RESEARCH PAPER

Beyond Glycemic Control: An Integrative Review of Intermittent Fasting in Type 2 Diabetes Through the Lens of Ayurveda and Modern Medicine

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ABSTRACT

Background

Type 2 diabetes mellitus (T2DM) is a complex metabolic syndrome that manifests as chronic hyperglycemia, decreased insulin response, reduced β-cell function, and increased risk for cardiometabolic complications. While improvement in glycemic control remains the primary target for T2DM management, current clinical practice has shifted towards emphasizing the role of body mass, insulin sensitivity, lipid status, blood pressure, inflammatory state, diet quality, and long-term behavioral adherence. Intermittent fasting (IF) is a collective term for different dietary regimens with alternating cycles of eating and fasting periods. In particular, time-restricted eating (TRE) was suggested to improve metabolic health in patients with T2DM.

Objective

This integrative review aimed to assess the effectiveness of intermittent fasting in patients with type 2 diabetes beyond glycemic control and explore the putative conceptual links between IF and key Ayurvedic principles related to metabolic health.

Methods

PubMed/MEDLINE, Scopus, Web of Science, ScienceDirect, and Google Scholar databases were searched to identify relevant literature. Additionally, reference lists of the retrieved studies were manually screened. The inclusion criteria were studies reporting on the effects of intermittent fasting, TRE, their impact on T2DM, insulin resistance, body weight, cardiometabolic outcomes, inflammation, oxidative stress, and safety. Manuscripts on Ayurveda, Upavāsa, Langhana, Agni, Kapha, Meda, and Prameha were considered separately. Due to substantial heterogeneity across the included studies, a narrative synthesis of the retrieved evidence was performed.

Results

The reviewed literature revealed that IF could lead to clinically meaningful reductions in body weight, glycemic indices, and cardiometabolic risk in patients with T2DM. However, the recent evidence suggests that IF is no better than continuous energy restriction for most of the studied outcomes. Potential mechanisms of action include reduced energy intake, improved insulin sensitivity, altered metabolic flexibility, circadian adaptation, and increased metabolic efficiency during fasting. Notably, metabolic health benefits of IF persisted after its termination. From the Ayurvedic perspective, the concepts of Upavāsa, Langhana, Agni, Kapha, Meda, and Prameha can help interpret nutritional deprivation and metabolic changes during fasting. However, these terms cannot be used interchangeably with the modern biomedical concepts.

Conclusion

Intermittent fasting can be considered a viable option for individualizing dietary treatment in patients with T2DM, with particular focus on nutritional quality, concomitant pharmacotherapy, and long-term behavior change. For the majority of the studied outcomes, the benefits of IF were comparable to continuous energy restriction. IF seems to be most beneficial for promoting adherence to dietary changes due to its structural simplicity, although it is not superior to personalized nutritional counseling in terms of health outcomes. Thus, this study supports further integrative research on fasting with Ayurvedic clinical practices through standardized assessments.

Keywords: intermittent fasting; time-restricted eating; type 2 diabetes mellitus; insulin resistance; metabolic health; Ayurveda; Upavāsa; Langhana; Agni; Prameha..

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1.INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a complex metabolic syndrome characterized by chronic hyperglycemia, decreased insulin response, reduced β-cell function, and increased risk for cardiometabolic complications. While improvement in glycemic control remains the core goal for managing T2DM, contemporary clinical practice increasingly highlights the importance of body weight, insulin sensitivity, lipid profile, blood pressure,

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inflammatory status, diet quality, and long-term behavioral adherence to dietary changes. According to American Diabetes Association's (ADA) 2026 Standards of Care, individualized medical nutrition therapy plays a pivotal role in improving health outcomes in patients with diabetes. Intermittent fasting (IF) is a collective term for different dietary regimens that involve alternating cycles of eating and fasting periods. In particular, time-restricted eating (TRE) was reported to affect multiple physiological functions and improve metabolic health in patients with T2DM. The present paper aims to review the clinical benefits of intermittent fasting and analyze potential parallels between IF and Ayurvedic principles in managing T2DM.

2. METHODOLOGY

An integrative narrative review was conducted following PubMed/MEDLINE, Scopus, Web of Science, ScienceDirect, and Google Scholar database searches, as well as a manual exploration of relevant publications' reference lists. The literature search was not constrained by any time limits. The inclusion criteria were studies investigating the impact of intermittent fasting, TRE, and other forms of caloric restriction on T2DM, cardiometabolic risk, inflammation, oxidative stress, and body weight. In addition, literature on Ayurveda, Upavāsa, Langhana, Agni, Kapha, Meda, and Prameha were retrieved separately. Due to the heterogeneity of the studies' designs, a narrative synthesis of the retrieved evidence was performed.

