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The Impact of Mindfulness-Based Interventions on Individuals with Type 1 Diabetes: A Biopsychosocial Approach

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Abstract

The biopsychosocial approach recognizes that overall health is composed of biological, psychological, and social factors, as well as their intersections. However, chronic conditions such as Type 1 Diabetes (T1D) are often treated primarily through a biological lens. HbA1c, a biomarker that indicates average blood sugar levels over a three-month span, can be influenced by psychological and social factors. Diabetic distress, the psychological burden of managing T1D, has been shown to affect HbA1c levels both indirectly and directly. Mindfulness practices highlight the mind-body connection, and while their general benefits are well established, their application to T1D remains underexplored. This systematic review includes five studies that examine the impact of mindfulness-based interventions (MBIs) on biological (e.g., HbA1c) and psychological (e.g., diabetes distress, general stress) health outcomes in individuals with T1D. Although research is limited and heterogeneous, existing data suggest that MBIs can be an effective tool to reduce diabetes distress and HbA1c levels.

Introduction

Type 1 Diabetes (T1D), previously known as juvenile diabetes, is an autoimmune disorder in which the body's immune system destroys the pancreatic beta cells that produce and secrete insulin. As a result, individuals become dependent on exogenous insulin, typically administered through a wearable pump. Though T1D has traditionally been diagnosed during adolescence, incidence rates among adults have risen in recent decades, rendering the term "juvenile" outdated. Globally, T1D affects an estimated 9.5 million people (Ogle et al., 2025).

The treatment regimen for Type 1 Diabetes involves monitoring blood glucose levels and manually administering exogenous insulin via injections or an insulin pump (Qing et al., 2020). Insulin is a key factor in regulating glucose levels in the bloodstream. Those with T1D need a constant flow of exogenous insulin throughout the day as well as doses to account for blood sugar changes following meals. Insulin dosages require precision and if administered incorrectly, individuals may see their glucose levels run low (hypoglycemia) or high (hyperglycemia). The fluctuation of glucose levels run both short term and long-term health risks. Hemoglobin A1c (HbA1c), or glycated hemoglobin, is a biomarker that reflects the average blood sugar in a three-month span. For this review, HbA1c is the glycemic outcome being tracked.

For Type 1 Diabetics, maintaining normal glucose levels is a constant, demanding battle. Although insulin is the main regulator, there are other factors that influence glucose levels. Stress, for example, spikes glucose levels. When an individual is in "fight or flight" mode, stress hormones signal the liver to release glucose for energy (Jones & Bloom, 2012). Diabetes distress (DD) refers to the negative psychosocial consequences of living with T1D, affecting one in four type 1 diabetics severely (ADA). Higher stress levels increase the risk for elevated HbA1c levels. Similarly, higher HbA1c levels increase stress levels. This becomes a vicious loop.

Mindfulness-based interventions, such as mindfulness-based stress reduction (MBSR), can alleviate symptoms associated with chronic conditions by directly targeting psychological distress. Due to the mind-body relationship, reduction in psychological distress can result in improved physical health outcomes. MBIs vary in structure but they all center around mindfulness practices such as meditation, breathwork, yoga, etc. A key concept in mindfulness is a nonjudgmental approach; an individual learns to observe their experience objectively.

Existing research suggests a positive correlation between diabetes distress and HbA1c (ADA). The purpose of this review is to explore how MBIs interact with and affect this relationship.

Literature Review

The Biopsychosocial Model

The biopsychosocial model (BPSM), outlined by George Engel in 1977, views illness as a combination and interaction of biological, psychological, and social factors. Engel's perspective largely originates from the idea that the dominant biomedical model (BMM) is incomplete. In his

1977 paper, *The Need for a New Medical: A Challenge for Biomedicine,* he explains that under the BMM, social factors are seen as a separate entity and that abnormal behavior must be explained by somatic processes. Moreover, the BMM operates under mind-body dualism, which states that mind and body are independent systems. He believes this reductionist approach obtained the status of "dogma", meaning that all data must fit the biomedical model or risk being excluded entirely. Engel's primary concern with the BMM is that it ignores the human experience of illness. He uses diabetes as an example: "While the diagnosis of diabetes is first suggested by certain core clinical manifestations, and then is confirmed by laboratory documentation of relative insulin deficiency, how these are experienced and how they are reported by anyone individual, and how they affect him, all require consideration of psychological, social, and cultural factors…" Although Engel acknowledges the benefits and merit of the BMM, he offers the BPSM as a more holistic approach to illness. He believes a medical model "must also take into account the patient, the social context in which he lives, and the complementary system devised by society to deal with the disruptive effects of illness, that is, the physician role and the health care system". Importantly, the BPSM was not designed to replace the BMM, but to expand it. (Engel, 1977).

