

Review

Global prevalence and correlates of diabetes distress in type 1 diabetes: A systematic review and meta-analysis

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ARTICLE INFO

Keywords:

Diabetes distress
Type 1 Diabetes
Prevalence
Risk Factors

ABSTRACT

This study synthesized evidence on the prevalence of diabetes distress (DD) in type 1 diabetes (T1D) and its associations with clinical, behavioral, psychological outcomes, and diabetes technology use. We systematically searched PubMed, PsycINFO, CINAHL, EMBASE, and Scopus (from inception through April 2026) for observational studies reporting DD prevalence or correlates in T1D. Risk of bias was assessed using JBI tools. Random-effects meta-analyses were conducted, with heterogeneity assessed using I^2 statistics. Subgroup analyses and mixed-effects meta-regression were used to explore sources of heterogeneity. Seventy-two studies involving children, adolescents, and adults with T1D were included. The pooled prevalence of elevated DD was 38.9% (95% CI: 33.6–44.5), with higher prevalence estimates observed among females than males. DD was positively correlated with HbA1c ($r = 0.24$), anxiety ($r = 0.42$), depressive symptoms ($r = 0.60$) and fear of hypoglycemia ($r = 0.60$), and negatively correlated with self-efficacy ($r = -0.58$), quality of life ($r = -0.35$) and self-management behaviors ($r = -0.30$). Evidence on diabetes technology use was limited and heterogenous. DD is highly prevalent in T1D and is associated with adverse clinical, behavioral, and psychological outcomes, supporting the integration of routine psychosocial screening and targeted interventions into T1D care.

1. Introduction

Type 1 diabetes (T1D) is a chronic autoimmune condition marked by progressive destruction of pancreatic beta cells, leading to absolute insulin deficiency and lifelong dependence on exogenous insulin [1,2]. Despite substantial advances in treatment and diabetes technologies, many individuals with T1D still do not achieve recommended glycemic targets ($HbA1c < 7.0\%$) [3,4]. Beyond its physiological complexity, T1D requires continuous and demanding self-management, including insulin administration, blood glucose monitoring, dietary regulation, and physical activity adjustments [5,6]. Importantly, diabetes technologies

(e.g., continuous glucose monitoring [CGM] and insulin pumps) have transformed self-management but may also add cognitive and emotional demands, increasing the complexity of daily diabetes care [7]. These ongoing demands can impose a considerable emotional burden, making psychological factors a key determinant of diabetes outcomes. Among these factors, diabetes distress (DD) has emerged as a major psychosocial challenge in individuals with T1D [8,9].

DD refers to the emotional burden and diabetes-specific worries arising from daily self-management demands, including frustration, fear of complications, and burnout [10,11]. Unlike depression and anxiety, DD is specific to the experience of living with diabetes [10,11].

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<https://doi.org/10.1016/j.diabres.2026.113452>

Received 25 May 2026; Received in revised form 14 July 2026; Accepted 17 July 2026

Available online 22 July 2026

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Emerging evidence suggests that DD may occur more frequently than clinical depression among individuals with diabetes [12] and may exert a more immediate influence on self-management behaviors and glyce-mic outcomes [13,14].

Evidence consistently shows that elevated DD is associated with poorer clinical, behavioral, and psychological outcomes in T1D. Higher DD has been linked to worse glycemic outcomes, reduced insulin adherence, and suboptimal self-management behaviors, including inconsistent self-monitoring of blood glucose (SMBG), diet, and physical activity [15,16]. Elevated DD has also been associated with lower self-efficacy, reduced quality of life, and higher levels of anxiety, depression and fear of hypoglycemia [8,15,17]. Furthermore, DD may undermine engagement with diabetes technologies such as CGM and insulin pump therapy, potentially limiting their clinical effectiveness [7]. These findings position DD as both a marker and a potential driver of suboptimal diabetes management in T1D.

Despite its clinical significance, prevalence estimates of DD in T1D vary widely across studies, ranging from 20 to 61%, depending on population characteristics and measurement approaches [14,18,19]. Studies have used different instruments to assess DD, including the Diabetes Distress Scale (DDS), Type 1 Diabetes Distress Scale (T1-DDS) and Problem Areas in Diabetes (PAID) [14,18,19]. Although these instruments assess related constructs, differences in conceptual emphasis and domain structure have complicated comparisons across studies and obscured the true prevalence of DD in T1D population [9,20]. Consequently, heterogeneity in operational definitions has limited comparability across studies and obscured the true magnitude of DD in T1D populations.

Previous reviews have primarily focused on the conceptualization and measurement of DD without quantitatively synthesizing pooled prevalence or associations with key diabetes outcomes [13,20]. As a result, the prevalence and correlates of DD in T1D remain insufficiently characterized. This gap is particularly important given that T1D differs from type 2 diabetes in treatment intensity, daily self-management demands, and psychosocial impact [21,22].

The purpose of this systematic review and meta-analysis was to (1) estimate the pooled prevalence of DD in individuals with T1D; (2) synthesize quantitative evidence on its associations with clinical (HbA1c), behavioral (overall self-management and specific behaviors such as SMBG frequency, diet, and exercise), and psychological outcomes (anxiety, depression, self-efficacy, quality of life, and fear of hypoglycemia); and (3) examine the relationship between DD and diabetes technology use. This synthesis provides a clearer estimate of burden and evidence patterns to inform clinical practice and future research.

2. Methods

This study was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for systematic reviews of prevalence and association studies and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines [23]. The protocol was registered in PROSPERO (Registration number: CRD420261379499).

