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**Original Research Article**

# AI-Driven Behavioral Health Education to Reduce Diabetes Distress: Early Clinical Evidence Informing AI Chatbot Design

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**Abstract:** Diabetes distress (DD) is a significant psychosocial factor that undermines effective self-management and glycemic control in individuals with Type 2 diabetes. This study evaluated the impact of a structured behavioural health intervention using the Diabetes Self-Management Education (DSME) toolkit and the Diabetes Distress Scale (DDS-17) in a primary care setting. Eleven patients with poorly controlled diabetes (A1c ≥ 8%) were enrolled, and four completed a seven-week telephonic DSME program. Pre-intervention and post-intervention DDS-17 scores were compared to assess changes in distress levels. Results showed a clinically meaningful reduction in diabetes distress, with participant scores shifting from high or moderate levels to moderate or low levels. Item-level analysis highlighted significant improvements in emotional burden and perceived overwhelm. Although initial interest was high, attrition underscored the challenges of sustained engagement in traditional care formats. These findings reinforce the efficacy of behavioural education and emotional screening in diabetes care and offer a blueprint for future digital transformation. Crucially, the intervention's structured format and measurable psychological benefits show how this kind of program could be turned into an AI-powered system paving the way for scalable, intelligent platforms that deliver personalized behavioural health support to diverse, at-risk populations, and helps patients stay engaged in managing their health globally. This study emphasizes the importance of integrating emotional health support into chronic disease care and offers practical insights for future digital and policy-driven diabetes management strategies.

**Keywords:** Diabetes Distress, Digital Health, AI in Healthcare, DSME, DDS-17, Type 2 Diabetes, Telehealth, Behavioural Intervention.

## INTRODUCTION

Diabetes mellitus is a globally prevalent chronic condition, posing substantial health, economic, and psychosocial challenges. According to the World Health Organization (2016), the number of people living with diabetes has almost quadrupled since 1980, with over 422 million adults affected worldwide, most residing in developing countries. Increasing rates of overweight and obesity primarily drive the rise in diabetes incidence. In the United States, the Centers for Disease Control and Prevention (CDC, 2023a) reports that approximately

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38 million Americans have diabetes, with 90–95% diagnosed with Type 2 diabetes mellitus (T2DM). While clinical management of diabetes often focuses on physiological parameters such as blood glucose and HbA1c levels, increasing attention is being directed toward diabetes distress (DD), a unique and critical psychosocial aspect of the disease. Diabetes distress is a negative emotional response to the burdens of living with and managing diabetes, encompassing feelings of frustration, fear, burnout, and perceived lack of support (Fisher *et al.,* 2010). Unlike clinical depression, DD is tied explicitly to the self-management demands and complications of diabetes and is prevalent among 22% to 36% of adults with T2DM (Beverly *et al.,* 2022).

The clinical significance of DD is profound, as it is strongly associated with poorer adherence to self-care behaviours and worsened glycemic outcomes (Gonzalez *et al.,* 2016; Fisher, Mullan *et al.,* 2010). Research demonstrates that DD not only reduces patients' motivation to engage in essential diabetes care routines, such as medication adherence, dietary regulation, and physical activity, but also diminishes quality of life and mental well-being (Peyrot *et al.,* 2005). Despite its impact, DD often remains undiagnosed and inadequately addressed in primary care settings due to a lack of awareness and training among healthcare providers (Owens-Gary *et al.,* 2018). To mitigate the effects of diabetes distress, behavioural interventions such as Diabetes Self-Management Education (DSME) have gained prominence. DSME programs equip individuals with the skills and knowledge required for effective diabetes self-care and have been shown to improve both psychological and clinical outcomes significantly. Studies have indicated that DSME interventions are effective in reducing diabetes distress levels, enhancing medication adherence, and improving HbA1c values (Qasim *et al.,* 2019; Zheng *et al.,* 2019). Furthermore, such programs bolster patients' self-efficacy and resilience, key psychological factors associated with sustained health behaviour change (Lorig *et al.*, 2001).

A central tool in assessing and monitoring diabetes distress (DD) is the Diabetes Distress Scale (DDS-17), a validated instrument developed by Polonsky *et al.,* (2005). The scale evaluates emotional burden, physician-related distress, regimen-related distress, and interpersonal distress. Clinical research has confirmed its reliability and utility in identifying patients in need of psychosocial support (Fisher *et al.,* 2010). The American Diabetes Association has since recommended the routine use of DD screening tools like the DDS-17 in cases where glycemic control is not achieved despite adequate pharmacologic treatment (Li *et al.*, 2020). Given the high prevalence of DD and its detrimental effects on diabetes outcomes, innovative solutions are necessary to enhance access to emotional and educational support, particularly in under-resourced or overburdened primary care settings. Recent studies advocate for the integration of digital tools and artificial intelligence (AI) to deliver personalized DSME content and behavioural health interventions at scale (Anjali *et al.,* 2023). AI-driven models, which can simulate human-led coaching and support, present promising avenues for reducing emotional barriers and improving self-management among diverse diabetic populations. This study explores the implementation of structured behavioural interventions delivered in a format that could be feasibly augmented or replicated by AI systems. It aims to assess the efficacy of combining distress screening with targeted diabetes self-management education (DSME) in a primary care setting. It lays the groundwork for future multinational applications of AI-driven behavioural health in diabetes care.

