

# Evaluation of an integrative Ayurvedic lifestyle program on metabolic outcomes and quality of life in type 2 diabetes: A 12-Week prospective observational study

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## Abstract

**Background:** Type 2 diabetes mellitus (T2DM) requires long-term management that extends beyond glycaemic control to include lifestyle modification and cardiometabolic risk reduction. Ayurveda-informed lifestyle approaches incorporating dietary guidance, Dinacharya, yoga, Pranayama, meditation, and behavioral counseling may support comprehensive diabetes care.

**Objective:** To evaluate changes in metabolic outcomes and quality of life among adults with T2DM following a 12-week integrative Ayurvedic lifestyle program.

**Methods:** This prospective observational study included 100 adults with established T2DM who participated in a structured Ayurveda-based lifestyle program while continuing their usual medical care. The intervention included individualized dietary and lifestyle counseling, yoga, Pranayama, meditation, sleep recommendations, and Ayurvedic guidance. Outcome measures included fasting blood glucose (FBG), postprandial blood glucose (PPBG), glycated hemoglobin (HbA1c), body mass index (BMI), waist circumference, blood pressure, lipid profile, and diabetes-related quality of life assessed using a validated questionnaire. Baseline and Week 12 measurements were compared using paired statistical analyses, with  $p < 0.05$  considered statistically significant.

**Results:** Significant improvements were observed in FBG, PPBG, HbA1c, BMI, waist circumference, blood pressure, and lipid parameters (all  $p < 0.05$ ). Quality-of-life scores improved across physical, psychological, and social domains. Adherence to the program was high, and no serious intervention-related adverse events were reported.

**Conclusion:** A 12-week integrative Ayurvedic lifestyle program was associated with favorable metabolic and quality-of-life outcomes in adults with T2DM. Larger randomized controlled studies with longer follow-up are needed to confirm the effectiveness and long-term sustainability of these findings.

## KEYWORDS

Type 2 diabetes mellitus; Ayurvedic lifestyle; Glycemic control; Metabolic outcomes; Postprandial blood glucose

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## Introduction

Type 2 diabetes mellitus (T2DM) represents a growing burden on healthcare systems worldwide because of its increasing prevalence and long-term clinical consequences. The condition develops through interacting metabolic abnormalities, particularly reduced responsiveness to insulin and a gradual decline in pancreatic  $\beta$ -cell function, resulting in inadequate regulation of blood glucose. Over time, prolonged glycaemic disturbance can contribute to complications affecting multiple organ systems and can substantially increase the healthcare needs of affected individuals [1-3].

Global estimates from the International Diabetes Federation (IDF) demonstrate the considerable scale of the diabetes burden. Current figures indicate that hundreds of millions of adults are living with diabetes worldwide, with T2DM accounting for the great majority of diagnosed cases. The continuing rise in diabetes prevalence highlights the need for management approaches that address not only glycaemic control but also modifiable lifestyle and cardiometabolic risk factors [1,2,4].

India has one of the largest diabetes burdens in the world and is often called the "diabetes capital of the world," with a fast-rising prevalence due to urbanization, sedentary lifestyle, unhealthy diet habits, obesity, and population aging [2,4]. The rising epidemic of diabetes carries significant social and economic consequences and is a major burden on health care systems. Microvascular and macrovascular complications like diabetic retinopathy, nephropathy

and neuropathy, and also ischaemic heart disease, stroke and peripheral vascular disease are associated with persistent hyperglycemia in T2DM. These complications have a large impact on quality of life, increase disability, and cause premature death [1,3]. The key to diabetes management is to maintain tight control of blood sugar levels. However, many patients are unable to achieve and sustain optimal blood glucose levels over the long term due to poor adherence to lifestyle recommendations, progressive disease pathology, adverse medication-related effects, and psychosocial barriers. Consequently, there is growing interest in complementary and integrative approaches that can improve conventional diabetes management and overall health and well-being. Lifestyle modification is generally accepted as the foundation for T2DM management. The scientific recommendations are good nutrition, regular physical activity, adequate sleep, reduction of stress, quitting smoking, and weight management. These interventions improve insulin sensitivity, reduce cardiovascular risk factors, and slow the progression of disease [5-10]. But in routine clinical practice, difficulty in sustained adherence to lifestyle modification is often due to cultural, behavioral, occupational, and environmental factors. Comprehensive lifestyle interventions such as behavioral counseling and holistic health practices are being studied to improve patient engagement and long-term outcomes [5-7, 11,12].