Although the BPSM has gained traction since 1977, the BMM is still the dominant model today. The BMM's "dogma" status has taken a hit, but the BPSM faces barriers and criticisms when attempting to integrate into the healthcare system. One of the most popular critiques of the BPSM is that it is impractical to implement on a large scale. Moreover, medical professionals are not strongly incentivized to adopt the BPSM, as the BMM is currently aligned more closely with profit-driven healthcare systems (Kusnanto et al., 2018). Additionally, where Engel sought to challenge dogmatism, some argue the BPSM risks swinging too far toward eclecticism. As Ghaemi (2009) observes, "This eclectic freedom borders on anarchy: one can emphasize the 'bio' if one wishes, or the 'psycho', or the 'social'. But there is no rationale why one heads in one direction or the other: by going to a restaurant and getting a list of ingredients, rather than a recipe, one can put it all together however one likes." In this sense, the BMM's reductionist approach offers a concrete and easily replicable framework, which may explain its enduring dominance. For the BPSM to be successfully widely implemented, it must be supported by clear, actionable steps and standardized procedures; without these, its adoption will likely remain slow and inconsistent.

Biological Factors of T1D

T1D is diagnosed by measuring glucose levels. If insulin production in the pancreas has failed, the patient will experience abnormally high glucose levels in the blood (hyperglycemia) because insulin regulates glucose in the blood. Normal fasting glucose levels typically fall under 100 mg/dl. An individual is diagnosed with diabetes with a fasting glucose level of 126 mg/dl. Medical professionals will also administer an HbA1c test, which is the average glucose level in a three-month span. Normal HbA1c levels are 5.7% and below. An HbA1c of 6.5% confirms the presence of T1D. Levels between 5.7% and 6.5% may indicate prediabetes, which is the early stages of diabetes and should continue to be monitored (ADA).

Symptoms of hyperglycemia include extreme thirst and frequent urination. If left untreated, the body breaks down fats instead of glucose for energy. This can lead to ketoacidosis, which is life-

threatening. Elevated glucose levels can also lead to long term complications such a kidney disease, cardiovascular disease, eye disease, and neuropathy. Type 1 diabetics also experience low glucose levels (hypoglycemia) as a result of too much exogenous insulin, strenuous exercise, low food intake, amongst other causes. Symptoms for hypoglycemia include dizziness, sweating, hunger, etc. Severe hypoglycemia can lead to coma or death. Unlike hyperglycemia, hypoglycemia does not carry significant long-term risks, as it can be treated much quicker (ADA).

Psychological Factors of T1D (Diabetes Distress)

The presence of these biological factors brings on psychological distress. For type 1 diabetics, this psychological distress is referred to as diabetes distress. The American Diabetes Association defines diabetes distress (DD) as "the emotional distress that results from living with diabetes and the burden of relentless daily self-management." Daily self-management is "relentless" because monitoring blood sugar requires a great deal of attention and energy. There is a plethora of factors that cause blood sugar to rise and fall, so an individual must be very intentional with exercise, food intake, exogenous insulin dosage, and stress levels. DD has a significant relationship to glucose levels and HbA1c in both a direct and indirect fashion. In a direct sense, stress hormones elevate glucose levels (citation). However, the indirect impact of DD is arguably the most influential. DD interferes with an individual's daily self-management routine due to increased feelings of powerlessness. Severe DD can lead to diabetes burnout, which is defined as "a state of physical or emotional exhaustion caused by continuous distress of diabetes (and efforts to self-manage it)". Both DD and diabetes burnout can result in neglect of self-management tasks (missing insulin doses and/or not monitoring glucose levels) as well as decreased physical activity, uncontrolled eating, and avoiding doctor appointments (ADA). This disengagement from self-care correlates with higher HbA1c levels.

The existence and manifestation of diabetes distress (DD) provides a strong argument against mind-body dualism; biological and psychological factors have an inherent link. Engel expands on this relationship: "…virtually each of the symptoms classically associated with diabetes may also be expressions of or reactions to psychological distress, just as ketoacidosis and hypoglycemia may induce psychiatric manifestations…" (Engel, 1977). DD is not a comorbidity, rather it is inherent in a T1D diagnosis. In other words, all T1D patients experience emotional distress related to their disease; the question is to what extent. Also, although symptoms may overlap, it is important to differentiate DD from general anxiety and depression. DD is specific to diabetes and is measured differently than general anxiety and depression.

