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Relationships between dispositional mindfulness, health behaviors, and hemoglobin A1c among adults with type 2 diabetes

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Abstract

Objectives—Examine cross-sectional relationships between dispositional mindfulness and diabetes self-care behaviors (i.e., medication adherence, diet and exercise behavior, and self-monitoring of blood glucose; SMBG), hemoglobin A1c (HbA1c, %), and body mass index (BMI; continuously and obese vs. not).

Method—Adults with type 2 diabetes (N=148, M_{age}=55.7±10.1) who were recruited to participate in a web-based diabetes medication adherence intervention completed all assessments at enrollment.

Results—In unadjusted analyses, mindfulness was associated with better dietary habits and worse HbA1c (p<.05). After controlling for a priori covariates (demographics, years since diabetes diagnosis, and insulin status), mindfulness remained associated with better dietary behavior (p<.01) but not HbA1c. Mindfulness was not associated with medication adherence, exercise behavior, SMBG, or body mass index.

Discussion—We found evidence that dispositional mindfulness plays an important role in dietary behaviors, supporting the use of mindful eating techniques in diabetes self-management interventions. Fostering mindfulness may be one of several behavioral tools needed to support key self-care behaviors and improve HbA1c.

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Compliance with Ethical Standards:

Conflicts of Interest: Jason Fanning declares no conflicts of interest; Chandra Osborn and Andrea Lagotte are employed by and have equity in Informed Data Systems Inc. to which this study does not report. Both have no conflict of interest. Lindsay Mayberry declares no conflicts of interest.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Keywords

Mindfulness; Diabetes Mellitus; Self-Care; Health Behavior; Diet; Exercise

Introduction

Successful behavioral self-regulation is necessary for the maintenance of health and well-being across the lifespan. On the whole, individuals must forgo comforting foods in favor of healthier alternatives, a relaxing weekend on the couch in favor of sustained movement—some of which should be of moderate-to-vigorous intensity—and nightly disengagement from the smartphone or television in favor of healthy sleep patterns. For the nearly 10% of Americans living with diabetes (Centers for Disease Control and Prevention 2014), these demands are more plentiful and urgent: medications must be taken at regular intervals, and physical activity and dietary control become vital for proper maintenance of circulating glucose.

The concept of mindfulness—which is characterized by non-judgmental awareness of, and attention to moment-by-moment cognition, emotion, and sensation without fixation on thoughts of past and future (Kabat-Zinn 1990)—has received considerable attention for its role in increasing awareness of daily health behaviors and helping to better self-regulate these behaviors. Mindfulness is often conceptualized as *state* mindfulness, or the immediate experience of being mindful that is cultivated in mindful meditation, and *trait* or *dispositional* mindfulness, which refers to one's tendency to be mindful in daily life. Interventions encouraging the regular practice of mindfulness meditation seek to improve trait mindfulness on average, which results in a variety of positive psychological and health changes (Carmody et al. 2008; Kiken et al. 2015; Shahar et al. 2010; Shapiro et al. 2008). For instance, mindfulness-based interventions have been successful in reducing depression and diabetes distress (i.e., the unique, emotional burden associated with managing diabetes; Fisher et al. 2012) among adults with type 2 diabetes (T2D; Hartmann et al., 2012; Noordali, Cumming, & Thompson, 2017; van Son et al., 2013; Young, Cappola, & Baime, 2009). Interventionists have begun employing mindfulness training to improve self-care and, in turn, hemoglobin A1c (HbA1c) levels (Gregg et al. 2007; Miller et al. 2012). However, to date there is little evidence on the relationships between dispositional mindfulness and key self-management behaviors such as taking medication, eating a heathy diet, being physically activity, or self-monitoring of blood glucose (SMBG) among adults with T2D (Caluyong et al. 2015).

