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Independent and relative effects of stress, depressive symptoms, and affect on college students' daily health behaviors

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Abstract Stress and depressive symptoms are associated with maladaptive health behavior practices such as unhealthy eating, sedentary behavior, insufficient sleep, and substance use. The relative and interactive effects of stress and depressive symptoms on health behavior practices are less well understood. The present study examined these processes in a daily diary study of 127 college students. Results from hierarchical generalized linear models indicated that depressive symptoms, and chronic and daily stress, but not acute stressful life events, were significantly associated with a composite score of daily maladaptive health behavior engagement (depressive symptoms $b = .01$, $SE = .00$, $p < .01$; chronic stress, $b = .03$, $SE = .01$, $p < .01$; daily stress, $b = .01$, $SE = .01$, $p = .02$); unexpectedly, the effect of stress on health behaviors was not moderated by depressive symptoms. Additionally, results demonstrated that the effect of depressive symptoms on health behaviors was mediated by fluctuations in daily negative affect. These results bear implications for intervention during a crucial period in the development of mental and physical health.

Keywords Health behaviors · Stress · Depressive symptoms · College students · Negative affect · Positive affect

Introduction

Young adults' health-related behaviors—such as sleeping, eating, exercise, and substance use—are influenced by a variety of factors. Such factors include not only resources such as access to healthy foods and time for exercise/sleep, but also psychological factors such as depressed mood and stress. The deleterious effects of clinical depression, depressive symptoms, and stress on health behavior engagement are well established (e.g., Boardman & Alexander, 2011; Goldschmidt et al., 2014; Wallace et al., 2017). Less work, however, has focused on differentiating the effects of stress and depressive symptoms, which are common and overlapping constructs (e.g., Hammen, 2005), on health behavior engagement in young adulthood. Additionally, little is known about mediators of the effects of depressive symptoms on daily health behavior engagement. It is important, conceptually and clinically, to better understand the relative effects of stress and depressive symptoms on health behavior practices among young adults.

Young adulthood is a critical period in the development of depressive disorders, as well as in the establishment of health behavior practices that influence outcomes in later life (Auerbach et al., 2014; Hedberg et al., 1999; Kessler et al., 2005). A majority of individuals who smoke as adults began smoking in adolescence and younger initiation of smoking is associated with greater risk of regular smoking (Fiore, 1992; Reidpath et al., 2014). Certain health behavior practices—including drinking and smoking—oc-

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cur at the highest rates in young adulthood, and are less prevalent with age (Patrick et al., 2016; Vierck & Hodges, 2003). There is evidence that physical activity, on the other hand, declines from childhood to adulthood, with the period of most rapid decline occurring in adolescence (Cairney et al., 2014). Additionally, life course research indicates that young adults, relative to other age groups, are particularly likely to use health behaviors (e.g., smoking, drinking, exercise) in response to stress (Umberson et al., 2008). Therefore, it is especially important to improve understanding of these processes during this time period.

Depressive symptoms and stress may affect health behavior engagement for a variety of reasons. One way of understanding this effect is that engagement in health behaviors represents attempts to cope with stress or depressive symptoms; health behaviors such as eating or drinking alcohol may promote emotion regulation and reduce distress associated with stressful circumstances and depressive symptoms. This process may be deliberately, consciously engaged, or may be undertaken without conscious awareness of this effect (e.g., mindless eating; Park & Iacocca, 2014). Notably, however, negative changes to health behaviors in association with stress or depressive symptoms do not necessarily represent efforts to cope with or alleviate distress, and may alternatively arise because stressful circumstances restrict other resources—such as time or energy—which in turn affect health practices.

One challenge in understanding the effects of stress on health behaviors among young adults is clarifying whether any and all stress is likely to negatively impact health behavior practices, or whether stressors must achieve a certain threshold of intensity or duration in order to influence behavior. While the chronicity of stress can be measured in several different ways, existing literature frequently focuses on three distinctions: *daily stressors* (sometimes referred to as daily hassles), which are relatively common, minor stressors likely to be encountered on a regular basis (for example, having a report or assignment due at work; Carney et al., 2006); *acute stressful life events*, which are more severe, discrete life events that may play out over the course of several days (for example, a break up; Sominsky & Spencer, 2014); and *chronic stress*, which refers to ongoing challenging conditions (for example, financial strain; Gallo et al., 2014). Studies of the effects of daily stressors on health behaviors have largely failed to consider daily stressors in the context of ongoing chronic stress. It is conceptually important and clinically relevant to understand whether daily stressors independently influence health behaviors, or whether the previously observed influence of daily stressors on health behaviors is purely attributable to ongoing stressful conditions. Prior studies of daily stressors have largely neglected to measure chronic stress, and therefore have

been unable to disentangle the impact of daily events and ongoing, chronic conditions.