Two valid measures of diabetes distress in T1D are the Problem Area in Diabetes Scale (PAID) and the Type 1 Diabetes Distress Scale (T1-DDS). Questions such as "Feeling overwhelmed by your diabetes?" are rated on a scale of 0 (not a problem) to 4 (severe problem) on the 20-item PAID scale. With the T1-DDS, patients rate statements like "Feeling worried that I will develop serious long-term complications, no matter how hard I try" on a scale of 0 (not a problem) to 6 (a very serious problem). The 28-item T1-DDS is an adaptation of the Diabetic Distress Scale (DDS) that accounts for seven subscales most relevant to those living with T1D (Powerlessness, Management Distress, Hypoglycemia Distress, Negative Social Perception Distress, Eating Distress, Physician

Distress, Friend/Family Distress). Hypoglycemia distress, for example, is rare for type 2 diabetics, so the general DDS differs in subscales measured. Those subscales include: Emotional Burden (EB), Regimen-Related Distress (RRD), Physician-Related Distress (PRD), and Interpersonal Distress (IPD). The DDS is a validated measure that can be administered to both type 1 and type 2 diabetics as it explores general problems that arise from living with diabetes. The scores in all scales are calculated to measure severity. Severe DD is reported in one in four type 1 diabetics (ADA). The "relentless daily self-management" is universal for type 1 diabetics, yet one's capacity and motivation to meet those demands can be attributed to the psychosocial factors outlined by the PAID, T1-DDS, and DDS.

Social Factors of T1D

Of the seven subscales the T1-DDS considers when calculating scores, three relate to social factors: 1) Negative Social Perception Distress, 2) Physician Distress, 3) Friend/Family Distress. Distress in these areas leads to feelings of isolation and loneliness.

Negative Social Perception Distress

A statement in this subscale includes: "Feeling that people will think less of me if they knew I had diabetes." Perceived stigmas surrounding T1D can be harmful to relationships as well as self-management strategies. For instance, if an individual is afraid to expose their diabetes in public, they may neglect treatment.

Physician Distress

A statement in this subscale includes: "Feeling that my diabetes doctor doesn't really understand what it's like to have diabetes." A positive relationship between doctor and patient is crucial to reduce stress and improve overall health. An individual must feel comfortable to discuss any and all issues that arise with T1D. It is the doctor's responsibility to establish that trust. It can be argued that the BPSM is a more empathetic approach to healthcare than the BMM. If a doctor solely focuses on biological factors, it can leave the patient feeling misunderstood. As a result, the distress grows and so do the negative physical health outcomes. As stated, experiences with diabetes vary greatly, rendering a "one-size fits all" approach reckless.

Friend/Family Distress

A statement in this subscale includes: "Feeling that my friends and family make a bigger deal out of diabetes than they should." It can be argued that the opposite of this statement (friends and family not making a big *enough* deal) can also contribute to distress. What is important is that the individual feels they have support from those closest to them.

Notably, neither the PAID scale or the T1-DDS address financial concerns about living with diabetes. The high cost of insulin and other diabetes treatment supplies is no secret. Further research can investigate the impact of socioeconomic status on diabetes distress.

Mindfulness-Based Interventions

Drawing on traditional Buddhist philosophies, Jon Kabat-Zinn introduced a secular form of mindfulness to Western society by developing Mindfulness-Based Stress Reduction (MBSR) in 1979. The emphasis on being *nonjudgmental* is crucial, as it enables individuals to lessen the resistance or resentment they may feel toward their condition. While observing stress and pain in the present moment does not treat these experiences in the same way traditional treatment might, it fosters a deeper understanding of the mind–body connection and cultivates a more compassionate and intimate awareness of one's internal experiences. Kabat-Zinn's Stress Reduction Clinic initially existed as a referral service for physicians when patients did not respond to traditional treatment regimens. At its conception, MBSR did not target specific conditions; rather it combated the suffering, pain, and stress that can be experienced across a variety of illnesses. The MBSR program was not designed to replace medical treatments. Instead, it served as a complement (Kabat-Zinn, 2003). Mindfulness-based interventions such as Mindfulness-Based Cognitive Therapy (MBCT) build off the foundations of MBSR. While MBSR treats general stress and pain, MBCT combines principles of Cognitive-Based Therapy (CBT) to target mental health conditions like depression or anxiety (Marchand, 2012). Since 1979, MBIs have been seen to reduce symptoms experienced in depression, anxiety, stress, insomnia, addiction, psychosis, pain, hypertension, weight control, and cancer (Zhang, 2021). In regards to diabetes, the effectiveness of mindfulness is in preliminary stages and a majority of the findings involve patients with T2D rather than T1D (Hamasaki, 2023).

