telomere length in the nationally representative US Health and Retirement Study. *Proceedings of the National Academy of Sciences of the United States of America*, **113**, E6335–E6342. doi:10.1073/pnas.1525602113

Queen, T. L., Butner, J., Berg, C. A., & Smith, J. (2019). Activity engagement among older adult spousal caregivers. *Journals of Gerontology: Series B: Psychological Sciences and Social Science*, **74**, 1278–1282. doi:10.1093/geronb/gbx106

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, **1**, 385–401. doi:10.1177/014662167700100306

Robinson, E., Sutin, A., & Daly, M. (2017). Perceived weight discrimination mediates the prospective relation between obesity and depressive symptoms in U.S. and U.K. adults. *Health Psychology*, **36**, 112–121. doi:10.1037/hea0000426

Rossi, A. S (Ed.). (2001). Developmental roots of adult social responsibility. *Caring and doing for others: Social responsibility in the domains of family, work, and community*. Chicago, IL: University of Chicago Press.

Russell, D., Peplau, L. A., & Cutrona, C. E. (1980). The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *Journal of Personality and Social Psychology*, **39**, 472–480. doi:10.1037/0022-3514.39.3.472

Ryff, C. D., & Singer, B. (1998). The contours of positive human health. *Psychological Inquiry*, **9**(1), 1–28. doi:10.1207/s15327965pli0901_1

Sabbath, E. L., Mejía-Guevara, I., Noelke, C., & Berkman, L. F. (2015). The long-term mortality impact of combined job strain and family circumstances: A life course analysis of working American mothers. *Social Science and Medicine (1982)*, **146**, 111–119. doi:10.1016/j.socscimed.2015.10.024

Schuster, T. L., Kessler, R. C., & Aseltine, R. H. Jr. (1990). Supportive interactions, negative interactions, and depressed mood. *American Journal of Community Psychology*, **18**, 423–438. Retrieved from https://onlinelibrary.wiley.com/toc/15732770/1990/18/3

Siegrist, J., Starke, D., Chandola, T., Godin, I., Marmot, M., Niedhammer, I., & Peter, R. (2004). The measurement of effort-reward imbalance at work: European comparisons. *Social Science and Medicine (1982)*, **58**, 1483–1499. doi:10.1016/S0277-9536(03)00351-4

Smith, J., Ryan, L. H., Fischer, G., Sonnega, A., & Weir, D. R. (2017). *Psychosocial and lifestyle questionnaire 2006–2016: Documentation report core section LB*. Ann Arbor: Survey Research Center, University of Michigan.

Sutin, A. R., Stephan, Y., & Terracciano, A. (2018). Psychological well-being and risk of dementia. *International Journal of Geriatric Psychiatry*, **33**, 743–747. doi:10.1002/gps.4849

Taylor, S. E., Repetti, R. L., & Seeman, T. (1997). Health psychology: What is an unhealthy environment and how does it get under the skin? *Annual Review of Psychology*, **48**, 411–447. doi:10.1146/annurev.psych.48.1.411

Tiedt, A. D. (2013). Cross-national comparisons of gender differences in late-life depressive symptoms in Japan and the United States. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **68**, 443–454. doi:10.1093/geronb/gbt013

Troxel, W. M., Matthews, K. A., Bromberger, J. T., & Sutton-Tyrrell, K. (2003). Chronic stress burden, discrimination, and subclinical carotid artery disease in African American and Caucasian women. *Health Psychology*, **22**, 300–309. doi:10.1037/0278-6133.22.3.300

Turner, R. J., Frankel, B. G., & Levin, D. M. (1983). Social support: Conceptualization, measurement, and implications for mental health. *Research in Community and Mental Health*, **3**, 67–111. Retrieved from http://psycnet.apa.org/record/1984-20538-001

Turner, R. J., Wheaton, B., & Lloyd, D. A. (1995). The epidemiology of social stress. *American Sociological Review*, **60**, 104. doi:10.2307/2096348

Wheaton, B., Young, M., Montazer, S., & Stuart-Lahman, K. (2013). Social stress in the twenty-first century. In C. S. Aneshensel (Ed.), *Handbook of the sociology of mental health* (2nd ed., pp. 299–323) . Dordrecht, The Netherlands: Springer Netherlands. doi:10.1007/978-94-007-4276-5_15

Williams, D. R., Yan Yu, Jackson, J. S., & Anderson, N. B. (1997). Racial differences in physical and mental health: Socio-economic status, stress and discrimination. *Journal of Health Psychology*, **2**, 335–351. doi:10.1177/135910539700200305

Wirtz, P. H., & von Känel, R. (2017). Psychological stress, inflammation, and coronary heart disease. *Current Cardiology Reports*, **19**, 111. doi:10.1007/s11886-017-0919-x

Zhang, Z., Hayward, M. D., & Yu, Y. L. (2016). Life course pathways to racial disparities in cognitive impairment among older Americans. *Journal of Health and Social Behavior*, **57**, 184–199. doi:10.1177/0022146516645925