Ayurveda has been practiced in India as a system of medicine for over 3000 years. An integrated strategy is needed to prevent disease and promote health. In Ayurvedic literature, diabetes is generally described as Madhumeha, a type of Prameha, which is characterized

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by excessive urination, metabolic disturbances, and impaired tissue metabolism [13-17]. The Ayurvedic management not only aims at controlling symptoms but also at correcting the underlying imbalance through individualized dietary regulation (Ahara), lifestyle modification (Vihara), daily routine (Dinacharya), seasonal regimen (Ritucharya), stress management, physical exercise (Vyayama), yoga, meditation, and, wherever applicable, herbal formulations [14-19]. These interventions are targeted at re-establishing metabolic homeostasis, optimizing digestive and metabolic function (Agni), and improving general physical and mental health.

In recent years, there has been a significant increase in scientific interest in integrative medicine. Integrative medicine is a combination of evidence-based conventional medicine with complementary practices that have an emerging evidence base. Multiple clinical trials have shown that yoga, mindfulness-based stress reduction, dietary changes, and some Ayurvedic herbal treatments are effective in improving glycemic control, lipid metabolism, inflammatory markers, oxidative stress, and mental health in patients with T2DM [20-26]. Yoga has been shown to improve insulin sensitivity, cardiovascular fitness, decrease stress hormone levels, and assist in weight loss [20-25]. Mindfulness practices and meditation can also help to reduce chronic psychological stress, which has been linked to the worsening of insulin resistance through neuroendocrine pathways [22,24,25].

The management of the diet remains one of the most important parts of treatment of diabetes. Ayurvedic diet advice: eat fresh, unprocessed foods; eat at the right times; eat in moderation; eat plenty of fiber-rich vegetables and whole grains; limit excess refined carbohydrates, sugars, and processed foods. These principles are consistent with current nutritional recommendations that support low glycemic load dietary patterns, adequate dietary fiber, and healthy fats to improve metabolic health [8,27]. This coming together of traditional Ayurvedic wisdom and modern nutritional science has raised interest in the evaluation of integrative lifestyle interventions using modern clinical research methods.

Quality of life has emerged as an important outcome measure in diabetes management [28,29]. Successful management of diabetes is more than glycemic control [28]. Fatigue, anxiety, depression, poor sleep, low physical functioning, and poor social participation are common among patients with T2DM. Psychological well-being is also affected by chronic medication, dietary restrictions, and fear of complications [28,29]. Therefore, integrated lifestyle interventions that target simultaneously physical, mental and emotional health may offer more holistic benefits than pharmacological treatment alone.

Although previous studies have investigated specific Ayurvedic or mind-body interventions, including yoga, meditation, and herbal therapies, evidence examining these components within a combined and systematically delivered lifestyle program remains comparatively limited [20-26, 19]. In particular, prospective data describing changes in metabolic indicators together with health-related quality of life over a predetermined follow-up period are not yet extensive. This evidence gap is especially relevant in Indian clinical practice, where Ayurvedic approaches may be used alongside conventional medical treatment [1,18,19]. Observational data from routine care settings may therefore contribute to a better understanding of how such integrative approaches can be incorporated into comprehensive diabetes management.

Against this background, the present prospective observational study followed adults with T2DM for 12 weeks while they participated in a structured integrative Ayurvedic lifestyle program in addition to their ongoing medical management. Changes in fasting blood glucose, postprandial blood glucose, glycated hemoglobin (HbA1c), body mass index (BMI), waist circumference, blood pressure, lipid parameters, and health-related quality of life were evaluated over the study period. It was hypothesized that participation in the program would be associated with favorable changes in glycaemic and cardiometabolic measures and improvements in quality of life.

## Materials and Methods

### Design

A prospective observational design with a 12-week follow-up period was used to examine changes in metabolic and quality-of-life outcomes among adults with T2DM participating in an integrative Ayurvedic lifestyle program [18,19]. The study was undertaken in accordance with the ethical principles outlined in the Declaration of Helsinki and applicable Good Clinical Practice (GCP) guidance.

### Study setting

The investigation was carried out at an integrative healthcare center where patients received conventional diabetes management together with Ayurvedic lifestyle counseling. Adults attending outpatient diabetes services were recruited between January and April 2026.

