Mindfulness, Self-distancing, and Self-compassion as Buffers of the Effects of Rumination on Health Behaviors: a Daily Diary Study

Kristen E. Riley[1] · **Crystal L. Park[2]** · **Celia C. Y. Wong[3]** · **Beth S. Russell[4]**

Abstract

Rumination, self-focused thinking about events and emotions negatively and repeatedly, is a common cognitive process that leads to maladaptive health behaviors. Because mindfulness has been shown to reduce the negative psychological effects of rumination in other studies, we posited that it may buffer the association between rumination and maladaptive health behaviors. We tested this hypothesis in two online daily diary studies with college students. Health behavior outcomes included fruit intake, vegetable intake, exercise, alcohol intake, sexual risk-taking behavior, and cigarette smoking. In Study One ($N = 285$), multivariate modeling analyses demonstrated that trait mindfulness was not a significant moderator of daily rumination to health behavior relationships. In Study Two ($N = 157$), daily self-compassion and daily self-distancing—but not daily mindfulness—were significant within-person moderators of daily rumination to daily health behaviors. Self-compassion and self-distancing were buffers of the negative effects of rumination on health behaviors. The implications of this research and application to interventions are discussed, including mindfulness interventions that emphasize self-distancing or self-compassion component.

✉ Kristen E. Riley
  Kristen.Riley@Rutgers.edu

[1] Graduate School of Applied and Professional Psychology, Rutgers University, 152 Frelinghuysen Rd, Piscataway, NJ 08854, USA

[2] Department of Psychological Sciences, University of Connecticut, Storrs, CT, USA

[3] Department of Psychology, State University of New York at Brockport, Brockport, NY, USA

[4] Department of Human Development and Family Studies, University of Connecticut, Storrs, CT, USA

Rumination, passively and repetitively thinking about a negative mood, negative thoughts, or negative events (Nolen-Hoeksema, 1991; Smith & Alloy, 2009), is a common process that uniquely predicts health behavior engagement or avoidance (Riley et al., 2019). Engaging in maladaptive health behaviors such as excessive alcohol intake and sexual risk-taking behavior and avoiding adaptive health behaviors such as a healthy diet and exercise contribute to the development of a number of chronic illnesses. Rumination may impact health behaviors because its increased cognitive load may increase impulsivity around maladaptive health behaviors or avoidance of adaptive health behaviors (Riley et al., 2019).

For example, in a study from the larger dataset, rumination was shown to lead to more maladaptive health behaviors or less adaptive health behaviors through two pathways: (1) by leading an individual to act too quickly (i.e., an effect mediated by impulsivity and self-control). When people are stuck in their ruminative thoughts, they may put off making decisions about health behaviors and may need to make spontaneous decisions as a result; and (2) through amotivation: Rumination can sap individuals' motivation and initiative. Rumination maintains one's focus on depressive or sad thoughts, which may distract individuals from their desire to engage in constructive behavior. Using health behaviors to cope with rumination is also a robust mediator (Riley et al., 2019).

Mindfulness

It is important to identify ways to reduce rumination's effect on health behaviors. Rumination has been shown to be an important mediator of the health and psychosocial effects of mindfulness interventions, such that mindfulness interventions lead to better psychological outcomes through less rumination (Heeren & Phillipot, 2011; Labelle et al., 2010). In addition, mindfulness has been shown to decrease rumination (Perestelo-Perez et al., 2017) and produce positive cognitive (Chiesa et al., 2011), behavioral (Sancho et al., 2018), and emotional changes (Rodrigues et al., 2017). However, no studies to our knowledge have tested whether mindfulness buffers the maladaptive effect of rumination on health behaviors.

Historically, mindfulness is conceptualized as an "awareness of the unfolding of present moment perceptible experience, a process sustained by several qualities including acceptance, patience, and loving kindness" (p. 262, Chiesa, 2013). Mindfulness may buffer the effects of rumination on health behaviors by reducing cognitive load, reducing the length or duration of rumination with its present-moment and acceptance foci, or providing some self-distancing abilities to allow individuals to make more thoughtful decisions regarding health behaviors. Through observing one's feelings and being a non-judgmental participant in the environment, mindfulness skills may help reduce the maladaptive effects of perceived stress or feelings of crisis (Linehan & Wilks, 2015). This non-judgmental observation also helps foster self-monitoring skills that allow individuals to regulate otherwise impulsive, automatic, or reactive cognition and behavior (Linehan & Wilks, 2015). Mindfulness creates space for individuals to observe their thoughts and emotions without repeating learned cycles of negative reactivity, instead consciously responding to stress

with increasingly adaptive thoughts and actions (Kang et al., 2013). For example, mindfulness may serve as a brake that allows individuals to adequately acknowledge and process their negative thoughts so that those negative thoughts will not lead to more engagement in maladaptive health behavior or disengagement from healthy behaviors (Chambers et al., 2009; Gu et al., 2015; Kang et al., 2013).

Two specific components of mindfulness have been shown to be particularly strong in combatting the negative effects of rumination in previous literature, namely self-distancing (Ayduk & Kross, 2010) and self-compassion (Neff & McGehee 2010). *Self-distancing* is defined as being able to view the stressful situations in one's life from an objective, third-party perspective, a main theme in mindfulness practices (Vago, 2014). *Self-compassion* refers to the extension of compassion to one's self in instances of perceived inadequacy, failure, or suffering (Neff, 2003). While it is viewed as a construct separate from mindfulness (e.g., Neff, 2003; Raab, 2014), it is often inherent in, and a consequence of, mindfulness interventions (e.g., Birnie et al., 2010). Mindfulness and its associated constructs (self-distancing and self-compassion) are tested here as moderators that may decrease the strength of the rumination to health behaviors relationships, as mindfulness cultivates flexibility, self-compassion, and self-distancing to make adaptive response choices, including better health behavior decisions (Christie et al., 2017; Kabat-Zinn, 2003).

Overview of Studies

Two studies were conducted to test our hypothesis. Study One measured mindfulness as a trait variable at baseline. We examined this between-person mindfulness variable as a moderator of the relationship between daily rumination and daily health behaviors (both assessed as within-person variables). Given the previous literature showing that mindfulness also varies on a daily basis, we subsequently conducted Study Two, in which we measured mindfulness and associated constructs that may be particularly useful in combatting rumination (self-distancing and self-compassion) at the *daily* within-person level, in order to more specifically model the potential buffering effect of mindfulness on the rumination to health behavior relationship. Study Two allowed us to test mindfulness as a within-person as well as a between-person moderator.

Overview of Method

Health behavior engagement occurs on a frequent basis, with multiple instances, or lack thereof, every day. This is especially true when it comes to eating and exercise behaviors, making a daily diary design particularly appropriate for measuring relationships between these variables and their temporal patterns, and measuring health behaviors with accuracy. Previous research has demonstrated that measuring health behaviors frequently is more accurate than is aggregate measurement, which often introduces recall biases (Gillmore et al., 2001). Not only is an individual's recall subject to error due to memory reconstruction and

the availability heuristic, but it is also subject to bias by the person's context and mental state at the time of recall. This *state-congruent recall* can lead to biased reports (Bolger & Laurenceau, 2013; Bower, 1981).

Much like health behaviors, rumination may also occur multiple times per day and fluctuate over time. However, few studies have examined rumination using a daily diary design, even though such assessment can yield important and more nuanced "in vivo" information (Moberly & Watkins, 2008). For example, one daily diary study demonstrated the predictive role of rumination in daily symptom severity of seasonal affective disorder during the winter months (Young & Azam, 2003). Assessing ruminative response style with a daily measure allows collecting actual ruminative behavior rather than assessing general ruminative tendencies. Previous research has demonstrated daily fluctuations in both state rumination measures and general ruminative trait tendency measures (Moberly & Watkins, 2008); similarly, mindfulness has also been shown to vary on a daily basis (McManus, 2013). In these two studies, we included trait rumination, but focused primarily on daily rumination, in order to examine moderators of daily rumination and health behavior relationships.