Accumulating evidence suggests dispositional mindfulness may play an important role in supporting health behavior. Individuals who report a general tendency to be attentive to, and aware of, events occurring in everyday life report a more positive psychological profile, including better life satisfaction (Kong et al. 2014), self-esteem and acceptance (Thompson and Waltz 2008), self-compassion (Birnie et al. 2010), and positive affect (Brown and Ryan 2003). They also tend to report lower levels of depression, neuroticism, rumination, and maladaptive emotion regulation (Keng et al. 2011). These and other psychological characteristics (e.g., self-efficacy), alongside habits, cultural norms, and environmental influences, act as powerful influences on health behavior (Levesque and Brown 2007; Ryan and Deci 2006). Mindfulness increases the likelihood individuals will inhibit destructive behaviors and perform behaviors that align with their goals (Ryan and Deci 2006) by creating a greater awareness of one's behaviors (e.g., eating, sitting) and the factors influencing them (e.g., stress from a challenging day). For example, in an experience sampling study, Levesque and colleagues (2007) found motivators that act on behavior subconsciously affected behavior only among individuals with low dispositional mindfulness. Jordan et al., (2014) found that higher dispositional mindfulness was associated with less impulsive eating, reduced calorie consumption, and healthier snack choices.

Dispositional mindfulness has been associated with normal plasma glucose levels and lower levels of obesity (Loucks et al. 2016), and some mindfulness interventions have improved glycemic control (HbA1c) or weight (Noordali et al. 2017) in adults with T2D. To date, however, limited research exists examining the relationships between dispositional mindfulness and the self-regulation of key diabetes self-care behaviors. To our knowledge, Caluyong et al., (2015) are the only researchers to address this question among adults with T2D by examining unadjusted relationships between mindfulness and dietary behavior, exercise, SMBG, and foot care. The study sample, however, was small and engaged in relatively good self-care (e.g., followed a healthy eating plan on five days per week on average). No significant relationships were identified.

We build on the work by Caluyong and colleagues by examining the cross-sectional relationships between dispositional mindfulness and diabetes self-management among adults with T2D and HbA1c≥6.5%. Specifically, we examined relationships with diet and exercise behaviors, medication adherence, blood glucose monitoring, body mass index (BMI), and HbA1c (%). Given the nature of dispositional mindfulness (i.e., a general awareness of events occurring in everyday life), we hypothesized individuals with higher levels of dispositional mindfulness would report better management of challenging health behaviors more susceptible to implicit motivators (i.e., diet, exercise), and in turn have lower BMI. Conversely, because suboptimal medication adherence and glucose monitoring are often associated with barriers such as forgetfulness, concerns about side effects, or cost (Polonsky 2015), we did not expect dispositional mindfulness to be significantly related to these behaviors. Finally, we hypothesized dispositional mindfulness would be inversely associated with HbA1c for several reasons. First, we expected better diet and exercise patterns would be related to lower levels of HbA1c. Moreover, Loucks et al. (2016) reported higher dispositional mindfulness was associated with having normal plasma glucose levels in a cohort study with a general population (though not with T2D prevalence). Finally, some mindfulness intervention studies have found improvements in HbA1c, although findings have been mixed (Noordali et al. 2017).

Methods

Participants

We recruited patients at Vanderbilt University Medical Center in Nashville, TN to participate in a randomized controlled trial (RCT) evaluating a web-based diabetes medication adherence intervention that did not provide mindfulness training (Nelson et al. 2016). Eligible participants were adults (≥18 years old) diagnosed with T2D and prescribed at least one diabetes medication (oral and/or insulin), English speaking, had access to the Internet, and were without severe mental, visual, or hearing impairment. Participants were excluded if they had a HbA1c value <6.5% within 3 months of enrollment or if a caregiver administered his/her medications. Data presented in this study were collected at study enrollment.

