Title

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Journal

The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 78(1)

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Publication Date

2023-01-28

DOI

10.1093/geronb/gbac113

Peer reviewed

THE GERONTOLOGICAL SOCIETY OF AMERICA®

Journals of Gerontology: Psychological Sciences
cite as: *J Gerontol B Psychol Sci Soc Sci*, 2023, Vol. 78, No. 1, 20–29
https://doi.org/10.1093/geronb/gbac113
Advance Access publication August 15, 2022

OXFORD

Research Article

Physical Activity and Daily Stress Processes in Older Adulthood

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Received: January 18, 2022; Editorial Decision Date: August 8, 2022

Decision Editor: Rodlescia Sneed, PhD, MPH

Abstract

Objectives: Older adults who are physically active report lower levels of stress. Less is known about the links between physical activity and exposure and reactivity to stressful events in daily life. The current study examined within-person associations between actigraphy-assessed daily physical activity and exposure and affective reactivity to naturally occurring interpersonal stressors.

Method: Older adults (N = 180) from the Daily Experiences and Well-being Study completed ecological momentary assessments (EMAs) every 3 hr for 5–6 days where they reported negative affect throughout the day and interpersonal tensions at the end of the day. They also wore Actical accelerometers to capture physical activity.

Results: Older adults reported greater numbers of interpersonal stressors on days when they spent less time being sedentary and engaged in more light physical activity. On days when older adults experienced more interpersonal stressors, they reported higher levels of negative affect, but this association was attenuated when they were more physically active that day.

Discussion: Physical activity may bolster older adults' capabilities to manage affective responses to interpersonal stressors in a more successful way. These findings underscore the importance of assessing physical activity and stressful events in daily life and have implications for both physical and psychological well-being.

Keywords: Actigraphy, EMA, Interpersonal stressors, Negative affect

Physical activity provides numerous benefits for older adults, including better mental health and well-being outcomes (Brown et al., 2014), increased physical function (Loprinzi et al., 2014), protection against numerous chronic conditions (Lacey et al., 2015), and a reduced risk of mortality (Gebel et al., 2015). The Center for Disease Control and Prevention recommends that older adults aged 65 and older engage in at least 150 min of moderate intensity physical activity per week, or 75 min of vigorous activity (U.S. Department of Health and Human Services, 2018). Yet, only about 40% of older adults meet these guidelines (Blackwell et al., 2014). In addition, a greater proportion of time spent sedentary confers health risks independent from physical activity levels (Wilmot et al., 2012). Engaging in physical activity has been proposed as an important factor for mitigating stress in older adults' lives (Vasiliadis & Bélanger, 2018). However, the current literature linking physical activity and sedentary behavior with both exposure and affective reactivity to stressors in daily life is limited. The current study examined the

day-to-day associations between physical activity and exposure and affective reactivity (i.e., greater negative affect on days when stressors occur) to daily interpersonal stressors in older adults.

Physical Activity and Stress

Physical activity may contribute to beneficial health and well-being not only because it directly benefits cardiovascular fitness, but also because exercise may reduce the effects of stressful events in daily life. The occurrence of daily stressors, such as an argument with a spouse or being stuck in traffic, are associated with worse self-reported health (DeLongis et al., 1982), physical health conditions (Sarid et al., 2018), and mortality (Jeong et al., 2016). In addition to daily stressor exposure, how people respond affectively to daily stressful events (i.e., affective reactivity) has also been linked with health outcomes. Heightened negative affective reactions to daily stressors are associated with a range of mental and physical health outcomes including chronic medical conditions (Piazza et al, 2013), depressive symptoms (Charles et al., 2013), and mortality (Chiang et al., 2018). In particular, interpersonal tensions (i.e., social interactions that are hurtful or irritating) are the most frequent daily stressors in older adulthood and are more strongly associated with health and well-being than other types of stressors (Birditt, 2014; Charles et al., 2009).