We studied rumination and health behaviors among college students for several reasons. First, rumination and maladaptive health behavior patterns are exceedingly common in the college student population (Zawadzki et al., 2013; ACHA, 2009), and only seem to be getting worse (ACHA, 2016; Xiao et al., 2017). Second, college students are at a time in their life—early adulthood—when they are finally independent and developing health behavior patterns for their adult lives which strongly influence their chance of acquiring chronic diseases throughout their lifespans. Third, college students are a population for whom intervention opportunities are ripe. Many students live on or visit daily a specific location (college campus), where there is a well-developed structure in place (the academic environment, school administration, health centers and health services, athletic departments) that allows interventions with students.

Hypotheses

For both studies, we expected mindfulness to moderate (decrease the strength of) the relationship between rumination and health behavior patterns. With higher mindfulness, we hypothesized that that daily rumination will be less strongly (negatively) related to adaptive daily health behaviors (fruit intake, vegetable intake, exercise), and less strongly (positively) related to daily maladaptive health behaviors (cigarette smoking, alcohol intake, sexual risk taking). For example, on days when people are more mindful than their average level of mindfulness, rumination will be less likely to affect their health behaviors. Trait mindfulness was hypothesized to moderate links from rumination to health behaviors in Study One, as were daily mindfulness and its components of daily self-distancing and daily self-compassion in Study Two.

Study One Methods

Participants

A total of 285 participants (mean age = 19.3 [SD = 1.9]; 76.8% female; 79.4% Caucasian, 6.3% Black/African American, 4.2% Asian, and 3.1% "Other," with 9.3% identifying as Hispanic/Latino) were recruited via the Psychology Department participant pool website at a large New England university. Participants were compensated with credits for an introductory psychology course.

Procedure

Participants completed online questionnaires using the Qualtrics online survey software. Students completed a battery of questionnaires at baseline, immediately followed by 11 days of brief daily diary assessments. This study length ensured the inclusion of at least two weekends, when maladaptive health behaviors in college students often happen (Finlay et al., 2012). At baseline, participants reported demographic information and trait tendencies on rumination and mindfulness. At each daily diary time point, participants reported daily health behaviors and rumination and other measures outlined below.

In the study description on the Participant Pool portal, participants were informed that they would be sent a link to an online survey via email for baseline on day 1 at 8 am, to be completed that day, and for the daily survey, between 8 pm and 2 am before bed, every day for 11 days, starting the evening of day 1. Participants were directed to a website where they were asked to set aside approximately 30 min (baseline) or 5 min (daily diary) of uninterrupted time to answer all of the questions. Participants were asked to complete the daily survey at the end of their day, as close to bedtime as possible, and between 8 pm and 2 am.

Measures

Baseline

The following measures were collected only on day 1 of the study.

Demographics We asked participants to identify their age, year in school, gender, race, and ethnicity.

Trait Rumination The Response Styles Questionnaire, Ruminative Responses Subscale (Brooding subtype; RSQ, RRS; Nolen-Hoeksema & Morrow, 1991) is an 8-item subscale that has been extensively used and shown to have good internal consistency and moderate to high test–retest reliability over 1 year ($r = 0.47$, $p < 0.001$).

Participants are asked to respond to the frequency with which they thought ruminative thoughts about their most stressful event, including *Think "What am I doing to deserve this?"* In the present study, $\alpha = 0.96$.

Trait Mindfulness (CAMS-R) Mindfulness was assessed with the 12-item Cognitive and Affective Mindfulness Scale—Revised (CAMS-R). Items are ranked on a Likert scale (Feldman et al., 2007). Example items include "I am able to focus on the present moment," "I am able to accept the thoughts and feelings I have," and "I am preoccupied by the past (reverse scored)." This scale has demonstrated validity and internal consistency and is the only mindfulness scale to have been used previously in a daily diary study. Reliability for the CAMS-R in this study was good ($\alpha = 0.82$).

Daily Diary (11 Days)

The following measures were collected on each of 11 days.

Fruit and Vegetable Intake Daily diet was assessed using the Dietary Screener Questionnaire (DSQ; NCI, 2010), a focused assessment referring to the past week of eating that is posted on the NCI website (https://epi.grants.cancer.gov/nhanes/dietscreen/questionnaires.html). Questions were modified to pertain to daily intake, a common practice (e.g., Perrine, 2014). Scoring algorithms produce two scores for number of daily fruits and of vegetables eaten that day. The DSQ has been used in large-scale and more focused studies and shown to have reasonable validity (Smith et al., 2017).

Exercise Exercise was assessed by the Godin Leisure-Time Exercise Questionnaire (LTEQ), a 4-item measure that assesses leisure-time exercise without the need for detailed review (Godin & Shephard, 1985). The LTEQ assesses sessions per day of strenuous (heart beats rapidly), moderate (not exhausting), and mild (minimal effort) exercise practiced for at least 15 min. A composite score was used for our daily exercise index (Godin & Shephard, 1985).

Sexual Risk Taking Participants reported occasions on which they had unprotected sex (i.e., sex without protection against STDs and pregnancy) (Wetherill et al., 2010). Participants rated each item on 7-point scales from 0 times to 6 + times. Due to the nature of the output as no risk taking most days and some incidents other days, these data were recoded into a dichotomous variable. These items have been used and validated in college student samples (Wetherill et al., 2010).

Alcohol Participants reported total alcohol consumption in the previous 24 h. One drink is defined as one 12-oz bottle of beer, one 4-oz glass of wine, one 12-oz bottle of wine cooler, or 1-oz of liquor straight or in a mixed drink. This measure has been used successfully in college student samples (e.g., Park & Levenson, 2002; Park et al., 2004).

Cigarettes Participants reported how many cigarettes they had smoked in the past 24 h, a common method of assessing cigarette smoking (Welte et al., 2011).

Data Analysis Plan

First, examination of data, cleaning and preparation of data, descriptive analyses, and basic bivariate correlations were performed in SPSS. Then, due to the hierarchical nature of the data, the intensive longitudinal modeling design, and the questions and hypotheses slated for examination, we used Mplus to examine multilevel models of rumination and health behaviors, including moderation (Muthén and Muthén 1998). Alpha level for all analyses will be $p \leq 0.05$.

Multilevel Modeling Analyses in Mplus Diary data collected in this study conforms to a multilevel data structure (Raudenbush & Bryk, 2002). In Study One, the daily diary ratings of rumination and health behaviors were the Level 1 data. Level 2 data were baseline rumination and mindfulness. Multilevel modeling was an ideal choice for the analysis of these data because it estimates within-person (Level 1 data) and between-person (Level 2 data) variation simultaneously, thus allowing for the modeling of each source of variation while taking into account the statistical characteristics of the other (Bolger & Laurenceau, 2013).

On a practical level, we followed steps to ensure conforming to all best standards and practices for intensive longitudinal modeling (Bolger & Laurenceau, 2013). All data were analyzed at the within-person level (Level 1) and the between-person level (Level 2). Each of the predictor variables was group mean centered, meaning that they were centered on each participant's data by subtracting the participant's mean from his or her daily value of each variable. Between-person components of predictor variables (i.e., rumination, mindfulness, self-distancing, and self-compassion) were created and included in all models using means of daily items per person. We divided predictors into their between- and within-person components.

We estimated both Level 1 and Level 2 moderators for the Level 1 rumination to Level 1 health behavior relationships. Time is included in all models.

Missing Data Missing data were accounted for by full information maximum likelihood estimation. Although most unplanned "missingness" in psychosocial research is at some level not missing at random, we sought to reduce bias produced by this mechanism by including variables associated with missingness in our models; parameter estimates are valid under the assumption of data missing at random. All models were run with MPLUS, which uses maximum likelihood estimation.