## Objectives

- To assess the impact of delivering Diabetes Self-Management Education (DSME) alongside Diabetes Distress Scale (DDS-17) screening on reducing emotional distress in adults with Type 2 diabetes.
- To demonstrate the real-world feasibility and outcomes of implementing this intervention in a primary care setting.
- To lay the groundwork for transforming this proven behavioral support model into an AI-powered platform for global implementation strategies.

## Related Work

The growing burden of diabetes worldwide has led to an increased focus not only on clinical management but also on the psychological and behavioural dimensions of chronic disease care. Among these dimensions, diabetes distress (DD) has emerged as a distinct and impactful factor. DD refers to the emotional turmoil and mental fatigue that individuals with diabetes often experience because of managing their condition on a daily basis. High levels of DD are associated with suboptimal diabetes self-care, poor glycemic control, and a diminished quality of life (Gonzalez, Tanenbaum, & Commissariat, 2016). Numerous studies have highlighted the prevalence and consequences of DD across various settings. For instance, Wong *et al.,* (2017) reported DD prevalence rates ranging from 19% to 35% in primary care and up to 43% in tertiary care facilities. These findings align with estimates by Beverly *et al.,* (2022), who identified that as many as one-third of adults with Type 2 diabetes may experience clinically significant distress. Importantly, DD is often overlooked in standard practice, with both clinicians and patients underreporting or misinterpreting its symptoms, leading to insufficient treatment (Bhaskara *et al.,* 2022).

The American Diabetes Association (ADA) has long recognized the importance of addressing DD as part of comprehensive diabetes care. It recommends that providers assess distress regularly, especially among patients with poorly controlled glucose levels or those experiencing diabetes-related complications (Fisher, Glasgow, & Strycker, 2010; Li, Dai, Xu, & Jiang, 2020). Tools like the Diabetes Distress Scale (DDS-17), developed and validated by Polonsky *et al.,* (2005), have proven effective in quantifying the emotional burden associated with diabetes. The scale's four subdomains, emotional burden, regimen-related distress, interpersonal distress, and physician-related distress, provide a nuanced picture of a patient's psychological state and facilitate targeted intervention. Behavioural interventions, particularly Diabetes Self-Management Education (DSME) programs, have been widely endorsed for their dual benefits: reducing DD and improving clinical outcomes such as HbA1c levels. Powers *et al.,* (2016) define DSME as a structured process that imparts knowledge, skills, and confidence to patients, enabling them to manage their condition effectively. These programs have consistently been associated with enhanced medication adherence, better dietary practices, increased physical activity, and improved emotional resilience (Zheng, Liu, Liu, & Deng, 2019).

Recent work has emphasized the importance of tailoring DSME to the cultural and contextual needs of patients. For instance, Anjali *et al.,* (2023) conducted a randomized controlled trial in India, demonstrating that a structured DSME module not only improved glycemic control but also significantly reduced diabetes distress (DD) levels. Similarly, Peña-Purcell *et al.,* (2019) found that DSME programs tailored for African American and Hispanic/Latino populations led to substantial improvements in psychological well-being and diabetes self-efficacy. Digital innovation has also played an increasingly central role in the evolution of behavioural interventions for diabetes. Studies, such as those by Cummings *et al.,* (2017), have explored the use of telephone-based or remotely delivered interventions, showing that such approaches can effectively reduce diabetes distress (DD), particularly among underserved and rural populations. Participants in their study, who received peer-led, telephone-delivered support, exhibited marked reductions in DD and corresponding improvements in self-care behaviours and HbA1c levels. Despite these promising outcomes, barriers to implementation remain. Many primary care providers lack the training or resources to screen for DD or deliver DSME interventions (Owens-Gary *et al.,* 2018). Moreover, time constraints and competing priorities within clinical visits limit the ability to offer psychosocial support. This gap highlights the urgent need for scalable solutions that can be integrated into everyday healthcare workflows without imposing additional burdens on providers.

