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Too Much of a Good Thing? Overexertion of Self-Control and Dietary Adherence in Individuals with Type 2 Diabetes

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Too Much of a Good Thing? Overexertion of Self-Control and Dietary Adherence in Individuals with Type 2 Diabetes

THESIS

Submitted in partial satisfaction of the requirements
for the degree of

MASTER OF ARTS

in Social Ecology

by

Brooke Nicole Jenkins

Thesis Committee:
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Table 1 Percent of Participants Who Did vs. Did Not Experience a Relapse in Dietary Adherence and their Level of Self-Control Exertion during Post-Lapse Recovery 20

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ABSTRACT OF THE THESIS

Too Much of a Good Thing? Overexertion of Self-Control and Dietary Adherence in Individuals with Type 2 Diabetes

By

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Master of Arts in Social Ecology

University of California, Irvine, 2016

Professor Karen S. Rook, Chair

Objectives: The resource model of self-control posits that self-control is a finite resource that can be depleted. Individuals with diabetes must continually control their diet, requiring self-control. As a result, dietary adherence is difficult, and lapses are common. People with diabetes who overexert self-control, to gain control of their diet, following a lapse in adherence may be especially likely to experience a subsequent relapse, as suggested by the resource model. This investigation used the resource model of self-control to test whether overexertion of dietary self-control following a lapse would be predictive of a subsequent relapse in dietary control. **Design:** We tested this prediction in a longitudinal daily diary study of 128 individuals with diabetes (M_{age} = 66.12). **Methods:** Participants' reports of their daily dietary adherence were used to define lapses in adherence, post-lapse adherence, and relapses. **Results:** Individuals who overexerted self-control after a lapse were more likely to experience a subsequent relapse (*OR* = 3.276, p = .016) and to do so sooner (*HR* = 2.12, p = .023). **Conclusions:** People with diabetes may seek to compensate for a lapse in adherence by overexerting self-control, but doing so may deplete their self-control and increase the risk of a future relapse.

Introduction

Self-control, or the ability to abstain or engage in productive actions, is essential to effective functioning in many life domains. This process, by which individuals regulate their thoughts and behaviors, helps people engage in healthy behaviors and avoid unhealthy behaviors. For example, greater self-control predicts better exercise regimen adherence (Hagger, Wood, Stiff, & Chatzisarantis, 2010), reduced alcohol consumption (Muraven, Collins, & Neinhaus, 2002), and less risky sexual behavior (Hernandez & Diclemente, 1992). Therefore, a person's ability to exert self-control may have important implications for health outcomes.

Self-control may be particularly important for individuals with a chronic illness, such as type 2 diabetes mellitus (T2DM), that requires regulation of health behavior on a daily basis. Individuals with T2DM must continuously regulate their dietary consumption, regularly monitoring, restricting, and carefully spacing the food they consume. People with T2DM find adhering to their dietary regimen to be an especially challenging aspect of their chronic illness management (Daly et al., 2009; Vijan et al., 2005), as it requires them to exert high levels of self-control on a day-to-day basis. Given the challenges of exerting such self-control on a daily basis, lapses in dietary adherence are common (Kirkley & Fisher, 1988).

When individuals with T2DM experience a lapse in dietary adherence, some may overcompensate as they seek to regain control over their dietary regimen. For example, they may be atypically restrictive of their dietary choices as they seek to resume more adherent behavior. Such overcompensation following a lapse could deplete self-control resources, paradoxically leading to an increased likelihood of relapse in the future. In this investigation, we drew upon the resource model of self-control (Muraven, Tice, & Baumeister, 1998) to examine how self-control exertion following a lapse in dietary adherence may increase the likelihood of subsequent relapses in dietary adherence among individuals with T2DM.

