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Relationships among adverse childhood experiences, delay discounting, impulsivity, and diabetes self-management

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Abstract

Objective: Adverse childhood experiences (ACEs) have been linked to risky health behaviors, as well as the development of chronic health conditions such as both type 1 and type 2 diabetes mellitus. A connection between ACEs and diabetes self-management has not yet been established. The current study aims to investigate the relationships among ACEs, delay discounting, impulsivity, and diabetes self-management.

Methods: A total of 227 adults aged 18 to 77 with type 1 diabetes, type 2 diabetes, and pre-diabetes were recruited to complete an online survey via Amazon's mechanical Turk. Participants completed validated measures of diabetes self-care, delay discounting, and impulsivity, as well as questions regarding diabetes history and financial strain.

Results: In the overall sample and controlling for financial strain, increased number of ACEs was significantly associated with poorer diabetes management ($r = -.15$, $p < .05$). Interestingly, higher delay discounting was associated with fewer ACEs ($r = -.31$, $p < .05$) and better diabetes care ($r = .42$, $p < .01$), as well as increased number of diabetes-related complications ($r = .33$, $p < .01$), controlling for financial strain. Participants who use insulin to manage their diabetes had significantly better diabetes self-care scores ($t(225) = 8.19$, $p < .01$), higher levels of delay discounting ($t(101) = 3.15$, $p < .01$), and fewer reported ACEs ($t(224) = -2.19$, $p < .05$).

Conclusions: ACEs are associated with poorer diabetes self-management later in life. This may be an important consideration for clinicians treating patients with diabetes and pre-diabetes.

Keywords

diabetes; adverse childhood experiences; adherence; impulsivity

Adverse childhood experiences (ACEs), such as physical abuse, sexual abuse, and household dysfunction have been associated with increased risk of having a chronic health condition as an adult (Felitti et al., 1998). ACEs are linked to a variety of risky health behaviors such as binge drinking and smoking (see Kalmakis & Chandler, 2015), as well as continued smoking despite diagnosis with a smoking-related disease (Edwards et al., 2007). Recent

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works have reinforced the existence of a link between ACEs and obesity, including during childhood (Rehkopf et al., 2016; Schroeder et al., 2021; Wiss & Brewerton, 2020; Mundi et al., 2021). Previous literature on the relationship between ACEs and obesity suggests multiple possible underlying mechanisms including poorer general health behaviors, increased psychological distress, as well as physiologic changes related to pro-inflammatory stress response and neural changes (see Godoy et al., 2020). Similarly, physiologic and behavioral models have been proposed to explain the mechanisms by which childhood adversity and other trauma exposure may contribute to the development of both type 1 and type 2 diabetes mellitus (T1DM & T2DM; see Huffhines et al., 2016). As the development of obesity and cardiovascular dysfunction is thought to mediate the relationship between ACEs and T2DM in adulthood (Deschenes et al., 2018), it is possible that similar mechanisms would underlie a link between ACEs and poorer glycemic control in patients with T1DM, T2DM, and pre-diabetes. However, a link between ACEs and later adherence to diabetes management has not previously been studied.

Childhood adversity and trauma has been found to act as a significant predictor of nonadherence to oral medications such as statins (Korhoen et al., 2015) and antiretrovirals in patients with HIV (e.g., Mugavero et al., 2006; Whetten et al., 2013). Likewise, exposure to stressful life events (e.g., being involved in a motor vehicle accident or having a close friend move away) has been found to predict poorer diabetic self-care behaviors, fewer blood glucose meter readings, and higher A1c over time in adolescents with T1DM (Helgeson et al., 2010). Additionally, a recent study by Iqbal et al. (2020) suggests that there is a relationship between increased ACE exposure and higher A1c in children and adolescents with T1DM, but the current literature is scant regarding the association between ACEs and self-management of diabetes in patients with T1 and T2DM.