Applications of stress and coping theories suggest individuals' health behaviors can play a role in determining the impact of stressors on health and well-being (Park & Iacocca, 2014). Engaging in physical activity is an effective means of managing stress and buffers the effects of stress on physical health (Gerber & Pühse, 2009). Being physically active may improve the way adults manage stress by modifying both physiological and affective responses to stressful events (Jackson, 2013). The majority of the literature on physical activity and stress has focused on broad and static reports of perceived stress. Both cross-sectional studies and prospective interventions generally show that greater levels of physical activity and less time spent sedentary are associated with less subjective stress in older adults (Ashdown-Franks et al., 2018; McHugh & Lawlor, 2012; Taylor-Piliae et al., 2010) and are effective behaviors for reducing perceived stress (Atlantis et al., 2004; King et al., 2002; Norris et al., 1992).

Fewer studies have examined links between physical activity and exposure and reactivity to daily stressors. In the existing literature, the relationship between physical activity and daily stressors is mixed. A couple of studies have shown that higher levels of physical activity are associated with experiencing fewer daily stressors (Nguyen-Michel et al., 2006; Stetson et al., 1997). Additionally, adults who spend more time being sedentary report greater numbers of daily stressors, but only when those stressors are interpersonal in nature (i.e., having an argument; Diaz et al., 2018). However, one study found the opposite association, such that higher physical activity levels were associated with experiencing a greater number of daily stressors (Uijtdewilligen et al., 2014). In terms of how people react affectively to daily stressors, laboratory-based studies indicate that people who are physically active experience less of an increase in negative affect in response to a stressor task (Rimmele et al., 2009). A few studies have examined the relationship between physical activity and reactivity to daily stressors in daily life. A study by Puterman et al. (2017) found that on days when adults were physically active, they experienced attenuated negative reactions to stressors experienced on that day. Yet, another study found that although people who engaged in more physical activity were generally less reactive to stressful events, these associations did not extend to within-person effects on the daily level (Almeida et al., 2020).

In sum, only a few studies link physical activity or sedentary behavior to exposure and reactivity to daily stressors, and those that do yield mixed findings. One limitation of these studies is that they use broad definitions of physical activity that do not take into account the level of intensity. Most of the scientific literature has focused on the impact of moderate to vigorous physical activity, but there are also several benefits of light physical activity, especially among older adults (Musich et al., 2017). Additionally, with a few exceptions, most studies have relied on retrospective self-reports of physical activity, which can be unreliable and subject to memory decay (Prince et al., 2008). The current study addresses these gaps by examining light, moderate, and vigorous physical activity with actigraphy-assessed physical activity and time spent sedentary. By using actigraphy and assessing intensity levels, this research will provide objective activity assessments to link daily stressor exposure and reactivity and physical activity in older adults. Additionally, the current study extends past work by focusing specifically on stressors that are interpersonal in nature. Examining interpersonal stressors is particularly important in older adulthood, as interpersonal stressors are the most commonly reported stressors in older adults and have the strongest associations with health and well-being (e.g., Birditt, 2014).

Current Study

The current study used ecological momentary assessments (EMA) to examine day-to-day associations between physical activity and interpersonal stressor exposure and reactivity in a sample of older adults. Physical activity declines with age, and older adults are at an increased risk of leading sedentary lifestyles (Sun et al., 2013). Thus, whereas physical activity is beneficial for stress management across adulthood, it is particularly important to examine sedentary behaviors (as well as physical activity) among older adults. Drawing on previous research linking physical activity and daily hassles in older adulthood, we first hypothesized that on days when older adults engaged in greater levels

of physical activity, they would report fewer interpersonal stressors. We also hypothesized that on days when they spent a greater proportion of time sedentary, they would report more interpersonal stressors. Second, we hypothesized that on days when older adults engaged in greater levels of physical activity, they would report less of an increase in negative affect (i.e., less affective reactivity) when they also reported interpersonal stressors on those days. We further hypothesized that on days when they spent a greater proportion of time sedentary, they would report greater increases in negative affect on days when they reported interpersonal stressors (i.e., greater affective reactivity). Finally, we conducted two sensitivity tests. The first test examined the directionality of these effects (i.e., whether physical activity predicted next-day stressor exposure and reactivity, and vice versa). The second test considered number of diverse social interactions as a moderator between physical activity and interpersonal stressor exposure given that the number of diverse social interactions in a given day may influence both the amount of interpersonal stressors experienced as well as physical activity level.