Emerging literature has begun to explore the potential for artificial intelligence (AI) and machine learning systems to bridge this gap. AI tools can deliver personalized content, simulate coaching interactions, monitor patient engagement, and flag distress signals based on behavioural data, offering a promising means of augmenting diabetes self-management education (DSME) delivery and expanding access to behavioural health interventions (Mathiesen *et al.,* 2018). While these technologies are still under development, their application in the behavioural management of chronic diseases such as diabetes represents a significant shift toward more holistic, patient-centered care. Collectively, these studies establish a strong foundation for implementing AI-driven behavioural health interventions. By drawing on validated tools like the DDS-17 and integrating them with scalable education models, the field is poised to enhance both the reach and effectiveness of diabetes care significantly.

## METHODOLOGY

Addressing diabetes distress requires not only psychological insight but also practical, structured interventions delivered in accessible formats. The foundation of effective intervention lies in evidence-based education and screening protocols that can be systematically implemented and adapted to various care settings. Among these, Diabetes Self-Management Education (DSME) programs have emerged as a cornerstone of effective chronic disease management. Powers *et al.,* (2016) emphasized that DSME is essential for helping individuals with diabetes make informed decisions, solve problems, and take responsibility for their care. These programs promote behavioral change through education on medication adherence, dietary planning, physical activity, and coping strategies, ultimately leading to better glycemic control and reduced psychological burden. In tandem with educational efforts, routine distress screening is critical for identifying those patients most at risk for poor diabetes self-management due to emotional strain. The Diabetes Distress Scale (DDS-17), developed by Polonsky *et al.,* (2005), has been widely validated and is now considered a standard tool in clinical and research settings. The DDS-17 measures four domains: emotional burden, regimen-related distress, interpersonal distress, and physician-related distress. Its application in primary care allows clinicians to detect and quantify distress, enabling the timely initiation of targeted behavioral interventions (Fisher *et al.,* 2010).

The Health Belief Model (HBM), a widely used psychological framework, has often been applied to guide the structure and delivery of Diabetes Self-Management Education (DSME) interventions. According to Glanz, Rimer, and Viswanath (2015), the HBM emphasizes individual perceptions of susceptibility, severity, benefits, and barriers related to health behaviours. It also incorporates concepts like cues to action and self-efficacy, both of which are critical in motivating behaviour change among patients with chronic illnesses. In the context of diabetes, patients who believe in the severity of complications and the benefits of proactive management are more likely to engage in self-care behaviours, especially when their confidence (self-efficacy) is reinforced through skill-building and support (Jones *et al.,* 2014). Implementing a DSME intervention in real-world settings often requires operationalizing these theoretical concepts into practical steps. For example, weekly education sessions delivered by phone, as explored by Cummings *et al.,* (2017), have proven effective in reaching patients in rural and underserved communities. Their study demonstrated that such remotely delivered interventions could significantly reduce diabetes distress while improving HbA1c, medication adherence, and self-efficacy.

The structure of DSME programs generally includes modules on monitoring blood glucose, adhering to medications, preparing healthy meals, staying physically active, checking feet regularly, and managing psychosocial stress. These topics align with recommendations made by the American Diabetes Association and are consistent with successful interventions reported in previous research (Powers *et al.,* 2016; Peña-Purcell *et al.,* 2019). Delivering this content in a progressive, week-by-week format allows patients to absorb information incrementally and practice new skills, thereby increasing the likelihood of sustained behavioural change. Stakeholder engagement and logistical planning are also crucial to the successful implementation of DSME and screening programs. As noted by Brunisholz *et al.,* (2014), improving the quality of care through DSME depends heavily on interdisciplinary collaboration, staff training, and the allocation of appropriate resources. Without institutional support and trained personnel, even the most evidence-based interventions may fail to achieve desired outcomes. Furthermore, data collection and outcome evaluation are indispensable components of intervention research. Reductions in DDS-17 scores from pre- to post-intervention serve as measurable indicators of decreased emotional burden and improved psychological resilience. These quantitative measures are complemented by qualitative insights from patient feedback and behavioural indicators, such as session attendance and engagement (Heisler *et al.,* 2010). Together, they offer a comprehensive understanding of the intervention's efficacy. Considering these insights from existing literature, implementing DSME in combination with routine distress screening, guided by the Health Belief Model and supported by well-trained staff, represents a best-practice approach to managing diabetes distress. This methodology aligns with current recommendations from public health authorities. It serves as a scalable framework for future integration with artificial intelligence systems that could deliver similar support at a broader, multinational level.