The connection between childhood trauma and impulsivity is well-studied, for example regarding its possible contribution to increased risk of suicidal behavior (e.g., Braquehais et al., 2010; Roy, 2005). Increased risk-taking propensity and sensation seeking have also been found to mediate the relationship between childhood abuse and engagement in HIV-associated risk behaviors (Bornovalova et al., 2008). It is possible that a relationship between ACEs and engagement in other risky health behaviors, such as non-adherence to diabetes management, may also be explained in part by the development of impulsive traits. There is some evidence that poorer impulse control is related to poorer diabetes management in young adults with T1DM (Stupiansky et al., 2013). A more recent study (Simon-Tuval et al., 2016) has linked greater risk preference (measured using a lottery choice task, comparing preference for either high risk/high reward or safe payout options) to poorer adherence to a variety of self-care behaviors in patients with T2DM.

Delay discounting (i.e., the tendency to prefer more immediate, small rewards over delayed, larger rewards) has been widely studied as a factor of impulsivity in a variety of clinical and non-clinical contexts. A 2016 study by Lebeau and colleagues revealed a significant relationship between delay discounting and glycemic control (which was partially mediated by adherence to hypoglycemic medication), such that a greater degree of delay discounting using hypothetical rewards was linked to higher hemoglobin A1c. Likewise, higher delay discounting has been linked to poorer adherence and higher hemoglobin A1c in young adults with type 1 diabetes (Lansing et al., 2017; Stoianova et al., 2018). The current study aims to 1) investigate whether a link between ACEs and adherence to diabetes management exists, and 2) investigate the relationships among delay discounting, impulsivity, and diabetes management. The authors hypothesized that ACEs, impulsivity, and delay discounting would be negatively associated with adherence to diabetes self-management.

Methods

Transparency and openness

The current study was conducted in accordance with the Declaration of Helsinki and was approved by the University of Kentucky Institutional Review Board. Sample recruitment, measures included in the study, criteria for data exclusion, and all statistical methods are reported. Data were collected using Qualtrics survey software (2019) and were analyzed using IBM SPSS Statistics 27 (2020). Data are available upon request. The study was supported by the University of Kentucky Scientist-Clinician (SCholar) Career Development Program and the NIH National Center for Advancing Translational Sciences through grant number UL1TR001998.

Sample recruitment

Participants were recruited using Amazon's Mechanical Turk (mTurk), a crowdsourcing platform which has demonstrated efficacy in sampling populations for psychological research (Strickland & Stoops, 2018), including research about ACEs and risky health behaviors (Meadows et al., 2019). Participants indicated informed consent before being asked screening questions about their age and diagnosis of diabetes or pre-diabetes ("Has a physician or a health professional ever given you a diagnosis of pre-diabetes, type 1 diabetes, or type 2 diabetes?"). In total, 870 participants were screened using this criterion. Of the participants with a diagnosis of diabetes or pre-diabetes, those with missing or likely erroneous data (i.e., self-reported HbA1c above 20, calculated BMI below 15 or above 100) were excluded from final analyses. This left a final sample of 227.

Measures

Adverse childhood experiences (ACE) questionnaire—The ACE questionnaire (Felitti et al., 1998) has been used widely to evaluate significant adverse experiences during one's childhood. This questionnaire asks participants about exposure to ten categories of ACEs: psychological abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, divorced parents, incarceration of a household member, witnessed violence toward one's mother, and the presence of mental illness or substance abuse in one's household. Participants are asked to respond "yes" or "no" to indicate whether they have ever experienced each item. A summative composite score was calculated to reflect total number of ACEs.

Diabetes management—The Self-Care Inventory-revised (SCI-R; Weinger et al. 2005) is a 15-item measure of a patient's perceived level of adherence to diabetes/pre-diabetes management behaviors recommended by a health care provider (e.g., checking blood glucose levels, taking insulin or oral diabetes medications, reading food labels, exercising).

This tool provides a scaled score between 0 and 100, with a score of 100 indicating complete adherence to all recommended self-care behaviors. SCI-r scores have been negatively correlated with hemoglobin A1c (HbA1c), consistent with the idea that optimal diabetes management yields lower levels of glycosylated hemoglobin. This measure demonstrated acceptable internal consistency, with a Cronbach alpha of 0.89 for this sample.