Methods

For this systematic review, a comprehensive search strategy was developed and conducted across PubMed, The American Diabetes Association, and The National Institutes of Health databases. First, information for the literature review was collected from these databases with keywords such as "Diabetes distress," "Mindfulness-based interventions," "Type 1 Diabetes," "HbA1c," "Biopsychosocial model." The goal of the literature review was to understand T1D through a biopsychosocial lens and obtain background information about MBIs. After the literature review, PubMed was exclusively used to collect studies that examined the desired variables. To be included in the review, the studies had to utilize a mindfulness-based-intervention or explore the correlation between mindfulness and health outcomes in individuals with Type 1 Diabetes. Required measures included HbA1c as well as diabetes distress and/or general stress. Sources that focused on the epidemiology and related interventions for Type 2 Diabetes were excluded.

Results

This section includes a table describing key points from each of the included studies, which are ordered chronologically. Below the table, each study is explained in more detail.

Table 1

Summary of Selected Studies from 2018 to 2024

Author, Year	Study Design & n	Intervention Type	Duration/ Frequency	Measures	Primary Findings	Limitations
Ellis et al., 2018	Pilot Randomized Controlled Trial (n=48 participants aged 16-20 with T1D)	9-week MBSR program	1x/week for 90-120 minutes	HbA1c, perceived stress scale (PSS), perceived stress reactivity scale (PSRS), Scale of Subjective Socioeconomic Status (SSSS)	↓ stress	Small sample size, lack of follow-up, low recruitment rate
Shukla et al., 2021	Randomized Controlled Trial (n= 32 adults with T1D)	6-month, Mindful Mediation (MM) program	Daily 20-minute sessions	HbA1c, DDS	For intervention group: ↓ DDS For both groups: ↓ HbA1c	Small sample size
Abujaradeh et al., 2021	Survey on the correlation between trait mindfulness/practices and HbA1c in adolescents with T1D (n=129)	N/a	N/a	Child and Adolescent Mindfulness Measure (CAMM), Diabetes Stress Questionnaire for Youths-Short Format (DSQY-SF), HbA1c	Trait mindfulness negatively correlated with diabetes distress and HbA1c	Small sample size, convenience sampling
Irwin et al., 2022	Ancillary study of participants from the Flexible Lifestyles Empowering Change (FLEX) trial at 18 months (n=152 adolescents with T1D)	N/a	N/a	Child and Adolescent Mindfulness Measure (CAMM), HbA1c	↑ CAMM correlated with ↓ HbA1c	Small sample size, lack of diversity, difficult to generalize results
Basch et al., 2024	Randomized Controlled Trial (n=42 adolescents with T1D)	6–7-week group virtual MBI sessions	1x/week for 60-90 min	HbA1c, PAID-T	↓ HbA1c	Small sample size, measurement of HbA1c was limited

Across the five studies, mindfulness was consistently associated with reductions in diabetes distress or general stress and, in most cases, improvements in HbA1c levels. However, results were inconsistent due to small sample sizes, varied MBI interventions, and heterogeneity in measurement tools.

Ellis et al., 2018

The stress in this study was not diabetes-specific, however stress was significantly lower at the end of the 9-week MBSR program (p=0.03) and at the 3-month follow-up (p=0.01). The change in HbA1c was insignificant.

Shukla et al., 2021

The data showed a significant reduction in total diabetes distress scores in the intervention group (p=0.003) at six months, however significant improvement was only seen in the emotional burden and the regimen-related distress subscales and not interpersonal distress and physician distress subscales. A significant decline in HbA1c was observed in both the intervention group (p=0.008) and the control group (p=0.005).

Abujaradeh et al., 2021

In this survey of adolescents with T1D (n=129), participants who reported higher levels of trait mindfulness saw lower diabetes distress (p<0.001) as well as lower HbA1c (p=0.013). CAMM scores assessed trait mindfulness (mindfulness tendencies), where mindfulness practices were assessed by either actively engaging with mindfulness practices (yoga, meditation, body scan) or not. No significant correlation was found for mindfulness practices and either HbA1c or diabetes distress.

Irwin et al., 2022

This ancillary study examined the correlation between Child Adolescent Mindfulness Measure (CAMM) and HbA1c in participants of the Flexible Lifestyles Empowering Change (FLEX) trial. FLEX was a randomized controlled trial (n=258) that provided an adaptive intervention for adolescents with T1D and suboptimal glycemia. Researchers found that mindfulness scores were negatively correlated with HbA1c; a model estimated a -0.22% change in HbA1c per five-point increase in CAMM scores.