### Study population

Adults with an established diagnosis of T2DM who were receiving routine outpatient care were assessed against the predefined eligibility criteria before enrolment.

### Sample size and recruitment

A total of 100 eligible participants were enrolled consecutively during the recruitment period. The selected sample was intended to provide sufficient observations for evaluating within- participant changes in metabolic and quality-of-life measures during the 12-week follow-up, while allowing for possible attrition.

### Inclusion criteria

Participants were eligible for enrolment when they met all of the following criteria:

- Age between 30 and 70 years.
- Diagnosis of T2DM based on the criteria of the American Diabetes Association (ADA) [1].
- Baseline HbA1c between 7.0% and 10.5%.
- Use of a stable oral glucose-lowering medication regimen for at least three months before enrolment.
- Willingness to participate in the complete 12-week lifestyle program.
- Ability to undertake mild-to-moderate physical activity.
- Provision of written informed consent before participation.

### Exclusion criteria

- Type 1 diabetes mellitus.
- Gestational diabetes.
- Severe diabetic complications requiring hospitalization.
- End-stage renal disease.
- Advanced liver disease.
- Active malignancy.
- Severe psychiatric illness.
- Recent cardiovascular events (<6 months).
- Pregnancy or lactation.
- Participation in another clinical trial.
- Inability to comply with study procedures.

### Study Intervention

Participants remained under their usual medical care and continued the diabetes medications prescribed by their treating physicians during the 12-week study period. The study protocol did not require alteration of ongoing pharmacological treatment. Where a medication

adjustment became clinically necessary, the decision was made independently by the participant's treating physician according to individual clinical requirements.

In addition to routine medical management, participants followed a structured Integrative Ayurvedic Lifestyle Program comprising several lifestyle-oriented components, as described below.

### Ayurvedic dietary guidance (Ahara)

Dietary guidance was individualized for each participant by integrating principles of Ayurvedic Ahara with established nutritional recommendations for people with T2DM. The advice was adapted to the participant's individual requirements and formed part of the overall lifestyle program followed throughout the 12-week observation period [18,19].

Recommendations included:

Dietary counselling emphasised the regular consumption of freshly prepared meals, fiber-rich vegetables, whole grains, legumes, and seasonal fruits and vegetables. Participants were advised to limit added sugars and processed foods and to avoid deep-fried foods as far as practicable. Guidance also included maintaining consistent meal timings, completing the evening meal before 8:00 PM, and ensuring adequate daily hydration. These recommendations were incorporated into the individualized dietary plan according to each participant's dietary requirements and lifestyle pattern.

### Daily routine (Dinacharya)

Participants received guidance on establishing a consistent daily routine (Dinacharya) throughout the 12-week study period. Recommendations included waking early, maintaining regular meal timings, following a consistent sleep schedule, walking after meals, maintaining adequate hydration, and reducing prolonged periods of sedentary behavior [14-17].

### Yoga therapy

Supervised yoga sessions were conducted five days per week by certified yoga instructors. Each session lasted approximately 45 minutes and consisted of a 5-minute warm-up, 10 minutes of stretching exercises, 20 minutes of selected yoga postures (asanas), and 10 minutes of relaxation.

The asanas practiced during the program included Tadasana, Trikonasana, Bhujangasana, Vakrasana, Pawanmuktasana, and Ardha Matsyendrasana. Participants were also encouraged to continue the prescribed yoga practices independently at home during weekends [20-25].

### Pranayama

Breathing practices (Pranayama) were incorporated into the daily program for approximately 15 minutes. The prescribed practices included Anulom Vilom, Bhramari, Nadi Shodhana, and deep diaphragmatic breathing. Participants were instructed in the appropriate technique before undertaking regular practice [23-25].

### Meditation

Participants undertook approximately 15 minutes of guided mindfulness meditation each day. Meditation was incorporated into the program as a stress-management and psychological well-being component of the lifestyle intervention [15,17,8] [22-25].

### Lifestyle counselling

Individual lifestyle counseling was provided weekly during the study period. Counseling addressed stress management, sleep hygiene, weight management, regular physical activity, reduction of sedentary behavior, smoking cessation, moderation of alcohol consumption, self-monitoring of blood glucose, and adherence to prescribed medications. Advice was tailored, where appropriate, to the participant's existing lifestyle and clinical requirements [5-10].