3. RESULTS AND EVIDENCE SYNTHESIS

3.1 Intermittent Fasting and Glycemic Control

Glycemic status is the central focus of diabetes management, and multiple clinical trials have investigated the capacity of IF to reduce blood glucose levels and hemoglobin A1c (HbA1c). The results of these studies were largely positive, demonstrating that fasting can improve glycemic control in patients with T2DM. However, the clinical relevance of these benefits is primarily conditional upon the particular patterns of energy intake, weight loss, and overall adherence to a chosen intermittent fasting regimen. A systematic review and meta-analysis of randomized controlled trials published in 2025 revealed that, compared to standard dietary interventions, IF produced similar improvements in terms of HbA1c, fasting glucose levels, and body weight, though the quality of evidence was mostly moderate or low. This implies that intermittent fasting is a valid but not necessarily superior option for reducing blood sugar in patients with T2DM. Recent clinical evidence suggests that the most important benefit of IF lies in the increased adherence to dietary interventions due to their relative simplicity, as opposed to significant metabolic advantages over continuous energy restriction.

3.2 Body Weight and Adiposity

Since obesity is a major contributor to the development of T2DM, most studies on IF primarily focus on body weight changes and alterations in adipose tissue functionality. Caloric restriction, regardless of the regimen, typically leads to reductions in body weight and improvements in cardiometabolic risk profiles, with intermittent fasting being no exception. According to ADA, TRE in the form of alternate-day fasting or daily time-restricted eating can lead to slight decreases in body weight, but there is no substantial evidence that it is significantly better than continuous energy restriction for most health outcomes. It is noteworthy that time-restricted eating and other forms of intermittent fasting rarely yield remarkable short-term weight loss benefits beyond reducing overall energy intake. Thus, the key advantage of TRE over continuous fasting lies in the increased possibility to adhere to the dietary regimen.

3.3 Insulin Resistance and Metabolic Flexibility

Insulin resistance is a hallmark of T2DM, and short-term fasting can transiently reduce fasting glucose levels and improve insulin sensitivity. IF can affect multiple metabolic processes, including gluconeogenesis, fatty acid oxidation, mitochondrial biogenesis, and autophagy, which in turn modulate insulin signaling pathways and energy metabolism. However, further research is needed to establish whether these physiological changes occur in patients with T2DM and if they lead to clinically significant improvements beyond weight loss and energy restriction. At present, the most plausible explanation for IF's beneficial impact on insulin resistance in patients with diabetes lies in reduced energy intake and concurrent weight loss.

3.4 Lipid Profile and Cardiovascular Risk

Dyslipidemia is a major risk factor for the development of atherosclerosis and cardiovascular disease (CVD), which are especially prevalent in patients with T2DM. Several observational studies and interventional trials indicate that IF can lead to reductions in triglyceride levels, low-density lipoprotein cholesterol (LDL-C), and other lipid profile indices in patients with diabetes. Similar to changes in body weight, these improvements are mainly driven by energy restriction and concurrent weight loss. Nevertheless, the cardiometabolic benefits of TRE largely depend on the nutritional quality of the food consumed during feeding windows. Therefore, beyond reducing overall energy intake, intermittent fasting should be combined with a healthy and balanced diet to achieve more favorable lipid profile changes in patients with T2DM.

3.5 Blood Pressure

Elevated blood pressure is another critical CVD risk factor that is commonly observed in patients with T2DM. Weight loss induced by IF can lead to reductions in blood pressure levels, thereby decreasing the overall CVD risk. However, most of the clinical evidence pertains to short-term interventions, and the long-term effects of intermittent fasting on blood pressure in diabetic patients remain undetermined. As with other cardiometabolic outcomes, the benefits of IF are largely linked to weight loss, which can be substantial in patients with obesity. The ADA standards

recommend individualized approaches to dietary intervention and highlight the importance of nutrient-dense diets, rather than focusing on the timing of food intake.

3.6 Inflammation, Oxidative Stress, and Cellular Health

Chronic low-grade inflammation is an integral part of the pathophysiology of T2DM and a major contributor to the development of CVD. IF can potentially modulate inflammatory signaling pathways and reduce oxidative stress, leading to improvements in metabolic health. A few clinical studies report that fasting interventions are capable of decreasing pro-inflammatory cytokine levels and enhancing the production of anti-inflammatory mediators. In addition, IF may be beneficial for mitigating glucose toxicity and restoring endogenous antioxidant systems, thus protecting pancreatic β-cells from damage. Nonetheless, most of the evidence comes from observational studies or trials with healthy populations, and further interventional research is needed to confirm these benefits in patients with T2DM.