Basch et al., 2024

Participants in this study were randomly assigned to either a MBI condition or a health education condition. Outcomes were measured at baseline, immediately post treatment (follow-up 1), and at three months (follow-up 2). For both groups, PAID scores decreased from baseline to three months. The clinical cut-off for PAID scores is 40, which indicates high diabetes distress. In the MBI group, 80% of participants were above this cut-off at baseline and decreased to 50% at follow-up 1 and 55% at follow-up 2. In the health education condition, 68% were above clinical cut-off at baseline, 50% above at follow-up 1, and 46% above at follow-up 2. The effect of the MBI program on diabetes distress was insignificant [$F(2, 34) = 0.38$, $p = .69$, $\eta_p 2 = .022$]. Average HbA1c

in the MBI group decreased from 7.72 to 7.60 from baseline to follow-up 2, while a decrease from 8.70 to 8.68 was observed in the health education group in the same timeline.

Discussion

This review explored whether mindfulness-based interventions could alleviate diabetes distress and thus reduce HbA1c levels. HbA1c, the biological component of T1D, has been shown to have a positive correlation to diabetes distress, a condition that is measured by both psychological and social stressors. Data from Shukla et al., 2021 suggest that mindfulness interventions interact more closely with the psychological subscales of diabetes distress rather than the social. Preliminary research suggests that the powerlessness subscale contributes most to total diabetes distress (Fischer et al., 2015). Further research can be done to understand how mindfulness interacts with both the psychological and social subscales outlined in the T1-DDS and DDS. If an individual is above the clinical cut-off due to social stressors (negative social perception distress, physician distress, friend/family distress), it is possible that mindfulness would not be as effective as interventions that directly target social factors. Diabetes distress appears to have high levels of variability in both severity and type. The subscales that contribute to raw diabetes distress scores must be clearly identified in order to develop an appropriate intervention, whether mindfulness-based or otherwise. Regardless of nature, severe levels of diabetes distress correlate with higher HbA1c because an individual's capacity and motivation for improvement is limited.

Social factors that are not represented in the PAID scale, T1-DDS, and DDS, are finances and access to healthcare. In the US, the average annual healthcare costs are 2.3 times higher for diabetics than the general population (Simeone et al., 2020). Social support, whether it comes from family, friends, or medical professionals, is crucial for the management of T1D. Across the five studies, SES was measured only in Ellis et al., 2018. Mean scores on the SSSS suggest the sample had a moderately low SES. Future research can explore the relationship between SES and diabetes distress in order to develop programs and interventions that account for socioeconomic variability.

Since T1D typically affects younger populations, it is possible that effectiveness of mindfulness-based interventions is age dependent. Studies by Basch et al., 2024 and Irwin et al., explored mindfulness in adolescent populations, but neither study examined populations under the age of 12. Further research is needed to evaluate age as an independent variable when assessing the effectiveness of mindfulness, particularly in earlier adolescence. Similarly, it is possible that mindfulness-based interventions depend on age of onset. In Basch et al., 2024 participants were required to have had T1D for at least one year. In Shukla et al., the mean duration of diabetes was 13.25 years in the intervention group. Distress at onset may look differently than distress at 13 years and it could be hypothesized that diabetes distress changes and evolves over time. More longitudinal studies are needed to understand this dynamic.

Conclusion

Although research is limited, mindfulness may be an effective intervention in conjunction with traditional treatment to reduce both diabetes distress and HbA1c in individuals with T1D. The BMM has provided the essential tools (insulin, glucose monitors, pumps) to treat biological outcomes. The BPSM expands on the BMM by incorporating psychological and social factors of illness. When addressing T1D, it is essential to acknowledge the biological, psychological, and social factors that influence the unique human experience of living with this chronic disease. The prevalence of diabetes distress indicates that the psychological and social aspects of T1D require more attention. Treating diabetes distress may lead to improvements in HbA1c due to an inherent link between mind and body.

Further research should continue to explore how mindfulness interacts with psychological domains of diabetes distress (powerlessness, management distress, emotional distress) and social domains (physician distress, interpersonal distress, negative social perception distress). Furthermore, researchers should seek to understand not only how the psychological and social domains interact with biological outcomes (HbA1c), but how the psychological and social factors interact with each other. Based on the BPSM, there would be an expected interaction between psychological and social factors, but what that interaction looks like is left to be examined. The interplay of biological, psychological, and social factors is well researched, but there are significant gaps to be filled in the context of T1D.

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