Procedures

Recruitment and enrollment occurred between August 2015 and May 2016, and all study procedures were approved by the institutional review board. Multiple methods were used to recruit participants, including email notifications sent via a Vanderbilt employee listserv and via Vanderbilt Medical Center newsletters, Research Match (www.researchmatch.org), and fliers posted in Vanderbilt clinics. An online questionnaire collected contact information and assessed eligibility. Potentially eligible participants received a detailed study description and completed an online informed consent. Consented participants' electronic health records (EHR) were subsequently reviewed, and those meeting eligibility were enrolled. Baseline questionnaires were administered electronically via the Research Data Capture (REDCap) suite (Harris et al. 2009) at Vanderbilt University; a secure web-based application that supports data capture for research studies. Participants completed a lab-drawn HbA1c test upon enrolment if the most recent HbA1c in the EHR was collected more than 3 months prior to enrollment. Participants were paid $40 for enrollment ($20 for completing baseline HbA1c and $20 for completion of the baseline survey).

Measures

Demographics and Diabetes History—EHR data provided years since T2D diagnosis and T2D-specific medications. Self-reported demographics included age, gender, race/ethnicity, education, and income.

Mindfulness—Mindfulness was assessed using the dispositional Mindfulness Attention Awareness Scale (MAAS; Brown and Ryan 2003), a 15-item self-report instrument yielding a single factor representing attention to and awareness across several domains of experience in daily life. Participants provide responses on a 6-point scale (1 = almost always; 6 = almost never). Example items include "I find it difficult to stay focused on what's happening in the present" and "I rush through activities without being really attentive to them." In our sample, Cronbach's alpha was 0.91. A 2013 systematic review of instruments measuring self-reported mindfulness reported that the MAAS is the most widely-used mindfulness measure, and was supported by positive evidence for internal consistency, reliability, construct validity by hypothesis testing, and responsiveness (Park et al. 2013).

Medication Adherence—Adherence to diabetes-specific medication was assessed using the Adherence to Refills and Medications Scale for Diabetes (ARMS-D; Kripalani et al. 2009; Mayberry et al. 2013). Items on this self-reported assessment reflect respondents' difficulties with taking and refilling their diabetes medications. Each of the 11 items is scored on a four-point scale. We reverse scored these items so higher scores indicate better adherence. The sum produced an overall adherence score ranging from 11–44; <44 represented suboptimal adherence and 44 represented optimal adherence. Such dichotomization can correct for inflated adherence reporting (Garber et al. 2011; Stirratt et al. 2015). Mayberry et al., (2013) reported good internal consistency (Cronbach's α = .86), convergent validity as evidenced by significant correlations with the Summary of Diabetes Self-Care Medication subscale (SDSCA-MS), and concurrent validity as evidenced by significant correlations with diabetes medication satisfaction. The authors also demonstrated that ARMS-D outperformed the SDSCA-MS when predicting HbA1c.

Self-Care Activities—An abbreviated version of the Summary of Diabetes Self-Care Activities (SDSCA; Toobert et al. 2000) provided assessments of general diet (i.e., following a healthy eating plan), specific diet (i.e., eating recommended servings of fruit and vegetables, avoiding high-fat foods, eating foods with few or lower carbohydrates), structured exercise behavior, and SMBG. Items ask respondents to report on how many days in the past week or average days per week over the past month they performed the self-care behavior, and did so accurately/as recommended. Subscale scores are averaged, with a greater number of days indicating more frequent performance of the specific self-care activity. The SDSCA has been demonstrated to have adequate validity and reliability (Toobert et al. 2000), and in the present study, Cronbach's α's ranged from 0.83 – 0.92, with the exception of the specific diet subscale (α=.34). As such, we analyzed the specific diet subscale items separately according to Toobert et al.'s (2000) recommendation.

Body mass index (BMI)—Participants' most recent height and weight was collected from the EHR and used to calculate BMI.

Analyses

Descriptive statistics were conducted to check for data entry errors, assess missing data, and characterize the sample. Next, Spearman's rho, Mann-Whitney U, and Kruskal-Wallis tests were performed to examine bivariate associations between demographics (i.e., age, gender, race/ethnicity, education, income) and mindfulness. Regression models examined the relationship between dispositional mindfulness and each self-care behavior, HbA1c, and BMI, both unadjusted and adjusted for *a priori* covariates including demographics, years since T2D diagnosis, and insulin status (i.e., insulin prescribed/not prescribed). Each outcome (i.e., medication adherence, general diet, specific diet items, exercise, SMBG, BMI, and HbA1c) was examined in separate models. Logistic regression models examined the relationship between mindfulness and dichotomized (suboptimal vs. optimal) medication adherence. Linear regression models examined relationships between mindfulness and continuous adherence to general diet, specific diet items, exercise, SMBG, BMI, and HbA1c. All models used robust standard errors for conservative estimates despite heteroscedasticity.