The resource model of self-control posits that self-control is a limited resource that can be temporarily depleted (Muraven et al., 1998). This model is often used to account for failure on a future task when a prior task requires people to engage in self-control, presumably depleting the finite self-regulatory resource. For example, young men instructed to engage in a self-control task in which they suppress thoughts of a white bear (a difficult task once a white bear is mentioned), subsequently consume more alcohol compared to those not asked to suppress their thoughts, despite being instructed to minimize alcohol intake even though they expected to take a driving test (Muraven et al., 2002). Similarly, participants who are trying to abstain from smoking are more likely to smoke after a self-control task that required them to resist eating dessert (Shmueli & Prochaska, 2009). In studies such as these, increasing one's alcohol intake and giving in to the urge to smoke are deemed to signify poor self-control. Researchers have inferred, therefore, that tasks that require individuals to exert self-control over thoughts or to resist temptations may deplete the finite self-control resource, rendering individuals less capable of subsequently refraining from unsound health behaviors (e.g., consuming more alcohol or smoking; Muraven et al., 1998; Muraven et al., 2002).

Predicting susceptibility to lapses when individuals are trying to adhere to a strict behavior regimen (such as the dietary regimen of individuals with T2DM) fits well with the resource model of self-control. Intense exertion of self-control to maintain a very specific nutritional requirement may influence an individual's subsequent ability to maintain strict dietary adherence over time. In fact, prior restraint of eating has been found to be related to the subsequent loss of self-restraint in the form of overeating (Polivy & Herman, 1985). Relatedly, studies examining dieting behavior have found that dietary lapses are often followed by very strict, and perhaps over-controlled, avoidance of food in dieters (Polivy & Herman, 1985). It is important to examine these processes in the context of T2DM, particularly with individuals who are not sufficiently adhering to their dietary regimen, because long-term dietary management is a key component of the treatment regimen that requires continuous self-control.

Most previous research on the resource model of self-control has been conducted in laboratory settings, and it is important to understand whether this model can be extended to self-regulatory processes in the naturalistic context of chronic illness management, such as dietary self-management in individuals with T2DM. In the current study, based on the resource model of self-control, we tested two hypotheses about the intensity of post-lapse recovery. First, we hypothesized that exerting uncharacteristically high dietary self-control, in an effort to become more adherent following a lapse in adherence, would be associated with an increase in the likelihood of a subsequent relapse. This is possibly due to the depletion of the self-control resource. Second, following this same logic, we hypothesized that, among those individuals who experienced a subsequent relapse, those who exerted the most intense self-control during post-lapse resumption of more adherent behavior would be likely to relapse sooner than would individuals who exerted less intense self-control during their post-lapse recovery period.

Methods

Participants

Data were derived from a study of 129 couples in which one partner was coping with T2DM (Iida, Stephens, Rook, Franks, & Salem, 2010; Stephens et al., 2013). Participants were recruited through newspaper advertisements, radio announcements, and brochures distributed in medical offices, diabetes education centers, and senior citizen organizations. Participants were eligible if they had a primary diagnosis of T2DM, were 55 years of age or older, were in a heterosexual marriage or marriage-like relationship and living with their significant other, had been recently advised by their physician to make improvements in their diet, and had a significant other who did not have a diagnosis of T2DM. Participants were compensated with $110. Participants in this study included 129 individuals (M_{age} = 66.12; SD_{age} = 7.71; range: 55-85 years) diagnosed with T2DM. Fifty percent of participants were female. Three-quarters (75%) of the participants were White, 23% were African American, 1% was American Indian, and 1% was Asian. Average household income was between $30,000 and $39,000. For highest level of education, 17% attended graduate school, 19% completed college, 23% attended college but did not graduate, 28% completed high school, and 13% did not complete high school. All participants had been advised to improve their diet in order to manage their diabetes, but many were using additional treatment approaches, as well, including exercise (95.3%), oral medication (78.9%), and insulin (36.7%). However, one participant was eliminated from the analyses due to extensive missing diary data (over 50% of diary days missing), resulting in a sample of 128 participants.

Procedure

Participants first completed a baseline interview that included the assessment of demographic characteristics, such as gender, number of comorbidities, and length of time since the participant was diagnosed with T2DM. Participants then completed an electronic daily diary between 8:00pm and 11:59pm each night for 24 consecutive days. Diaries were completed in participants' homes on laptop computers provided to them and included questions assessing dietary adherence. Participants received training on use of the computer and question content.