An additional challenge in considering the impact of stress and depressive symptoms on health behavior practices is in differentiating the effects of depressed mood and stress. Stressful life events and circumstances are well-known causes of depressive symptoms and disorders, and individuals suffering from symptoms of depression have elevated rates of stressful life events and circumstances relative to their non-depressed peers (Hammen, 2005; Hinkers et al., 2014; Uliaszek et al., 2012). The overlapping nature of stress and depressive symptoms presents a challenge to differentiating the impact of each on related behavior or outcomes, including health behaviors. Nonetheless, it is important to identify whether stress and depressive symptoms contribute uniquely to negative health behavior change because different interventions are warranted by each (e.g., cognitive behavioral therapy (CBT) for depression or stress reduction therapy or CBT for stress). Furthermore, it may be the case that individuals with elevated depressive symptoms are more susceptible to the deleterious effects of stress than those without elevated depressive symptoms.

Finally, although a robust body of literature supports associations between depressive disorders and symptoms and poor health behavior practices, the mechanisms by which these effects take place on a daily basis remain less well understood. Observed relationships between depressive symptoms/diagnoses and daily health behaviors may be partially capturing the impact of daily affect on health behaviors. Clinical depression is generally associated with higher levels of negative affect (e.g., transitory emotional states such as anger, fear, guilt) and lower levels of positive affect (e.g., joy, excitement, satisfaction; Watson et al., 1988). Cross-sectional studies suggest that negative affect is associated with poor health behaviors, including increased cigarette consumption and reduced exercise and fruit intake (e.g., Allgower et al., 2001; Anton & Miller, 2005), while positive affect has generally been linked with health-promoting behaviors, such as healthy eating and exercise (Griffin et al., 1993), however, both positive and negative emotions have been linked with increased alcohol consumption (Armeli et al., 2000; Simons et al., 2005; Steptoe & Wardle, 1999). The influence of depressive symptoms on daily health behaviors might be mediated by daily experiences of heightened negative affect and/or diminished positive affect.

The present study utilized a daily diary methodology to assess naturally occurring relationships between stressors, affect, and health behaviors in college students with varying levels of depressive symptoms. Chronic stress and acute stressful life events were measured using an objective, interview-based assessment at study baseline, allow-

ing for comparison of the effects of chronic, acute, and daily stress on health behaviors in students with and without elevated depressive symptoms. Maladaptive health behaviors were measured as a composite that included substance use, lack of physical activity, and poor diet and sleep, as all of these behaviors have previously demonstrated susceptibility to the effects of stress (Butler et al., 2010; Sun et al., 2011; VanKim & Nelson, 2013; Wallace et al., 2017). It was predicted that: (1) chronic stress, acute stress, and daily stress would be independently associated with maladaptive health behavior engagement; (2) depressive symptoms would interact with stress to predict maladaptive health behaviors; and 3) that positive and negative affect would mediate the relationship between depressive symptoms and health behaviors.

Methods

Participants

Participants were 127 undergraduate students at a large, public American university who received course credit for study completion. Of the 127 participants, 100 (75.2%) were female, 26 (20.5%) were male, and 1 (.8%) identified as other/preferred not to answer. Participants were between 18 and 24 years of age (mean age = 19.11 years, SD = 1.13). The racial composition of the sample was as follows: 39.4% Asian, 29% white, 15% Latino/Hispanic, 2.4% African-American/Black, 2.4% Middle Eastern, and 11.8% Other/Biracial/Multiracial. The median reported family income was \$80,000–\$99,000.