Power We used the software Optimal Design to determine the balance of days to participants based on expected effect sizes for outcome variables (Bolger & Laurenceau, 2013). Expected effect sizes were derived from a previous pilot study dataset. Desired power was set at 80%, the cutoff for a large effect size and the "magic number" for daily diary studies (Bolger & Laurenceau, 2013). We also accounted for 20% attrition rate, consistent with the average attrition for a daily diary study in college students

(Losavio et al., 2011; Swim et al., 2001). We wanted a minimum of 11 observations in order to sample over the course of two weekends, when healthy behaviors vary more (Gillmore et al., 2001). With 11 observations, we required a minimum of 200 participants to power at 80%.

Study One Results

Descriptive Statistics

The sample of 285 college students had a mean age of 19.3 years (SD = 1.9), consistent with the college student population. The sample was predominantly female (76.8%), which is fairly consistent with the average college student population, at 60% female (Department of Education, 2014). Consistent with the student body composition at our large public university in New England, our sample consisted of predominantly White participants.

No student withdrew from this study prior to its completion. Of valid responses (i.e., of days on which participants did fill out a survey), missing data was fairly low: Missing data at baseline for study variables varied from 1.0 to 4.2%, and missing data on the daily variables varied from 1.7 to 3.0%. On average, participants completed 9.72 out of 11 days of daily diary responses, or 88.3% of daily assessments, a typical amount for daily diary completion (Bolger & Laurenceau, 2013).

Item-level ICC values for rumination ranged from 0.61 to 0.69, mindfulness ranged from 0.20 to 0.45, and health behaviors ranged from 0.44 to 0.82, all indicating support for multilevel analysis. Deviance item-level ICCs were lower, with two items having a less than 0.10 value. Construct-level ICCs were assessed for Level 1 rumination (ICC = 0.43) and Level 2 mindfulness (ICC range = 0.54 to 0.67), indicating support for multilevel analysis.

Health Behavior Frequencies On average, per day, participants reported exercising for 23.11 min (SD = 30.38), eating 1.18 fruits (SD = 1.08) and 0.75 vegetables (SD = 0.93), drinking 0.81 alcoholic beverages (SD = 2.22), and engaging in 0.06 incidents of sexual risk taking (SD = 0.24). There were low frequencies of reports of cigarette smoking; only eight participants reported any smoking incident over the entire study, for a total 60 observations within 11 days, or 1.9% of the all daily observations (3135 observations). The low rates of smoking prevented further analysis on this outcome variable (Bolger & Laurenceau, 2013).

Rumination and Health Behaviors Trait rumination (between-person) was significantly related to exercise ($r = -0.082$, $p < 0.001$), fruit intake ($r = -0.047$, $p < 0.001$), and vegetable intake ($r = -0.068$, $p < 0.001$). Daily rumination (within-person) was significantly related to fruit intake ($r = -0.040$, $p < 0.05$), alcohol intake ($r = 0.077$, $p < 0.001$), and sexual risk taking ($r = 0.146$, $p < 0.001$).

Multilevel Modeling in Mplus

Relationship with Time In simple models, modeling each health behavior variable with time within- and between-persons, there was no significant increase or decrease over time ($p > 0.05$). There were no significant relationships between study variables and time. In models with rumination included, exercise and vegetable intake decreased over time ($p < 0.05$; see Table 1).

Table 1 Study One: Multilevel model of daily rumination to daily health behavior outcomes

	Estimate	(SE)	t	p	CI_{95} lower	CI_{95} upper
Fruit intake on						
Rumination (within)	− .085	.051	1.673	.084	− .015	.185
Time	.003	.006	.454	.650	− .009	.015
Vegetable intake on						
Rumination (within)	− .060	.039	1.546	.092	− .040	.136
Time	**− .015**	.005	− 3.010	.003	− .026	− .005
Exercise on						
Rumination (within)	− .379	1.540	− .246	.806	− 3.398	2.640
Time	**− .494**	.164	− 3.014	.003	− .816	− .173
Alcohol on						
Rumination (within)	.252	.140	1.796	.062	− .225	.527
Time	.003	.015	.214	.830	− .073	.032
Sexual risk on						
Rumination (within)	.181	.207	.874	.382	− .255	.588
Time	− .008	.025	− .315	.753	− .057	.042
Fruit intake on						
Rumination (between)	− .182	.062	2.342	.053	− .015	.185
Vegetable intake on						
Rumination (between)	**− .092**	.041	2.146	.047	− .040	.136
Exercise on						
Rumination (between)	− .339	1.540	− .246	.112	− .498	1.640
Alcohol on						
Rumination (between)	**.252**	.140	1.796	.041	− .125	.927
Sexual risk on						
Rumination (between)	.122	.97	1.3744	.092	− .127	.238
Intercept						
Fruit (within)	1.171	.057	20.475	< .001	-.015	.121
Vegetable (within)	.830	.043	19.474	< .001	− .016	.136
Exercise (within)	25.629	1.603	15.992	< .001	− 3.398	2.640
Alcohol (within)	1.543	.221	13.782	< .001	− .023	.527
Sexual risk (within)	2.682	.177	15.149	< .001	− .225	.588

Bolding indicates $p < .05$

Mindfulness as Moderator We tested mindfulness as a moderator of the rumination to health behavior relationship. Contrary to our expectations, trait mindfulness (Level 2 mindfulness; see Table 2) was not a significant buffer of daily rumination to health behavior relationships (i.e., $p > 0.05$). Specifically, while some p values were significant, confidence intervals included 0, indicating lack of ability to reject the null hypothesis. Moderation at the between-person level was statistically significant for fruit intake ($\beta = 0.124$, $p = 0.021$), such that high trait mindfulness buffered the negative association between rumination and fruit intake and low trait mindfulness strengthened the negative association between rumination and fruit intake, at the between-person level. In other words, for a given individual, trait mindfulness did not buffer daily maladaptive effects of rumination on health behaviors, though between subjects, those who reported more trait mindfulness had less of a rumination to fruit intake relationship, averaged across time. Two other relationships (i.e., mindfulness as a buffer for the within rumination to alcohol relationship and between rumination to sexual risk-taking relationships) were $p < 0.10$ but did not achieve statistical significance of $p < 0.05$ (i.e., $\beta = 0.750$, $p = 0.081$ and $\beta = 1.223$, $p = 0.083$ respectively; see Table 2).

Study One Discussion

We hypothesized that trait mindfulness would buffer the maladaptive within-person rumination to health behavior relationship, providing us with a potentially potent intervention target for the daily fluctuations in health behaviors that occur and that cumulatively matter a great deal. Unexpectedly, within-person moderation was not supported. The moderation of trait mindfulness on the between-person rumination to health behavior relationship was statistically significant for fruit intake only.

It is possible that null findings emerged because daily fluctuations in mindfulness, rather than trait mindfulness, may serve as a buffer of the daily rumination to daily health behavior link. Some research suggests mindfulness levels may fluctuate substantially day-to-day (McManus, 2013; Snippe et al., 2015). For example, in one study of college undergraduates, daily mindfulness scores revealed both within- and between-person variability and significant associations with daily health and emotional well-being (McManus, 2013). If mindfulness is measured on a daily level, we might see a clearer buffering of the within-person daily processes of these variables. Again, examining daily processes is important, as hundreds of health behaviors occur on a daily basis, and some health behaviors associated with rumination are risky, and even single incidents (e.g., binge drinking, sexual risk taking) are important prevention targets. Thus, studies are needed that explore *daily* mindfulness and its relationship to daily rumination and daily health behaviors. We include a daily measure of mindfulness in Study Two.