The software was designed to be easy to use, the font size was large, and only one question was presented per screen; paper diaries were available in case technical difficulties arose.

Measures

Daily dietary adherence. Dietary adherence was measured each day using 5 items derived from the diet subscale of the Summary of Diabetes Self-Care Activities measure (SDSCA; Toobert, Hampson, & Glasgow, 2000). The items asked participants how often during the day they had "made some unhealthy food choices that got you off track with your diabetic diet" (reverse coded), "followed a healthful eating plan," "ate five or more servings of fruits and vegetables," "avoided high fat foods such as red meat or full fat dairy products," and "spaced carbohydrates evenly throughout the day" and were worded to assess dietary adherence on the current day. Items were rated on a 3-point scale (1 = *not at all*, 2 = *somewhat*, 3 = *very much*). These 5 items were averaged to create a daily adherence score (reliability across all days: $\alpha = .74$; range of day-specific reliability estimates: $\alpha = .66$ to .81). The daily adherence scores for each participant were also averaged over the 24 diary days to create a 24-day mean adherence score for each participant ($M = 2.37$; $SD = .32$).

Lapses, post-lapse recovery, and subsequent relapses. Information about participants' daily adherence was used to define lapses in adherence, post-lapse recovery of more adherent behavior, and subsequent relapses in dietary adherence (Rook, August, Sorkin, Stephens, & Franks, 2015). A *lapse* was defined as occurring when a participant's daily adherence score was below -.50 standard deviations of their 24-day mean adherence score for at least two consecutive days. A *post-lapse recovery of adherence* was defined as occurring when a participant's daily adherence score was at or above -.50 standard deviations of their 24-day mean adherence score for at least two consecutive days after having experienced a prior lapse in adherence. A subsequent *relapse* was defined as occurring when a participant's daily adherence score was below -.50 standard deviations of their average daily adherence score for at least two consecutive days after having recovered from the preceding lapse. Rook et al. (2015) found that days characterized as lapses (and subsequent relapses) in adherence, defined using these criteria, were significantly correlated with higher blood glucose readings (lapse/relapse onset: $b = 9.69$, $SE = 1.91$, $p < .001$; lapse/relapse continuation: $b = 3.97$, $SE = 1.54$, $p = .006$). These associations demonstrated that blood glucose levels were higher on days defined as lapses or relapses, thus helping to validate the clinical significance of lapses and relapses as operationalized in this study.

Self-control exertion during initial post-lapse recovery. Consistent with existing literature (Dvorak & Simons, 2009; Muraven et al., 2002; Shmueli & Prochaska, 2009), self-control exertion during the post-lapse recovery was conceptualized as the participant's level of dietary adherence during the first two days of the recovery period relative to his or her average level of adherence over the 24 diary days. We examined the first two recovery days because this was defined as the minimum recovery length across participants. To capture the intensity of post-lapse self-control, we first standardized each participant's daily adherence score for the first two days of the recovery period (using each participant's 24-day mean and the within-person standard deviation across the 24 days) and then averaged the standardized values for the two days. This variable indicates the participant's level of adherence during the first two days of the recovery period *relative* to his or her own typical level of adherence during the 24 diary days and thus reflects the participant's self-control exertion upon resumption of dietary adherence.

Subsequent relapse. A dichotomous variable was created that reflected whether or not the participant experienced a subsequent relapse after their post-lapse recovery period (0 = *no* *relapse occurred*; 1 = *relapse occurred*). We focused on relapses that occurred within 12 days after the start of the recovery period to examine a uniform window of time in which a subsequent relapse could be counted as having occurred. This strategy avoided the possibility that participants whose initial lapse might have occurred relatively early in the daily diary sequence would have had more time to experience a subsequent lapse than would participants who experienced a lapse at a later point in their diary sequence, and vice-versa. If a participant either did not have 12 days left in their diary after their first recovery or did not relapse again before the end of their diary, they were not included in the analysis (N = 18). For example, if a participant recovered on diary day 19 (and maintained his or her recovery on day 20), only 4 days would remain in the diary (diary days 21 through 24) to observe whether or not the participant experienced a relapse. Therefore, a period of 12 days was specified as the standardized window to minimize the number of participants who would otherwise be excluded from the analysis while allowing sufficient time for a lapse to be observed. Twelve was selected because this is exactly half of the number of daily diary days.