Delay discounting—Degree of delay discounting was assessed using the Monetary Choice Questionnaire (MCQ-27). This questionnaire presents participants with 27 choices between smaller, immediate rewards and larger, delayed rewards (e.g., "Would you prefer $31 today or $65 in 7 days?"). As described by Kirby et al. (1999), this measure is scored using a discount parameter (k) that is derived from the following equation: $V = A/(1+kD)$, where V is the value of an immediate reward, A is the value of a delayed reward, and D is the delay time. Values of k indicate the point at which a participant is indifferent toward the delayed or immediate reward. These values range from 0.00016 to 0.25, with larger values indicating higher levels of delay discounting (i.e., propensity toward choosing the smaller, but more immediate reward). An automatic scoring tool (Kaplan et al. , 2014) was utilized to calculate k for all participants. For participants with only one missing item, the response for the preceding item was carried over (Gray et al., 2017). Participants with more than one missing item did not receive k scores that would be used in final analyses.

Impulsivity—Impulsivity was assessed using the short Impulsive Behavior Scale (S-UPPS-P; Cyders et al., 2014). This 20-item measure provides an overall impulsivity score as well as subscale scores for five factors of impulsivity: negative urgency, lack of premeditation, lack of perseverance, sensation seeking, and positive urgency. Sub-scores were calculated as sums of their respective items, with possible scores ranging from 4 to 16. Internal consistency varied among the 4-item subscales. Cronbach alphas were 0.61 and 0.69 for sensation seeking and lack of perseverance, respectively. The remaining three subscales demonstrated acceptable internal consistency, with alphas ranging from 0.76 to 0.88.

Demographic and health information—Participants were asked additional questions about demographic information and financial strain (i.e., difficulty affording food, clothing, medical supplies, etc). They also completed questions pertaining to general health and diabetes management including height and weight (for BMI calculation), insulin use, use of oral medications for diabetes, and diabetes-related complications (diabetic ketoacidosis, diabetic neuropathy, diabetic retinopathy, kidney disease, myocardial infarction, or cerebrovascular accident/transient ischemic attack). Participants were additionally asked to report their most recently recorded HbA1c but were not asked to specify how recently it was measured.

Data analysis

Analyses for the current study were conducted in IBM SPSS Statistics 27. To test the hypothesis that ACEs would be associated with lower adherence to diabetes management and to investigate the possible relationships among delay discounting, impulsivity, and other study variables, partial correlations were computed, controlling for financial strain. Financial strain was chosen because of its potential to directly impact access to treatment, such as ability to afford medications, diabetes-related equipment, and nutritious food. Subset analyses were performed for participants with each type of diabetes. Additional analyses included independent samples *t*-tests to compare these variables across participants who use insulin to manage their condition with those who do not.

Results

Sample characteristics

Out of the final sample of 227 participants, 121 (53.3%) identified as female, and 149 (65.6%) identified as white. Fewer identified as Hispanic (10.1%), black/African American (9.7%), east/southeast Asian (3.5%), western Asian (3.1%), or multi-racial (5.7%). The ages of the participants ranged from 18 – 77 with an average age of 35.9 years (SD = 12.2). One-hundred eighteen (52.0%) reported being diagnosed with pre-diabetes, 57 (25.1%) with T2DM, and 52 (22.9%) with T1DM. See Table 1 for complete demographic and diabetes-related health characteristics.

Correlations

For the overall sample, there was a positive relationship between number of ACEs and BMI ($r = .33$, $p < .001$), such that a greater number of ACEs is associated with higher BMI. Additionally, greater number of ACEs was significantly correlated with lower perceived diabetes self-care ($r = -.16$, $p = .02$). Greater perceived diabetes self-care (measured using the SCI-R) was associated with a lower BMI ($r = -.22$, $p < .01$). There was no significant relationship between ACEs and self-reported HbA1c or with number of diabetes-related complications. See Table 2 for partial correlation coefficients by type of diabetes, controlling for financial strain.

Interestingly, greater levels of delay discounting were associated with fewer ACEs ($r = -.20$, $p = .04$), lower BMI ($r = -.31$, $p < .01$), and greater perceived diabetes self-care ($r = .42$, $p < .001$). Similarly, greater levels of positive urgency (i.e., the tendency to behave impulsively when one is in a good mood) were associated with lower BMI ($r = -.24$, $p < .001$), and higher SCI-R score ($r = .23$, $p < .001$). Delay discounting was positively correlated with positive urgency ($r = .35$, $p < .001$), and none of the other impulsivity subscales. Increased delay discounting was also associated with number of diabetes-related complications ($r = .33$, $p < .001$). See Table 2 for partial correlation coefficients for delay discounting score with ACEs, BMI, SCI-R, and positive urgency by type of diabetes, controlling for financial strain.