3.7 Circadian Rhythm, Chrononutrition, and the Timing of Meals

Chrononutrition is a relatively new concept that highlights the importance of aligning food intake with circadian rhythms for optimal metabolic health. Both observational and interventional studies demonstrate that the timing of food intake can affect body weight, lipid metabolism, and glycemic control. Specifically, late-night eating is associated with increased cardiometabolic risk, whereas consuming meals at regular hours can reduce overall CVD mortality. Time-restricted eating is a form of intermittent fasting that emphasizes the importance of circadian alignment, making it potentially beneficial for cardiometabolic health. According to the ADA, chronic nutrition is a rapidly evolving field, and future research on time-dependent feeding and its health effects is needed to establish the cardiometabolic benefits of TRE. Therefore, time-restricted eating should be further investigated as an innovative approach to improving metabolic health in patients with T2DM.

4. POTENTIAL MECHANISMS OF INTERMITTENT FASTING

4.1 Energy Restriction

The most evident mechanism of intermittent fasting is that it decreases total energy intake. TRE reduces the overall number of eating occasions per day (i.e., the duration of the eating window), which, in turn, decreases total energy consumption. Thus, energy restriction is the most plausible explanation for most metabolic effects of TRE, including weight loss and improvements in cardiometabolic health.

4.2 Altered Insulin Exposure

Fasting induces a decrease in circulating insulin levels, which reduces glucose uptake and utilization by tissues. This allows the body to utilize energy from alternative sources, such as fatty acids, thereby promoting weight loss and improving metabolic flexibility.

4.3 Increased Lipolysis

Decreased insulin levels during fasting stimulate lipolysis, leading to the release of free fatty acids from adipose tissue. These fatty acids can be oxidized for energy production in various tissues.

4.4 Circadian Alignment

Time-restricted eating can help maintain circadian rhythmicity by aligning food intake with the body's internal clock. This, in turn, may reduce cardiometabolic risk by improving glucose metabolism and lipid homeostasis.

4.5 Cellular Stress Adaptation

Fasting activates cellular stress response mechanisms, including the production of reactive oxygen species. These molecules play a critical role in cellular signaling, contributing to autophagy, mitochondrial biogenesis, and other adaptive responses that improve metabolic health.

5. AYURVEDIC PERSPECTIVE

5.1 Upavāsa

Upavāsa refers to a concept of regulated restriction of food and is practiced in Indian philosophy, medicine, and spirituality. There is a certain similarity between intermittent fasting and Upavāsa, as they both recommend avoiding eating for specified periods. However, they were developed within vastly different cultural and philosophical traditions, and Upavāsa encompasses a wide range of practices with significantly varying rules and goals. Therefore, Upavāsa should not be conflated with modern concepts of intermittent fasting.

5.2 Langhana

Langhana is primarily associated with the concept of lightness, and its goal is to reduce body weight and achieve longevity. According to Ayurveda, Langhana can be incorporated into the treatment of various diseases. It can be used as a standalone intervention or in combination with herbal medicine, yoga, and other therapeutic measures. While Langhana shares certain similarities with calorie restriction, it is better to view it as a holistic approach to health rather than a dietary practice.

5.3 Agni

Agni is the classical Ayurvedic term for fire, which is regarded as the source of energy and vitality. Agni is intimately connected to the processes of digestion and nutrient utilization. Modern biomedical science focuses on the detailed analysis of metabolic pathways and their contribution to health and disease. Therefore, it is not scientifically accurate to equate Agni to the concept of metabolism. A more plausible interpretation is to consider Agni as a biological process that supports digestion, nutrient assimilation, and cellular function.

5.4 Kapha and Meda

According to Ayurveda, Kapha is one of the three fundamental physiological principles of life, along with Pitta and Vata. Kapha governs bodily fluids and tissues and

is connected to the development of several metabolic disorders, including obesity and diabetes. Meda refers to adipose tissue, which is also central to the pathophysiology of T2DM. These concepts are similar to the modern understanding of metabolic syndrome and obesity, but they cannot be directly compared to contemporary biomedical terms.

5.5 Prameha and Madhumeha

Prameha and its complication Madhumeha are integral elements of the Ayurvedic understanding of diabetes. Modern scientific literature contains a number of theories regarding the potential parallels between Prameha/Madhumeha and T2DM. However, these concepts are essentially distinct, as they were developed within different scientific frameworks. An integrative review of the literature on Prameha/Madhumeha and T2DM can help generate hypotheses for further research on the similarities between the Ayurvedic and the modern understanding of diabetes.