The participant sample was over-selected for depressive symptoms, such that 33% ($n = 42$) of participants met criteria for at least mild depressive symptoms as determined by a score of 14 or higher on the Beck Depressive Inventory-II. In keeping with previous daily diary investigations of depression, participants were informed that they were ineligible to enroll in the study if they had any history of bipolar disorder or psychotic disorders (e.g., Starr & Davila, 2012). Participants were also informed that they were ineligible for study enrollment if they did not have regular access to a computer at night or were not comfortable reading and speaking in English, as these factors would hinder their ability to complete the daily diaries.

Procedure

The study consisted of one in-person baseline assessment lasting approximately 2 hours and 14 days of daily diary completion online (taking approximately 5–8 min daily; at bed time or between 8 PM and 2 AM); study recruitment and participation took place between April 2015 and

February 2016. Fourteen days is consistent with the length of time used for other daily diary investigations of the relationship between stress, affect, and health behaviors, and allows for naturally occurring changes in students' schedules between weekends and weekdays (e.g., Butler et al., 2010; Todd, 2004). Participants providing informed consent completed the baseline interview and self-report measures and began daily diary assessments the evening of their baseline study visit. Study procedures were approved by the Institutional Review Board at the University of California, Los Angeles.

Measures

Chronic stress

The UCLA Life Stress Interview (LSI; Hammen et al., 1987) was used at study baseline to measure ongoing chronic stress over the past 6 months across a variety of life domains such as school, family, friends, romantic relationships, and finances. The LSI is a semi-structured interview that uses standard general probes to elicit typical and ongoing conditions across a number of life domains, with each domain scored by the interviewer on behaviorally anchored scales that are independent of the participant's subjective perception of stressfulness. The scales each ranged from 1 (exceptionally positive conditions) to 5 (extremely difficult, negative conditions). A total chronic stress score was calculated by summing the chronic stress ratings across domains. The UCLA LSI is a reliable and valid assessment of acute and chronic life stress in adolescents and young adults (Hammen et al., 1995).

Acute stressful life events

The LSI was also used to assess acute stressful life events in the 3 months preceding the interview at study baseline. In addition to assessing ongoing conditions across a variety of domains, the LSI uses standard general probes to elicit specific, discrete life events in the past 3 months with follow-up questions to establish the timing and factors associated with each event that determine the context in which the event occurred. Rating teams blind to participants' actual emotional reactions to the events were presented with written transcripts of each participant's description of the event written by the interviewers. The rating team then assigned a severity rating indicating the impact this event would be expected to have on an average person in the same circumstances. Severity scores range from 1 (no impact) to 5 (extremely severe). A total objective acute stress score was calculated for each par-

ticipant by summing the rating team's severity ratings across all events.

The baseline LSI interviews were carried out by the principal investigator and three undergraduate volunteer research assistants who were formally trained in the administration of this measure. Ten percent of all interviews were randomly selected for reliability testing and the average interrater reliability across domains of chronic stress was excellent (Intraclass correlation coefficient = .91); interrater reliability across the 10 domains of chronic stress ranged from .76 to .96.

Daily stress

Daily stressors were assessed on each of the 14 daily diary days with a checklist of 24 minor events likely to be regularly encountered by college students (e.g., "Had a conflict or disagreement with a friend;" "Did poorly on or failed an exam or project"). This list is based on several measures of daily stressors/hassles, including the Daily Stress Inventory (DSI; Brantley et al., 1987), the Hassles and Uplifts Scale (DeLongis et al., 1988), The Inventory of College Students' Recent Life Experiences (Kohn et al., 1990), and additional interpersonal items that have been shown to have predictive utility over and above existing measures in college students (Maybery & Graham, 2001). Such measures have previously demonstrated good reliability, validity, and acceptable internal consistency (Brantley et al., 1987; Lay & Safdar, 2003). The checklist also contained spaces for participants to identify up to two additional stressors not included in the list. A daily stress score was calculated as a count of stressors reported for that day, with a possible range of 0–24.

Depressive symptoms

Depressive symptom severity was assessed at study baseline using the BDI-II (Beck et al., 1996). The BDI-II includes 21 questions with a four-point rating scale ranging from 0 to 3. The BDI-II has been well-validated and is widely used among college student samples (Storch et al., 2004). Internal consistency on the BDI was good ($\alpha = .89$).

Health behaviors

Participants' engagement in various health behavior practices was assessed at study baseline and on a daily basis in order to allow for testing of within-person deviations from typical health behavior practices.

