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Opinion

Understanding Psychological Functioning in Type 1 Diabetes: Toward an Integrated Framework

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Abstract

Type 1 diabetes mellitus (T1DM) is increasingly recognized as a condition in which psychological processes play an important role in disease management, adaptation, and clinical outcomes. Although research has identified a growing number of relevant psychological constructs, these have largely been investigated independently, limiting understanding of their interactions with behavioral and biological processes. This contribution discusses the principal conceptual gaps that currently constrain theoretical integration and proposes an integrative psychobiological framework in which individual and contextual factors, psychological processes, self-management behaviors, and biological and metabolic dimensions are conceptualized as components of a dynamic and temporally embedded system. The framework emphasizes potentially mediated, moderated, and reciprocal pathways whose relative contribution may vary across individuals, life stages, and the disease trajectory. By providing a structure through which these processes can be jointly operationalized and empirically investigated, this perspective may support more coherent research strategies and help identify individual and evolving assessment and intervention priorities in diabetes care.

Keywords: clinical psychology; diabetes; distress; psychological functioning; type 1 diabetes mellitus

1. Introduction

Type 1 diabetes mellitus (T1DM) is a major global health challenge, affecting approximately 9.5 million people worldwide, with its prevalence expected to increase substantially over the coming decades [1,2]. Despite remarkable advances in insulin therapy, diabetes technologies, and multidisciplinary care, T1DM continues to impose a considerable clinical and public health burden owing to its lifelong nature, the risk of acute and chronic complications, and persistent difficulties in healthcare access and outcomes [1–3].

As T1DM is increasingly recognized as a lifelong condition, improving long-term outcomes requires a better understanding not only of its biological basis but also of the behavioral and psychological processes that influence disease management across the lifespan. Over the past two decades, psychological research has progressively shifted from describing psychological comorbidities to investigating the psychological processes underlying disease management [4]. Accordingly, contemporary international guidelines recognize psychological care as an essential component of routine, person-centered, multidisciplinary diabetes care [5].

Growing recognition of the psychological dimension of T1DM has stimulated increasing interest in psychological assessment and intervention. Systematic reviews indicate

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that psychological interventions improve psychological adjustment, diabetes-related distress, coping, and quality of life, although their effects on glycemic outcomes remain inconsistent [6–10].

At the same time, research has expanded beyond traditional indicators of emotional distress to investigate constructs such as alexithymia, attachment, family functioning, transitional adjustment, fear of hypoglycemia, and other psychosocial determinants of diabetes management [11–14]. This evolution suggests that psychological functioning in T1DM is inherently multidimensional, while also highlighting the need for an integrated framework capable of accounting for how psychological processes interact with behavioral, interpersonal, contextual, and biological dimensions of disease adaptation.

Despite substantial empirical progress, theoretical integration has lagged behind. Psychological constructs continue to be investigated largely in isolation, while their relationships with self-management processes, biological and metabolic dynamics, and clinical outcomes remain incompletely integrated within a common explanatory structure. Understanding T1DM adaptation as a dynamic process arising from interactions across these domains therefore represents an important conceptual challenge and provides the rationale for the integrated psychobiological framework proposed in this contribution.

2. Current State of Knowledge

2.1. Psychological Burden in T1DM

The psychological burden associated with type 1 diabetes (T1DM) is now well established and extends far beyond traditional psychopathology. Systematic reviews consistently demonstrate increased rates of depression and anxiety across the lifespan, with psychological consequences frequently affecting not only individuals living with T1DM but also their families and caregivers [15–18]. Beyond conventional psychopathological symptoms, growing attention has been devoted to diabetes-specific distress, fear of hypoglycemia, eating-related disturbances, and impairments in health-related quality of life, all of which represent distinct dimensions of the psychological experience of T1DM [19–25]. Collectively, these findings indicate that psychological burden should be understood as a multifaceted construct rather than as the mere presence of depression or anxiety.