## Data Analysis

Evaluating the effectiveness of behavioural interventions in diabetes care requires a robust and multidimensional data analysis strategy that includes both quantitative and qualitative measures. In recent years, studies have increasingly emphasized the value of pre- and post-intervention assessments to determine the clinical and psychological impact of self-management programs. Specifically, changes in diabetes distress levels, as measured by validated tools, have served as a key outcome indicator of intervention efficacy (Fisher *et al.,* 2010). The Diabetes Distress Scale (DDS-17) is widely used to assess emotional responses to living with diabetes, offering quantitative insight into four dimensions of distress: emotional burden, regimen-related distress, interpersonal stress, and physician-related distress (Polonsky *et al.,* 2005). Each item on the scale is scored on a Likert scale, typically ranging from "not a problem" to "a serious problem," allowing researchers to assign mean scores and track changes over time. Studies have demonstrated that reductions in these scores correspond with improved psychosocial functioning and, frequently, better glycemic control (Peyrot *et al.,* 2005; Fisher, Glasgow, & Strycker, 2010).

For intervention evaluation, pre- and post-test designs are frequently employed to measure changes in distress levels before and after the educational or therapeutic exposure. According to Cummings *et al.,* (2017), using the DDS-17 as both a baseline and follow-up measure provides a reliable method for assessing the emotional impact of telephonic and behavioural health interventions. In their study, significant improvements in distress scores were associated with increased engagement in self-care behaviours and better HbA1c values, underscoring the utility of this tool for outcome tracking. Statistical methods for analyzing DDS-17 data typically include descriptive statistics to summarize mean scores and inferential techniques, such as paired t-tests or non-parametric equivalents, to determine the significance of observed changes. Although small sample sizes are standard in pilot studies, meaningful trends can still emerge when effect sizes are large or distress reductions are consistent across participants (Mathiesen *et al.,* 2018). Additionally, item-level analysis can reveal specific domains where intervention had the most significant psychological impact, for example, decreases in emotional burden or perceptions of being overwhelmed by diabetes demands (Rariden, 2019). Complementing quantitative assessments, behavioural and engagement metrics can provide valuable context to interpret outcomes. Studies by Peña-Purcell *et al.,* (2019) and Anjali *et al.,* (2023) have shown that consistent participation in DSME sessions correlates with greater reductions in distress scores. Tracking session attendance, dropout rates, and patient-reported feedback helps illuminate patterns of responsiveness to intervention content and delivery method. This dual approach enhances the reliability of findings and allows for more nuanced conclusions about what aspects of an intervention were most effective.

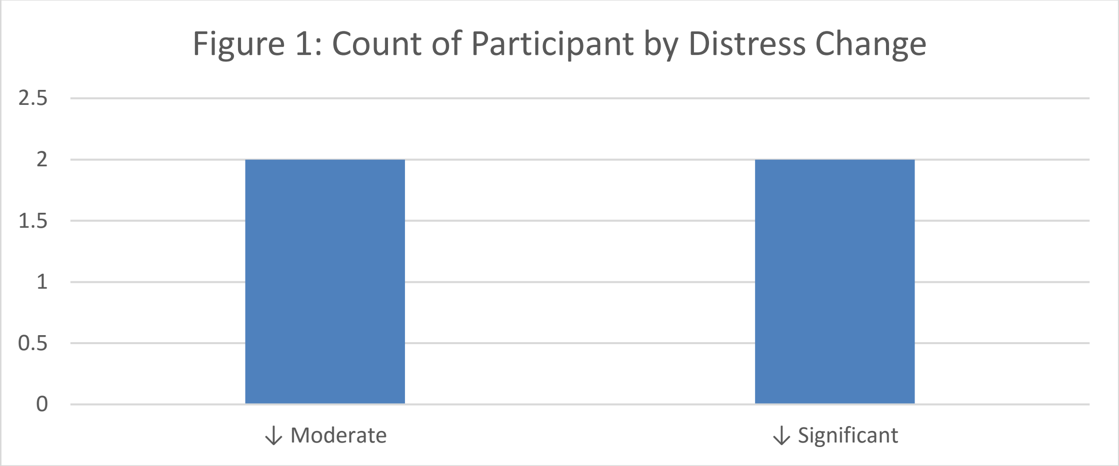
Moreover, analyzing patient responses to specific DDS-17 items has become a standard technique for understanding emotional shifts. For example, Fisher *et al.,* (2010) noted that changes in responses to questions about fear, frustration, and perceived support often reflect broader improvements in psychological readiness for self-care. Such item-level comparisons can be especially revealing in interventions that prioritize emotional and motivational support. Ultimately, rigorous data analysis in behavioural diabetes research requires triangulating distress scores, behavioural engagement indicators, and contextual variables to ensure that observed improvements are not only statistically significant but also clinically meaningful. As the field moves toward AI-enabled behavioural health models, incorporating structured and repeatable analytic frameworks will be essential for validating digital interventions at scale (Zheng *et al.,* 2019). These frameworks provide the empirical foundation for future adaptations and expansions into multinational and technology-driven care models.