### Ayurvedic herbal medication

No standardized Ayurvedic herbal formulation was initiated as a study-specific intervention. Participants who were already using Ayurvedic medicines prescribed by their physicians were permitted to continue these medicines under appropriate medical supervision. The study protocol did not introduce any new herbal medication specifically for research purposes.

### Outcome Measures

Clinical and laboratory assessments were performed at baseline (Week 0) and following completion of the 12-week observation period.

#### Primary outcomes

The primary glycaemic outcomes were fasting blood glucose (FBG; mg/dL), postprandial blood glucose (PPBG; mg/dL), and glycated hemoglobin (HbA1c; %).

Anthropometric assessment included body weight (kg), height (cm), body mass index (BMI; kg/m<sup>2</sup>), and waist circumference (cm).

#### Secondary outcomes

##### Blood pressure:

Blood pressure was measured using a calibrated digital sphygmomanometer after participants had rested for five minutes. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded.

##### Lipid profile:

Venous blood samples were analyzed for total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C).

##### Health-related quality of life:

Quality of life was evaluated using the Diabetes Quality of Life (DQOL) questionnaire. The instrument was used to assess relevant aspects of participants' diabetes-related well-being and treatment experience in accordance with its prescribed scoring procedure [28].

### Data collection

Baseline demographic and clinical information was collected for each participant. Recorded variables included age, gender, educational status, occupation, duration of diabetes, family history of diabetes, smoking status, alcohol consumption, physical activity level, and current medication use. Clinical assessments and laboratory investigations were undertaken by trained healthcare personnel using predefined procedures.

### Laboratory assessment

Venous blood specimens were collected following an overnight fast of 8–10 hours. Fasting blood glucose was determined using the glucose oxidase-peroxidase method, while HbA1c was measured using high-performance liquid chromatography (HPLC). Lipid parameters were assessed using automated enzymatic methods. Laboratory investigations were carried out in an NABL-accredited clinical laboratory under established quality-control procedures.

### Assessment of program adherence

Adherence to the lifestyle program was evaluated using multiple measures, including attendance at supervised yoga sessions, weekly lifestyle diaries, telephone follow-up, dietary adherence checklists, and participant-reported records of home practice. Participants who completed at least 80% of the scheduled program sessions were classified as adherent for the purpose of compliance assessment.

### Safety monitoring

Adverse events reported or identified during the observation period

were documented during follow-up. Participants requiring additional medical assessment were referred to their treating physicians. Any serious adverse event occurring during the study was to be reported to the Institutional Ethics Committee in accordance with the applicable reporting procedure.

### Statistical analysis

Study data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarised using mean and standard deviation (SD) when appropriate, whereas categorical variables were reported as frequencies and percentages.

The distribution of continuous variables was examined using the Shapiro–Wilk test. Changes between baseline and Week 12 were assessed using the paired Student's *t*-test for normally distributed continuous variables and the Wilcoxon signed-rank test for variables that did not satisfy the assumption of normality. Where comparisons of categorical variables were required, the Chi-square test or Fisher's exact test was applied as appropriate. All statistical tests were two-sided, and a *p*-value <0.05 was considered statistically significant.

### Ethical Considerations

The study protocol received approval from the Institutional Ethics Committee before participant enrolment. Written informed consent was obtained from each participant after providing information about the purpose of the study, study procedures, anticipated benefits, and potential risks. Participation was voluntary, and withdrawal from the study was permitted at any stage without affecting the participant's ongoing medical care. Confidentiality was maintained by anonymising participant data used for study analysis.

## Results

### Participant characteristics

A total of 100 participants with Type 2 Diabetes Mellitus were enrolled, and all completed the 12-week observational study. The mean age of the participants was  $54.8 \pm 8.9$  years (range: 34– 70 years). Males constituted 58% (*n* = 58) of the study population, while 42% (*n* = 42) were females. The mean duration of diabetes was  $7.2 \pm 3.8$  years, and the mean baseline body mass index (BMI) was  $28.3 \pm 3.4$  kg/m<sup>2</sup>. Baseline demographic and clinical characteristics of the study participants are presented in Table 1.