2.1. Search strategy

A systematic search strategy was developed in consultation with a medical librarian. PubMed, EMBASE, PsycINFO, CINAHL, and Scopus were searched from inception to August 2025, with an updated search in April 2026. Controlled vocabulary (e.g., MeSH and Emtree terms) and free-text keywords were combined using Boolean operators (“AND”, “OR”) to capture key concepts. The search included T1D (“type 1 diabetes” OR “T1D”), distress (“diabetes distress” OR “diabetes-related distress”), prevalence (“prevalence”), and correlates (“correlates” OR “associated factors”) to ensure comprehensive retrieval of relevant studies. Additional studies were identified through backward and

forward citation tracking in Google Scholar and reference lists of included articles. Searches were limited to English-language, peer-reviewed publications, with no date restrictions to maximize sensitivity. Full database-specific search strategies are provided in [Supplementary Appendix 1](#).

2.2. Study selection

All retrieved citations were imported into Covidence® for deduplication, screening, and data management. Five reviewers (EAA, EE, GYO, DAB, VBK) independently screened titles/abstracts and assessed full texts, with disagreements resolved by discussion or a third reviewer (SA). Eligible studies included individuals with T1D reporting DD prevalence using validated instruments (e.g., PAID, DDS, T1-DDS) or associations with clinical, psychological, behavioral outcomes, or diabetes technology use. Observational designs (cross-sectional, cohort, longitudinal) and baseline data from intervention studies were included. Studies involving type 2 diabetes, gestational diabetes, qualitative designs, intervention trials without extractable baseline data, and grey literature were excluded. Mixed-methods studies were included if quantitative data were available.

2.3. Quality appraisal

Methodological quality was assessed using the JBI Critical Appraisal Checklists for cross-sectional, cohort, and quasi-experimental studies [24]. The tools evaluate key domains including sampling, measurement validity and reliability, confounding, and statistical analysis. Items were rated as “Yes,” “No,” “Unclear,” or “Not applicable.” Studies were categorized as low, moderate, or high risk of bias based on the overall pattern of responses across JBI checklist items, with greater proportions of “Yes” responses indicating higher methodological quality. Two reviewers (EPO, FO) conducted assessments independently, with disagreements resolved by a third reviewer (MB).

2.4. Results of the search

The literature search identified 1,145 records. Following removal of 113 duplicates, 1,032 articles were screened at title and abstract phase and 140 at the full-text level. Ultimately, 72 studies were included in the final review ([Fig. 1](#)).

2.5. Data extraction and synthesis

A standardized data extraction form was used to collect study characteristics (first author, year, country, study design), participant characteristics (sample size, population type, age, sex, HbA1c, diabetes duration, complications), treatment variables (insulin pump and CGM use), DD instruments and cut-offs, and outcome data (correlates and prevalence of DD). Where necessary, study authors were contacted for clarification. Missing or unclear information was recorded as “not reported,” and no assumptions were made during extraction. Data were synthesized using both narrative and quantitative approaches. Narrative synthesis was used to summarize evidence on clinical, psychological, behavioral, and diabetes technology-related correlates of DD in T1D.

2.5.1. Prevalence synthesis, heterogeneity, and bias assessment

Prevalence estimates were pooled using random-effects meta-analysis with variance-stabilizing transformations where appropriate. Leave-one-out sensitivity analysis was conducted by sequentially omitting one study at a time to assess the robustness of the pooled prevalence estimate. Heterogeneity was assessed using Cochran’s Q and I² statistics (25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively). Where data permitted, subgroup analyses and meta-regression examined potential sources of heterogeneity, including population group (adolescents, adults, or mixed), gender, measurement

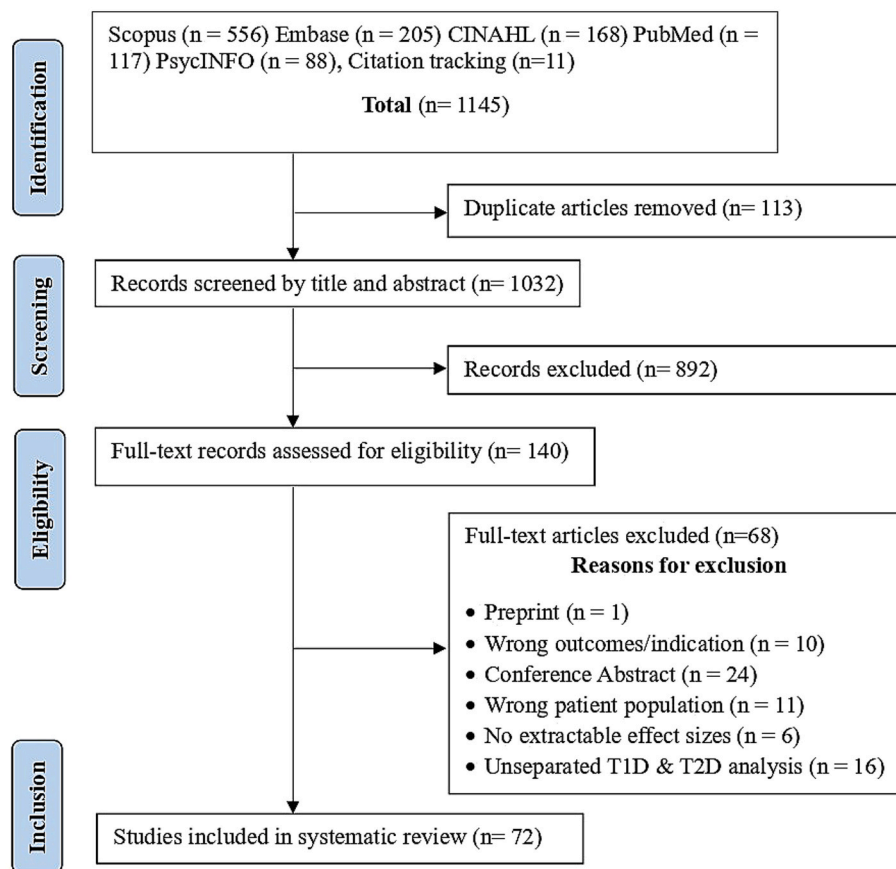


Fig. 1. PRISMA flow chart.

instrument, geographical region, publication year, and diabetes technology use. Studies were grouped by publication year into three predefined periods (2012–2016, 2017–2021, and 2022–2026) to ensure adequate statistical power and assess temporal differences in effect sizes. Publication bias was assessed separately for subgroup meta-analyses that included ≥ 10 studies, using funnel plots and Egger's test. Study locations were classified according to World Health Organization regional groupings: Africa, the Americas, Eastern Mediterranean, Europe, South-East Asia, and Western Pacific regions [25].