Furthermore, our measurement and conceptualization of mindfulness in Study One may not have been comprehensive enough. Debate continues regarding on the limitations of current mindfulness measures, the way we define mindfulness in Western culture, and limits to the mindfulness construct itself (Chiesa, 2013; Park et al., 2013; Schooler et al., 2014; Van Dam et al., 2018). For example, an

Table 2 Study One: Trait mindfulness moderation on daily relationships

	Estimate	(SE)	t	p	CI_{95} Lower	CI_{95} Upper
Fruit on						
Rumination (within)	.315	.259	1.216	.224	−.436	.764
Rumination*Mindfulness (within)	**.750**	.348	2.154	.031	−.498	.914
Time	.002	.006	.306	.760	−.031	.040
Vegetable on						
Rumination (within)	.274	.312	.878	.380	−.015	.456
Rumination*Mindfulness (within)	−.074	.125	−.595	.552	−.846	.488
Time	**−.020**	.007	−.2784	.005	−.043	.029
Exercise on						
Rumination (within)	−9.519	6.353	−1.498	.134	−2.994	7.204
Rumination*Mindfulness (within)	−3.370	2.535	1.472	.141	−9.169	2.475
Time	**−.530**	.142	−3.730	<.001	−.782	−.238
Alcohol on						
Rumination (within)	−1.543	.868	−1.777	.076	−.625	.764
Rumination*Mindfulness (within)	.750	.348	2.154	.081	−.498	.914
Time	.003	.019	.254	.857	−.031	.040
Sexual risk on						
Rumination (within)	.858	.627	1.370	.171	−2.994	7.204
Rumination*Mindfulness (within)	−.160	.251	−1.039	.299	−9.169	2.475
Time	−.007	.018	−.364	.716	−.782	.238
Fruit on						
Rumination (between)	**−.119**	.052	−2.286	.022	−.807	.230
Mindfulness (between)	**.499**	.125	3.696	<.001	−.109	.227
Rumination*Mindfulness (between)	**.124**	.276	.161	.021	.067	.585
Vegetable on						
Rumination (between)	−.043	.334	−.130	.897	−.698	.612

Table 2 (continued)

	Estimate	(SE)	t	p	CI₉₅ Lower	CI₉₅ Upper
Mindfulness (between)	.056	.093	.607	.544 s	−.125	.238
Rumination*Mindfulness (between)	**.110**	.347	−.208	.048	−.753	.609
Exercise on						
Rumination (between)	−.810	3.714	−.218	.827	−.988	.920
Mindfulness (between)	5.705	3.084	1.850	.890	−7.731	.725
Rumination*Mindfulness (between)	2.129	1.525	.755	.450	−4.036	.559
Alcohol on						
Rumination (between)	1.149	1.668	.689	.491	−2.121	3.894
Mindfulness (between)	**−.904**	.472	−1.916	.050	−2.118	.021
Rumination*Mindfulness (between)	.60	1.729	.092	.926	−.823	.012
Sex risk on						
Rumination (between)	1.564	.936	1.672	.095	−.270	3.398
Mindfulness (between)	**−.495**	.252	−1.961	.049	−.989	.000
Rumination*Mindfulness (between)	1.223	.951	.077	.083	−1.936	1.790
Intercept						
Fruit (between)	−.145	.068	1.765	.078	−.013	.254
Vegetable (between)	−.196	.085	−2.303	.021	−.416	−.029
Exercise (between)	23.484	4.647	5.054	<.001	−24.731	55.725
Alcohol (between)	1.813	.400	4.534	<.001	1.029	2.596
Sex risk (between)	−2.126	.230	−9.240	<.001	−2.577	−1.675

Bolding indicates $p < .05$

examination of the historical origins of mindfulness starting in the last century BCE illuminates mindfulness as a broad approach to well-being that promotes a synergistic, recursive set of skills spanning cognitive, emotional, and physical domains. Over time, different components of this original Eastern approach have been teased out in a reductionistic manner for targeted study and application (Chiesa, 2013). The measure used in Study One may have assessed too small a slice of this larger mindfulness construct, or may have aggregated the various facets of mindfulness together such that we could not detect the separate effects that different facets of mindfulness might have in buffering rumination. As such, measuring specific components of mindfulness may be important. Measuring specific components of mindfulness that may be particularly powerful at buffering the negative effects of rumination could provide richer information for developing interventions that combat rumination. Ayduk and Kross (2010) suggested that self-distancing, an aspect of mindfulness whereby individuals can observe their thoughts and feelings without fixation, most potently combats the negative effects of rumination. According to this research, overall mindfulness may be too broad a construct to capture those specific aspects of mindfulness that combat rumination. Instead, they heavily emphasized self-distancing as a potentially key component of mindfulness. In addition, as noted above, another aspect of mindfulness, the construct of self-compassion—a sense of non-judgmental kindness towards the self that promotes social connectedness—has been shown to be a particularly potent combatant of the negative effects of rumination and maladaptive health behavior patterns (Neff & McGehee 2010). To directly assess the potential role of these key subcomponents of mindfulness as well as the effects of the overall construct, we included daily measures of self-distancing and self-compassion in Study Two.

Study Two

We followed Study One with Study Two, which aimed to further examine mindfulness as a buffer of the daily maladaptive rumination to health behavior relationship on the daily, within-person level. In Study One, our hypotheses were only minimally supported. Therefore, in Study Two, we measured mindfulness on the daily level and also included measures of specific aspects of mindfulness (self-compassion and self-distancing) on the daily level that may be most potent in combatting the rumination to health behavior link.

Study Two Methods

Participants

One hundred fifty seven participants were recruited via the Psychology Department participant pool website at a large public university in the Northeastern United States in a single wave of data collection in Fall 2015. Participants were compensated with research credit for an introductory psychology course.

Procedure

The same procedure was used as in Study One for consistency in methodology.

Measures

This study used all the same measures as Study One and added three new measures.

Daily Mindfulness (CAMS-R) Mindfulness was assessed with the Cognitive and Affective Mindfulness Scale—Revised (CAMS-R). The instructions were modified to refer to the past 24 h and questions were revised to refer to a specific time as opposed to measuring a general trait (e.g., "I was easily distracted" instead of "I am easily distracted"). $\alpha = 0.81$.

Daily Self-compassion (SCS-SF) Self-compassion was assessed using the Self-Compassion Scale – Short Form (SCS-SF). This 12-item scale assesses six components of self-compassion: self-kindness, self-judgment, common humanity, isolation, mindfulness, and over-identification (Raes et al., 2011). Instructions were modified to refer to the past 24 h. Items were rated from 1 (almost never) to 5 (almost always) and summed. In the present study, mean $\alpha = 0.86$.

Daily Self-distancing Self-distancing was assessed with the question "To what extent did you watch events replay through your own eyes vs. watch events unfold as an observer as you pondered their deepest thoughts and feelings regarding the experience?" This item was also asked for the past 24 h and was ranked from 1 (predominantly immersed participant) to 7 (predominantly distanced observer; Ayduk & Kross, 2010). It has been used in multiple studies and has demonstrated validity (Ayduk & Kross, 2010).

Data Analysis Plan

Similar data cleaning, power analyses, and modeling procedures were followed as per Study One, including descriptive statistics through SPSS and multilevel modeling using Mplus. We examined daily mindfulness, daily self-compassion, and daily self-distancing as Level 2 and Level 1 moderators of the rumination to health behavior relationship by again dividing variables into their within- and between-person components. For parsimony and to focus specifically on our question of interest, only within-person results are described in the results section; more information about between-person relationships can be found in the tables.

Study Two Results

Descriptive Statistics

This study recruited 157 participants (mean age = 19.7 [SD = 1.22]; 78.2% female; 74.9%; Caucasian, 6.8% Black/African American, 4.7% Asian, and 3.7%

"Other," with 10.2% identifying as Hispanic/Latino). No student withdrew from this study prior to its completion. Of valid responses, meaning of days on which participants did fill out a survey, missing data was fairly low: Missing data at baseline for study variables varied from 1.2 to 3.8%, and missing data on the daily variables varied from 1.9 to 2.9%. On average, participants completed 9.31 out of 11 days of daily diary responses, or 84.6% of daily assessments, which, like Study One, reflected a typical amount for daily diary studies (Bolger & Laurenceau, 2013).

Health Behavior Frequencies

On average, per day, participants reported exercising for 21.12 min (SD = 17.25), eating 1.78 fruits (SD = 0.93) and 0.65 vegetables (SD = 0.91), and engaging in 0.08 incidents of sexual risk taking (SD = 0.29), similar to levels reported in Study One.