Method

Participants and Procedure

Participants were from the Daily Experiences and Well-being Study (DEWS), a study involving 333 community-dwelling adults aged 65 and older from the greater metropolitan area of Austin, TX. Participants were oversampled from high-density minority neighborhoods to obtain a more racially and ethnically diverse sample.

Participants completed a 2-hr in-person interview where they reported demographic characteristics and questions about their social network. Participants then completed a 5- to 6-day intensive data assessment (to ensure that at least two of the days were weekend days). During these 5–6 days, participants completed ecological momentary assessments (EMAs) on an Android mobile device every 3 hr while awake. For each assessment, they filled out surveys that included questions about their mood during the past 3 hr. At the end of the day, participants reported the stressors they experienced during that day. Participants completed an average of 20 assessments throughout the study week. Additionally, participants wore an Actical accelerometer to objectively measure physical activity and sedentary behavior during the 5- to 6-day period. Respondents received $50 for completing the baseline survey and $100 for completing the EMA component.

Of the 333 adults who completed the initial interview, 269 participants completed at least two ecological momentary assessments, one end-of-day survey, and wore the Actical accelerometer. Additionally, participants had to report experiencing at least one stressful event to be included in analyses. Eighty-nine participants were excluded for reporting zero stressful events throughout the study period. The final analytic sample was 180 participants. Compared with excluded participants, these 180 participants were younger, better educated, female, and reported more negative affect. The mean age of this sample was 73.40 years; 61% were female and 80% were White. The sample was well educated: 58% of participants had a bachelor's degree.

Measures

Interpersonal stressors

At the end of each day, participants answered three questions about negative interactions that took place over the previous day (Fingerman et al., 2016). Questions included "did you have any social interactions that made you feel irritated, hurt or annoyed," "did you have social interactions in which you could have felt irritated, hurt, or annoyed but decided not to," and "did you think about a relationship problem or worry about someone." Participants reported experiencing zero interpersonal stressors on 42% of all days, one stressor on 42% of days, two stressors on 11% of days, and three stressors on 5% of days.

Positive and negative affect

Every 3 hr throughout the day, participants rated the extent to which they experienced five negative emotions (i.e., nervous/worried, irritated, bored, lonely, and sad) and four positive emotions (i.e., calm, proud, content, and loved) on a scale from 1 (*not at all*) to 5 (*a great deal*; Fingerman et al., 2016). Items were averaged at each measurement time to create one score ($\alpha = .72$) for negative affect and one score for positive affect ($\alpha = .70$). We then calculated an average positive affect score and negative affect score for each day.

Physical activity

Phillips Respironics Actical Zs assessed objective measures of physical activity. The Actical captures motion in several directions and calculates the intensity of physical activity. The Actical has been previously validated as a measure of light and moderate physical activity in older adults (Hooker et al., 2011). Participants wore the Actical on their wrist for the 5- to 6-day study period. Data were collected continuously throughout the day. Actical data are reported as an index of proportion of time spent sedentary, time spent doing light activity, time spent doing moderate activity, and time spent doing vigorous activity. The device calculates intensity of physical activity based on the participant's energy expenditure, expressed in kilocalories per minute and factoring in weight (kcal/min/kg). Light activity included energy expenditure of greater than zero, but less than 0.031 kcal/min/kg (e.g., sorting cards, writing a letter). Moderate activity included 0.031 up to <0.083 kcal/min/kg (e.g., sweeping, vacuuming). Vigorous activity included 0.083 kcal/min/kg or greater (e.g., brisk walking, jogging). Finally, the total accumulated minutes in each

intensity range within the given time interval (i.e., 3 hr) was divided by the time interval duration to obtain the proportion of time spent in each range. The proportion of time spent in each range was then averaged across the 3-hr time periods to create a daily average for each physical activity range. Proportions ranged from zero (0%) to one (100%). Previous research has found that a period of 3–4 days is adequate to capture daily physical activity in older adults (Huisingh-Scheetz et al., 2016), and use of an accelerometer is considered to be the gold standard for measuring physical activity and sedentary behavior (Troiano, 2006).