## RESULTS

The outcomes of the intervention were evaluated across three core domains: overall reduction in diabetes distress scores, changes in specific emotional burden indicators, and participant engagement over time. These outcomes are visually represented in Figures 1, 2, and 3, which summarize pre- and post-intervention measures.

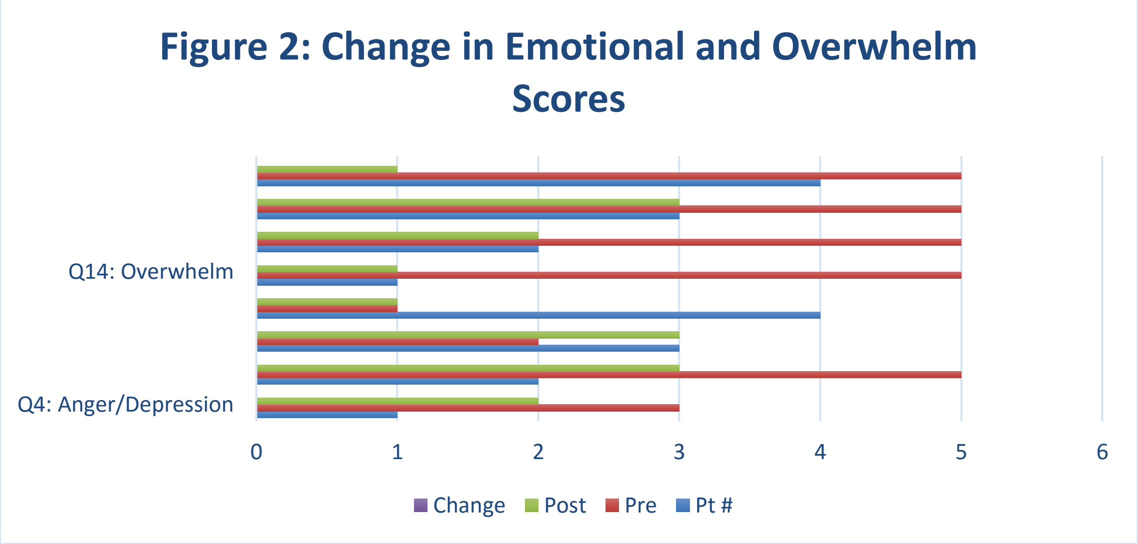
### Reduction in DDS-17 Mean Scores

The most direct quantitative outcome was the change in mean DDS-17 scores from pre- to post-intervention. These scores were calculated for each of the four participants who completed the full seven-week DSME program. Figure 1 presents the pre- and post-intervention mean scores across participants, each of whom initially exhibited moderate to high distress levels. For example, Participant #2 had a notably high baseline score of 4.6, which decreased to 2.7 post-intervention, indicating a shift from high to moderate distress. Participant #1's distress dropped from 3.3 to 1.6, moving from high to low. This overall reduction in scores reflects a clinically significant decline in diabetes-related emotional strain, supporting evidence from past studies that DSME programs can mitigate distress by promoting coping strategies, health literacy, and self-efficacy (Peyrot *et al.,* 2005; Cummings *et al.*, 2017). **Figure 1 shows** the trajectory of each participant's distress reduction and highlights the individual variability in outcomes, reinforcing the importance of personalized support within structured interventions.