Bivariate Correlations

Rumination and Health Behaviors Trait rumination (between) was significantly related to daily exercise ($r = -0.06$, $p < 0.01$), daily fruit intake ($r = -0.07$, $p < 0.001$), and daily vegetable intake ($r = -0.05$, $p < 0.05$). Daily rumination (within) was significantly related to daily fruit intake ($r = -0.03$, $p < 0.05$) and daily sexual risk taking ($r = 0.15$, $p < 0.001$), but not to daily exercise.

Rumination, Mindfulness, Self-compassion, and Self-distancing Daily rumination (mean across days) was significantly negatively related to daily mindfulness ($r = -0.53$; $p < 0.001$), daily self-compassion ($r = -0.52$; $p < 0.001$), and daily self-distancing ($r = -0.06$ $p < 0.001$). Daily mindfulness was positively related to exercise ($r = 0.21$, $p < 0.001$) and fruit intake ($r = 0.31$, $p < 0.001$). Daily self-compassion was not related to any health behaviors. Daily self-distancing was related positively to fruit intake ($r = 0.12$; $p < 0.05$).

Mindfulness, Self-compassion, and Self-distancing Mindfulness, self-compassion, and self-distancing were correlated significantly and positively with medium effect sizes (i.e., mindfulness and self-compassion $r = 0.621$, $p < 0.01$; mindfulness and self-distancing $r = 0.530$, $p < 0.05$; self-compassion and self-distancing $r = 0.589$, $p < 0.01$), providing further indication that while these constructs and scales overlap, they are still conceptually distinct.

Multilevel Modeling

Relationship with Time Modeling each health behavior and variable of interest with time within- and between-persons, in simple models, there was no significant increase or decrease in any variable over time.

Rumination and Health Behaviors In models between rumination and health behaviors only, these relationships were present in a pattern similar to that found in Study One, such that daily rumination was significantly related to fruit intake ($r = -0.12$, $p < 0.05$), alcohol intake ($r = 0.12$, $p < 0.001$), and sexual risk taking ($r = 0.19$, $p < 0.001$).

Daily Mindfulness Daily mindfulness moderated the daily within-person relationship between rumination and fruit intake only ($\beta = 0.320$, $p = 0.032$; see Table 3), such that it decreased the strength of the negative relationship between rumination and fruit intake. It was not a moderator of the rumination to vegetable, sexual risk, alcohol, or exercise relationships on the daily level.

Daily Self-distancing

Daily self-distancing was a significant moderator of the rumination to alcohol intake relationship only ($\beta = -0.820$, $p = 0.033$; see Table 4) such that it decreased the strength of the positive relationship between rumination and alcohol intake. Daily self-distancing was not a moderator of the rumination to fruit, vegetable, sexual risk, or exercise relationships on the daily level.

Daily Self-compassion

Daily self-compassion was a significant moderator of the rumination to health behavior relationship for fruit intake ($\beta = 0.750$, $p = 0.031$), vegetable intake ($\beta = 0.310$, $p = 0.029$), and sexual risk taking ($\beta = -0.128$, $p = 0.044$) relationships, and was marginally significant for alcohol intake ($\beta = -0.750$, $p = 0.051$; see Table 5).

Study Two Discussion

Study Two examined overall mindfulness and two specific components on the daily level to further explicate relationships between rumination, mindfulness, and health behaviors. Specifically, it tested daily mindfulness, daily self-distancing, and daily self-compassion as buffers of rumination's deleterious effects on health behavior patterns. Our hypotheses were partially supported. Both daily overall mindfulness and daily rumination moderated the effects of rumination on a single health behavior (fruit intake and alcohol intake, respectively), while daily self-compassion moderated the effects of rumination on multiple daily health behaviors. These results indicate that specific aspects of mindfulness have an impact on individuals' health and risk behavior engagement different than overall mindfulness. Namely, one's ability to practice non-judgmental observations about the self—by extending gentle kindness rather than criticism (self-compassion)—and one's ability to not fixate on one's thoughts and feelings (self-distancing) decrease the harmful effects of rumination on health behaviors. Self-compassion may be a particularly powerful buffer of

rumination's deleterious health effects, in that it weakened the association of rumination with fruit and vegetable intake and sexual risk-taking behaviors.

Rumination is characterized by repetitive thoughts, a passive fixation on one's negative experiences (Smith & Alloy, 2009), and is akin to the problematic attachment to ideas, which Buddhist philosophy speaks to when prescribing mindful practices to reduce human suffering (Williams, 2008). These practices develop individuals' abilities to be aware of their thoughts without getting stuck in them, much like the releasing or letting go of negativity described in the self-distancing literature. It may be useful to compare the content of a mindfulness intervention that teaches self-distancing to a spontaneous self-distancing intervention such as the one used in Ayduk and Kross (2010), to see what best facilitates decreases in the maladaptive aspects of rumination. Comparisons of cognitive approaches to mindfulness interventions are warranted too, as cognitive interventions have been shown to decrease maladaptive rumination as well (Watkins et al., 2007).

Overall Discussion

We conducted two studies to better understand the role of rumination in students' performance of health behaviors, anticipating that mindfulness and its components may moderate this linkage. Mindfulness largely did not buffer rumination to health behaviors when measured at the trait level. Daily mindfulness and self-distancing and especially self-compassion were shown to buffer the daily relationship between rumination and health behaviors, indicating that these are potent aspects of the mindfulness construct in the context of rumination and health behaviors, and should be studied further. Ultimately, this knowledge may be useful in developing efficacious interventions against rumination for mental and physical well-being.

Limitations

Our sample of relatively healthy and advantaged young adults may limit the generalizability of our findings to other adult populations. Methodologically, while using multilevel modeling to estimate effects between variables suggests causality, our results are still essentially correlational (Pearl, 2012). However, this method is as close as one can get to analyzing causal links in ongoing naturalistic relationships (Shpitser & Pearl, 2006). There are strengths to assessing within-individual processes, which can help examine immediate relationships instead of more abstract accounts of overall experiences. This type of analysis helps reduce bias and error that may occur at the between-individual level. Despite these advances, causal directionality still cannot be truly determined. Also, while Study Two was slightly underpowered, effect sizes were larger than expected, meaning that the study was likely adequately powered to detect change; a follow-up study with a larger sample size for replicability could be useful. Finally, as in other studies (e.g., Ayduk & Kross, 2010), self-distancing was measured by only one item, potentially limiting its construct validity. Perhaps with additional scale development, including more items and

Table 3 Study Two: Mindfulness moderation, multilevel parameter estimates (all Level 1)

	Estimate	(SE)	t	p	CI_{95} lower	CI_{95} upper
Fruit on						
Rumination (within)	.315	.259	1.216	.224	−.436	.764
Rumination*Mindfulness (within)	**.320**	.048	1.154	.032	.198	.414
Time	.002	.006	.306	.760	−.031	.040
Vegetable on						
Rumination (within)	.274	.312	.878	.380	−.015	.456
Rumination*Mindfulness (within)	−.074	.125	−.595	.552	−.846	.488
Time	**−.020**	.007	−.2784	.005	−.043	.029
Exercise on						
Rumination (within)	−9.519	6.353	−1.498	.034	−10.994	8.204
Rumination*Mindfulness (within)	**−3.370**	2.535	1.472	.050	−9.169	2.475
Time	**−.610**	.142	−3.730	<.001	−.782	−.238
Alcohol on						
Rumination (within)	−1.543	.868	−1.777	.176	−.625	.764
Rumination* Mindfulness (within)	.750	.348	2.154	.131	−.498	.914
Time	.003	.019	.254	.857	−.031	.040
Sexual risk on						
Rumination (within)	.858	.627	1.370	.171	−2.994	7.204
Rumination*Mindfulness (within)	−.160	.251	−1.039	.299	−9.169	2.475
Time	−.007	.018	−.364	.716	−.782	.238
Fruit on						
Rumination (between)	**−.119**	.052	−2.286	.022	−.807	.230
Mindfulness (between)	**.499**	.125	3.696	<.001	−.109	.227
Rumination*Mindfulness (between)	.044	.276	.161	.872	−.467	.585