**Table 1.** Baseline demographic and clinical characteristics (*n* = 100).

| Variable                                 | Value          |
|------------------------------------------|----------------|
| Age (years), Mean $\pm$ SD               | $54.8 \pm 8.9$ |
| Male, <i>n</i> (%)                       | 58 (58%)       |
| Female, <i>n</i> (%)                     | 42 (42%)       |
| Duration of Diabetes (years)             | $7.2 \pm 3.8$  |
| BMI (kg/m <sup>2</sup> )                 | $28.3 \pm 3.4$ |
| Hypertension, <i>n</i> (%)               | 46 (46%)       |
| Family History of Diabetes, <i>n</i> (%) | 61 (61%)       |
| Current Smokers, <i>n</i> (%)            | 18 (18%)       |

### Changes in glycemic parameters

Changes in glycemic parameters between baseline and Week 12 are summarized in Table 2. Significant improvements were observed in all glycemic indicators after completion of

the 12- week integrative Ayurvedic lifestyle program.

The mean fasting blood glucose (FBG) decreased from  $164.2 \pm 23.8$  mg/dL at baseline to  $136.4$

$\pm 19.7$  mg/dL at Week 12 (*p* < 0.001).

Similarly, postprandial blood glucose (PPBG) decreased from  $246.7 \pm 34.5$  mg/dL to  $198.3 \pm 28.6$  mg/dL (*p* < 0.001).

Mean HbA1c improved from  $8.42 \pm 0.71\%$  to  $7.41 \pm 0.58\%$  after the intervention (*p* < 0.001).

**Table 2.** Changes in glycemic parameters.

| Parameter                           | Baseline         | Week 12          | Mean Difference | p-value |
|-------------------------------------|------------------|------------------|-----------------|---------|
| Fasting Blood Glucose (mg/dL)       | $164.2 \pm 23.8$ | $136.4 \pm 19.7$ | $-27.8$         | <0.001  |
| Postprandial Blood Glucose (mg/ dL) | $246.7 \pm 34.5$ | $198.3 \pm 28.6$ | $-48.4$         | <0.001  |
| HbA1c (%)                           | $8.42 \pm 0.71$  | $7.41 \pm 0.58$  | $-1.01$         | <0.001  |

### Changes in anthropometric measurements

Changes in anthropometric parameters during the study period are presented in Table 3. Body weight and obesity-related measurements showed statistically significant reductions following the intervention.

Mean BMI decreased from  $28.3 \pm 3.4$  kg/m<sup>2</sup> to  $27.2 \pm 3.1$  kg/m<sup>2</sup> (*p* < 0.001).

Waist circumference reduced significantly from  $98.5 \pm 8.6$  cm to  $94.8 \pm 7.9$  cm (*p* < 0.001).

**Table 3.** Changes in Anthropometric Parameters.

| Parameter                | Baseline        | Week 12         | p-value |
|--------------------------|-----------------|-----------------|---------|
| Weight (kg)              | $78.6 \pm 11.8$ | $75.9 \pm 11.1$ | <0.001  |
| BMI (kg/m <sup>2</sup> ) | $28.3 \pm 3.4$  | $27.2 \pm 3.1$  | <0.001  |
| Waist Circumference (cm) | $98.5 \pm 8.6$  | $94.8 \pm 7.9$  | <0.001  |

### Changes in blood pressure

Changes in systolic and diastolic blood pressure are presented in Table 4. Changes in systolic and diastolic blood pressure are presented in Table 4. The intervention resulted in modest but statistically significant reductions in blood pressure.

Mean systolic blood pressure decreased from  $138.6 \pm 12.8$  mmHg to  $131.5 \pm 10.7$  mmHg, while diastolic blood pressure declined from  $86.4 \pm 8.2$  mmHg to  $81.7 \pm 7.4$  mmHg (both *p* < 0.001).

**Table 4.** Blood pressure changes.

| Parameter           | Baseline         | Week 12          | p-value |
|---------------------|------------------|------------------|---------|
| Systolic BP (mmHg)  | $138.6 \pm 12.8$ | $131.5 \pm 10.7$ | <0.001  |
| Diastolic BP (mmHg) | $86.4 \pm 8.2$   | $81.7 \pm 7.4$   | <0.001  |

### Changes in lipid profile

Changes in lipid profile parameters are summarized in Table 5. Significant improvements were observed in serum lipid concentrations.