The established heterogeneity of this psychological burden provides the basis for a further question: whether the traditional constructs used to describe distress are sufficient to explain the psychological processes involved in living with and managing T1DM.

2.2. Emerging Psychological Constructs

Although depression, anxiety, and diabetes distress remain central domains of investigation, contemporary psychological research has progressively expanded towards a broader range of constructs capable of capturing the complexity of living with T1DM. Rather than focusing exclusively on psychopathology, this literature increasingly considers psychological processes and individual characteristics that may contribute to adaptation and disease management.

Increasing attention has been directed towards affective processing, including alexithymia [12], affective processing and regulation [26–28], and intolerance of uncertainty [29,30], interpersonal functioning, including attachment [31], cognitive and behavioral processes, including illness perception [32], coping [33], psychological flexibility [34], and self-efficacy in individuals and caregivers [35–37] and individual difference variables such as resilience [38] and personality [39].

This diversification reflects the increasing sophistication of psychological research in T1DM. However, at the same time, it reveals a progressively fragmented literature in which individual psychological constructs are typically investigated in isolation, with limited

attention devoted to their reciprocal relationships or to the broader psychological architecture underlying disease adaptation and self-management. Consequently, the challenge is no longer merely the identification of new psychological constructs but the development of an integrated framework capable of accounting for their relationships with behavioral, self-management, and biological processes involved in disease adaptation.

2.3. Psychological Factors and Clinical Outcomes

A growing body of evidence indicates that psychological factors are closely associated with clinically relevant outcomes in T1DM, extending beyond emotional well-being to influence multiple aspects of disease management. Psychological functioning has been consistently associated with glycemic control and metabolic outcomes, with disease acceptance, eating-related behaviors, and broader psychosocial factors emerging as important contributors to HbA1c and diabetes management [7,13,40,41]. Likewise, psychological interventions have shown beneficial effects on self-management, treatment adherence, and coping, although improvements in metabolic control remain less consistent across studies [6,9,42,43]. Psychological processes have also been associated with patient-reported outcomes related to diabetes technologies, particularly diabetes distress, fear of hypoglycemia, and treatment satisfaction [44], as well as with the risk of acute complications, including recurrent diabetic ketoacidosis [45]. Taken together, these findings firmly establish the clinical relevance of psychological factors in T1DM while highlighting the need to clarify the pathways through which psychological processes relate to self-management, metabolic dynamics, and clinical outcomes.

3. From Critical Gaps to an Integrated Framework

Despite the substantial progress achieved in psychological research on T1DM, several conceptual challenges remain. These interconnected issues continue to influence the development of a more integrated understanding of psychological functioning and point towards the value of a coherent psychobiological framework.

A first issue concerns the fragmentation of psychological constructs. The increasing number of psychological constructs has substantially broadened the understanding of T1DM. However, these constructs have generally evolved in parallel rather than within an integrated conceptual framework, meaning that their reciprocal interactions are not yet fully understood. A second consideration relates to the predominance of cross-sectional evidence, which provides only limited insight into how psychological processes evolve over time and contribute to long-term adaptation. This is accompanied by a still limited mechanistic understanding of how psychological functioning relates to behavioral and clinical outcomes. Although numerous associations between psychological factors and clinical outcomes have been identified, the pathways through which these processes influence behavioral and biological outcomes have yet to be fully elucidated.

Another important consideration concerns the integration of psychological and biological processes. Psychological and biomedical research have often progressed along complementary but relatively separate trajectories, making it more difficult to develop explanatory models that encompass both domains. Additional considerations include the heterogeneity of psychological assessment and the limited personalization of psychological models, both of which may constrain the accumulation of comparable evidence and the development of tailored approaches to care.