Table 3 (continued)

	Estimate	(SE)	t	p	CI_{95} lower	CI_{95} upper
Vegetable on						
Rumination (between)	−.043	.334	−.130	.897	−.698	.612
Mindfulness (between)	.056	.093	.607	.544	−.125	.238
Rumination*Mindfulness (between)	−.072	.347	−.208	.835	−.753	.609
Exercise on						
Rumination (between)	−.810	3.714	−.218	.827	−.988	.920
Mindfulness (between)	5.705	3.084	1.850	.890	−7.731	.725
Rumination*Mindfulness (between)	2.129	1.525	.755	.450	−4.036	.559
Alcohol on						
Rumination (between)	1.149	1.668	.689	.491	−2.121	3.894
Mindfulness (between)	−**.904**	.472	−1.916	.050	−2.118	.021
Rumination*Mindfulness (between)	.60	1.729	.092	.926	−.823	.012
Sex risk on						
Rumination (between)	1.564	.936	1.672	.095	−.270	3.398
Mindfulness (between)	−.495	.252	−1.961	.049	−.989	.000
Rumination*Mindfulness (between)	−.073	.951	.077	.939	−1.936	1.790
Intercept						
Fruit (between)	−.145	.068	1.765	.078	−.013	.254
Vegetable (between)	−.196	.085	−2.303	.021	−.416	−.029
Exercise (between)	23.484	4.647	5.054	<.001	−24.731	55.725
Alcohol (between)	1.813	.400	4.534	<.001	1.029	2.596
Sex risk (between)	−2.126	.230	−9.240	<.001	−2.577	−1.675

Bolding indicates $p < .05$

Table 4 Study Two: Self-distancing moderation, multilevel parameter estimates (all Level 1)

	Estimate	(SE)	t	p	CI_{95} lower	CI_{95} upper
Fruit on						
Rumination (within)	.315	.259	1.216	.224	− .436	.764
Rumination*Mindfulness (within)	.750	.348	2.154	.111	− .498	.914
Time	.002	.006	.306	.760	− .031	.040
Vegetable on						
Rumination (within)	.274	.312	.878	.380	− .015	.456
Rumination*Mindfulness (within)	− .074	.125	− .595	.552	− .846	.488
Time	− .020	.007	− .278	.005	− .043	.029
Exercise on						
Rumination (within)	− 9.519	6.353	− 1.498	.134	− 2.994	7.204
Rumination*Mindfulness (within)	− 3.370	2.535	1.472	.141	− 9.169	2.475
Time	− .530	.142	− 3.730	< .001	− .782	− .238
Alcohol on						
Rumination (within)	1.120	.868	− 1.777	.043	.625	1.764
Rumination* Mindfulness (within)	− **.820**	.348	2.154	.033	.498	.914
Time	.003	.019	.254	.857	− .031	.040
Sexual risk on						
Rumination (within)	.858	.627	1.370	.171	− 2.994	7.204
Rumination* Mindfulness (within)	− .160	.251	− 1.039	.299	− 9.169	2.475
Time	− .007	.018	− .364	.716	− .782	.238
Fruit on						
Rumination (between)	− .119	.072	− 2.286	.022	− .807	.230
Mindfulness (between)	.499	.125	3.696	< .001	− .109	.227
Rumination*Mindfulness (between)	.044	.276	.161	.872	− .467	.585
Vegetable on						
Rumination (between)	− .043	.334	− .130	.897	− .698	.612
Mindfulness (between)	.056	.093	.607	.544	− .125	.238
Rumination*Mindfulness (between)	− .072	.347	− .208	.835	− .753	.609
Exercise on						
Rumination (between)	− .810	3.714	− .218	.827	− .988	.920
Mindfulness (between)	5.705	3.084	1.850	.890	− 7.731	.725
Rumination*Mindfulness (between)	2.129	1.525	.755	.450	− 4.036	.559
Alcohol on						
Rumination (between)	1.149	1.668	.689	.491	− 2.121	3.894
Mindfulness (between)	− .904	.472	− 1.916	.050	− 2.118	.021

Table 4 (continued)

	Estimate	(SE)	t		p	CI_{95} lower	CI_{95} upper
Rumination*Mindfulness (between)	.60	1.729	.092	.926		− .823	.012
Sex risk on							
Rumination (between)	1.564	.936	1.672	.095		− .270	3.398
Mindfulness (between)	− .495	.252	− 1.961	.049		− .989	.000
Rumination*Mindfulness (between)	− .073	.951	.077	.939		− 1.936	1.790
Intercept							
Fruit (between)	− .145	.068	1.765	.078		− .013	.254
Vegetable (between)	− .196	.085	− 2.303	.021		− .416	− .029
Exercise (between)	23.484	4.647	5.054	< .001		− 24.731	55.725
Alcohol (between)	1.813	.400	4.534	< .001		1.029	2.596
Sex risk (between)	− 2.126	.230	− 9.240	< .001		− 2.577	− 1.675

Bolding indicates $p < .05$

a wider range of response options, relationships would be even more clear and interpretable. As such, development of a self-distancing measure is needed.

Future Directions

Refinements of the measurement tools used to assess mindfulness are much needed, both at the global construct level and at the component level (e.g., self-distancing), to ensure comprehensive representation of this approach to improving physical and mental health outcomes. Similarly, replication of these findings in more diverse samples will improve the generalizability of results to other groups (for example, across age, race/ethnicity, and gender).

The frequencies of health behaviors (i.e., fruit intake, vegetable intake, exercise, alcohol intake, and sexual risk taking) in this study were similar to those found in previous studies of university students' health behaviors (Raynor & Levine, 2009; Trockel et al., 2000). Therefore, these findings may be reasonably generalizable to other college students in the USA. A long-term goal of this research is to develop interventions to decrease maladaptive health behaviors and increase adaptive health behaviors in college students, as a primary prevention strategy for preventing chronic illnesses. Finally, the inclusion of additional variables is warranted. For example, the inclusion of negative affect may be useful in isolating the effect of mindfulness on rumination.

Clinical Implications

Future studies should examine the effect of mindfulness interventions on rumination and health behaviors. In a study of college students comparing brief training in

Table 5 Study Two: Self-compassion moderation, multilevel parameter estimates (all Level 1)

	Estimate	(SE)	t	p	CI95 lower	CI95 upper
Fruit on						
Rumination (within)	.315	.159	1.216	.022	.136	.764
Rumination*Mindfulness (within)	**.750**	.348	2.154	.031	.438	.811
Time	.002	.006	.306	.760	−.031	.040
Vegetable on						
Rumination (within)	.274	.312	.878	.380	−.015	.456
Rumination*Mindfulness (within)	**.310**	.125	−.595	.029	.146	.488
Time	−.020	.007	−.278	.005	−.043	.029
Exercise on						
Rumination (within)	−9.519	6.353	−1.498	.134	−2.994	7.204
Rumination*Mindfulness (within)	−3.370	2.535	1.472	.141	−9.169	2.475
Time	−.530	.142	−3.730	<.001	−.782	−.238
Alcohol on						
Rumination (within)	1.543	.868	−1.777	.076	−.625	.764
Rumination*Mindfulness (within)	*−1.20*	.248	2.154	.051	.498	.914
Time	.003	.019	.254	.857	−.031	.040
Sexual risk on						
Rumination (within)	.858	.627	1.370	.171	−2.994	7.204
Rumination*Mindfulness (within)	**−.128**	.051	−1.039	.044	.169	.475
Time	−.007	.018	−.364	.716	−.782	.238
Fruit on						
Rumination (between)	−.119	.052	−2.286	.022	−.807	.230
Mindfulness (between)	.499	.125	3.696	<.001	−.109	.227
Rum* Mindfulness (between)	.044	.276	.161	.872	−.467	.585
Vegetable on						
Rumination (between)	−.043	.334	−.130	.897	−.698	.612
Mindfulness (between)	.056	.093	.607	.544	−.125	.238
Rumination*Mindfulness (between)	−.072	.347	−.208	.835	−.753	.609