Self-reported A1c was positively associated with lack of perseverance (i.e., the tendency to leave tasks unfinished; $r = .16$, $p = .02$) and lack of premeditation (i.e., the tendency to act without first developing a plan; $r = .14$, $p = .03$), suggesting that higher impulsivity in these realms is associated with poorer glycemic control.

Compared to participants who do not use insulin to manage their diabetes, those who reported using insulin had significantly higher SCI-R scores ($t(225) = 8.19$, $p < .001$), higher levels of delay discounting ($t(101) = 3.15$, $p = .002$), lower BMI ($t(225) = -4.60$, $p <$

.001), and fewer reported ACEs ($t(224) = -2.19$ $p = .03$). See table 3 for means, standard deviations, and independent samples *t*-test results.

Discussion

The primary purpose of this study was to evaluate the relationship among ACEs, impulsivity, and self-management of T1DM, T2DM, and pre-diabetes. As hypothesized, increased number of ACEs was significantly associated with poorer diabetes self-care in patients with T1, T2, and pre-diabetes. To the authors' knowledge, this is the first study to report this connection, but it is consistent with previous research which demonstrates an association between childhood adversity or trauma with risky health behaviors and decreased adherence to oral medication regimens (e.g., Edwards et al., 2007; Korhonen et al., 2015; Mugavero et al., 2006; Whetten et al., 2013). The current study additionally builds upon recent findings by Iqbal et al. (2002) that describe this relationship in youth with T1DM. The reported findings also support the previously established association between ACEs and increased BMI (Rehkopf et al., 2016). This study additionally contributes to a growing body of evidence in support of the utility of crowdsourcing platforms in collecting data about health behaviors and ACEs (Meadows et al., 2019).

Unlike in previous literature (Lebeau et al., 2016; Simon-Tuval, 2016; Stoianova et al., 2018; Stupiansky et al., 2013), there was no significant association between increased impulsivity or delay discounting with poorer diabetes self-care or glycemic control. However, these are not the first findings to suggest a relationship between delay discounting and health-related factors. A 2012 study by Budria et al. found lower levels of delay discounting in a sample of patients affected by obesity compared to age-matched controls. They attributed this to differences in commitment to weight loss and future health goals in the sample with obesity compared to their peers without obesity.

In the current study, participants who reported using insulin to manage their diabetes had significantly higher self-care scores, but also reported significantly more diabetes-related complications. These individuals also demonstrated significantly higher levels of delay discounting and positive urgency. This was the case for the total sample, as well as participants who reported having pre-diabetes or T2DM. Initiation of insulin therapy in patients with T2DM is typically associated with greater severity of disease and suboptimal glycemic control despite oral medication therapy. One explanation for the significant positive correlation between SCI-R score and delay discounting may be that this may be an indirect relationship. It is possible that greater delay discounting contributes to poorer glycemic control, greater complications, and the eventual necessity for insulin therapy. Faced with a more severe illness, patients may strive to adhere more closely with recommended treatment plans. Associated behavior changes may then translate to a generally stronger appreciation for longer-term rewards over more immediate gratification. Given the cross-sectional, online survey design of the current study, it is difficult to fully characterize the relationship between delay discounting and diabetes self-management as there may be a temporal component.

The findings that ACEs are negatively associated with perceived diabetes self-care are consistent with a 2018 study by Brockie and colleagues, which found a significant relationship between ACEs and poorer perceived physical health among a sample of American Indian adults with T2DM. However, they also found that increased health-related social support and sense of involvement in one's community moderates this negative relationship between ACEs and perception of physical well-being. Such findings highlight the importance of not only screening adult patients for childhood trauma exposure but connecting them with mental health and social resources to improve disease-related outcomes. The presence of ACEs may also contribute negatively to patient relationships with the healthcare system. In a sample of patients with obesity, those who had experienced abuse as a child were more likely to report feeling judged by healthcare providers about their weight and were more likely to feel as though they were not always treated with respect in the medical setting (Mundi et al., 2021). Increased recognition of the impact of early life trauma on diabetes-related health outcomes may improve therapeutic alliance by fostering more open discussion between patients and clinicians about factors that underlie difficulty with treatment adherence and glycemic control. In general, screening adult patients for ACEs has the potential to provide an opportunity for better trauma-informed care.