Time to a subsequent relapse. How quickly a patient experienced a subsequent relapse in dietary adherence following a prior lapse and recovery was operationalized as the number of days between the beginning of the patient's post-lapse recovery period and the beginning of a subsequent relapse (M_{days} = 6.18; SD_{days} = 2.89; range: 3-12 days). For example, if a patient began a post-lapse recovery of dietary adherence on study day 11 and then experienced a relapse in adherence on study day 16, the time to the relapse was calculated as 6 days.

Covariates. Length of time (in years) since a patient had been diagnosed with T2DM and number of comorbidities (assessed by asking the participant 19 questions about other medical conditions (e.g., heart disease, cancer, emphysema or chronic obstructive pulmonary disease, kidney problems, stroke, arthritis, ulcers) were both considered as potential covariates as they have been shown to influence diabetes health care adherence (Daly et al. 2009; Kalsehar et al., 2006; Lin et al., 2010). These variables were included as covariates in the final models only if they were significantly correlated with either the independent or dependent variables.

Data Analysis

Our first hypothesis was tested using a logistic regression analysis to determine whether the level of self-control exerted during the beginning of the post-lapse recovery of more adherent behavior was associated with the likelihood of a subsequent relapse occurring in the next 12 days. A power analysis conducted using the powerlog program in Stata 14 revealed that a sample size of 92 would be sufficient to detect a small to medium odds ratio effect size of 1.83 with statistical power to evaluate this hypothesis at the recommended .80 level (Cohen, 1988).

Our second hypothesis was tested using a Cox hazard regression model to examine the association between the level of self-control exertion during recovery and how quickly a participant relapsed, among those participants who did experience a subsequent relapse (N = 49). A power analysis conducted using the power cox program in Stata 14 revealed that a sample size of 49 would be sufficient to detect a large hazard ratio effect size of 2.2 with statistical power to evaluate this hypothesis at the recommended .80 level (Cohen, 1988).

Results

Descriptive Statistics

Participants on average completed 97.4% of diary entries. The majority of participants (64%) completed all 24 diary entries while 26% completed 23 diary entries, 7% completed 21 or 22 diary entries, and 3% completed 15 to 18 diary entries. Of the 128 participants, 113 had at least one lapse in adherence during the 24-day diary assessment. Of those 113, 110 participants had a post-lapse recovery of improved adherence. The average self-control recovery score was .51 (*SD* = .47), indicating that, in general, when participants recovered from a lapse, they were adhering to their diet more than their average level of adherence throughout the 24 days. Of the 110 participants who recovered from a lapse in adherence, 43 did not relapse within the subsequent 12 days (see Table 1), 49 did relapse within the subsequent 12 days, and 18 did not have 12 days left in their diary, making it impossible to know if they would have relapsed in 12 days; these 18 participants were, therefore, excluded from further analyses.

Covariates

Of the covariates considered for inclusion in the hypothesis tests, only the length of time since the patient's diagnosis was significantly related to either the independent variable (self-control during recovery) or either of the two dependent variables (subsequent relapse, time to subsequent relapse). Specifically, individuals who had been diagnosed for longer were significantly more likely to relapse in the subsequent 12 days (*Wald* $X^2(90) = 3.95$, $p = .047$, *OR* = 1.05, 95% CI [1.00, 1.11]). Therefore, we controlled for length of time since diagnosis in our hypothesis test when the variable subsequent relapse was examined.

Was Greater Self-Control Exertion during Initial Recovery Associated with an Increased Likelihood of a Subsequent Relapse?

Our first hypothesis test examined whether self-control exertion during recovery was associated with an increased likelihood of a subsequent relapse in dietary adherence. As expected, and consistent with the resource model of self-control, a logistic regression analysis revealed that participants who exerted higher self-control during the beginning of their post-lapse recovery period were significantly more likely to relapse within the subsequent 12 days ($\beta = 1.19$, *SE* = 0.49, *Wald* $X^2(1) = 5.81$, $p = .016$, *OR* = 3.28, 95% CI [1.25, 8.60]). In this multivariable model, length of time since diagnosis was only marginally related to the likelihood of a subsequent relapse in dietary adherence (β = 0.05, *SE* = 0.03, *Wald* $X^2(1)$ = 3.34, *p* = .068, *OR* = 1.05, 95% CI [1.00, 1.12]).