Results

Of the 170 interested participants who satisfied initial eligibility requirements, 151 completed informed consent, the baseline survey, and had a baseline HbA1c value. Of those 151, 148 completed the MAAS measure of dispositional mindfulness and were included in analyses. Among the N=148, n=1 was missing age, n=3 were missing HbA1c, and n=18 were missing BMI. Demographic and clinical characteristics of study participants ($N = 148$, $M_{age} = 55.7 \pm 10.1$) are presented in Table 1. Most participants were female (60%), White (76%), with some college education ($M_{years} = 15.2 \pm 1.9$), and earned at least $40,000 annually (74%). Over three-quarters of the sample (78%) was obese (BMI≥30 kb/m^2). The average HbA1c was 8.0±1.5; 75% of the sample had HbA1c≥7.0% (IQR 6.8 – 8.5). Spearman's rho and Mann-Whitney U/Kruskal-Wallis tests indicated there were no significant associations between dispositional mindfulness and age, gender, race, education, income, years since a T2D diagnosis, or insulin status.

Results from the unadjusted and adjusted logistic and linear regression models are displayed in Table 2. In unadjusted models, mindfulness was significantly associated with adherence to general diet (β=.24; p=.010) and eating more fruit or vegetables (β=.20; p=.006), and with higher (i.e., worse) HbA1c (β=.18; p=.026). After controlling for age, gender, race, education, income, years since T2D diagnosis, and insulin status, mindfulness remained significantly and positively associated with general diet (β=.31; p=.002) as well as eating more fruit or vegetables (β=.21; p =.023) and eating fewer carbohydrates (β=.23; p =.025) such that higher dispositional mindfulness was associated with healthier eating. The association with HbA1c did not persist after adjustment for covariates (β=.12; p=.153). Mindfulness scores were not significantly associated with reporting optimal medication adherence, exercise, SMBG, or with BMI in unadjusted or adjusted analyses (ps ≥ .399).

Discussion

We examined the cross-sectional relationships between dispositional mindfulness and self-reported self-care behaviors and medication adherence, BMI and HbA1c. As hypothesized, dispositional mindfulness was significantly associated with both specific (e.g., eating fruits and vegetables) and general (e.g., following a healthful eating plan) dietary behaviors, and not with self-reported medication adherence or self-monitoring of blood glucose. Contrary to our hypotheses, dispositional mindfulness was not associated with BMI or structured exercise participation. Notably, dispositional mindfulness was associated with HbA1c in the opposite-than-hypothesized direction in unadjusted analyses, but this finding did not persist after adjusting for covariates.

Our findings regarding self-care behaviors largely replicate the null findings presented by Caluyong et al. (2015). Collectively, these results suggest dispositional mindfulness on its own is not associated with several important T2D self-care behaviors. In contrast to Caluyong et al.'s (2015) findings, dispositional mindfulness was related to dietary decision making in our study. This is in line with literature on the role of mindfulness in promoting self-regulation of challenging behaviors for which success depends on both an awareness of daily behavior and the inhibition of desired alternative behaviors. Notably, the measure of mindfulness we utilized focuses on attention to the present moment, and does not capture non-reactivity, which is relevant to inhibition. Follow-up research using multifactorial mindfulness instruments may enhance our understanding of the specific components of dispositional mindfulness that relate to diabetes self-care behaviors (e.g., Baer et al. 2006).