Limitations and future research

One significant limitation of the current study is reliance on subjective and self-reported rather than objective data. The reported findings rely on an assumption that participants were truthful and reliable in their responses. Given the online survey design as well as questions about health, this study is subject to bias from recall and social desirability. Future research should expand on the current findings with collection of biometric data for a more accurate assessment of weight, HbA1c, and verification of adherence to diabetes management. Psychological, social, and financial stressors that have accompanied the global COVID-19 pandemic may have impacted psychometric data. As a majority of the study sample identified as white, generalizability is limited due to lack of racial diversity. The present study only controlled for financial strain to account for difficulties with treatment adherence related to affordability. Given the profound impact other social determinants of health may have on outcomes such as glycemic control, future research should be aimed at further exploring the potential influence of other social factors on the relationship between ACEs and diabetes self-management. In addition, the cross-sectional nature of this study only allows for an assessment of delay discounting and other factors at only one point in time. A prospective cohort study, beginning in the pediatric setting, would help clarify the relationship among ACEs and diabetes management as well as how delay discounting and impulsivity factors may be predictive of adherence to diabetes self-care behaviors.

Conclusion

In summary, ACEs may contribute to difficulties with adherence to diabetes management later in life. In the clinical setting, concern about poor adherence to diabetes self-management warrants further investigation into underlying factors that can be addressed. Screening for ACEs is routinely recommended in the pediatric setting, but there may be utility in screening adults with diabetes and pre-diabetes for significant life stressors that have occurred throughout their development. Such an intervention could improve outcomes by facilitating discussions about the ways in which prior trauma and adversity may contribute as an impediment to current self-care behaviors.

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Table 1

Demographic and diabetes-related characteristics

	n **(%)**	***M*** **(*SD*)**	**Range**
Age		35.9 (12.2)	18- 77
Gender			
Female	121 (53.3)		
Male	105 (46.3)		
Non-binary	1 (0.4)		
BMI		32.5 (10.8)	17.1- 68.8
HbA1c		6.8 (2.0)	4.0- 17.0
SCI-R		59.4 (18.8)	13.6- 100
Diabetes type			
Pre-diabetes	118 (52)		
T2DM	57 (25.1)		
T1DM/juvenile diabetes	52 (22.9)		
Insulin use, yes	88 (38.8)		
P.O. medication use, yes	130 (57.3)		
# of diabetes-related complications		0.67 (0.95)	0- 6

Table 2

Pearson correlations between number of ACEs with BMI and SCI-R by diabetes type, controlling for financial difficulties

	Total sample ***n* = 227**	**Pre-diabetes** ***n* = 118**	**T2DM** ***n* = 57**	**T1DM** ***n* = 52**
BMI	0.33**	0.33**	0.16	0.37**
SCI-R	−0.16*	−0.15	0.10	−0.05

*$p < 0.05$

**$p < 0.001$

Table 3

Pearson correlations between delay discounting score (k) and other variables by diabetes type, controlling for financial difficulties

	Total sample ***n* = 103**	**Pre-diabetes** ***n* = 48**	**T2DM** ***n* = 26**	**T1DM** ***n* = 29**
ACEs	−0.20 *	−0.16	−0.23	−0.09
BMI	−0.31 *	−0.18	−0.46 *	−0.36
SCI-R	0.41 **	0.42 *	0.32	0.28
Positive Urgency	0.35 **	0.30 *	0.19	0.55 *
# of Complications	0.33 **	0.60 **	0.17	0.14

* $p < 0.05$

** $p < 0.001$

Table 4.

Between-group differences in study variables for participants who use insulin versus those who do not

	Insulin Use				
	Yes		No		
	M	***SD***	***M***	***SD***	***t***
SCI-R	70.70	13.88	52.27	17.98	8.192 **
Delay discounting	0.102	0.106	0.044	0.075	3.145 *
# of ACEs	2.38	2.58	3.10	2.31	−2.185 *
BMI	28.56	8.76	35.05	11.25	−4.599 **
Positive Urgency	9.14	3.38	8.07	3.08	2.411 *
# of complications	0.989	1.07	0.468	0.801	4.189 **

* $p < 0.05$

** $p < 0.001$