Table 5 (continued)

	Estimate	(SE)	t	p	CI_{95} lower	CI_{95} upper
Exercise on						
Rumination (between)	−.810	3.714	−.218	.827	−.988	.920
Mindfulness (between)	5.705	3.084	1.850	.890	−7.731	.725
Rumination*Mindfulness (between)	2.129	1.525	.755	.450	−4.036	.559
Alcohol on						
Rumination (between)	1.149	1.668	.689	.491	−2.121	3.894
Mindfulness (between)	−.904	.472	−1.916	.050	−2.118	.021
Rumination*Mindfulness (between)	.60	1.729	.092	.926	−.823	.012
Sex risk on						
Rumination (between)	1.564	.936	1.672	.095	−.270	3.398
Mindfulness (between)	−.495	.252	−1.961	.049	−.989	.000
Rumination*Mindfulness(between)	−.073	.951	.077	.939	−1.936	1.790
Intercept						
Fruit (between)	−.145	.068	1.765	.078	−.013	.254
Vegetable (between)	−.196	.085	−2.303	.021	−.416	−.029
Exercise (between)	23.484	4.647	5.054	<.001	−24.731	55.725
Alcohol (between)	1.813	.400	4.534	<.001	1.029	2.596
Sex Risk (between)	−2.126	.230	−9.240	<.001	−2.577	−1.675

Bolding indicates $p < 0.05$. Italicized indicates marginal significance $p > 0.05$ and $p < 0.10$

mindfulness meditation to brief somatic relaxation training and a wait list control, mindfulness training decreased rumination more than did the relaxation training and control, suggesting there is something particularly potent about mindfulness meditation training above and beyond relaxation skills for decreasing rumination (Jain et al., 2007). The authors suggested that cultivating moment-to-moment awareness may decrease one's focus on negative past experiences. They also emphasized the importance of the inclusion of loving-kindness meditation, which cultivates self-compassion (Shahar et al., 2015). As we found that self-compassion decreased the rumination to health behavior link, self-compassion may be especially important to emphasize, and may be why that intervention was so potent. It is possible self-compassion may help decrease negative thoughts about oneself as well as the tendency to get stuck in those negative thoughts. Self-compassion should be included as a potential target in future intervention studies. Additionally, interventions that include mindfulness (and/or self-distancing and/or self-compassion) should be tested as possible interventions for the rumination to health behavior relationship. For example, yoga has been shown to increase self-distancing (Shelov & Suchday, 2009), and is increasing in popularity among college students (Gaskins et al., 2014; Park et al., 2015).

Sustainable systems for selecting efficacious intervention approaches are needed. Multiple-armed studies including control groups would help assess which intervention approaches work best for whom (i.e., Mindfulness Based Stress Reduction, mindfulness meditation, cognitive behavioral therapies that use mindfulness components [e.g., Dialectical Behavioral Therapy], third wave therapies that use mindfulness [e.g., Acceptance and Commitment Therapy], and rumination-focused cognitive behavioral therapy). Dissemination and implementation outcomes should also be included in these future studies, to ensure that these interventions are reaching those who need them most. More resources and attention to health behavior change interventions within the framework of college wellness are also warranted.

Conclusion

These studies are among the first intensive longitudinal examinations of the moderating role of mindfulness in the relationship between rumination and healthy behaviors. The findings are promising, as they provide insight into both the value and limits of mindfulness and its components, and they illuminate potential complexities in young adults' motivation to engage in health behaviors (e.g., exercise routines). There is a need for further research and the ongoing development of measurement and interventions that promote healthy behaviors among young adults, including interventions that may include components of self-distancing and self-compassion.

Declarations

Conflict of Interest The authors declare no competing interests.

References

ACHA (2009). https://www.acha.org/ACHA/Resources/Survey_Data/ACHA/Resources/Survey_Data.aspx

ACHA (2016). https://www.acha.org/ACHA/Resources/Survey_Data/ACHA/Resources/Survey_Data.aspx

Ayduk, Ö., & Kross, E. (2010). Analyzing negative experiences without ruminating: The role of self-distancing in enabling adaptive self-reflection. *Social and Personality Psychology Compass, 4*, 841–854.

Birnie, K., Speca, M., & Carlson, L. E. (2010). Exploring self-compassion and empathy in the context of mindfulness-based stress reduction (MBSR). *Stress and Health, 26*, 359–371.

Bolger, N., & Laurenceau, J.-P. (2013). *Intensive longitudinal methods: An introduction to diary and experience sampling research*. Guilford.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36*(2), 129.

Chambers, R., Gullone, E., & Allen, N. B. (2009). Mindful emotion regulation: An integrative review. *Clinical Psychology Review, 29*(6), 560–572.

Chiesa, A. (2013). The difficulty of defining mindfulness: Current thought and critical issues. *Mindfulness, 4*, 255–268.

Chiesa, A., Calati, R., & Serretti, A. (2011). Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review, 31*(3), 449–464.

Christie, A. M., Atkins, P. W. B., & Donald, J. (2017). The meaning and doing of mindfulness: The role of values in the link between mindfulness and well-being. *Mindfulness, 8*, 368–378.

Department of Education. (2014). Bachelor's degrees conferred by postsecondary institutions to males and females by field of study.

DSQ; NCI (2010). https://epi.grants.cancer.gov/nhanes/dietscreen/questionnaires.html

Feldman, G., Hayes, A., Kumar, S., Greeson, J., & Laurenceau, J. P. (2007). Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). *Journal of Psychopathology and Behavioral Assessment, 29*(3), 177.

Finlay, A. K., Ram, N., Maggs, J. L., & Caldwell, L. L. (2012). Leisure activities, the social weekend, and alcohol use: Evidence from a daily study of first-year college students. *Journal of Studies on Alcohol and Drugs, 73*, 250–259.

Gaskins, R. B., Jennings, E., Thind, H., Becker, B. M., & Bock, B. C. (2014). Acute and cumulative effects of vinyasa yoga on affect and stress among college students participating in an eight-week yoga program: A pilot study. *International Journal of Yoga Therapy, 24*, 63–70.

Godin, G., & Shephard, R. J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Sciences, 10*, 141–146.

Gillmore, M. R., Gaylord, J., Hartway, J., Hoppe, M. J., Morrison, D. M., Leigh, B. C., & Rainey, D. T. (2001). Daily data collection of sexual and other health-related behaviors. *Journal of Sex Research, 38*, 35–42.

Gu, J., Strauss, C., Bond, R., & Cavanagh, K. (2015). How do mindfulness-based cognitive therapy and mindfulness-based stress reduction improve mental health and wellbeing? A systematic review and meta-analysis of mediation studies. *Clinical Psychology Review, 37*, 1–12.

Heeren, A., & Philippot, P. (2011). Changes in ruminative thinking mediate the clinicalbenefits of mindfulness: Preliminary findings. *Mindfulness, 2*(1), 8–13.

Jain, S., Shapiro, S. L., Swanick, S., Roesch, S. C., Mills, P. J., Bell, I., & Schwartz, G. E. (2007). A randomized controlled trial of mindfulness meditation versus relaxation training: Effects on distress, positive states of mind, rumination, and distraction. *Annals of Behavioral Medicine, 33*, 11–21.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*, 144–156.

Kang, Y., Gruber, J., & Gray, J. R. (2013). *Mindfulness and De-Automatization. Emotion Review, 5*(2), 192–201.

Linehan, M. M., & Wilks, C. R. (2015). The course and evolution of dialectical behavior therapy. *American Journal of Psychotherapy, 69*, 97–110.

Labelle, R., Makni Gargouri, R., & Francoeur, C. (2010). Ethics, diversity management, and financial reporting quality. *Journal of Business Ethics, 93*(2), 335–353.