Diet is highly influenced by motivators that often act below the level of conscious awareness. Individuals commonly seek the comfort of food to alleviate stress (Torres and Nowson 2007), negative affect (Bekker et al. 2004), or tiredness (Chaput 2010). Mindful awareness may allow the individual to better recognize and act on factors influencing daily food choices, including affective states, stress, and important internal cues such as satiety (Dalen et al. 2010). A small number of research teams have successfully implemented mindful eating techniques. For example, in a comparative effectiveness study, Miller et al., (2012) randomly assigned adults with diabetes to three months of mindful eating training or an evidence-based diabetes self-management education intervention. Those in the mindfulness-based intervention focused on cultivating mindful awareness, and participants practiced mindful meditation. In the self-management education intervention, participants set weekly physical activity and diet goals, and received in-depth dietary information specific to diabetes. Interestingly, even in the absence of weekly goals and specific diet and activity guidance, participants in the mindfulness-based intervention demonstrated a significant reduction in body weight, HbA1c, energy intake, and insulin after three months, and effects did not differ between conditions. Our evidence suggests lower levels of dispositional mindfulness are related to less healthy eating patterns. For these individuals, cultivating state mindfulness via meditation and mindful eating techniques may ultimately improve dispositional mindfulness and bolster the efficacy of traditional diabetes self-care interventions.

Consistent with findings among individuals with T2D (Caluyong et al. 2015) and HIV (Duncan et al. 2012), mindfulness was unrelated to medication adherence, and our findings also suggest a limited relationship between dispositional mindfulness and blood glucose monitoring. Polonsky (2015) suggests medication adherence is contingent upon the low cost provision of supplies, effective education, and intervention strategies such as cuing that can help to combat forgetfulness. For healthcare providers or interventionists designing a mindfulness-based self-care intervention, this underscores the importance of including additional behavior change techniques targeting glucose testing and medication adherence to improve HbA1c. Importantly, there are additional psychological predictors of medication adherence that may be benefited by mindfulness-based intervention, including depressive symptoms, sleep disorders, and life stress (Salmoirago-Blotcher and Carey 2018). Therefore, although we did not find an association between dispositional mindfulness and medication adherence among individuals not receiving mindfulness-based intervention content, fostering state-mindfulness through training may improve adherence behavior indirectly by acting on key psychological predictors of adherence.

Limitations & Future Research

There is a growing awareness of the importance of mindfulness for guiding health behaviors, and we present an early report examining the relationships between dispositional mindfulness and key diabetes self-management behaviors. Notably, the only other study exploring these relationships (Caluyong et al., 2015) had higher scores on measures of self-care compared to our sample (i.e., average SDSCA scores were lower in our sample), and we used a different measure of dispositional mindfulness. Data were collected at the start of a randomized controlled trial that did not include a mindfulness component. Therefore, these analyses do not speak to the value of mindfulness training and state mindfulness for supporting self-care behaviors, and only cross-sectional analyses were possible with the full sample. Additionally, self-care behaviors and medication adherence were self-reported, introducing the risk for recall bias and social desirability bias, though we note both the SDSCA (Toobert et al., 2000) and ARMS-D (Kripalani et al. 2009; Mayberry et al. 2013) have been validated against objective measures of diabetes self-care behaviors and medication adherence, respectively. Our assessment of exercise focused on structured exercise. We did not assess other components of the movement continuum, including sedentary behavior, which may be more related to dispositional mindfulness. Sitting shares many characteristics with eating (e.g., it is necessary each day, occurs habitually), is independent from physical activity behavior, and breaking up sitting behavior has implications for glucose control (Healy et al., 2008; Healy, Matthews, Dunstan, Winkler, & Owen, 2011). Because dispositional mindfulness may guard against common psychological variables known to influence participation in daily activity (e.g., negative mood, stress; Hofmann, Sawyer, Witt, & Oh, 2010), we think future research on the relationship between mindfulness and different aspects of physical activity is warranted. Finally, though our sample was fairly diverse with respect to income, our ability to generalize to minority populations is limited. Similarly, the study excluded patients with very well-controlled HbA1c. Additional research should examine these relationships longitudinally among individuals with a range of HbA1c values.