Total cholesterol decreased from **204.8 ± 29.6 mg/dL** to **184.2 ± 25.4 mg/dL** ( $p < 0.001$ ).

Triglycerides decreased significantly from **188.6 ± 41.2 mg/dL** to **161.3 ± 34.8 mg/dL** ( $p < 0.001$ ).

LDL cholesterol showed a significant reduction, whereas HDL cholesterol increased modestly.

**Table 5.** Changes in lipid profile.

| Parameter                 | Baseline     | Week 12      | p-value |
|---------------------------|--------------|--------------|---------|
| Total Cholesterol (mg/dL) | 204.8 ± 29.6 | 184.2 ± 25.4 | <0.001  |
| Triglycerides (mg/dL)     | 188.6 ± 41.2 | 161.3 ± 34.8 | <0.001  |
| LDL Cholesterol (mg/dL)   | 128.9 ± 24.7 | 112.8 ± 21.3 | <0.001  |
| HDL Cholesterol (mg/dL)   | 41.2 ± 6.4   | 45.8 ± 6.9   | <0.001  |

### Quality of life assessment

Quality-of-life outcomes assessed using the DQOL questionnaire are presented in Table 6. The Diabetes Quality of Life (DQOL) questionnaire demonstrated significant improvements across all measured domains.

The overall DQOL score increased from **61.8 ± 8.5** at baseline to **76.9 ± 7.8** after 12 weeks ( $p < 0.001$ ).

Improvements were observed in physical functioning, emotional well-being, treatment satisfaction, and social functioning.

**Table 6.** Quality of life scores.

| Domain                   | Baseline    | Week 12    | p-value |
|--------------------------|-------------|------------|---------|
| Physical Health          | 63.1 ± 10.2 | 77.8 ± 8.4 | <0.001  |
| Psychological Well-being | 60.4 ± 9.6  | 76.3 ± 8.7 | <0.001  |
| Social Functioning       | 62.7 ± 8.3  | 75.9 ± 7.5 | <0.001  |
| Treatment Satisfaction   | 61.0 ± 8.8  | 77.5 ± 7.2 | <0.001  |
| Overall DQOL Score       | 61.8 ± 8.5  | 76.9 ± 7.8 | <0.001  |

### Compliance and safety

Participant adherence to the integrative Ayurvedic lifestyle program was high, with **91%**

attending at least 80% of scheduled yoga and counseling sessions.

No serious adverse events related to the intervention were reported during the study period. Mild transient muscle soreness following initial yoga sessions was reported by **6 participants (6%)**, which resolved without medical intervention. No participant discontinued the study because of intervention-related adverse effects.

### Summary of Findings

Over the 12-week observation period, participants showed significant changes from baseline across several clinical measures, including glycaemic indices, anthropometric parameters, blood pressure, lipid levels, and diabetes-related quality of life. Adherence to the prescribed lifestyle programme was high, with no major safety concerns observed during follow-up. Taken together, these findings indicate that an integrative Ayurvedic lifestyle programme, when used alongside ongoing medical care, may have value as an adjunctive approach for adults with Type 2 Diabetes Mellitus. However, the observational nature of the study should be considered when interpreting these associations.

### Discussion

This prospective observational study examined changes in clinical and patient-reported outcomes among adults with Type 2 Diabetes Mellitus (T2DM) who participated in a 12-week integrative Ayurvedic lifestyle program while continuing their usual medical treatment. At the end of the observation period, favorable changes were identified in measures of glycemia, body composition, blood pressure, lipid parameters, and diabetes-related quality of life. Although the absence of a comparison group prevents these changes from being attributed exclusively to the program, the findings provide useful clinical observations regarding the incorporation of a structured Ayurveda-informed lifestyle approach into routine diabetes care [18,19].

A prominent finding was the improvement in glycaemic measures over the 12-week period. Fasting blood glucose (FBG), postprandial blood glucose (PPBG), and glycated hemoglobin (HbA1c) were lower at follow-up than at baseline. The mean reduction in HbA1c was approximately one percentage point, suggesting a meaningful improvement in overall glycaemic status during the study period. Because HbA1c reflects average glycaemic exposure over the preceding several weeks, the observed change is particularly relevant when considering the short duration of follow-up. However, these findings should be interpreted in the context of continued pharmacological treatment and any medication adjustments that may have occurred during the observation period [5-10].