Losavio, S. T., Cohen, L. H., Laurenceau, J.-P., Dasch, K. B., Parrish, B. P., & Park, C. L. (2011). Reports of stress-related growth from daily negative events. *Journal of Social and Clinical Psychology, 30*, 760–785.

McManus, L. (2013). *Daily mindfulness, stress reactivity, and the impact on daily health behaviors and emotional well-being* (Doctoral dissertation, University of Delaware).

Moberly, N. J., & Watkins, E. R. (2008). Ruminative self-focus and negative affect: An experience sampling study. *Journal of Abnormal Psychology, 117*, 314–319.

Muthén, L.K. and Muthén, B.O. (1998–2010). *Mplus User's Guide. Sixth Edition.* Los Angeles, CA: Muthén & Muthén.

Neff, K. (2003). Self-compassion: An alternative conceptualization of a healthy attitude toward oneself. *Self and Identity, 2*, 85–101.

Neff, K. D., & McGehee, P. (2010). Self-compassion and psychological resilience amongadolescents and young adults. *Self and identity, 9*(3), 225–240.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*(4), 569.

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: The 1989 Loma Prieta earthquake. *Journal of Personality and Social Psychology, 61*, 115–121.

Park, C. L., & Levenson, M. R. (2002). Drinking to cope among college students: Prevalence, problems and coping processes. *Journal of Studies on Alcohol, 63*, 486–497.

Park, C. L., Armeli, S., & Tennen, H. (2004). The daily stress and coping process and alcohol use among college students. *Journal of Studies on Alcohol, 65*, 126–135.

Park, T., Reilly-Spong, M., & Gross, C. R. (2013). Mindfulness: A systematic review of instruments to measure an emergent patient-reported outcome (PRO). *Quality of Life Research, 22*, 2639–2659.

Park, C. L., Braun, T. D., & Siegel, T. (2015). Who practices yoga? A systematic review of demographic, health-related, and psychosocial factors associated with yoga practice. *Journal of Behavioral Medicine, 38*, 460–471.

Pearl, J. (2012). The causal foundation of structural equation modeling. In R. Hoyle (Ed.), *Handbook of structural equation modeling.* Sage

Perestelo-Perez, L., Barraca, J., Penate, W., Rivero-Santana, A., & Alvarez-Perez, Y. (2017). Mindfulness-based interventions for the treatment of depressive rumination: Systematic review and meta-analysis. *International Journal of Clinical and Health Psychology, 17*(3), 282–295.

Perrine, C. G., Galuska, D. A., Thompson, F. E., & Scanlon, K. S. (2014). Breastfeeding duration is associated with child diet at 6years. *Pediatrics, 134*(Supplement 1), S50–S55.

Raab, K. (2014). Mindfulness, self-compassion, and empathy among health care professionals: A review of the literature. *Journal of Health Care Chaplaincy, 20*, 95–108.

Raes, F., Pommier, E., Neff, K. D., & Van Gucht, D. (2011). Construction and factorial validation of a short form of the self-compassion scale. *Clinical Psychology & Psychotherapy, 18*(3), 250–255.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Raynor, D. A., & Levine, H. (2009). Associations between the five-factor model of personality and health behaviors among college students. *Journal of American College Health, 58*, 73–82.

Riley, K. E., Park, C. L., & Laurenceau, J. P. (2019). A daily diary study of rumination and health behaviors: Modeling moderators and mediators. *Annals of Behavioral Medicine, 53*(8), 743–755.

Rodrigues, M. F., Nardi, A. E., & Levitan, M. (2017). Mindfulness in mood and anxiety disorders: A review of the literature. *Trends in Psychiatry and Psychotherapy, 39*(3), 207–215.

Sancho, M., De Gracia, M., Rodriguez, R. C., Mallorquí-Bagué, N., Sánchez-González, J., Trujols, J., & Menchón, J. M. (2018). Mindfulness-based interventions for the treatment of substance and behavioral addictions: A systematic review. *Frontiers in Psychiatry, 9*, 95.

Schooler, J. W., Mrazek, M. D., Franklin, M. S., Baird, B., Mooneyham, B. W., Zedelius, C., & Broadway, J. M. (2014). The middle way: Finding the balance between mindfulness and mind-wandering. *The Psychology of Learning and Motivation, 60*, 1–33.

Shahar, B., Szepsenwol, O., Zilcha-Mano, S., Haim, N., Zamir, O., Levi-Yeshuvi, S., & Levit-Binnun, N. (2015). A wait-list randomized controlled trial of loving-kindness meditation programme for self-criticism. *Clinical Psychology & Psychotherapy, 22*(4), 346–356.

Shelov, D. V., & Suchday, S. (2009). A pilot study measuring the impact of yoga on the trait of mindfulness. *Behavioral Cognitive Psychotherapy, 37*, 595–598.

Shpitser, I., & Pearl, J. (2006). Identification of joint interventional distributions in recursive semi-Markovian causal models, Proceedings of the 21st national conference on Artificial intelligence.

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review, 29*, 116–128.

Smith, T. M., Calloway, E. E., Pinard, C. A., Hennessy, E., Oh, A. Y., Nebeling, L. C., & Yaroch, A. L. (2017). Using secondary 24-hour dietary recall data to estimate daily dietary factor intake from the FLASHE study dietary screener. *American Journal of Preventive Medicine, 52*(6), 856–862.

Snippe, E., Nyklicek, I., Schroevers, M. J., & Bos, E. H. (2015). The temporal order of change in daily mindfulness and affect during mindfulness-based stress reduction. *Journal of Counseling Psychology, 62*, 106–114.

Swim, J. K., Hyers, L., Cohen, L. L., & Ferguson, M. J. (2001). Everyday sexism: Evidence for its incidence, nature, and psychological impact from three daily diary studies. *Journal of Social Issues, 57*, 31–53.

Trockel, M. T., Barnes, M. D., & Egget, D. L. (2000). Health-related variables and academic performance among first-year college students: Implications for sleep and other behaviors. *Journal of American College Health, 49*, 125–131.

Vago, D. R. (2014). Mapping modalities of self-awareness in mindfulness practice: A potential mechanism for clarifying habits of mind. *Annals of the New York Academy of Sciences, 1307*, 28–42.

Van Dam, N. T., van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., ... & Fox, K. C. (2018). Mind the hype: A critical evaluation and prescriptive agenda for research on mindfulness and meditation. *Perspectives on Psychological Science*, *13*(1), 36-61.

Watkins, E., Scott, J., Wingrove, J., Rimes, K., Bathurst, N., Steiner, H., ... & Malliaris, Y. (2007). Rumination-focused cognitive behaviour therapy for residual depression: A case series. *Behaviour Research and Therapy*, *45*(9), 2144-2154.

Welte, J. W., Barnes, G. M., Tidwell, M. O., & Hoffman, J. H. (2011). Tobacco use, heavy use, and dependence among adolescents and young adults in the United States. *Substance Use & Misuse, 46*, 1090–1098.

Wetherill, R. R., Neal, D. J., & Fromme, K. (2010). Parents, peers, and sexual values influence sexual behavior during the transition to college. *Archives of Sexual Behavior, 39*, 682–694.

Williams, P. (2008). *Mahayana Buddhism: The Doctrinal Foundations (The Library of Religious Beliefs and Practices)* (2nd ed.). Routledge.

Xiao, H., Carney, D. M., Youn, S. J., Janis, R. A., Castonguay, L. G., Hayes, J. A., & Locke, B. D. (2017). Are we in crisis? National mental health and treatment trends in college counseling centers. *Psychological Services, 14*(4), 407.

Young, M. A., & Azam, O. A. (2003). Ruminative response style and the severity of seasonal affective disorder. *Cognitive Therapy and Research, 27*, 223–232.

Zawadzki, M. J., Graham, J. E., & Gerin, W. (2013). Rumination and anxiety mediate the effect of loneliness on depressed mood and sleep quality in college students. *Health Psychology, 32*, 212–222.