2.5.2. Meta-analysis of correlates

For quantitative synthesis, Pearson correlation coefficients (r) were extracted or derived and transformed to Fisher's z values before pooling. Random-effects meta-analyses were used to account for between-study heterogeneity. Effect sizes were interpreted as weak (<0.40), moderate (0.40 – 0.70), or strong (>0.70) associations [26]. Self-efficacy measures were harmonized prior to analysis. Measures included the Self-Efficacy for Diabetes Scale, Confidence in Diabetes Self-Care Scale, Perceived Competence in Diabetes Scale, Dietary Self-Efficacy Scale, and the PAID Lack of Confidence in Self-Care Subscale. The PAID Lack of Confidence Subscale was reverse-coded so that, across all measures, higher scores consistently reflected greater self-efficacy and corresponded to lower DD. All analyses were conducted in R using the *metafor* package, and statistical significance was set at $p < 0.05$.

3. Findings

3.1. Study and sample characteristics

Full details of the study and participant characteristics are provided in the [Supplementary Appendix 2](#). This review included 72 articles

[8,15–19,27–75], [S1–S18], most of which ($n = 46$) were published between 2020 and 2026. Most studies focused exclusively on adults ($n = 41$), followed by pediatric populations ($n = 26$) and mixed pediatric–adult populations ($n = 5$). Adult-only studies included substantially older populations, with mean ages ranging from 20.7 to 70.5 years (pooled mean: 43.3 years), whereas pediatric-only studies primarily enrolled children and adolescents, with mean ages ranging from 11.3 to 17.9 years (pooled mean: 14.6 years). DD prevalence demonstrated considerable heterogeneity across age groups, ranging from 6.7% to 82.5% in adult-only studies and from 14.0% to 64.4% in pediatric-only studies.

Cross-sectional designs predominated ($n = 66$), while the remaining studies employed cohort ($n = 4$) and quasi-experimental designs ($n = 2$). Most studies originated from the United States ($n = 30$), followed by Australia and Germany ($n = 5$ each), and the United Kingdom ($n = 4$), while the remaining studies were distributed across multiple countries in Europe, Asia, and the Middle East. No studies were identified from Africa, highlighting a critical gap in the global evidence base. The total sample size across studies was 32,555. Females comprised 53.1% of participants, with an overall mean age of 37.9 years ($n = 57$, range = 11.3–70.5 years). On average, participants had an HbA1c of 7.8% ($n = 46$, range = 6.6–9.9%), and diabetes duration of 19.2 years ($n = 40$). The use of insulin pump and CGM was 30.5% ($n = 45$) and 36.4% ($n = 15$), respectively, while the prevalence of diabetes-related complications was 5.8% ($n = 11$).

3.2. Quality of included studies

The results of the quality assessment are summarized in [Supplementary Appendix 1](#). Most studies ($n = 40$, 55.6%) had low risk of bias. The majority clearly described inclusion criteria ($n = 60$), study

setting ($n = 53$), used valid and reliable measures of DD ($n = 52$), applied appropriate statistical analyses ($n = 60$), and addressed confounding factors ($n = 43$). Overall, the methodological quality of included studies was considered acceptable for meta-analysis.

3.3. Measurement of T1D diabetes distress

Across studies, DD was assessed using validated instruments, most commonly the PAID scale, DDS-17, and T1-DDS. The PAID assesses diabetes-related emotional distress, including concerns related to emotional burden, treatment management, food-related issues, and interpersonal challenges. The DDS-17 evaluates four domains of DD: emotional burden, regimen-related distress, interpersonal distress, and physician-related distress. The T1-DDS assesses seven domains specific to T1D: powerlessness, management distress, hypoglycemia distress, negative social perceptions, eating distress, physician distress, and friend/family distress. Other instruments used to assess DD included the Diabetes Stress Questionnaire (DSQ/DSQY), which evaluates stressors related to diabetes management, self-care, diet, and hypoglycemia, and the Issues in Coping with IDDM (ICD) Scale, which assesses diabetes-related coping difficulties and emotional upset.

Brief versions of established instruments were also used, including the PAID-5 and DDS-2, which provide shorter assessments of diabetes-related emotional distress and DD, respectively. Pediatric-specific adaptations included the PAID-T, PAID-Peds/PAID-Ped-20, and PAID-C, which were developed to capture DD among children and adolescents. Across instruments, higher scores indicate greater DD, with commonly applied thresholds including PAID ≥ 40 , PAID-5 ≥ 8 –11, DDS-2 ≥ 3 , and T1-DDS ≥ 2.0 . Full measurement details are provided in [Supplementary Appendix 3](#).

3.4. Correlates of diabetes distress: Demographic factors

Associations between age and DD were inconsistent across studies. Among 25 studies, 12 reported significant weak positive or negative associations ($r = -0.36$ to 0.18) [16,48,49,52,62,64,69,70,74], [S2, S12, S16], while 13 found no significant relationship [17,29,34,36,38,40,49,55,62,71], [S3, S7, S15] ([Supplementary Appendix 4](#)).