Conclusions

Individuals living with T2D must manage several challenging health behaviors each day. They must engage in healthy patterns of physical activity, restrict certain foods, monitor blood glucose, and adhere to a regular medication schedule. Of course, successfully managing each of these behaviors requires unique behavior change strategies. For instance, adhering to a dietary regimen requires an individual to recruit planning skills and motivational resources across the day while recognizing changing psychological states (e.g., fluctuations in affect and stress). Exercise, on the other hand, occurs in a discrete and effortful bouts and medication adherence may be most consistent when cues are routinized, requiring less sustained mindfulness on a day-to-day basis. In this light, it is not surprising that our results support a relationship between dispositional mindfulness and healthier food choices. In these cross-sectional analyses, mindfulness was not related to medication adherence, structured exercise participation, blood glucose testing, BMI, or HbA1c. This suggests the important role of mindfulness in promoting dietary self-care behaviors, while underscoring the importance of packaging mindfulness-promoting tools (e.g., meditation training, mindful eating) alongside other strategies for promoting physical activity, blood glucose monitoring, and medication adherence to improve the self-care of adults with T2D.

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Table 1

Demographic and clinical characteristics of study participants

N = 148	M ± SD or n (%)	Range
Age, years	55.7 ± 10.1	29 – 85
Gender (Female)	89 (60)	
Race/Ethnicity		
Non-Hispanic White	113 (76)	
Non-Hispanic Black	23 (16)	
Other	12 (8)	
Education, years	15.2 ± 1.9	10 – 18
Income (USD)		
< $25,000	11 (7)	
$25,000 – 39,999	26 (18)	
$40,000 – 89,999	64 (43)	
> $90,000	47 (32)	
Insulin prescribed	67 (45)	
Diabetes duration, years	9.9±7.2	0.2 – 35.0
Dispositional Mindfulness (MAAS)	4.9±0.8	1.9 – 6.0
Self-Care Behaviors		
Optimal medication adherence (ARMS-D)	28 (19)	
General Diet (SDSCA)	4.2±1.9	0 – 7
Specific Diet (SDSCA)		
Eating 5 servings of fruits/vegetables	3.7±2.3	0 – 7
Not eating high fat foods	3.5±1.9	0 – 7
Eating fewer or low carbohydrates	4.2±2.0	0 – 7
Exercise (SDSCA)	2.3±2.0	0 – 7
SMBG (SDSCA)	3.8±2.8	0 – 7
Body Mass Index (BMI)	35.5±6.7	22.0 – 53.2
Obese (BMI≥30 kb/m^2)	102 (78)	
Hemoglobin A1c (%)	8.0 ± 1.5	5.0 – 13.8
HbA1c≥7.0%	109 (75)	

Notes: ARMS-D = Adherence to Refills and Medications Scale for Diabetes; SDSCA = Summary of Diabetes Self-Care Activities; SMBG = Self-Monitoring of Blood Glucose

Table 2

Unadjusted and adjusted linear regression models

	Unadjusted Models		Adjusted Models*	
Outcome	**OR**	***p***	**AOR**	***p***
Optimal Medication Adherence[a]	1.70	.105	1.83	.102
	β	***p***	**β**	***p***
General Diet[b]	.24	.010	.31	.002
Specific Diet[b]				
Eating 5 servings of fruits/vegetables	.22	.006	.21	.023
Not eating high fat foods	.16	.051	.38	.068
Eating fewer or low carbohydrates	.17	.078	.23	.025
Exercise[b]	.03	.744	.02	.829
SMBG[b]	.07	.449	.08	.399
Body Mass Index	−.07	.395	−.03	.774
Hemoglobin A1c (%)	.18	.026	.12	.153

Notes: AOR = Adjusted Odds Ratio; OR = Odds Ratio; SMBG = Self-Monitoring of Blood Glucose;

[a]Adherence to Refills and Medications Scale for Diabetes score=44;

[b]Summary of Diabetes Self-Care Activities subscales. Covariates include age, gender, race/ethnicity, education, and income, years since diabetes diagnosis, and insulin status