**Changes in Emotional Burden and Perceived Overwhelm**

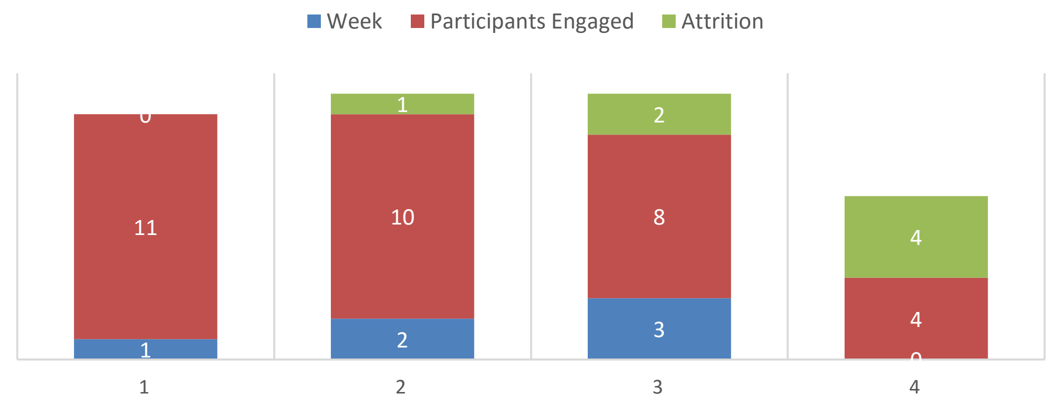
Beyond the global distress scores, item-specific analysis revealed important emotional changes. Two emotionally sensitive DDS-17 items, *Item 4: Feeling angry, scared, and/or depressed when thinking about living with diabetes*, and *Item 14: Feeling overwhelmed by the demands of living with diabetes*, were examined to assess shifts in specific emotional responses. **Figure 2** displays the pre- and post-intervention responses for each participant on these two items. Initially, all four participants rated Item 14 as a serious problem (score of 5), indicating a profound sense of being overwhelmed. After the seven-week intervention, scores for this item decreased across all participants, dropping as low as 1 (not a problem) for two individuals. For Item 4, the emotional burden also improved, with scores generally falling from moderate-to-severe to mild levels. These results suggest that participants not only gained practical knowledge but also experienced emotional relief, which aligns with prior findings that emotional burden often decreases with structured education and support (Fisher *et al.,* 2010; Gonzalez *et al.*, 2016). **Figure 2 illustrates** how these changes in subjective emotional responses parallel overall reductions in DDS-17 scores, emphasizing the intervention's psychosocial effectiveness.



**Participant Engagement Across Weekly Sessions**

A key factor influencing the outcomes was participant engagement over time. The intervention was structured around seven weekly telephone sessions, and **Figure 3** charts the number of participants engaged each week. Of the 11 individuals initially enrolled, 10 attended the first session, but participation began to decline in subsequent weeks. By week 4, only 4 participants remained actively engaged, and these were the same individuals who completed the full program and submitted post-intervention DDS-17 scores. **Figure 3 shows** this declining attendance trend, with the most significant drop-off occurring between weeks 2 and 4. Despite the attrition, the strong correlation between full participation and distress score improvement suggests that consistent exposure to DSME content may be critical for impact. This observation reflects earlier literature noting that program adherence is often directly linked to psychological benefit (Peña-Purcell *et al.,* 2019; Owens-Gary *et al.*, 2018).

FIGURE 3: WEEKLY ENGAGEMENT AND DROP-OFF RATE



## DISCUSSION

The results of this intervention provide compelling evidence that structured behavioral health support, delivered through a diabetes self-management education (DSME) framework, can significantly reduce diabetes distress (DD) among adults with poorly controlled Type 2 diabetes. These findings are consistent with a growing body of research that underscores the psychological benefits of DSME in both clinical and community settings (Peña-Purcell *et al.*, 2019; Powers *et al.,* 2016). One of the most notable outcomes was the overall reduction in DDS-17 scores across all four participants who completed the intervention. This mirrors previous findings by Zheng *et al.,* (2019), who reported statistically and clinically significant improvements in distress levels following DSME participation. The transition from high to moderate or low distress observed in this project aligns with results reported by Cummings *et al.,* (2017), who found that structured, peer-led educational support via phone significantly reduced DD and improved diabetes-related self-care behaviors. The success of this intervention can be partially attributed to the way it addressed multiple components of the Health Belief Model (HBM), which has been widely used to guide behavior change interventions (Glanz *et al.*, 2015). Participants were made aware of their perceived susceptibility to diabetes complications through education, which increased their perception of the severity of the disease. The intervention simultaneously highlighted the benefits of behavior change and minimized perceived barriers by providing accessible, culturally sensitive education through telephonic sessions. As emphasized by Jones *et al.,* (2014), when individuals believe in their ability to enact change and are provided with tools to do so, self-efficacy increases, leading to sustained behavioral engagement.

The significant reduction in scores for DDS-17 items related to emotional burden (e.g., “feeling angry, scared, or depressed”) and overwhelm further supports the psychological value of consistent educational engagement. Fisher *et al.,* (2010) have pointed out that reductions in specific DDS-17 item scores can be reliable indicators of improved emotional functioning, even in the absence of significant clinical change. In this context, the improvements in participants’ emotional responses suggest that the program offered not only practical knowledge but also a sense of empowerment and psychological relief. Despite these encouraging outcomes, the intervention faced substantial attrition. While 11 individuals initially enrolled, only 4 completed the program. This pattern is not uncommon in behavioral health interventions for chronic illness and has been observed in prior studies, particularly those targeting underserved populations (Bhaskara *et al.,* 2022). Factors such as transportation issues, scheduling conflicts, limited health literacy, or competing life demands may explain participant dropout. These challenges echo those documented by Owens-Gary *et al.,* (2018), who emphasized the need for flexible, scalable intervention formats in primary care settings.