Was Greater Self-Control Exertion during Initial Recovery Associated with a Shorter Period of Time to a Subsequent Relapse?

Our second hypothesis tested whether greater self-control exertion during recovery was associated with a shorter period of time to a subsequent relapse in dietary adherence within the next 12 days. As expected, the results of a Cox hazard regression analysis revealed that participants who exerted higher self-control during the beginning of their post-lapse recovery period were significantly more likely to relapse sooner (β = 0.75, *SE* = 0.33, *Wald* $X^2(1)$ = 5.16, *p* = .023, *HR* = 2.12, 95% CI [1.12, 4.04]). Thus, for every 1 unit increase in self-control exertion during post-lapse recovery, a patient had a 212% percent greater chance of experiencing a relapse on each day after beginning recovery.

Supplemental Analyses

We conducted supplemental analyses to examine whether our use of standardized adherence scores to operationalize lapses (and relapses) could have influenced our classification of individuals as lapsed (or not) on particular days. Individuals with high 24-day mean adherence scores or with smaller daily adherence standard deviations might have been more likely than other individuals to have daily dietary adherence scores that fell below the -.5 SD threshold for potentially being classified as lapsed. For example, if a participant's 24-day mean adherence score was high relative to other participants, their adherence scores on a given day might have been more likely to fall below their mean, as compared to a participant with a 24-day mean adherence that was low relative to other participants. To address this concern, we examined participants' 24-day mean adherence and 24-day adherence standard deviation as predictors of a relapse in adherence (among those who had experienced a prior lapse) in two separate analyses. Neither the 24-day mean adherence nor 24-day standard deviation were significant predictors of the likelihood of a relapse in adherence (p = .337 and p = .416, respectively). Thus, it seems unlikely that our primary results are driven by participants having either a higher 24-day mean adherence score or a smaller daily adherence standard deviation.

Discussion

The management of a chronic illness often requires individuals to engage in considerable self-control on a daily basis. Theory and research suggest, however, that self-control is a limited resource that can be depleted by prior tasks that require the exertion of self-control. The current study investigated this idea in the context of dietary adherence among individuals with T2DM. The results of this study suggest that overexertion of self-control may have detrimental effects on subsequent dietary adherence in individuals with T2DM. Specifically, this investigation found that individuals who exerted self-control that was greater than their own typical level of adherence following a lapse in dietary adherence were more likely to experience a subsequent relapse in adherence. Moreover, those who had exerted even greater self-control relapsed sooner. These findings are consistent with the resource model of self-control that describes self-control as a limited resource that can be temporarily depleted (Gröpel, Baumeister, & Beckmann, 2014; Muraven et al., 2002; Shmueli & Prochaska, 2009).

Notably, our use of within-participant standardized dietary adherence scores to examine participants' exertion of self-control during post-lapse recovery meant that we were examining participant's adherence relative to their own average adherence across the 24-day daily diary assessment. It is this relative exertion of self-control that is likely to have the greatest phenomenological relevance to individuals. Seeking to exercise an unusually high degree of vigilance and restraint over one's diet (compared to one's normal vigilance and restraint), may, paradoxically, increase the risk of a future lapse.