Diverse social interactions

We also measured participant's diversity of social interactions. During the ecological momentary assessment, participants indicated every 3 hr whether they had contact with 10 social partners whom they had identified as close and important to them during the baseline interview (Antonucci et al., 2014). They also indicated if they had contact with anyone else during the 3-hr period and listed their relationship (e.g., friend, service provider) with up to six of those people. From these responses, consistent with other studies on social network diversity (Cohen & Lemay, 2007), we generated an index of encounters with diverse social ties in the prior 3 hr, including spouse/romantic tie, child/stepchild, child-in-law, sibling, sibling-in-law, friend, grandchild/step grandchild, niece/nephew, acquaintance, service provider, stranger, and so on. Responses were coded as one for each type of relationship encountered (e.g., one if they encountered any number of friends, any children, etc.) and zero if the participant did not encounter that type of social tie in the prior 3 hr. These responses were summed so that each score represented the number of diverse encounters (i.e., encounters with different types of relationships) a participant had each day.

Covariates

All models included demographic factors that were collected in the baseline interview and included age; gender (0 = *female*, 1 = *male*); years of education (1 = *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college*, 6 = *college graduate*, 7 = *postcollege education*, 8 = *advanced degree*); marital status (0 = *never married, divorced, or separated*, 1 = *married or cohabitating*); race (0 = *non-Hispanic White*, 1 = *ethnic or racial underrepresented group*); and weekday or weekend (0 = *weekday*, 1 = *weekend*). Participants self-rated their physical health from 1 (*poor*) to 5 (*excellent*; Idler & Kasl, 1991). We also included grip strength as an objective measure of physical health (Bohannon, 2019). Participants were instructed to squeeze a hand dynamometer as hard as possible for a few seconds and then release (Rantanen et al., 1999). Participants squeezed the dynamometer a total of four times, twice with each hand. Twenty-five missing values for grip strength were replaced using "hot deck" imputation (Rubin & Schenker, 1986). Results were recorded in kilograms, with each of the four squeezes averaged to result in one measure of grip strength (higher values indicate stronger grip strength and thus better health).

Analytic Strategy

Hypothesis testing involved two-level multilevel models using SAS PROC MIXED to account for nested data, where day-level variables were nested within participant-level variables. Our first hypothesis examined within-person associations between interpersonal stressor exposure and (1) time spent engaging in light, moderate, or vigorous physical activity and (2) time spent sedentary. In these models, number of daily interpersonal stressors is predicted by daily physical activity and time spent sedentary. Our second hypothesis examined within-person associations between interpersonal stressor reactivity and time spent being physically active or sedentary. In these models, we tested the interaction between daily interpersonal stressor exposure and time spent being physically active or sedentary on daily negative affect. In all models, day-level predictors were person-mean centered to make within-person comparisons. We included person-level predictors of each physical activity and interpersonal stressor variable to distinguish between day- and person-level variance. A random intercept and slope for daily physical activity were included to allow people to vary from one another in the magnitude of the within-person association between physical activity and stressor occurrence. All models included age, gender, education, race, marital status, number of diverse social interactions, and physical health as person-level covariates.

Results

Descriptive Statistics

Table 1 shows descriptive statistics for all variables of interest. On average, participants spent a little less than half their time per day being sedentary (47%) and a little less than half their time engaging in light activity (49%). Participants spent 4% of their time per day engaging in moderate physical activity, and less than 0.01% of their time engaging in vigorous physical activity. Participants reported an average of 0.57 stressors per day and low levels of negative affect (M = 1.23, SD = .34).

Physical Activity and Interpersonal Stressors

Results from the two-level models examining within-person associations between daily physical activity and interpersonal stressor exposure are shown in Table 2. Because participants spent less than 0.01% of their time engaging in vigorous physical activity, we did not examine its relationship with interpersonal stressors. Therefore, we ran three separate models: time spent sedentary, engaging in light