The success among those who completed the program suggests a strong correlation between full participation and improved outcomes. This finding underscores the importance of program adherence and points toward the potential role of technology, particularly artificial intelligence (AI), in improving accessibility and retention. AI-enabled systems could offer 24/7 personalized education, real-time distress monitoring, and automated reminders, helping to sustain engagement while easing the burden on clinical staff. Mathiesen *et al.,* (2018) have already suggested that psychosocial interventions augmented by digital tools are promising in reaching vulnerable populations more efficiently. Moreover, the psychological improvements documented in this intervention have implications beyond diabetes care. Gonzalez *et al.,* (2016) noted that DD is associated with a higher risk of depression, anxiety, and diminished quality of life. By mitigating DD early, programs like this may reduce long-term mental health complications and the associated healthcare costs. This highlights the broader value of integrating psychosocial support into chronic disease management, a recommendation that has gained support from both clinicians and policymakers.

Finally, the study's small sample size limits the generalizability of its findings, yet it does not diminish their significance. The consistency of distress reduction across all participants who completed the study speaks to the intervention's potential scalability, particularly if delivered through culturally adapted, digitally supported platforms. As Peña-Purcell *et al.,* (2019) have shown, tailored interventions yield greater engagement and efficacy among marginalized populations—an approach that could be further strengthened through AI personalization and multilingual delivery.

## RECOMMENDATIONS

Considering the study's findings and alignment with existing research, several strategic recommendations can be made to enhance the management of diabetes distress in primary care settings. First, it is imperative that routine screening for diabetes distress be integrated into standard diabetes care. Validated tools, such as the Diabetes Distress Scale (DDS-17), should be employed systematically to identify patients experiencing a high emotional burden. As Fisher, Glasgow, and Strycker (2010) emphasize, early detection of distress allows for targeted psychosocial interventions that may prevent deterioration in both emotional well-being and clinical outcomes. To improve accessibility and patient engagement, diabetes self-management education (DSME) should be made available through flexible delivery models. Offering programs through telephone, mobile platforms, or virtual sessions can overcome barriers such as transportation limitations and scheduling conflicts, factors that commonly affect participation among vulnerable populations. Cummings *et al.,* (2017) demonstrated that even remotely delivered DSME, when structured and culturally relevant, significantly reduces diabetes distress and enhances adherence to self-care behaviours. The adoption of artificial intelligence (AI) technologies presents a transformative opportunity in this regard. AI can be utilized to personalize DSME content, simulate interactive coaching, and monitor distress levels over time through user input or behavioural data. Mathiesen *et al.,* (2018) argue that AI-powered behavioural health interventions can reach underserved populations more efficiently, offering scalable and cost-effective solutions that extend beyond the limitations of traditional healthcare models.

A significant barrier to implementing distress screening in practice remains the lack of awareness and training among healthcare providers. Many clinicians are unfamiliar with diabetes distress or lack confidence in addressing its emotional aspects. Owens-Gary *et al.,* (2018) note that this knowledge gap contributes to the underdiagnosis and undertreatment of distress in primary care settings. Therefore, it is essential to provide interprofessional training for physicians, nurses, and support staff to equip them with the necessary skills to identify and manage psychosocial factors influencing diabetes outcomes. Moreover, diabetes self-management education (DSME) programs should be tailored to the cultural and emotional contexts of the populations they serve. Research by Peña-Purcell *et al.,* (2019) and Anjali *et al.,* (2023) highlights the importance of culturally adapted interventions in increasing both relevance and effectiveness. This involves not only translating materials but also aligning them with local beliefs, values, and lived experiences that shape how patients perceive and manage their illness.

Finally, efforts should be made to reduce dropout rates by incorporating retention strategies such as personalized follow-up, peer support, and small incentives. Bhaskara *et al.,* (2022) emphasize that consistent engagement is a key predictor of positive outcomes in behavioural health interventions. Strategies that enhance patient motivation and accountability throughout the program can strengthen its overall impact and sustainability. Together, these recommendations underscore the need for a more integrated, patient-centered approach to diabetes care, one that addresses both clinical indicators and the emotional burdens of chronic disease. Embedding psychosocial screening and support within primary care and enhancing these efforts through technology can significantly improve the quality of life and health outcomes for individuals living with Type 2 diabetes.