Consequently, the translation of psychological knowledge into integrated clinical practice remains an ongoing objective. These considerations suggest that future progress may benefit from the integration of existing knowledge within a coherent psychobiological framework. Rather than conceptualizing adaptation to T1DM as the product of isolated

psychological variables, the proposed framework distinguishes several interdependent domains. Individual factors encompass person- and disease-related characteristics that provide the background within which adaptation occurs, including life stage, disease duration, and treatment-related characteristics. Interpersonal and contextual factors comprise the relational and environmental conditions surrounding disease management, including family functioning and support, social relationships, and broader contextual resources and constraints. Previous conceptual models of T1DM adaptation have similarly emphasized the contribution of individual, family, and contextual characteristics, while highlighting the need to consider their interactions with psychosocial responses and self-management processes [46–48].

The present framework (Figure 1) builds on, rather than replaces, these established perspectives. Its distinctive contribution lies in integrating the broader range of psychological processes increasingly examined in contemporary T1DM research with behavioral/self-management processes and a more explicitly differentiated biological dimension, encompassing plausible physiological pathways, measurable glycemic dynamics, and clinical/metabolic outcomes. Rather than assigning fixed causal roles to these components, the framework conceptualizes their relationships as potentially mediated, moderated, temporally varying, and, for specific pathways, reciprocal. In this sense, the framework provides an integrative and hypothesis-generating structure through which psychological, behavioral, and biological processes can be jointly operationalized and empirically tested.

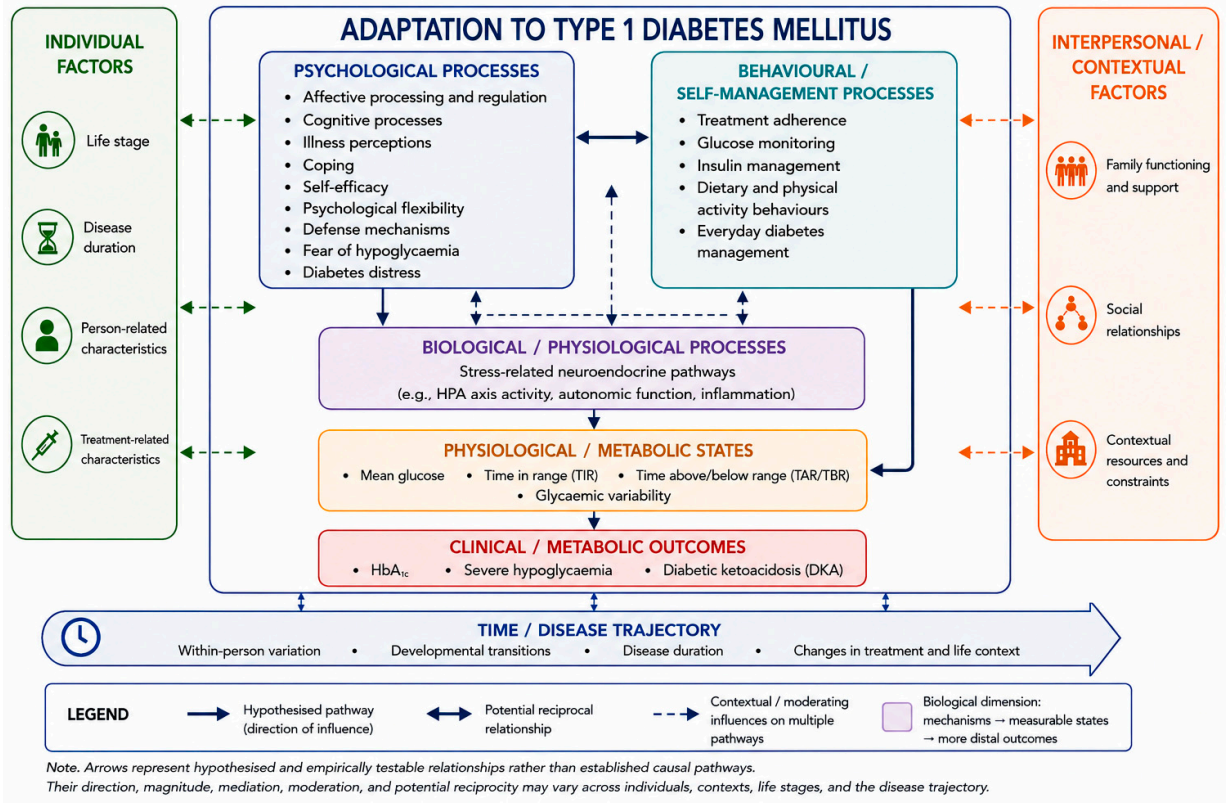


Figure 1. Proposed framework for adaptation to type 1 diabetes mellitus.