Table 1. Descriptive Information for Participants and Daily Experiences

	M/%	*SD*	Range
Day-level Variables			
Interpersonal stressors	0.79	0.83	0–3
% of time being sedentary	0.47	0.19	0–0.98
% of time being physically active—light	0.49	0.17	0.01–0.93
% of time being physically active—moderate	0.04	0.06	0–0.74
% of time being physically active—vigorous	0.00	0.00	0–0.001
Negative affect	1.28	0.36	1–3.4
Diverse social interactions	7.38	4.88	0–30
Person-level Variables			
Age	73.40	6.12	65–89
Self-rated health	3.60	1.05	1–5
Grip strength	25.74	8.81	5–49
Education[a]	6.02	1.49	2–8
Male[b]	38%		
Married[c]	57%		
Ethnic or racial minority[d]	20%		

Notes:
[a]1 = *no formal education*, 2 = *elementary school*, 3 = *some high school*, 4 = *high school*, 5 = *some college/vocation or trade school*, 6 = *college graduate*, 7 = *postcollege but no additional degree*, 8 = *advanced degree*.
[b]0 = *female*, 1 = *male*.
[c]0 = *not married/divorced*, 1 = *married*.
[d]0 = *non-Hispanic white*, 1 = *ethnic or racial minority*.

activity, and engaging in moderate activity. In contrast to our hypotheses, we found that on days with higher than average levels of time spent sedentary, adults reported fewer interpersonal stressors ($\gamma = -.69$, $p = .033$). Additionally, on days with higher than average levels of time spent doing light physical activity, adults reported more interpersonal stressors ($\gamma = .70$, $p = .027$). In contrast, time spent doing moderate physical activity was not associated with number of interpersonal stressors experienced. Additionally, there were no significant between-person effects. Time spent engaged in physical activity or sedentary behavior across the 5- to 6-day period was not associated with average numbers of interpersonal stressors.

Physical Activity and Interpersonal Stressor Reactivity

Results from the three models examining within-person associations between daily physical activity and interpersonal stressor reactivity are shown in Table 3. Consistent with stress reactivity literature (i.e., Almeida, 2005), on days when participants experienced greater numbers of interpersonal stressors, they reported higher levels of negative affect ($\gamma = .05$, $p < .001$). In line with our main hypothesis, we found that time spent sedentary moderated the association between interpersonal stressors and negative affect, such that on days when adults experienced greater numbers of interpersonal stressors and spent more time sedentary, they had higher levels of negative affect than on days when they were less sedentary ($\gamma = .27$, $p = .008$; Figure 1). Conversely, on days when adults experienced interpersonal stressors and spent more time engaging in light or moderate physical activity, they reported lower levels of negative affect than on days when they were less physically active (light activity: $\gamma = -.20$, $p = .04$, moderate activity: $\gamma = -.97$, $p = .002$). Additionally, similar to the relationship between physical activity and stressor exposure, there were no between-person effects with physical activity and stressor reactivity.

Sensitivity Tests

We further probed the relationship between interpersonal stressor exposure and time spent sedentary and engaging in light physical activity by testing if these relationships varied as a function of how many diverse interactions a person had in a given day. There was not a significant relationship between number of diverse interactions and number of interpersonal stressors ($r = .05$, $p = .07$). Furthermore, there was not a significant interaction between the number of diverse interactions and (a) the percentage of time spent sedentary ($\gamma = .02$, $p = .51$) or (b) the percentage of time spent engaging in light physical activity ($\gamma = -.03$, $p = .61$) when predicting interpersonal stressor exposure.

Finally, we also examined the directionality of these effects by testing for lagged associations (i.e., whether physical activity predicted next-day stressor exposure and reactivity, and vice versa). Engaging in more light physical activity on a given day did not affect next-day stressor exposure ($\gamma = -.43$, $p = .20$) or next-day stressor reactivity ($\gamma = -.18$, $p = .13$). Additionally, physical activity was not affected by previous-day stressor exposure ($\gamma = -.27$, $p = .50$) or reactivity ($\gamma = .20$, $p = .14$).