6. INTEGRATIVE RESEARCH

The integrative analysis of the available evidence can be visualized as a conceptual framework that incorporates both biomedical and Ayurvedic perspectives on intermittent fasting.

Intermittent fasting
Reduced eating frequency / energy intake
Altered insulin exposure and substrate utilization
Changes in body weight and adiposity
Potential improvement in insulin sensitivity and metabolic parameters

Alongside the established biomedical mechanisms, Ayurveda provides additional insights into the nature of intermittent fasting:

Body weight regulation: Upavāsa → Langhan
Nutritional status: nEating period → Fasting state → Upavāsa
Digestive function: Nutrient processing → Agni
Adipose tissue: Body composition → Meda
Metabolic phenotype: Insulin resistance/metabolic dysfunction → Kapha framework
Diabetes phenotype: T2DM → Prameha/Madhumeha
Individualization of care: Personalized nutrition → Prakṛti/Doṣa consideration

7. IF BEYOND GLYCEMIC CONTROL: A PROPOSED INTEGRATIVE MODEL

The main integrative value of this review lies in the identification of similarities and differences between intermittent fasting and Ayurvedic concepts. The model below demonstrates the equivalence of modern biomedical terms and Ayurvedic principles related to fasting:

Domain category
Modern biomedical perspective Ayurvedic translation
Food deprivation Energy intake Langhana
Fasting state No food intake Upavāsa
Digestive processes Nutrient breakdown
Agni
Body weight and adiposityFat massMeda
Metabolic changes Insulin resistance Kapha framework
Diabetes state T2DM Prameha/Madhumeha
Individual approach Personalized treatment Prakṛti/Doṣa considerations

This model should be regarded as a hypothesis-generating tool that can be further expanded in future studies.

8. SAFETY AND CLINICAL CONSIDERATIONS

Safety is a key concern when implementing intermittent fasting in patients with T2DM, particularly due to the potential risk of hypoglycemia. Insulin or insulin secretagogues can cause fasting glucose levels to drop dangerously low, especially when combined with prolonged fasting periods. Thus, patients should be made aware of the potential risks of engaging in intermittent fasting and advised to consult a healthcare provider before initiating this type of dietary intervention. Additionally, those who are taking glucose-lowering medications should closely monitor their blood sugar levels and adjust the dosages accordingly. In terms of safety, TRE can also be associated with several adverse effects, most of which are related to physiological responses to the altered eating schedule.

The key considerations for patients who wish to adopt TRE include:

Diabetes status: Disease duration, baseline glycemic control, medication, and risk of hypoglycemia
Individual needs: Renal and cardiovascular function, dietary requirements, occupation, adherence preferences
Current health status: Age, frailty, and potential comorbidities

Intermittent fasting should not be used as a substitute for the recommended glucose-lowering medication.

9. ADHERENCE TO DIETARY REGIMEN AND PATIENT-CENTERED NUTRITION

Dietary adherence is the cornerstone of effective diabetes management, and it is largely dependent on the complexity of the chosen regimen. One of the advantages of TRE is that it can be relatively easy to adopt as compared to continuous energy restriction. In fact, the ability to consume food within an unrestricted eating window is the primary benefit of TRE. However, this advantage might be canceled out by the inability to adjust the eating schedule in accordance with an individual's needs and lifestyle. For example, feeding time alignment may disrupt an individual's circadian rhythm, which compromises metabolic health. Furthermore, social and cultural factors, such as family dinners or religious practices, might hinder TRE adherence. Overall, individual preferences and cultural background play a crucial role in dietary regimen adherence. According to ADA, patients should be encouraged to make individual dietary choices guided by their personal needs and values, rather than following a universal eating pattern.

10. EVIDENCE GAPS AND FUTURE DIRECTIONS

Some research gaps were identified in the literature.