Our results should not be taken to mean that individuals should avoid efforts to exert self-control in seeking to follow a treatment regimen. Rather, the results suggest that overcompensating for lapses in adherence can be risky and may set individuals up for failure (cf. Rogers & Smit, 2000). Instead, unless it is medically contraindicated, individuals might be better off seeking to resume their usual level of adherence following a lapse in adherence or, possibly, seeking to achieve small, but steady, improvements in their adherence over time (Perri, Nezu, Patti, & McCann, 1989). Gradual improvements in dietary adherence may be easier to sustain and build upon than efforts to increase adherence markedly. In fact, we found some evidence for this idea among individuals who did not relapse. Those who did not relapse were exerting higher than average (within person) levels of self-control during their post-lapse recovery period (M = .39; see Table 1) but just not as much as those who went on to relapse (M = .66). If these results are replicated in future studies, practitioners could consider encouraging individuals to adopt goals of small, steady improvements following a lapse in adherence rather than striving for dramatic improvements all at once. If, however, individuals have a strong desire to attempt a dramatic improvement in their treatment adherence following a lapse they should be encouraged to anticipate and seek to avoid or minimize other substantial self-control demands during the post-lapse transition in order to conserve their self-control resources for the task of resuming markedly improved adherence (cf. Hagger et al., 2010). An additional characteristic of this process that must be considered when adopting these clinical implications is whether individuals are conscious of their shifts in dietary adherence. If individuals are not conscious of these shifts, it may be more difficult to implement advice because individuals with T2DM may not be able to consciously alter their behavior. If it is indeed the case that shifts are not conscious, practitioners could consider implementing daily diaries with their patients so that patients could keep track and consequentially be more aware of their trends. Enabling patients to be more aware of their shifts could allow them to recognize when the most optimal time to gradually improve their diet might be.

The resource model of self-control is particularly relevant for the patient population used in this study. Investigating self-control in the context of chronic illness management, such as dietary adherence for individuals with diabetes, sheds light on factors that contribute to lapses and relapses in behaviors that require continuous self-control and have direct consequences for health. This model could also be related to nonpatient populations in which continual self-regulation is required to complete an important health-related task or goal. For example, healthy individuals aiming to improve their physical fitness or lose weight must sustain a continuous level of physical activity, often on a daily basis, and this continual exertion of effort may lead to depletion of the self-control resource, with risks for lapses and relapses akin to those experienced by individuals managing a chronic illness.

For populations with and without a chronic illness, however, fundamental questions still remain about the nature and assessment of the self-control resource (Hagger et al., 2010; Inzlicht, Schmeichel, & Macrae, 2014; Muraven et al., 1998) and the conditions that contribute to its depletion or, alternatively, its renewal (Hagger et al., 2010; Inzlicht et al., 2014; Tice, Baumeister, Shmueli, & Muraven, 2007). With respect to the nature of the self-control resource, researchers have speculated that it may include executive functioning (Bray, Martin Ginis, & Woodgate, 2011) and motivation (Inzlicht et al., 2014). For example, exerting control over one’s behavior may require planning and decision-making abilities, recognition of behavior-goal contingencies, thought or emotion suppression, and other executive processes (Bray, et al., 2011). Motivation is also implicated in self-control, with engaging in demanding tasks potentially leading to a preference to devote subsequent effort to desired, rather than mandatory goals (Inzlicht et al., 2014). This motivational perspective is likely to be relevant to understanding self-control of health behaviors that people "should" engage in regularly (such as those involved in management of a chronic illness) versus health behaviors that they "want" to engage in regularly (such as those involved in enjoyable workouts or sports). Developing strategies for assessing the self-control resource in its natural state, as opposed to manipulating it experimentally, can be guided by emerging perspectives on its key components.

More needs to be learned, as well, about how long it takes to replenish the self-control resource. In some experimental studies, periods of rest of 10 to 45 minutes in duration following an initial self-control task have been found to contribute to recovery of depleted self-control (e.g., Oaten, Williams, Jones, & Zadro, 2008). How much rest might be required to promote recovery of depleted self-control over health behaviors in clinical and non-clinical populations warrants investigation in future research. In addition to rest, other restorative factors such as sleep (Hagger et al., 2010) or positive affect (Tice et al., 2007) have been shown to replenish the self-control resource.

Given that almost all of the literature on the resource model of self-control explores this model through an experimental paradigm, this study adds to the literature by testing the ecological validity of the model. The findings of the current study indeed suggest that the resource model of self-control can be extended to naturally occurring contexts in which self-control must be exerted on a daily basis, unlike the more time-bounded self-control tasks typically examined in experimental tests of the model. Moreover, the results of the current study suggest that the resource model of self-control can be extended to contexts in which both the initial task that depletes self-control and the subsequent task that requires self-control are the same (such as the recurring demands of adhering to a restricted diet), unlike experimental studies in which the two tasks typically differ. Therefore, examining the resource model of self-control in naturalistic contexts allows for meaningful extensions and practical applications of the model.