3.5. Correlates of diabetes distress: Clinical factors

Clinical factors included HbA1c and diabetes duration ([Supplementary Appendix 4](#)). Among 40 studies examining HbA1c, 29 reported significant positive associations with DD, with effect sizes ranging from weak to moderate ($r = 0.16$ – 0.66) [8,15,16,34,36,41,42,47–49,51,53–57,61,64–68,73,74], [S3, S4, S10, S11], while 11 found no significant relationship [17,38–40,44,60,62,63,71], [S7, S15]. Findings regarding diabetes duration were mixed across 11 studies; the majority reported non-significant weak associations with DD [17,34,36,38,47,55,62], while a few studies found weak but significant positive ($r = 0.12$ – 0.20) [63], [S7, S15] or negative ($r = -0.16$) associations [40].

3.6. Correlates of diabetes distress: Self-management behaviors

Self-management behaviors included overall self-management ($n = 5$), SMBG ($n = 8$), diet control ($n = 4$), and exercise ($n = 4$) ([Supplementary Appendix 4](#)). Overall self-management showed weak-to-moderate negative associations with DD ($r = -0.30$ to -0.46) [16,56,63,73], although one study reported a weak positive association ($r = 0.13$) [83]. SMBG was negatively associated with DD, with weak effect sizes ($r = -0.045$ to -0.34) [15,48,56,63,74], [S6, S7]; however, one study reported a weak positive association ($r = 0.17$) [16]. Diet control consistently showed weak-to-moderate negative associations with DD ($r = -0.13$ to -0.43) [15,63,71,74]; whereas exercise

behaviors demonstrated weak negative correlations ($r = -0.01$ to -0.27) [15,29,63,74].

3.7. Correlates of diabetes distress: Psychosocial outcomes

Psychological outcomes included anxiety symptoms ($n = 5$), depressive symptoms ($n = 12$), fear of hypoglycemia ($n = 5$), self-efficacy ($n = 6$), and quality of life ($n = 8$) ([Supplementary Appendix 4](#)). Anxiety symptoms showed significant moderate positive associations with DD ($r = 0.51$ to 0.60) [17,29,75], [S1, S10]. Depressive symptoms demonstrated significant weak-to-strong positive associations with DD ($r = 0.39$ to 0.76) [8,29,44,54,64,67,74,75, S3, S6, S10, S18]. Similarly, fear of hypoglycemia exhibited significant moderate positive associations with DD ($r = 0.54$ to 0.65) [8,67,69,83], although one study reported a weak, non-significant association ($r = 0.29$) [65]. In contrast, DD showed significant weak-to-strong negative correlations with self-efficacy ($r = -0.20$ to -0.94) [15,39,44,61,71], [S15], while significant weak-to-moderate negative correlations were also observed with quality of life ($r = -0.33$ to -0.69) [8,17,63,68,69,73], [S3, S10].

3.8. Correlates of diabetes distress: Diabetes technologies (CGM, insulin Pumps)

Diabetes technologies, including CGM and insulin pump therapy, demonstrated mixed associations with DD in individuals with T1D [S11–S14, S16] ([Supplementary Appendix 4](#)). CGM use yielded conflicting results, with small effect sizes observed for both higher and lower DD, with small effects observed ($\beta = 0.11$; $r = -0.29$ to 0.33 ; $d = 0.26$ – 0.59); higher distress often reflected device burden and alarm-related stress [S11, S14, S16]. Insulin pump therapy was more often linked to lower DD with small effects ($\beta = -0.09$; $d = 0.18$ – 0.29), although findings were not consistent across studies, with one reporting no significant association [S11, S12, S16].

3.9. Results of the meta-analysis

3.9.1. Prevalence of diabetes distress

Across 53 studies, DD prevalence among individuals with T1D ranged from 6.6% [S12] to 82.5% [37]. The pooled prevalence was 38.9% (95% CI: 33.6–44.5), with substantial heterogeneity ($I^2 = 98.3\%$, $p < 0.001$) ([Fig. 2](#)). Leave-one-out sensitivity analysis showed no meaningful change in pooled DD prevalence (38.1–39.95%), indicating stability, with no single study disproportionately influencing the findings ([Supplementary Appendix 5](#)). Subgroup analyses did not demonstrate significant differences across most demographic, methodological, and regional factors ([Supplementary Appendix 3](#)). However, significant differences were observed by gender, with a higher prevalence among females.

3.9.2. Correlational Meta-Analysis

As shown in [Figs. 3–5](#), the results of the meta-analysis indicate a weak positive correlation between DD and HbA1c ($r = 0.24$, 95% CI: 0.20 to 0.29). Higher DD was also associated with lower engagement in self-management behaviors, including poorer overall self-management ($r = -0.30$, 95% CI: -0.48 to -0.08), lower SMBG frequency ($r = -0.15$, 95% CI: -0.27 to -0.01), reduced exercise engagement ($r = -0.14$, 95% CI: -0.28 to -0.02), and poorer dietary control ($r = -0.15$, 95% CI: -0.25 to -0.03). There was a moderate positive correlation between DD and anxiety symptoms ($r = 0.42$, 95% CI: 0.13 to 0.64), depressive symptoms ($r = 0.60$, 95% CI: 0.53 to 0.66), and fear of hypoglycemia ($r = 0.60$, 95% CI: 0.55 to 0.65). Conversely, DD exhibited a moderate negative correlation with self-efficacy ($r = -0.58$, 95% CI: -0.81 to -0.21) and a weak negative correlation with quality of life ($r = -0.35$, 95% CI: -0.51 to -0.17). Age and diabetes duration showed small, non-significant correlations with DD ([Supplementary Appendix 5](#)). A meta-analysis of diabetes technology use was not possible due to