Discussion

Physical activity has clear benefits for health and well-being, but few studies have examined the day-to-day links between physical activity and sedentary behavior with exposure and affective reactivity to daily stressful events. The overarching goal of this study was to examine these links in a sample of community-dwelling older adults using actigraphy-assessed physical activity and time spent sedentary, as well as daily exposure and reactivity to interpersonal stressors. Using a within-person design, we found that older adults reported greater numbers of interpersonal

Table 2. Two-Level Models Predicting Daily Interpersonal Stressors From %Time Spent at Each Level of Physical Activity

	% time sedentary		% time light activity		% time moderate activity	
Variable	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Fixed effects						
Intercept	1.87***	0.78, 2.96	1.28*	0.36, 1.76	1.78**	0.66, 2.90
Day-level activity (% time)	−0.69*	−1.35, −0.06	0.71*	0.11, 1.37	0.67	−1.81, 3.15
Person-level activity (% time)	0.01	−0.01, 0.00	0.01	−0.00, 0.01	0.01	−0.02, 0.02
Number of diverse social interactions	0.01	−0.01, 0.02	0.01	−0.01, 0.02	0.01	−0.01, 0.02
Weekday	0.03	−0.08, 0.14	0.03	−0.14, 0.09	0.01	−0.09, 0.12
Gender	−0.06	−0.27, 0.13	−0.06	−0.26, 0.14	−0.05	−0.25, 0.15
Age	0.00	−0.01, 0.01	0.00	−0.02, 0.01	0.00	−0.10, 0.25
Education	0.02	−0.04, 0.07	0.02	−0.04, 0.07	0.01	−0.02, 0.01
Marital status	0.17	−0.03, 0.30	0.16	−0.01, 0.32	0.17*	0.01, 0.34
Race	−0.24*	−0.49, −0.05	−0.25*	−0.47, −0.04	−0.24*	−0.46, −0.02
Health	−0.14***	−0.22, −0.06	−0.14***	−0.21, −0.06	−0.13**	−0.21, −0.05
Grip strength	−0.01*	−0.02, −0.00	−0.01*	−0.02, −0.00	−0.01*	−0.02, −0.00
Random effects						
Intercept variance	0.12		0.11		0.12	
Activity level slope variance	0.21		0.21		0.14	
Residual variance	0.54		0.55		0.53	

Notes: CI = confidence interval.
*$p < .05$.
**$p < .01$.
***$p < .001$.

Table 3. Two-Level Models of Effects of Interpersonal Stressors and %Time Spent at Each Level of Physical Activity on Daily Negative Affect.

	% time sedentary		% time light activity		% time moderate activity	
Variable	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Fixed effects						
Intercept	1.52***	0.98, 2.02	1.67***	1.07, 2.23	1.63***	1.08, 2.17
Interpersonal stressors	0.05***	0.02, 0.07	0.05***	0.02, 0.07	0.05***	0.02, 0.69
Day-level activity (% time)	−0.11	−0.32, 0.08	0.09	−0.09, 0.27	0.61	−0.10, 1.32
Stressors × day-level activity	0.27**	0.07, 0.46	−0.20*	−0.40, −0.01	−0.97**	−1.57, −0.24
Person-level activity	0.00	−0.00, 0.00	0.00	−0.00, 0.00	−0.01	−0.01, 0.00
Average stressors	0.17***	0.09, 0.25	0.17***	0.09, 0.25	0.16***	0.08, 0.24
Number of diverse social interactions	−0.01	−0.01, 0.00	0.00	−0.01, 0.00	0.00	−0.01, 0.00
Weekday	−0.01	−0.03, 0.02	−0.01	−0.02, 0.02	−0.01	−0.03, 0.02
Gender	0.07	−0.02, 0.16	0.07	−0.02, 0.16	0.08	−0.01, 0.17
Age	0.00	−0.01, 0.00	0.00	−0.01, 0.00	0.00	−0.01, 0.00
Education	0.00	−0.03, 0.03	0.00	−0.03, 0.03	0.00	−0.03, 0.03
Marital status	−0.08	−0.18, 0.00	−0.08	−0.17, 0.01	−0.09	−0.17, 0.00
Race	−0.06	−0.18, 0.06	−0.06	−0.18, 0.06	−0.07	−0.19, 0.05
Health	−0.07**	−0.11, −0.02	−0.07**	−0.11, −0.02	−0.07**	−0.11, −0.03
Grip strength	0.00	−0.00, 0.00	0.00	−0.00, 0.00	0.00	−0.00, 0.00
Random effects						
Intercept variance	0.06		0.06		0.06	
Activity level slope variance	0.09		0.03		0.01	
Stressor slope variance	0.01		0.01		0.01	
Residual variance	0.03		0.03		0.03	

Notes: CI = confidence interval.
*$p < .05$.
**$p < .01$.
***$p < .001$.