The first gap is related to the long-term evidence. According to a meta-analysis published in 2025, some beneficial effects of intermittent fasting on metabolic markers may disappear after its discontinuation, which highlights the importance of its long-term compliance.
The second gap lies in the fact that the fasting interventions differ considerably between the studies.
A third gap is due to significant variations in the use of medications.
A fourth gap is a limited number of the studies reporting on the continuous glucose monitoring, body composition, visceral adiposity, and inflammatory biomarkers.
A fifth gap is the lack of integration of the Ayurvedic literature into the standardized assessments of clinical outcomes.
Therefore, future studies need to (1) report long-term results of randomized trials, (2) assess standardized intermittent fasting interventions, (3) measure continuous glucose monitoring, (4) evaluate insulin-sensitivity, (5) evaluate the body-composition, (6) report cardiovascular outcomes, (7) evaluate medication-specific safety, (8) assess quality of life and adherence, (9) conduct standardized Prakṛiti assessments, (10) develop validated Doṣa assessment tools, (11) standardize the assessments of Agni, and (12) perform prospective studies of Ayurvedic phenotypes as potential moderators of response to intermittent fasting.

11. STRENGTHS AND LIMITATIONS

The main strength of this review is a multidisciplinary approach that combined evidence from contemporary metabolic research with the concepts developed in the Ayurvedic tradition. This approach allowed exploring intermittent fasting not as a tool for reducing glucose levels but as an intervention with broad implications for metabolic, behavioral, and cardiovascular health.
However, there are limitations in this review that should be noted. First, the reviewed studies differed in terms of fasting protocols, the duration of interventions, characteristics of the study populations, medication use, dietary interventions, and outcome assessments, which complicates the comparison between the trials. Second, the evidence on specific mechanistic outcomes is limited, and the contribution of Ayurvedic components is conceptual, which means that it cannot establish causal relationships between Ayurvedic constructs and biomedical biomarkers. Finally, a quantitative analysis of the reviewed evidence was not performed.

12. DISCUSSION

Emerging evidence suggests that the clinical utility of intermittent fasting in people with type 2 diabetes extends beyond the reduction of HbA1c. Although optimizing glycaemic control is undeniably important, body weight, insulin sensitivity, cardiovascular risk factors, circadian eating patterns, and adherence to the intervention may ultimately determine its clinical value.
The available evidence does not currently support the idea that intermittent fasting is superior to continuous energy restriction diets. A 2025 systematic review and meta-analysis of randomized trials showed broadly similar effects of intermittent fasting and regular dietary approaches for HbA1c, fasting glucose, and weight. In a similar vein, the 2026 ADA Standards characterize intermittent fasting and TRE as possible dietary strategies for managing diabetes but not universally superior approaches.
This distinction is of great importance because a dietary intervention does not need to be better from a physiological standpoint to be clinically valuable. If a person finds it easier to follow an intermittent fasting regimen, this approach may serve as a practical framework for achieving dietary and weight-management goals.
The Ayurveda–modern medicine interface offers another valuable perspective. The Ayurvedic constructs of Upavāsa and Langhana may help generate new hypotheses related to regulated dietary restrictions, while Agni, Kapha, and Meda may serve as frameworks for understanding the basic mechanisms of digestion. At the same time, one should avoid oversimplified statements, such as that Agni equals metabolism or Kapha equals obesity, because they have not been supported by evidence.
An evidence-based integrative approach would rather aim to explore whether standardized characteristics of the Ayurvedic tradition can predict variations in metabolic outcomes. Future studies can build on existing evidence on the influence of individual characteristics on the outcomes of intermittent fasting to examine whether Prakṛiti or standardized scores for Doṣa can modify the changes in HbA1c, HOMA-IR, body composition, lipid profile, or continuous glucose monitoring.
Such an approach may help transform theoretical Ayurvedic constructs into empirical evidence that can contribute to the field of diabetes research.

13. CONCLUSION

Intermittent fasting is a promising dietary strategy for a selected group of people with type 2 diabetes mellitus (T2DM) who can benefit from its regulation of nutritional intake, medication regime, metabolic state, preferences, and capacity to comply with the intervention. Current evidence suggests that intermittent fasting may improve some metabolic outcomes, body weight, and selected cardiometabolic indicators, but its efficacy is mostly comparable to the outcomes of regular dietary restriction strategies, which underscores the importance of adherence to any dietary intervention. The clinical value of intermittent fasting for people with T2DM largely depends on their willingness to comply with its dietary and temporal aspects as well as their capacity to achieve optimal nutritional adequacy and improve long-term metabolic outcomes.
The Ayurvedic constructs of Upavāsa and Langhana offer a valuable theoretical framework that can inform the clinical use of intermittent fasting. At the same time, Agni, Kapha, Meda, and Prameha provide a set of concepts that can complement the contemporary understanding of the mechanisms of digestion and metabolic disease. Therefore, future research should build on existing evidence to move beyond theoretical explorations and start addressing the

impact of specific components of intermittent fasting on cardiometabolic outcomes, medication use, safety, adherence, and overall wellbeing of people with T2DM

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