### Future Research Directions

While the current findings reinforce the effectiveness of structured behavioural health interventions in reducing diabetes distress, they also point to critical areas for future exploration. First, there is a need for larger-scale studies that evaluate the long-term effects of DSME interventions on both psychological and clinical outcomes. Although reductions in distress were evident in this short-term program, future research should investigate whether these improvements are sustained over time and whether they translate into lasting benefits such as improved glycemic control, reduced hospitalizations, and decreased healthcare costs. As noted by Fisher, Mullan *et al.,* (2010), the relationship between distress and glycemic control is complex and may require longitudinal data to understand its trajectory fully. Another key area for future research is the integration of artificial intelligence into behavioural health delivery. As digital health technologies evolve, AI has the potential to transform how education and emotional support are provided to patients with chronic conditions. Future studies should evaluate the comparative effectiveness of AI-driven versus clinician-led DSME interventions in reducing diabetes distress. This includes assessing patient satisfaction, clinical efficacy, and cost-efficiency. Mathiesen *et al.,* (2018) highlight that technology-assisted psychosocial interventions are particularly promising for reaching vulnerable populations, but their scalability and adaptability across cultural settings remain underexplored.

Additionally, future research should focus on customizing DSME content using culturally responsive frameworks. As Peña-Purcell *et al.,* (2019) and Anjali *et al.,* (2023) have shown, interventions are more effective when tailored to the linguistic, cultural, and emotional realities of specific populations. Studies should examine how variables such as ethnicity, socioeconomic status, and health literacy influence the uptake and outcomes of both traditional and digital DSME models. Mixed-methods approaches could be particularly valuable in capturing both the quantitative impact and qualitative experiences of diverse patient groups. The high dropout rate observed in this and similar interventions also warrants further investigation. Understanding the factors that contribute to participant disengagement, ranging from logistical barriers to emotional resistance, can inform the development of more inclusive and resilient program designs. Bhaskara *et al.,* (2022) suggest that tailored engagement strategies and support structures may significantly improve retention rates. Future research could experiment with peer mentorship, gamified interfaces, or behavioural nudges to boost adherence and participation, particularly on digital platforms.

Lastly, future work should examine the impact of integrating diabetes distress screening into broader healthcare systems and policy frameworks. Owens-Gary *et al.,* (2018) emphasize that systemic changes are needed to prioritize emotional well-being in chronic disease management. Research should evaluate how the organizational adoption of tools like the DDS-17 affects workflow, provider behaviour, and patient outcomes, as well as whether policy incentives or mandates could facilitate widespread use. Taken together, these research directions reflect an urgent need to move beyond proof-of-concept interventions and toward scalable, inclusive, and sustainable solutions. By deepening our understanding of distress dynamics, technological delivery, cultural relevance, and health system integration, future studies can help shape the next generation of person-centered diabetes care.

## CONCLUSION

Diabetes distress represents a major and often overlooked barrier to effective diabetes management, particularly among individuals with poorly controlled Type 2 diabetes. As prior research has demonstrated, elevated distress levels are associated with poor adherence to treatment, diminished self-efficacy, and suboptimal glycemic control (Gonzalez *et al.,*, 2016; Fisher *et al.,* 2010). The findings of this study add to the growing body of evidence supporting the integration of psychosocial interventions, specifically structured diabetes self-management education (DSME), into primary care settings as a means of significantly reducing this emotional burden and improve the well-being of individuals with poorly controlled Type 2 diabetes. Participants who completed the seven-week DSME intervention experienced clinically meaningful reductions from feelings of overwhelm and distress, reinforcing the value of integrating emotional support into routine care. These improvements echo the outcomes of earlier studies by Cummings *et al.,* (2017) and Zheng *et al.,* (2019), reinforcing the value of structured behavioural support in fostering emotional resilience and promoting better disease self-management. Moreover, the use of the Diabetes Distress Scale (DDS-17) as both a screening and evaluation tool proved instrumental in identifying at-risk individuals and tracking their emotional progression over time, consistent with the recommendations of the American Diabetes Association and other authorities (Li *et al.,* 2020).

However, the high dropout rate also highlights the need for more flexible and accessible models, particularly in underserved populations. The attrition observed underscores the importance of designing flexible, patient-centered interventions that account for logistical, cultural, and emotional barriers to participation. In this regard, future adaptations that leverage artificial intelligence to deliver personalized diabetes self-management education (DSME) and real-time distress monitoring may offer a promising pathway to scalability and inclusivity, as suggested by Mathiesen *et al.,* (2018). Ultimately, the integration of behavioural health into chronic disease care is no longer optional but essential. This project demonstrates that even modest, resource-conscious interventions can yield significant psychological benefits for individuals navigating the daily complexities of diabetes. By prioritizing emotional well-being alongside clinical outcomes, healthcare systems can foster more compassionate, comprehensive, and effective models of personalized support to more people, particularly in low-resource or underserved communities making diabetes care more inclusive, scalable, and sustainable. Continued investment in research, technology, and policy reform will be critical to transforming these insights into widespread, sustainable change. This work not only supports existing evidence but also opens the door to a new era of intelligent, patient-centered healthcare solutions that prioritize both emotional and clinical outcomes.

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