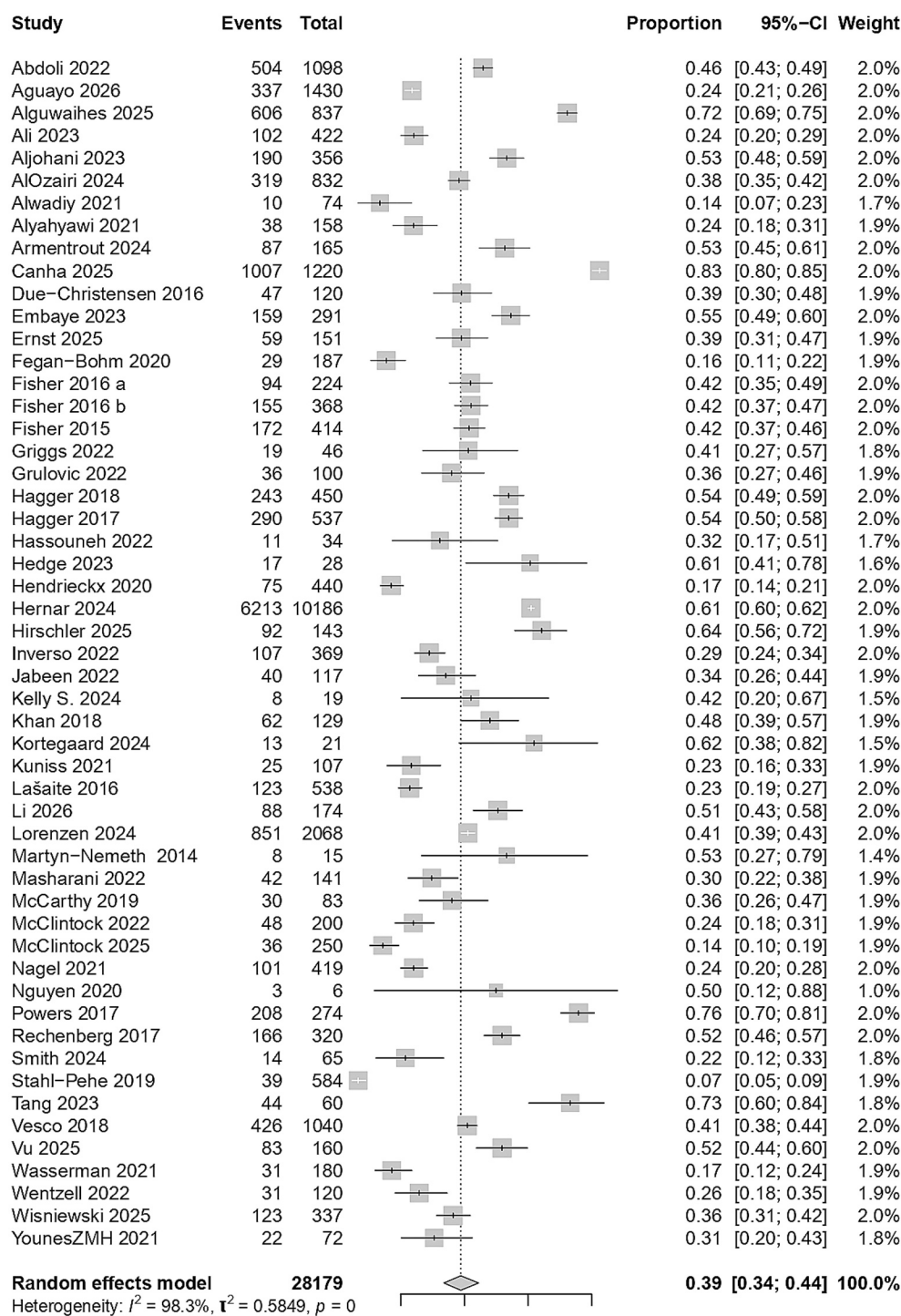


Fig. 2. Prevalence of diabetes distress.

limited evidence.

3.10. Meta-regression analyses

Meta-regression analyses indicated that population group (adolescents, adults, or mixed), diabetes technology use, measurement instrument, publication year, and geographical region were not significant moderators of DD prevalence ($p > 0.05$) (Supplementary Appendix 3). Gender was the only significant moderator, with a higher prevalence observed in females than males ($\beta = 2.26$, $p = 0.019$). For correlates of DD, HbA1c ($\beta = 1.08$, $p < 0.001$) and depression ($\beta = 1.55$, $p < 0.001$)

were significant moderators (Supplementary Appendix 3). Meta-regression was not feasible for other psychosocial and behavioral outcomes due to insufficient studies and limited data availability.

3.11. Publication bias

For DD prevalence, the funnel plot appeared symmetrical on visual inspection, although Egger's test indicated significant asymmetry and possible small-study effects ($p = 0.0006$). Given the high heterogeneity ($I^2 > 97\%$), these findings should be interpreted cautiously. For DD-HbA1c and DD-depression associations, funnel plots demonstrated