The program incorporated several behavioral components rather than relying on a single therapeutic measure. Dietary modification, yoga, increased daily movement, Pranayama, meditation, sleep-related guidance, and regular lifestyle counseling were implemented concurrently. It is therefore not possible to determine which component contributed most strongly to the observed glycaemic changes. The results are better interpreted as the outcome of participation in a multimodal lifestyle program within the context of ongoing diabetes treatment [5-10,23-25].

Dietary counseling represented an important part of the program. Participants were encouraged to favor freshly prepared foods, vegetables, whole grains, legumes, and other fibre-containing foods while limiting added sugars, highly processed foods, and deep-fried foods. Attention was also given to meal regularity and the timing of the evening meal. Several aspects of this approach are compatible with contemporary nutritional strategies used in T2DM management. Improvements in dietary quality and consistency may therefore have contributed to the changes observed in glucose regulation and anthropometric measures during follow-up [8,27].

Changes in body weight, BMI, and waist circumference were also observed by Week 12. Waist circumference is particularly relevant in T2DM because abdominal adiposity is closely related to insulin resistance and cardiometabolic risk. The program addressed several behaviors that could influence body composition, including food choices, regular physical activity, post-meal walking, yoga practice, sleep habits, and reduction of sedentary behavior. The simultaneous implementation of these measures provides a plausible context for the anthropometric changes recorded during the study, although their individual effects cannot be separated within the present design [5-7,11,12].

Cardiovascular risk-related measures also changed during follow-up. Both systolic and diastolic blood pressure declined, together with favorable changes in total cholesterol, triglycerides, LDL cholesterol, and HDL cholesterol. This is relevant because management of T2DM extends beyond glucose reduction and includes attention to blood pressure, dyslipidemia, body weight, and other cardiovascular risk factors. The concurrent changes across these measures suggest that a broader lifestyle framework may be useful when addressing multiple modifiable risk factors in people with T2DM [5-7,9,11,12,30].

Several mechanisms described in previous research could potentially contribute to the pattern of findings observed in this study. Physical activity can increase skeletal-muscle glucose utilization and improve insulin responsiveness, while reductions in excess adiposity

may contribute to improved metabolic regulation. Yoga, controlled breathing, and meditation have also been investigated for their possible effects on stress regulation, autonomic function, and psychological well-being. These mechanisms were not directly measured in the present study; therefore, they should be regarded as possible explanations rather than demonstrated pathways underlying the observed changes [20-25].

In addition to metabolic outcomes, the study examined diabetes-related quality of life. Participants reported improvement in quality-of-life measures following completion of the program. This aspect is clinically relevant because living with diabetes involves more than biochemical control; daily self-management, dietary restrictions, medication use, psychological burden, and concerns about future complications may all affect an individual's well-being. The program provided repeated lifestyle counseling together with yoga, meditation, and active participant engagement, which may have contributed to the reported changes. Nevertheless, the absence of a control group and the use of participant-reported outcomes should be considered when interpreting these findings [28,29].

The present observations can be considered alongside previous research examining lifestyle and mind-body approaches in T2DM. Studies of yoga and related practices have reported changes in glycaemic indices and selected cardiometabolic outcomes, while Ayurveda-based lifestyle approaches have traditionally emphasized Ahara (diet), Dinacharya (daily routine), physical activity, and behavioral regulation. The current study differed from interventions centered primarily on herbal formulations because its principal focus was lifestyle modification. No standardized Ayurvedic herbal medicine was introduced specifically as part of the study protocol [13-17,19-26].

Another practical feature of the program was that participants continued their prescribed conventional diabetes treatment. The Ayurveda-informed lifestyle measures were therefore used as adjuncts rather than replacements for established medical management. This distinction is important when interpreting the findings and when considering how similar programs might be implemented in clinical practice. The observations from this study relate to an integrative model in which lifestyle support is provided alongside routine diabetes treatment [9,10,30].

Program participation was generally high, with more than 90% of participants attending most scheduled sessions. No serious adverse events were reported during the 12-week follow-up. Mild and temporary muscle soreness occurred in a small proportion of participants and resolved without requiring withdrawal from the program. These observations suggest that the program was acceptable to most participants who enrolled in the study. However, the sample size and limited follow-up period do not permit definitive conclusions regarding safety.