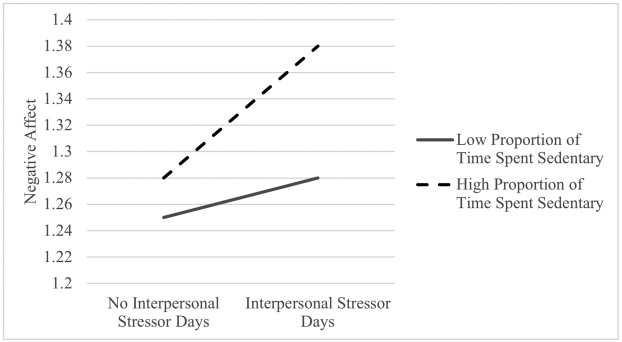

Figure 1. Negative affect on days with and without stressors moderated by proportion of time spent sedentary.

stressors on days that they spent less time being sedentary. They also reported more interpersonal stressors on days they spent more time engaging in light, but not moderate, physical activity. Additionally, on days when older adults experienced an interpersonal stressor, they reported higher levels of negative affect. This association was attenuated on days when older adults spent less time sedentary and more time engaged in light or moderate physical activity.

Contrary to our original hypothesis, on days when older adults spent less time being sedentary and engaged in more light physical activity, they reported greater numbers of interpersonal stressors, not fewer. This finding contradicts previous work showing that higher levels of physical activity and less time spent sedentary are associated with experiencing fewer daily stressors (Diaz et al., 2018; Nguyen-Michel et al., 2006; Stetson et al., 1997). One explanation for this finding may be that older adults are more physically active and spend less time sedentary on days when they are busy and thus engaging in more interpersonal interactions. Previous work has shown that on days when older adults engage in more social encounters, they are more physically active and spend less time sedentary (Fingerman et al., 2020). Engaging in more social encounters may lead to a greater likelihood of one of those encounters being tense or stressful. Of note, we included a number of diverse social interactions in our models as a covariate, and the relationship between physical activity and interpersonal stressor exposure did not change. Additionally, we did not find any interactive effects between number of diverse social interactions and physical activity in interpersonal stressor exposure. Another possible explanation is that older adults engage in physical activity as a coping mechanism to manage the effects of stressors that have already occurred.

An important distinction between previous work and the current study is that whereas previous literature examined between-person associations, the current study used an EMA design to examine within-person associations between physical activity and interpersonal stressors. Between-person associations do not necessarily reflect within-person processes. In the current study, we found no between-person associations between physical activity and interpersonal stressor exposure. These results highlight the importance of examining within-person associations between physical activity and stressor exposure and suggest that older adults experience more interpersonal stressors on days when they engage in more light physical activity and spend less time sedentary.

Even though more physical activity and less time spent sedentary were unexpectedly related to more interpersonal stressors, older adults were also less affectively reactive to those stressors, which is consistent with our second hypothesis. These results are consistent with the idea that physical activity is beneficial for stress management in older adulthood by reducing negative affective responses to stressful events. Findings are also in line with another study indicating that affective responses to daily stressors are attenuated on days when adults are more physically active (Puterman et al., 2017). The current study adds to the sparse literature on physical activity and affective reactivity to daily stressful events by (a) using objective measures of actigraph-assessed physical activity by intensity level and (b) focusing on interpersonal stressors, a specific domain of daily stressors that has vital implications for well-being. Engaging in physical activity improves both mental health and the ability to cope with stressful encounters (Salmon, 2001). A key finding of the current study is that even though older adults report greater numbers of interpersonal stressors on days when they are less sedentary and engage in more light and moderate physical activity, they are less reactive when these stressors do occur. The daily stress literature posits that how people react to daily stressful events is particularly important for health and well-being (Piazza et al., 2013; Sin et al., 2015). Findings from the current study suggest that physical activity co-occuring with interpersonal stressors may be one mechanism accounting for the relationship between affective reactivity and health and well-being outcomes.