Within this broader context, psychological processes include affective, cognitive, and representational dimensions relevant to adaptation, encompassing affective processing and regulation, cognitive processes, illness perceptions, coping, self-efficacy, psychological flexibility, defense mechanisms, fear of hypoglycemia, and diabetes distress. These processes should be distinguished conceptually from behavioral and self-management processes, which concern the actions through which individuals manage the demands of T1DM in

everyday life. This distinction does not imply a fixed causal sequence. Psychological, interpersonal, and behavioral variables may assume different functional roles depending on the hypothesis under investigation. For example, self-management may mediate associations between psychosocial or family-related factors and metabolic control, while psychological variables such as self-efficacy may themselves participate in indirect pathways linking contextual conditions to diabetes management [49]. Accordingly, mediation and moderation are better understood as potential properties of specific relationships within the framework rather than as fixed attributes of individual constructs: psychological or behavioral processes may mediate specific associations, whereas individual, disease-related, or contextual characteristics may modify the strength or direction of particular pathways.

Importantly, the biological dimension of the framework should extend beyond the use of clinical outcomes as proxies for biological functioning. Stress-related neuroendocrine pathways provide one plausible interface through which psychological processes may influence glucose regulation, although the magnitude and direction of glycemic responses to psychosocial stress are heterogeneous across individuals with T1DM [50]. These biological processes should be distinguished from physiological and metabolic states, which can be operationalized through continuous glucose monitoring-derived measures such as mean glucose, time in range, time above or below range, and glycemic variability, and from more distal clinical and metabolic outcomes, including HbA1c, severe hypoglycemia, and diabetic ketoacidosis. Intensive longitudinal research combining ecological momentary assessment with continuous glucose monitoring further demonstrates that psychological functioning, self-management, and glycemic regulation can be examined as temporally varying within-person processes rather than exclusively as between-person associations [51,52]. The proposed framework therefore does not assume universal bidirectionality or fixed causal roles.

The temporal dimension of the framework also extends beyond short-term within-person variation. Developmental transitions may alter the relative configuration of interpersonal, psychological, and self-management processes. During adolescence, for example, diabetes management involves a dynamic and iterative renegotiation of responsibility between young people and their families, with progressive changes in autonomy, agency, support, and self-management demands [53]. Psychological experiences such as diabetes distress should likewise not be regarded as uniform across individuals and contexts [54]. Life stage and disease duration should therefore be considered temporal dimensions of the framework whose influence on the relative contribution of family functioning, self-efficacy, coping, fear of hypoglycemia, and diabetes distress requires longitudinal investigation rather than being assumed a priori.

Overall, the framework conceptualizes T1DM adaptation as a dynamic and temporally embedded psychobiological system in which the direction, magnitude, mediation, moderation, and potential reciprocity of pathways may vary across individuals, contexts, life stages, and the disease trajectory. Such an approach provides a basis for formulating experimentally and longitudinally testable hypotheses regarding how psychological, behavioral, and biological processes jointly contribute to adaptation and disease management.