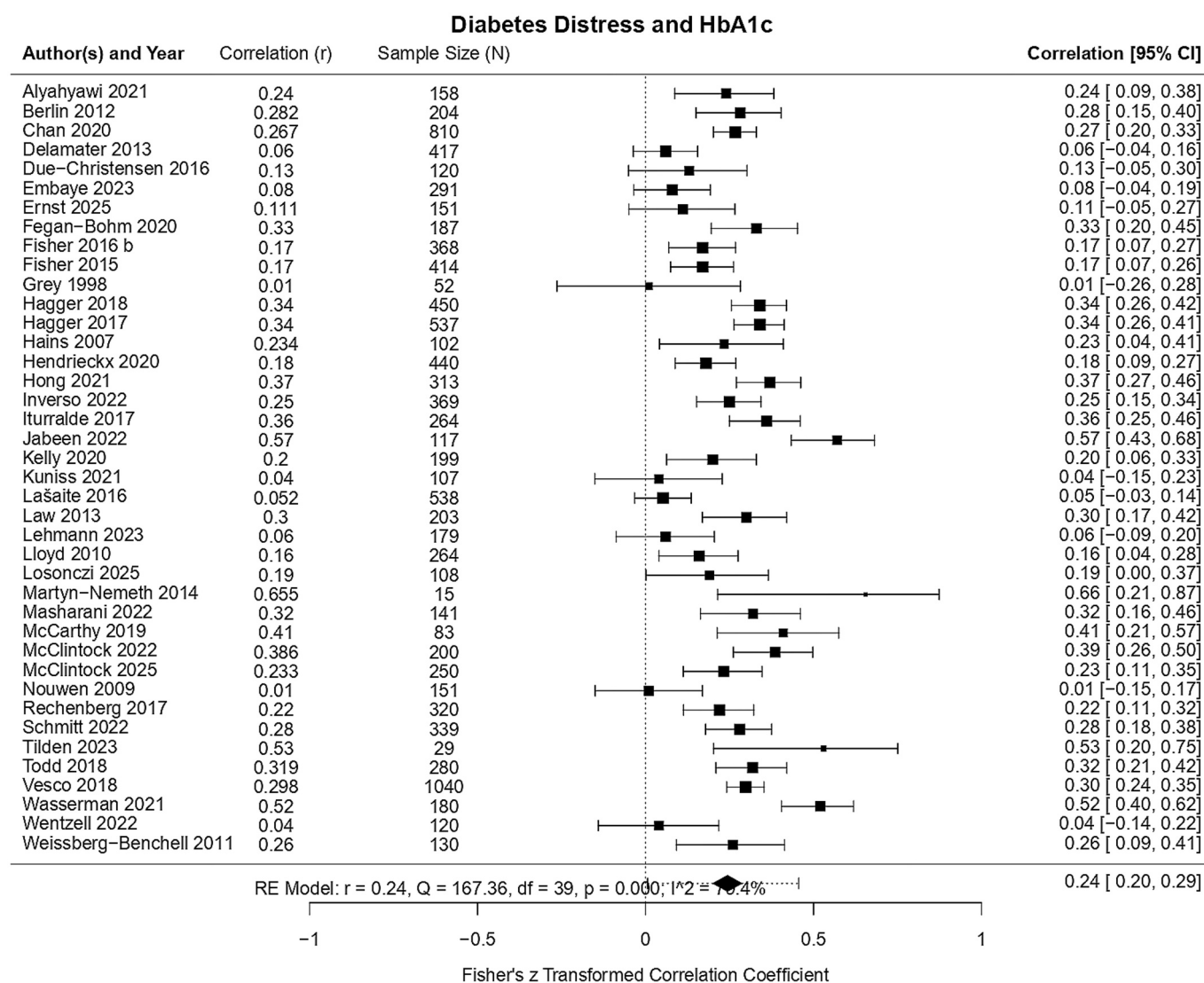


Fig. 3. Meta-correlation between diabetes distress and HbA1c.

symmetry with no evidence of publication bias, a conclusion supported by Egger's tests (DD-HbA1c: $z = 1.31$, $p = 0.190$; DD-depression: $z = -0.16$, $p = 0.872$) (Supplementary Appendix 3 and 5).

4. Discussion

This meta-analysis estimated a global pooled DD prevalence of 38.9% among individuals living with T1D, affecting nearly two in five individuals worldwide. This exceeds estimates reported in type 2 diabetes (36%) and mixed diabetes populations (22%) [21], [S19], highlighting a substantial psychosocial burden in T1D. Subgroup analyses showed significantly higher prevalence in females, consistent with evidence of greater psychological vulnerability in this group [14,21].

Several factors were associated with DD. We found a positive association between DD and HbA1c in T1D, consistent with evidence linking greater emotional burden to poorer glycemic control [6,9]. Although statistically significant, the small effect size should be interpreted cautiously, given uncertainty regarding its clinical significance. This relationship may reflect behavioral mechanisms through which emotional burden interferes with insulin administration, glucose monitoring, dietary regulation, and problem-solving behaviors [58], [S21]. Nevertheless, causal mechanisms remain uncertain because few studies have examined mediation pathways, and evidence regarding

self-management as an explanatory mechanism is inconsistent [63,74]. Bidirectional effects are also plausible, whereby sustained hyperglycemia may exacerbate distress through perceived threat and cognitive burden [14], while neuroendocrine stress responses, including cortisol secretion, may further worsen glycemic control [S21], increasing the risk of complications. Collectively, these findings support a reciprocal and biopsychosocial model of DD in T1D, in which emotional, behavioral, and physiological processes interact dynamically over time.

Consistent with prior research, elevated DD was associated with poorer self-management behaviors [9]. However, the strength of these associations varied across behavioral domains. Dietary behaviors and insulin administration or restriction showed more consistent impairment, while findings for SMBG were mixed [14]. This pattern suggests that DD affects specific self-management behaviors rather than exerting a uniform influence across all domains [9], indicating that interventions may be more effective when tailored to the behaviors most affected rather than relying on generalized self-management strategies.

DD was associated with poorer psychological well-being, diabetes-related fears, and reduced quality of life, suggesting that distress occurs within a broader network of emotional, cognitive, and behavioral factors that influence diabetes management [15], [S22]. While DD is conceptually distinct from mood disorders, overlap among constructs may contribute to shared effects on self-management and glycemic