Several limitations of the current study should be taken into account when evaluating the results and considering directions for future research. First, although our findings suggest that some individuals may have overcompensated following a lapse in dietary adherence, we did not assess whether individuals were troubled by lapses in adherence or whether they consciously sought to make up for such lapses by engaging in atypically intense self-control. Further, because lapses and relapses were defined empirically, rather than subjectively, participants may not have been fully cognizant of these shifts in their dietary adherence. Such perceptions would be useful to examine in future research.

The temporal nature of self-control fluctuations is also important to consider when examining self-control depletion. The fact that participants in the current study reported their dietary adherence at the end of each day meant that we could not examine within-day shifts in adherence. Some individuals might experience a lapse in adherence early in the day and seek to compensate for it later in the day, leading to within-day swings in adherence that could be problematic for subsequent adherence (Egi, Bellomo, Stachowski, French, & Hart, 2006; but see also Kilpatrick, Rigby, & Atkin, 2006). Within-day assessments of dietary adherence would be useful to include in future research. Further, objective measures of dietary adherence, such as biochemical (Das et al., 2007) and photographic (Gemming, Utter, & Ni Mhurchu, 2015) measures, could also help to overcome the limitations of self-report measures. For example, limitations of self-report measures include memory (participants not being able to remember their exact food intake), false reports (participants may intentionally report false reports), and the effects of monitoring (participants may change their diets simply because they are monitoring themselves more closely due to the daily diaries). Although objective measures may overcome these limitations, objective measures might be difficult to use on a daily basis in a daily diary study, but they could be used periodically to supplement and corroborate the self-report measures.

Finally, the current study focused on dietary adherence as an especially difficult aspect of the treatment regimen for T2DM and, as a result, did not examine the extent to which individuals' efforts to adhere to non-dietary aspects of their treatment regimen, such as physical exercise, might have affected their dietary adherence and, in turn, their susceptibility to lapses and relapses in dietary adherence. Given that many chronic illnesses require people to adhere to multiple health behaviors on a daily basis, understanding how exertion of self-control with respect to one health behavior might interfere with a patient's ability to adhere to another health behavior is an important direction for future research (cf. Prochaska, 2008). Indeed, studies examining how self-control over different health behaviors would mirror experimental self-control studies in which dissimilar tasks are used.

Despite these potential limitations, this study adds to the current literature on self-control in several ways. This daily diary study extends the resource model of self-control to naturally occurring self-regulation among individuals with a chronic illness and, thus, helps to support the ecological validity of the model. The current investigation used a novel method of defining lapses, post-lapse recovery of increased adherence, and subsequent relapses that allowed us to test hypotheses derived from the resource model of self-control. The evidence presented here suggests that the resource model of self-control can be used to predict shifts in dietary adherence over at least short periods of time (i.e., a few weeks). Paradoxically, but consistent with this model, uncharacteristically high exertion of self-control following a lapse in adherence may increase the risk of a subsequent relapse in adherence. More moderate exertion of self-control following a lapse, in contrast, did not appear to set individuals up for subsequent relapses. If these results are replicated in future studies, they may help to inform dietary interventions in the context of diabetes management by offering guidelines for how individuals might seek to resume self-control over their health behaviors following lapses to promote better long-term treatment adherence and to prevent relapses in adherence.

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Table 1

Percent of Participants Who Did vs. Did Not Experience a Relapse in Dietary Adherence and their Level of Self-Control Exertion during Post-Lapse Recovery

Subsequent Relapse	Total Sample		Self-Control Exertion During Post-Lapse Recovery	
	N%	*N*	*M*	*SD*
Yes	53%	49	.66	.51
No	47%	43	.39	.41
Overall	100%	92	.51	.47

Note. Self-control exertion refers to the participant's average standardized dietary adherence (*Z* score) during the first two days of the post-lapse recovery period.