Sleep Participants reported on average number of hours of sleep obtained each night over the past 30 days (baseline) and daily hours of sleep, which is a standard assess-

ment of sleep duration, and is similar to that used in The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). Such assessments have previously demonstrated good reliability, validity, and specificity and are widely used to assess sleep among college students (e.g., Carney et al., 2006). The average number of hours of sleep reported per night in the current sample was 6.8 (range 3–9; SD = 1.12).

Cigarette use Number of days smoked and average number of cigarettes smoked on days smoked in the past 30 days were used to establish baseline smoking levels. Participants reported on daily cigarettes consumed in the daily diaries. Previous studies have utilized self-report measures of average number of cigarettes smoked daily with young adults (e.g. Emery et al., 2012), and such items have demonstrated reliability comparable with daily diary measures of cigarette consumption (Harris et al., 2009). At baseline, 87% (n = 111) of participants reported that they had not smoked on any days in the past 30; among smokers, the average number of cigarettes consumed daily was 4.35 (range 1–35).

Drinking Number of days on which participants consumed alcohol and average number of alcoholic beverages consumed on days in which drinking occurred in the past 30 days were used to establish baseline alcohol consumption. Participants reported on daily drinks consumed in the daily diaries. These assessments are consistent with assessments of drinking quantity and frequency used in previous studies (e.g., Young et al., 2006), which have demonstrated sound validity (Leigh, 2000). Participants reported on the number of days out of the past 30 on which they drank alcohol: 24% never, 40% monthly or less; 24% 2–4 times per month, and 12% 2–3 times per week. The average number of drinks participants reported drinking on days on which they drank was 2.79 (range 0–20; SD = 3.44).

Eating Several facets of participants' typical eating habits over the past thirty days (baseline) and daily were assessed. In keeping with standard measures of daily eating habits, participants were asked to report on their average daily numbers of portions consumed of fruits, vegetables, sweets, and fats (e.g., Conner et al., 2014). Participants reported consuming an average of 1.82 portions of fruit (range 0–8, SD = 1.24), 2.14 portions of vegetables (range 0–8, SD = 1.66), 1.30 servings of high-fat foods (range 0–6, SD = 1.10), and 1.31 servings of sweets (range 0–5, SD = .99). Twenty-nine percent of participants reported typically consuming the recommended daily intake of five or more daily servings of fruits and vegetables in the past month.

Exercise Participants were asked about frequency, duration, and intensity of past month (baseline) and daily exercise behavior. Assessments of intensity and duration of exercise are in line with established exercise guidelines as

outlined by the World Health Organization (WHO; “Global Recommendations on Physical Activity for Health,” 2015). Self-reports of mild, moderate, and vigorous physical activity have demonstrated good reliability and validity (Godin et al., 1986). Participants reported exercising on an average of 13.33 days out of the past 30 (range 0–30; SD = 8.70). Participants reported that on days exercised, they exercised for an average of 52.61 min (range 0–180, SD = 33.61).

Daily affect

Daily negative and positive affect were assessed using the brief version of the Positive and Negative Affect Scales (PANAS; Watson et al., 1988a, b). Participants were asked to rate their experience of twenty different emotions (e.g., irritable, proud) in the past day from 1 (very slightly or not at all) to 5 (extremely). The PANAS is a well-validated and widely used measure of affect (Watson et al., 1988a, b) and has regularly been used to assess daily positive and negative affect (e.g., Dunkley et al., 2014; Zheng et al., 2016). Internal consistency was excellent for the positive affect scale ($\alpha = .92$) and good for the negative affect scale ($\alpha = .85$).

Daily health behaviors and composite scores

A composite score of daily maladaptive health behaviors was constructed in accordance with previous studies of maladaptive and/or risky health behaviors (e.g., Ford & Collins, 2013; see supplementary material for composite score information and scoring). The composite score included consumption of fats, sweets, fruits, and vegetables at or above recommended daily intake levels (per World Health Organization 2015 guidelines), alcohol and cigarette use, sedentary behavior (defined as lack of any exercise, including mildly vigorous exercise such as walking) and inadequate exercise, and inadequate (or too much) sleep (as defined by National Sleep Foundation, 2015). This index is similar to the positive and negative health behavior scales in the 69-item Multidimensional Health Profile-Health Functioning scale (MHP-H), which has previously been used in college student populations (e.g., Visser & Hirsch, 2014) and demonstrated good test-retest reliability and validity with other health behavior measures (Karoly et al., 2005). The present composites are shorter than the MHP-H in order to maximize feasibility for daily use. The possible range of scores for the daily maladaptive health behavior composite was 0–14, with higher scores indicating more maladaptive health behaviors.