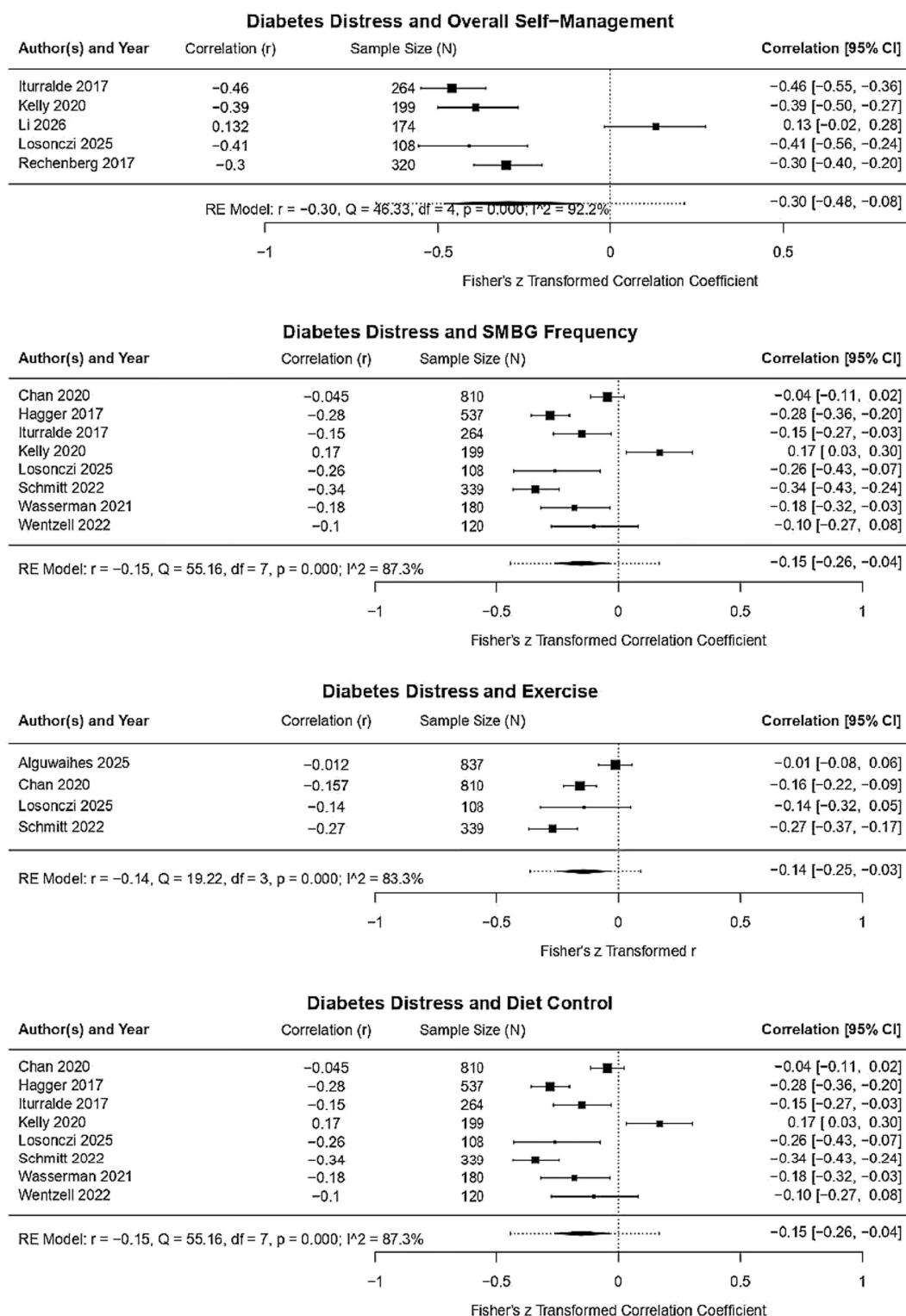


Fig. 4. Meta-correlation between diabetes distress and self-management behaviors.

outcomes [6,10,11], [S23], raising questions about its incremental utility beyond established psychological measures. These findings align with contemporary self-regulation frameworks, in which cognitive appraisal, emotional response, and behavioral control interact dynamically to influence chronic disease management [S20].

The mixed associations between diabetes technologies and DD suggest that these tools do not simply reduce self-management demands but also reshape the experience of self-management, conferring benefits

such as improved glycemic outcomes and perceived safety while introducing new sources of burden, including device-related stress and alarm fatigue [6], [S24,S25]. Their overall impact on DD is therefore likely influenced by individual adaptation and coping capacity, and the conditions under which technologies alleviate versus contribute to distress warrant further investigation.

Age and diabetes duration showed small, non-significant associations with DD, consistent with prior studies reporting variable