### Strengths and Limitations

A strength of the study was its evaluation of a multimodal lifestyle program under routine clinical conditions. The assessment included glycaemic, anthropometric, cardiovascular, biochemical, and patient-reported outcomes, allowing changes across several dimensions of diabetes management to be examined simultaneously. The program also emphasized non-pharmacological Ayurvedic lifestyle principles while participants remained under conventional medical care. Several limitations require consideration. Most importantly, the study did not include a control or comparator group. Consequently, changes observed between baseline and Week 12 cannot be attributed solely to the integrative Ayurvedic lifestyle program. Continued medical treatment, medication changes, increased clinical contact, participant motivation, regression to the mean, and other unmeasured factors may have influenced the results.

The 12-week observation period also limits conclusions regarding whether the changes would persist over longer periods. Another limitation of the study is that some measures of program adherence were based on participant-reported lifestyle diaries and home-practice

records. Such self-reported measures may be subject to recall bias and social desirability bias, potentially leading to overestimation of adherence. Furthermore, because dietary guidance, yoga, Pranayama, meditation, daily-routine modification, and lifestyle counseling were delivered as a combined program, the independent contribution of individual components could not be determined. The study was conducted within a single clinical setting, which may limit the generalisability of the findings to other populations and healthcare environments.

### Implications for Future Research

The findings provide a basis for more rigorous investigation of structured Ayurveda informed lifestyle programs in T2DM. Future studies would benefit from randomized controlled designs, larger and more diverse populations, multiple clinical centers, and longer follow-up periods. Recording changes in antidiabetic medication and evaluating their influence on metabolic outcomes would also strengthen interpretation.

Additional research could examine objective measures related to insulin resistance, inflammation, oxidative stress, and glucose variability where clinically and scientifically justified. Continuous glucose monitoring may provide further information about changes in daily glucose patterns that cannot be captured fully by isolated fasting and postprandial measurements. Future studies could also investigate program adherence, patient acceptability, healthcare utilization, and cost effectiveness.

Factorial or component-specific study designs may help determine whether particular elements-such as dietary counseling, yoga, Pranayama, meditation, or structured *Dinacharya*-provide additional benefit individually or in selected combinations. Such research would help distinguish the effects of individual components from those of the complete multimodal program.

Although the present findings are encouraging, further well-designed randomized controlled trials are needed to confirm these observations, establish causal relationships, and evaluate the long-term sustainability of the observed benefits.

### Overall Interpretation

During 12 weeks of participation in an integrative Ayurvedic lifestyle program alongside conventional medical management, adults with T2DM experienced favorable changes in several glycaemic, anthropometric, cardiovascular, and quality-of-life measures. Given the observational design and absence of a control group, these findings demonstrate associations over time rather than proof of a treatment effect. Nevertheless, they provide preliminary clinical evidence supporting further investigation of structured Ayurveda-informed lifestyle care as an adjunct to established diabetes management.

### Conclusion

The findings of this 12-week prospective observational study suggest that participation in a structured integrative Ayurvedic lifestyle program, alongside ongoing conventional medical care, was associated with favorable changes in multiple clinically relevant outcomes among adults with Type 2 Diabetes Mellitus. Improvements were observed in glycaemic parameters, anthropometric measures, blood pressure, lipid profile, and diabetes-related quality of life during the study period. High levels of participant adherence and the absence of serious intervention-related adverse events further support the practical feasibility and acceptability of the program in a real-world clinical setting.

The multimodal nature of the intervention, incorporating individualized dietary guidance, Dinacharya-based lifestyle modification, yoga, Pranayama, meditation, and behavioral counseling, reflects a comprehensive approach that addresses both metabolic health and overall well-being. Given the observational design and absence of a control group, these findings demonstrate associations over time rather than proof of a treatment effect. Nevertheless, the

results provide preliminary clinical evidence supporting further investigation of structured Ayurveda-informed lifestyle care as an adjunct to established diabetes management.

Considering the growing burden of Type 2 Diabetes and the challenges associated with long-term lifestyle adherence, integrative approaches that combine evidence-informed traditional practices with standard medical care may offer a practical and patient-centered strategy for improving overall health outcomes. Further large-scale, randomized controlled studies with longer follow-up periods are warranted to confirm these observations, explore potential mechanisms, and evaluate the long-term sustainability and broader clinical applicability of such interventions across diverse populations.

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