Data analysis

Primary study hypotheses were examined using hierarchical generalized linear modeling (Poisson) which allows for nesting of data at multiple time points within individuals by estimating both within-person (Level 1) and between-person (Level 2) error variances with a dependent count variable. Models for testing interactional and meditational effects follow guidelines established by Preacher et al. (2015, quantpsy.org) and Zhang et al. (2009). Level 1 predictors, for example, daily stress, were person-mean centered, such that the variable represents the difference between the number of daily stressors occurring on a given day for a given individual and that individual’s average level of daily stressors (Mroczek & Almeida, 2004). Level 2 variables, for example, chronic stress, were group-centered such that they represented an individual’s standing on a given variable relative to other participants. Additional models were run in which gender was included as a Level 2 covariate in order to control for possible effects of gender on stress, affect, and health behaviors; inclusion of gender did not alter the results presented below. Given the small number of male participants ($n = 26$), tests separated by gender were not conducted. Due to the fact that multiple a priori tests were conducted in the present study, a false discovery control rate procedure was implemented to correct for the potential false discovery of significant results associated with multiple tests (Benjamini & Hochberg, 1995); implementation of this procedure with a significance rate set to .05 altered one of the presented findings (mediation by positive affect, described below). Primary study analyses were conducted using HLM 7 Hierarchical Linear and Nonlinear Modeling software.

Results

Descriptive statistics and daily diary completion

Descriptive statistics and correlations among primary study variables are presented in Table 1. The average number of daily diaries completed was 12.86 out of 14 (range 3–14, SD 1.64), which is comparable to or better than other daily diary studies using college student samples (e.g., Covault et al., 2007; Ford & Collins, 2013). Participants completing fewer than 50% ($n = 2$) of the 14 daily diaries were excluded from the daily diary analyses, in keeping with previous literature (e.g., Ford & Collins, 2013; Seacat et al., 2014).

Table 1 Descriptive statistics and intercorrelations for primary study variables

	Mean	SD	Range	1	2	3	4	5	6	7
1. Chronic stress	22.00	2.82	17–31							
2. Acute stress	3.09	2.73	0–12.50	.34**						
3. Depressive symptoms	11.00	8.24	0–35	.53**	.34**					
4. Daily stressors (Avg.)	2.10	2.13	0–17	.34**	.26**	.37**				
5. Daily negative affect (Avg.)	16.31	6.25	10–50	.24**	.21**	.24**	.54**			
6. Daily positive affect (Avg.)	22.51	8.57	10–50	-.26**	.02	-.19*	-.02	.19*		
7. Mal. health behavior comp. (Avg.)	4.58	1.94	0–11	.21*	.18*	.28**	.42**	.19*	-.14	

* $p < .01$, ** $p < .001$

Study hypotheses

The first aim of the study concerned the independent effects of chronic stress, acute stressful life events, daily stress, and depressive symptoms on health behaviors. Chronic stress had a significant independent association with daily maladaptive health behaviors, such that more chronic stress was associated with higher levels of maladaptive health behaviors (see Table 2). Acute stressful life events in the past 3 months were not significantly associated with daily maladaptive health behaviors (Table 2). Person-centered daily stress was significantly associated with higher same-day maladaptive health behaviors, controlling for baseline health behavior levels (see Table 2). Depressive symptoms at baseline had a significant association with daily maladaptive health behaviors, such that higher levels of depressive symptoms were associated with higher levels of daily maladaptive health behaviors (see Table 2).