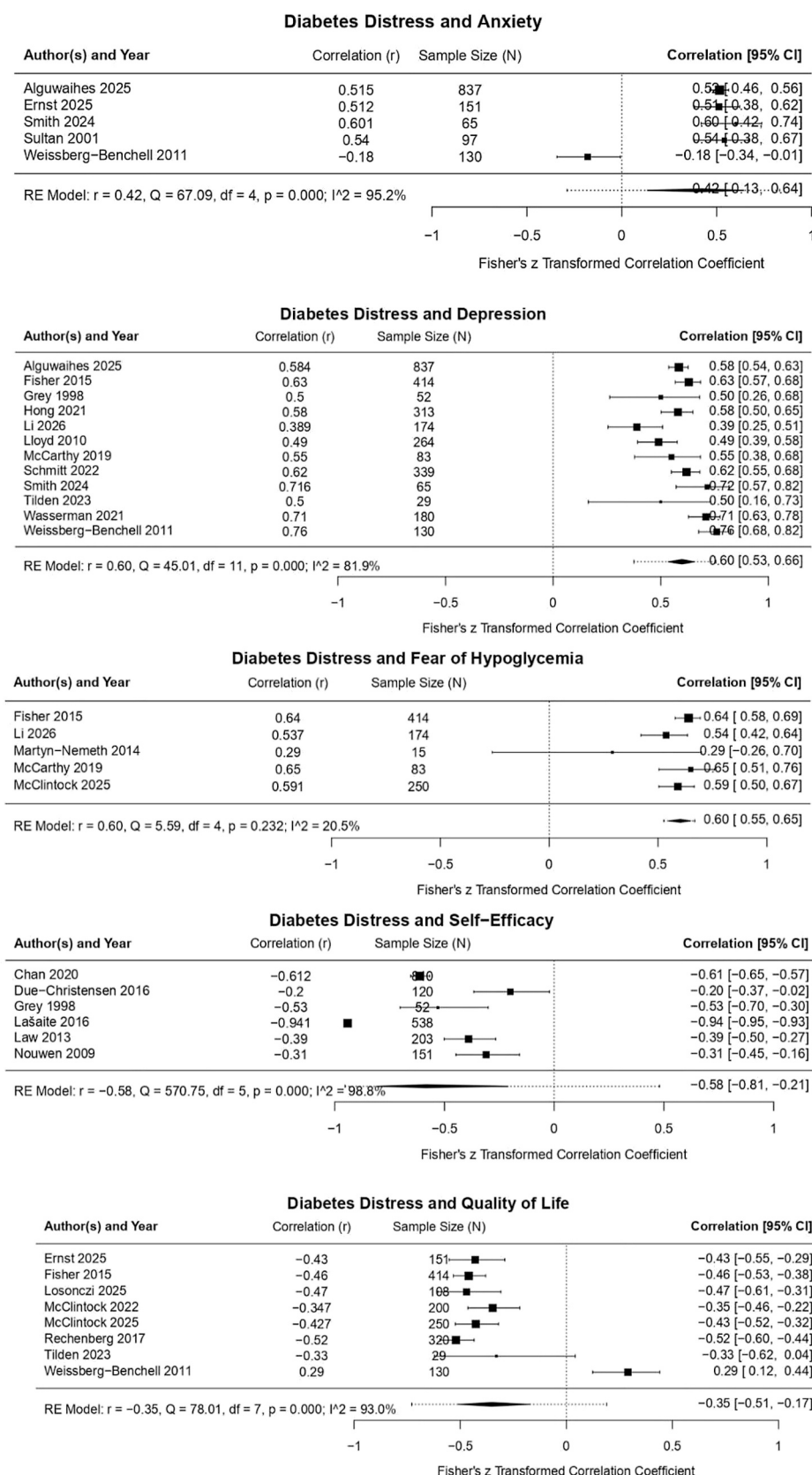


Fig. 5. Meta-correlation between diabetes distress and psychological outcomes.

associations [13]. These results suggest that DD is influenced more by the ongoing demands of diabetes self-management than by chronological age or disease duration [S26].

5. Strengths and limitations

This is the first known systematic review and meta-analysis focused exclusively on T1D, providing precise pooled estimates of DD and its associations with clinical, behavioral, psychological, and diabetes technology outcomes. The breadth of outcomes supports an integrated understanding of DD. However, several limitations merit consideration. First, the exclusion of non-English articles may have limited the generalizability of the findings. Second, substantial heterogeneity across studies likely reflects variation in study design, populations, and measurement approaches. Third, heterogeneity in the definition and measurement of diabetes-related outcomes may have affected the comparability of pooled estimates. Fourth, the predominance of observational studies, particularly cross-sectional designs, limits causal inference, highlighting the need for additional longitudinal and experimental research to better establish causal relationships between DD and diabetes-related outcomes in T1D. Finally, meta-regression and publication bias analyses were conducted only for outcomes with ≥ 10 contributing studies, limiting their applicability across all outcomes.

6. Implications for clinical practice and future research

The present findings have important implications for clinical practice and research. The high prevalence of DD and its association with adverse diabetes outcomes highlight its clinical importance in T1D. However, DD should not be conceptualized as a standalone treatment target or primary endpoint in clinical care or research trials. Rather, it is more appropriately understood as a symptom-level construct that reflects the cumulative emotional and cognitive demands of intensive diabetes self-management. Accordingly, the clinical utility of DD lies primarily in its role as a screening and case-finding tool to identify individuals who may benefit from further assessment and tailored behavioral and psychosocial support. Screening is most meaningful when embedded within a structured care pathway that enables appropriate follow-up and intervention.

Emerging evidence also suggests that DD is modifiable through psychoeducational and behavioral interventions [S27]. Programs combining diabetes self-management education with emotional support produce modest reductions in DD, particularly when using motivational interviewing and affect-focused strategies, although effects on glycemic outcomes remain inconsistent [S27]. However, there is limited consensus regarding what constitutes a clinically meaningful change in DD and the extent to which reductions in distress translate into meaningful improvements in outcomes that matter most to people living with T1D, including self-management capacity, daily functioning, quality of life, and glycemic outcomes [6,S28]. From a clinical perspective, prioritizing a focused set of patient-centered outcomes alongside DD may help reduce assessment burden and clarify which improvements are most meaningful to people living with T1D [S23,S28]. Future intervention studies should therefore evaluate both changes in DD and their impact on these broader patient-centered outcomes.

7. Conclusion

DD affects nearly two in five individuals living with T1D and is consistently associated with poorer glycemic outcomes, reduced self-management behaviors, and increased psychosocial burden. Routine assessment of DD may help identify individuals requiring tailored psychosocial and behavioral support. Future intervention studies should determine the extent to which reducing DD translates into meaningful improvements in patient-centered outcomes.

Funding

Research reported in this publication was supported (in part) by funding from the Substance Abuse and Mental Health Services Administration (SAMHSA) under the Grant Number 1H79SM090074 02, awarded to the fourth author (FO). The views expressed in written training materials or publications and by speakers and moderators do not necessarily reflect the official policies of the Department and Human Services; nor does mention of trade names, commercial practices, or organizations imply endorsement by the U.S. Government.

CRedit authorship contribution statement

Eric Peprah Osei: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Emmanuel Ekpor:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Samuel Akyirem:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Folarin Olanrewaju:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Gideon Yaw Osei:** Writing – review & editing, Methodology, Investigation, Data curation. **Vera Boatemaa Kusi:** Writing – original draft, Methodology, Investigation, Data curation. **Emefa Awo Adawudu:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Derick Atta Boahen:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Michelle Danny Stampley Boakye:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.diabres.2026.113452>.

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