4. Implications for Research and Clinical Practice

The perspective proposed in this contribution may offer a useful foundation for future developments in both research and clinical practice. From a research perspective, the proposed framework may be operationalized through multidomain designs in which psychological processes, behavioral/self-management variables, contextual characteristics, and physiological or metabolic measures are assessed within the same study. The selection and temporal resolution of these measures should follow the pathway under investigation rather

than rely on a fixed set of variables. In particular, intensive longitudinal designs combining repeated psychological or behavioral assessments with continuous glucose monitoring may allow the temporally aligned examination of within-person relationships between psychological functioning, self-management, and glycemic dynamics. Recent studies integrating ecological momentary assessment with continuous glucose monitoring illustrate the feasibility of examining such dynamic, person-specific associations in everyday life [52,55]. This approach may help distinguish within-person from between-person processes and provide an empirical basis for testing temporal pathways and hypothesized mediation and moderation effects within the framework. For instance, future studies could examine whether changes in psychological processes precede changes in self-management and subsequent glycemic dynamics, whether behavioral/self-management processes mediate associations between psychological functioning and metabolic outcomes, and whether these pathways vary according to life stage, disease-related characteristics, or contextual conditions.

A complementary research direction involves the use of network approaches to examine how psychological processes are organized and interconnected rather than treating each construct as an isolated predictor. Recent network research in adults with T1DM illustrates how symptom-level relationships within and between psychological constructs can be examined simultaneously, while also showing that theoretically related dimensions need not necessarily form a densely interconnected system [56]. Extending such approaches to the broader set of psychological processes considered in the present framework could help identify specific clusters, bridge processes, and individual configurations that warrant further longitudinal investigation.

From a clinical perspective, the framework may support a shift from the identification of isolated psychological difficulties towards the assessment of individual configurations of psychological, behavioral, interpersonal/contextual, and metabolic characteristics. Such configurations should not be regarded as fixed clinical profiles or as direct determinants of treatment selection but rather as a means of identifying assessment and intervention priorities. For example, a configuration characterized predominantly by diabetes distress or fear of hypoglycemia may indicate a greater need to address emotional and diabetes-specific psychological processes, particularly when these interfere with self-management. Conversely, when low self-efficacy and behavioral barriers to diabetes management are more prominent, intervention priorities may focus more directly on self-management support and related behavioral processes. In children and adolescents, configurations involving family functioning, parental involvement, or difficulties in the distribution of diabetes-management responsibilities may instead highlight interpersonal and stage targets alongside individual needs. This multidimensional approach is consistent with current recommendations emphasizing routine psychosocial assessment, attention to diabetes distress, fear of hypoglycemia, self-management difficulties, family and social resources, and appropriate family involvement in diabetes care [57,58].

Importantly, personalization within this framework should also be considered dynamic rather than static. The relative salience of psychological, behavioral, interpersonal, and metabolic processes may change within the same individual transitions, changes in treatment, emerging complications, or other shifts in the disease and life trajectory. Assessment could therefore be conceived as an iterative process in which current configurations inform intervention priorities and subsequent reassessment determines whether these priorities remain appropriate over time. This perspective is consistent with recommendations for repeated psychosocial assessment at clinically meaningful transitions and when changes in health status, treatment, self-management, or life circumstances occur [57].

Ultimately, recognizing psychological functioning as a core component of disease adaptation may contribute to more integrated models of care, in which psychological

and biomedical factors are considered together in understanding individual differences in disease management and clinical outcomes.

5. Conclusions

Psychological research has considerably advanced the understanding of T1DM, identifying a broad range of factors associated with disease management, adaptation, and clinical outcomes. As this body of evidence continues to evolve, greater attention to the relationships among psychological, behavioral, and biological processes may help move the field beyond the study of isolated constructs. The psychobiological framework proposed in this contribution conceptualizes these processes as components of a dynamic and temporally embedded system, whose relationships may vary across individuals, contexts, life stages, and the disease trajectory. Integrating these dimensions within longitudinal and multidomain research may facilitate the formulation and testing of more coherent mechanistic hypotheses, while their consideration in clinical assessment may help identify individual and evolving intervention priorities. Ultimately, such an approach may contribute to a more integrated and personalized understanding of adaptation to T1DM across the lifespan.

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Abbreviations

The following abbreviations are used in this manuscript:

DKA	Diabetic ketoacidosis
HbA1c	Glycated hemoglobin
HPA	Hypothalamic–pituitary–adrenal
T1DM	Type 1 diabetes mellitus
TAR	Time above range
TBR	Time below range
TIR	Time in range

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