In order to compare the independent effects of stress and depressive symptoms on daily maladaptive health behaviors, a model was run in which chronic stress, acute stressful life events, and depressive symptoms were included in Level 2 and daily stress was included in Level 1. In this model, acute stressful life events and depressive symptoms were not independently associated with maladaptive daily health behaviors; daily stress ($b = .01$, $SE = .00$, $p = .02$) and chronic stress ($b = .02$, $SE = .01$, $p = .03$) were significantly associated with daily mal-

adaptive health behaviors. The interaction of daily stressors and baseline chronic stress was not significant in predicting daily maladaptive health behaviors ($b = .01$, $SE = .01$, $p = .07$); thus, the present findings did not support a model in which chronic stress affected health behaviors only in the context of daily stress.

The second study question sought to examine the potential interaction between the effects of depressive symptoms and stress on maladaptive health behaviors. Depressive symptoms did not moderate the effects of chronic ($b = .00$, $SE = .00$, $p = .85$) or daily stress ($b = .01$, $SE = .01$, $p = .06$) on daily maladaptive health behaviors.

The third study aim considered the role of daily negative and positive affect as mediators of the effect of depressive symptoms on health behaviors. The effect of depressive symptoms at baseline on daily maladaptive health behaviors was mediated by both daily positive and negative affect (see Table 3 for results and Sobel's Z tests). In accordance with guidelines established by Zhang et al. (2009), these analyses controlled for both within and between subject effects of daily affect. Thus, the results indicate that the effect of depressive symptoms on maladaptive health behaviors took place through changes to an individual's daily level of both positive and negative affect. This mediation was classified as complete rather than partial as the effect of depression on maladaptive health became non-significant when the mediator was included in the model. However, the mediational effects of positive

Table 2 Effects of Level 2 variables (chronic stress, acute stress, and depressive symptoms) and Level 1 variable (daily stress) on daily maladaptive health behavior

Predictor	Chronic stress			Acute stress			Dep. symptoms			Daily stress		
	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>
Overall intercept,												
Intercept	1.43	.03	< .01	1.43	.03	< .01	1.43	.03	< .01	1.10	.07	< .01
Predictor (<i>Stress, BDI, or Affect, as indicated in first row</i>) on Maladaptive HB	.03	.01	< .01*	.01	.01	.50	.01	.00*	< .01	.01	.01	.02*

*Indicates statistical significance after implementation of false discovery rate procedure

Table 3 Mediation of the effect of baseline depressive symptoms on daily maladaptive health behaviors by negative and positive affect

Estimation of effects on maladaptive health behaviors	Negative affect						Positive affect					
	Without mediator			With mediator			Without mediator			With mediator		
	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>
<i>Overall intercept</i>												
Intercept	1.43	.03	< .01	1.43	.03	< .01	1.43	.03	< .01	1.43	.03	< .01
Average affect				.00	.01	.56				.00	.00	.50
Depressive symptoms	.01	.00	< .01	.01	.00	.10	.01	.00	< .01	.01	.00	.05
<i>For affect slope</i>												
Intercept				.01	.00	.01				.01	.00	.02
Results of Sobel’s Z Test	Z = 2.01, SE = .00, <i>p</i> = .04*						Z = 2.05, SE = .00, <i>p</i> = .04					

*Indicates statistical significance of Sobel’s results after implementation of false discovery rate procedure

affect became non-significant when the false discovery control rate procedures were implemented (obtained *p* value = .04, FDC *p* value threshold = .03).

Effect sizes

Although there is no standard method of effect size calculation in multilevel modeling, one method of estimating the magnitude of effects of Level 2 predictors is the *proportional reduction in variance* statistic, which is calculated by subtracting the variance of the model with the predictor from the variance of a model without a predictor (the “base” model), and dividing the difference by the variance of the base model (Peugh, 2010; Nezlek, 2012). The result is an estimate of the percentage of the residual variance that has been explained by the predictor. Using the proportional reduction in variance to estimate the percentage of residual variance explained by Level 2 predictors in the estimation of daily health behavior practices, we find that 7% of residual variance is explained by a participant’s baseline level of chronic stress and 5% of residual variance is explained by a participant’s baseline level of depressive symptoms. The strongest Level 2 predictor of a person’s daily health behavior practices is, as expected, their baseline level of health behaviors accounting for 24% of the variance in daily health behaviors between participants.