Of note, whereas light and moderate physical activity attenuated affective reactivity to interpersonal stressors, there was not enough variation in vigorous activity to assess its relationship with interpersonal stressors in this study. In our sample of older adults, participants spent less than 0.01% of their time engaging in vigorous physical activity. Older adults are often limited in their capabilities for vigorous physical activity (Loprinzi & Brosky, 2014). Instead, engaging in light or moderate physical activity, such as walking, gardening, or washing the dishes, has been shown to have immense health benefits in older adulthood (Hamer et al., 2014; Varma et al., 2014). With this in mind, researchers have questioned whether the CDC guidelines on moderate and vigorous physical activity should be reevaluated as too high for older adults to achieve (Hupin et al., 2015). Thus, vigorous physical activity is not common in older adulthood and may not be necessary to manage stressful events. Alternatively, low variability in time spent doing vigorous physical activity in our sample may have

obscured any associations between vigorous physical activity and stressor reactivity.

The current study has several strengths, including an EMA within-person study design, objective measures of physical activity and intensity-level data, and adjusting for several important sociodemographic and behavioral factors associated with stress exposure and physical activity, including age, gender, education, marital status, race, self-reported health, and number of diverse social interactions. The study is also constrained by a few limitations. The sample included over 30% older adults from ethnic or racially minoritized groups (i.e., African American, Hispanic) and a full range of education (15% high school education or less), but nevertheless, it was more highly educated than the general population of older adults, and this may have generated biases in greater likelihood of engaging in social connections and in physical activity. Second, although physical activity was assessed throughout the day via actigraphy, interpersonal stressors were assessed via self-report and were asked once at the end of the day. Therefore, our analyses are restricted to the day level. End-of-day recall represents a significant improvement over retrospective reports but is still subject to memory bias. Furthermore, because we do not know when during the day the stressor took place, we cannot tease apart any temporal sequence for physical activity, affect, and stressors. EMAs that are event-contingent and ask participants to fill out questionnaires when they are experiencing an interpersonal stressor as opposed to at set intervals throughout the day could further disentangle the relationship between a bout of physical activity and negative affect in response to a stressful event. Third, 46% of adults in the study did not report an interpersonal stressor during the 5- to 6-day period and were not included in the final analyses. Future research should examine the role of physical activity in the lives of adults who report noninterpersonal stressors or no stressors at all, as current findings may not generalize to all types of stressful experiences. Physical activity may be particularly important for attenuating affective reactivity to noninterpersonal stressors, as recent research has shown that negative affect in older adults when they are sedentary is higher when they are alone compared with when they are not alone (Hevel et al., 2021). Finally, the 5- to 6-day data collection offers a snapshot into the daily life of older adults, but longitudinal data across a greater period are needed to untangle the bidirectional relationships between stressor exposure and physical activity and examine their ability to predict health outcomes.

Physical activity is widely beneficial for health and well-being in older adulthood. The current study demonstrated that although older adults reported greater numbers of interpersonal stressors on days when they were physically active and spent less time sedentary, their affective reactivity to those stressors was less pronounced. Physical activity may bolster older adults' capabilities to manage affective responses to interpersonal stressors in a more successful way. These findings underscore the importance of assessing physical activity and stressful events in daily life and have implications for both physical and psychological well-being.

Funding

This work was supported by the National Institute on Aging (R01AG046460 to K. L. Fingerman) and the Eunice Kennedy Shriver National Institute of Child Health and Human Development (P2CHD042849 to the Population Research Center [PRC] at the University of Texas at Austin).

Author Contributions

K. A. Leger developed the study idea, reviewed the literature, performed statistical analyses, and wrote the manuscript. S. T. Charles helped to develop the study idea, and C. J. Brown assisted with data analysis and interpretation. S. T. Charles, C. J. Brown, and K. L. Fingerman provided critical revisions to the manuscript. K. L. Fingerman was the Principal Investigator on the grant that funded the study; she designed the Daily Experiences and Well-being Study and oversaw data collection. The study was not formally preregistered, but the research design was generated in advance and reviewed by the National Institute on Aging prior to implementation. The authors agree to make the materials and data available to the journal and other researchers upon request.

Conflict of Interest

None declared.

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