Discussion

The present study sought to examine the independent, relative, and interactive effects of depressive symptoms and stressors of varying severity and chronicity on daily self-reported health behaviors among college students. The results demonstrated that depressive symptoms, chronic stress, and daily stress, but not acute stressful life events,

were associated with daily maladaptive health behaviors. Furthermore, the present results suggest that chronic stress and daily stress are independently associated with college students’ daily health behavior engagement. The current study expands upon prior literature in the field to suggest that one of the ways in which depressive symptoms influence health behavior practices is through fluctuations in and changes to daily negative affect.

The present results support previous literature showing that higher levels of depressive symptoms are associated with a greater degree of maladaptive health behavior engagement. This is consistent with prior studies demonstrating that adults with elevated depressive symptoms report more frequent daily binge eating and less physical activity than adults without elevated depressive symptoms (Goldschmidt et al., 2014; Hopko & Mullane, 2008). The present findings corroborate previous correlational studies demonstrating that college students with elevated depressive symptoms are at risk for engaging in worse health behavior practices relative to their peers with low levels of depressive symptomatology. Notably, the present observed relationship between depression and poor health practices was demonstrated with depressive *symptoms*; relatively few of the participants (*n* = 11) met full diagnostic criteria for a current major depressive episode. These findings are consistent with previous evidence that depressive symptoms alone, without necessarily achieving full diagnostic threshold for depressive disorders, are sufficient to affect health behavior practices (e.g., Allgower et al., 2001; Halperin et al., 2010; Hopko & Mullane, 2008).

The present study attempted to further clarify the nature of the relationship between depressive symptomatology and daily maladaptive health behavior engagement by testing possible mediators and moderators of this relationship. The hypothesis that individuals with elevated depressive symptoms would show a stronger effect of stress on maladaptive health behavior engagement was not

supported. While this has not been thoroughly tested in the literature, it is consistent with prior findings of maladaptive stress-coping strategies among individuals with depression (Li et al., 2006; Sun et al., 2011). The present results indicated that neither chronic stress nor daily stress significantly moderated the effects of depressive symptoms. Thus, in the present study, individuals with elevated depressive symptoms were not likelier than those without elevated depressive symptoms to exhibit worsened health behaviors in the presence of chronic or daily stress. It is possible that the hypothesized interactions between depressive symptoms and stress would have been demonstrated in a sample including individuals with a stronger severity of depressive symptoms and/or with more participants meeting diagnostic criteria for a depressive disorder. Alternatively, it may be that all college students, regardless of depression status, are equally susceptible to the effects of stress on health behaviors. In the present study, models containing stress and depressive symptoms simultaneously indicated effects of chronic and daily stress over and above depressive symptoms on maladaptive health behaviors; these results also support an interpretation of relatively more potent effects of stress than depressive symptoms on college students' daily maladaptive health behaviors.

In the present study, daily fluctuations in negative affect mediated the effect of baseline depressive symptoms on daily health behavior engagement. These findings are consistent with previous evidence that college students' beliefs about the utility of substances to alleviate negative affect mediate the relationship between depressive symptoms and substance use (Buckner et al., 2007; Schleicher et al., 2009). These findings are also consistent with evidence that negative affectivity precedes binge eating episodes (Haedt-Matt & Keel, 2011). It is possible that individuals with elevated depressive symptoms who experience increased negative affect may engage in poor health behaviors in an effort to reduce distress and/or mitigate the effects of negative affect. The present results concerning the role of positive affect in mediating the effects of depressive symptoms on maladaptive health behavior practices were not significant when corrections to significance levels were made to account for multiple tests. The relationships between depression, positive affect and health behaviors warrants further investigation in light of the fact that previous studies have documented associations between daily positive affect and adaptive health behaviors such as fruit and vegetable consumption, fewer sleep problems, and self-reported exercise (Garcia & Archer, 2014; Steptoe et al., 2007; White et al., 2013). It is important to note that these analyses indicate an impact of day to day changes in a person's individual level of positive and/or negative impact on their health behavior

engagement (relative to their own typical level of health behavior engagement).

Several limitations should be kept in mind when interpreting the present findings. First, the presently demonstrated effects of stress, depressive symptoms, and affect on health behaviors among college students may not extend to older adult populations, who may have higher degrees of physical illness or limitations. It should also be kept in mind that use of a daily diary design, while allowing for assessment of day to day changes in behaviors and affect within and between participants, does not allow for precise timing of onset between specific daily stressors and specific instances of health behavior engagement. Additionally, although participants were able to respond to the open-ended life stress interview questions with answers pertaining to social media, it may be helpful in future studies to explicitly probe about participants' social media stress. While the present study sought to examine effects of stress and depressive symptoms on health behaviors in aggregate; future assessment with specific health behaviors would be useful. The aggregate health behavior composite score created for this study is a potential limitation due to lack of previous knowledge of the validity of the measure. Finally, although there is evidence of the validity of using daily diary methodology to assess young adults' daily habits (Gillmore et al., 2001), it is still possible that participants attempted to provide socially desirable responses or were biased in their recall of past stressors, possibly as a result of their current mood state.

A primary strength of the present study is the use of multi-method assessments of stress that allowed for distinction between chronic stress, acute stressful life events, and daily stressors. Few previous studies of the effects of stress on health behaviors have directly measured or considered distinctions between stressor chronicity, and the present results advance the literature base by indicating significant, independent effects of daily and chronic, but not acute, stressors on maladaptive health behaviors. These findings suggest that repeated, ongoing stressors are associated with deleterious health behavior practices. The results also indicate that relatively minor, daily stressors are associated with same-day maladaptive health behaviors, but that acute stressful life events occurring in the three months prior to the study did not have a lasting impact on health behaviors. The lack of demonstrated association between acute stressful life events and maladaptive health behaviors is somewhat inconsistent with previous research showing an effect of life events on health behaviors (e.g., Childs & de Wit, 2010; Kim & Dimsdale, 2007). It is possible that, in the current study, the acute stressful life events reported as occurring in the three months leading up to the study (e.g., romantic relationship break-up, changing academic major, or a fight/disagree-

ment with a roommate or friend) were not significant enough to have a lasting impact on health behavior engagement. Given that daily hassles were associated with changes to same-day health behavior practices, it seems plausible that these acute events exerted a temporary impact on health behavior practices, but this effect was not sustained in duration. These findings underscore the importance of careful measurement of stress in studies of health behavior practices, as the chronicity of stressors may be important in understanding their effects on health behaviors. Finally, the current results are strengthened by use of a daily diary design with baseline assessments of health behavior practices that enabled testing for deviations from an individual's typical level of maladaptive health behavior practices.

The current results have implications for health outcomes among college students. Results indicate that students with chronically stressful lives, higher loads of daily stress, and depressive symptoms are at increased risk for engaging in daily maladaptive health behaviors. Prior research suggests that some common areas of stress or concern among college students include academic performance, perceived pressure to succeed in school, and post-graduation plans (Beiter et al., 2015). College students' perceived financial stress has also been shown to be negatively associated with their subjective well-being (Cliff, 2017). The present findings underscore the idea that even day-to-day increases or decreases in an individual's negative affect, or changes in numbers of daily, mundane stressors (e.g., having an exam, running late to class) experienced, are enough to impact daily health behaviors. Although these results require replication with greater precision of timing, they tentatively indicate that interventions targeting affect regulation and adaptive coping with stress could be useful in promoting healthy behavior engagement in college students with and without elevated depressive symptomatology. Therapeutic interventions that target affect-regulation skills have been shown to improve psychotherapy outcomes generally (Berking et al., 2008), and results from a preliminary pilot study suggest that a 4-week long resilience training program enhances coping strategies, increases positive affect, and decreases negative affect in college students (Steinhardt & Dolbier, 2010). Young adults, particularly those at risk of developing depression by virtue of elevated depressive symptoms or those experiencing high levels of ongoing stress, may benefit from emotion-regulation training that targets response to daily experiences of negative affect/emotion and facilitates use of healthy coping responses over maladaptive health behavior engagement. Identification of college students most likely to benefit from such interventions could potentially take place through health screenings that assess depressive symptoms and/or chronic

stress. Additionally, there is evidence that college students with a history of clinical depression have a stronger affective reaction to stress even when in remission from their depression (O'Hara et al., 2014). The present study advances understanding of how depressive symptoms affect health behavior engagement day-to-day, and suggests that daily changes in negative affect may be a fruitful target of intervention with potential implications for mental and physical health.

Compliance with ethical standards

Conflict of interest Elizabeth Dalton and Constance Hammen, declare that they have no conflicts of interest.

Human and animal rights and Informed consent All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee at the University of California, Los Angeles and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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