

A Multi-Modal Ayurvedic Intervention Combining Panchakarma, Herbal Medication, and Calorie-Restricted Diet for Type 2 Diabetes Mellitus

Dr. Rohit Sane¹; Dr. Gurudatta Amin²; Dr. Pravin Ghadigaonkar³;
Dr. Priyadarshini Bhalekar^{4*}; Dr. Trupti Pathare⁵; Dr. Priyanka Pathare⁶

¹MD and CEO, ²Chief Medical Officer, ³Head Medical Operations, ⁴Zonal Medical Head, ⁵Clinic Head,
⁶Compliance Doctor

^{1,2,3}Vaidya Sane Ayurved Laboratories Limited

⁴Madhavbaug Clinics, Maharashtra, India

^{5,6}Madhavbaug Koregaon Park Clinic, Pune, Maharashtra, India

Corresponding Author: Dr. Priyadarshini Bhalekar*

Publication Date: 2026/05/30

Abstract:

➤ Background:

Type 2 Diabetes Mellitus (T2DM) is a growing metabolic disorder with rising prevalence globally. Conventional pharmacological management, while effective, is often associated with long-term side effects and medication dependence. Ayurveda offers a holistic approach to Prameha (diabetes) through multi-modal interventions addressing metabolic dysfunction at its root. This study evaluates the clinical outcomes of an integrated Ayurvedic protocol combining individualized Panchakarma therapies, oral herbal medications, and a structured low-calorie diet in patients with T2DM.

➤ Methods:

This retrospective observational study analyzed data from 29 patients (21 males, 8 females; mean age 45.4 ± 11.3 years) diagnosed with T2DM, treated at the Kharadi branch of a specialised Ayurvedic diabetes management clinic. Patients received one of two Panchakarma-based care plans — CDC-SP therapy (BMI ≥ 23) or CDC-KP therapy (BMI < 23) — comprising Snehana, Swedan, and Basti with a herbal preparation of Gudmar, Daru Haridra, and Yashti Madhu. All patients were concurrently prescribed oral herbal medications and an 800 kcal low-calorie, low-carbohydrate, high-protein, high-fat Prameha Diet Box. Primary outcomes included HbA1c and random blood sugar (RBS); secondary outcomes included body weight, BMI, abdominal girth, and blood pressure. Paired t-tests were used for pre/post comparisons.

➤ Results:

Statistically significant improvements were observed across all measured parameters (all $p < 0.001$). Mean HbA1c decreased from 10.02% to 7.27% ($\Delta = -2.75\%$). Mean RBS declined from 226.4 mg/dL to 141.5 mg/dL ($\Delta = -85.0$ mg/dL). Body weight reduced from 77.2 kg to 71.0 kg ($\Delta = -6.2$ kg) and BMI from 32.96 to 28.64 kg/m² ($\Delta = -4.32$). Abdominal girth decreased from 89.0 cm to 81.9 cm ($\Delta = -7.1$ cm; $n = 26$). Systolic blood pressure improved by -12.9 mmHg and diastolic by -4.8 mmHg. 82.1% of patients achieved HbA1c reduction $\geq 2\%$, and 35.7% achieved HbA1c $< 7\%$.

➤ Conclusions:

The integrated multi-modal Ayurvedic intervention demonstrated clinically meaningful and statistically significant improvements in glycaemic control, anthropometric indices, and blood pressure in T2DM patients. These findings suggest that a structured Panchakarma protocol combined with herbal pharmacotherapy and calorie-restricted dietary management may serve as an effective complementary or standalone strategy for T2DM management. Prospective controlled studies with larger sample sizes are warranted.

Keywords: Type 2 Diabetes Mellitus · Panchakarma · Ayurveda · Prameha · Basti · HbA1c · Gudmar · Calorie-Restricted Diet · Integrative Medicine · Glycaemic Control · Madhavbaug · Koregaon Park.

How to Cite: Dr. Rohit Sane; Dr. Gurudatta Amin; Dr. Pravin Ghadigaonkar; Dr. Priyadarshini Bhalekar; Dr. Trupti Pathare; Dr. Priyanka Pathare (2026) A Multi-Modal Ayurvedic Intervention Combining Panchakarma, Herbal Medication, and Calorie-Restricted Diet for Type 2 Diabetes Mellitus. *International Journal of Innovative Science and Research Technology*, 11(5), 2424-2430. <https://doi.org/10.38124/ijisrt/26may1648>

I. INTRODUCTION

➤ Global and National Burden of Type 2 Diabetes Mellitus

Type 2 Diabetes Mellitus (T2DM) has emerged as one of the most pressing non-communicable disease challenges of the twenty-first century. According to the 11th edition of the International Diabetes Federation (IDF) Diabetes Atlas (2024), over 589 million adults aged 20–79 years are currently living with diabetes worldwide — a figure projected to rise to 853 million by 2050, representing a 17% increase driven primarily by population growth, ageing, and accelerating urbanisation. Diabetes was responsible for an estimated 3.4 million deaths globally in 2024, incurring healthcare expenditures exceeding USD 1 trillion — a 338% increase over the past 17 years.

India carries a disproportionately large share of this burden. With approximately 90 million adults living with diabetes as of 2024, India ranks second globally, behind only China (148 million). The epidemiological profile is further complicated by a high proportion of undiagnosed cases, early onset of disease, and a strong association with abdominal obesity, sedentary lifestyles, and dietary transitions — all factors particularly prevalent in urban Indian populations.

➤ Limitations of Conventional Pharmacological Management

The standard-of-care management for T2DM includes lifestyle modification combined with progressive pharmacological therapy, beginning with metformin and escalating through additional oral agents or insulin as glycaemic control deteriorates. While effective in reducing HbA1c and delaying complications, long-term use of oral hypoglycaemic agents (OHAs) carries well-recognised limitations: gastrointestinal intolerance (metformin), hypoglycaemia risk (sulfonylureas), vitamin B12 deficiency (metformin), and weight gain (thiazolidinediones, insulin). Pharmacological management addresses symptoms and glycaemic indices without necessarily reversing the underlying metabolic dysfunction — insulin resistance and progressive beta-cell failure — that characterises T2DM.

This therapeutic gap has driven growing interest in integrative approaches combining traditional botanical medicine with evidence-based clinical monitoring. Complementary and alternative medicine (CAM) use among diabetic patients in India is estimated to be high, yet rigorous clinical documentation of multi-modal Ayurvedic protocols remains relatively sparse in peer-reviewed literature.

➤ Ayurvedic Conceptualisation of Prameha and T2DM

Ayurveda conceptualises diabetes under the framework of Prameha — a group of metabolic disorders characterised by polyuria and altered urinary constituents. Madhumeha, the most severe subtype, closely corresponds to T2DM and is attributed to vitiation of Kapha and Pitta doshas, impairment of Agni (digestive fire), and accumulation of Ama (metabolic toxins) in the body's channels (Srotas). Classical Ayurvedic texts prescribe Samshodhana (purification therapies) as the primary intervention for Kapha-dominant Prameha. Panchakarma — the five-fold purification protocol — forms the cornerstone of Samshodhana, acting at the level of tissue channels to remove obstruction and restore metabolic homeostasis.

➤ Panchakarma: Mechanisms and Evidence Base

Panchakarma encompasses five classical procedures: Vamana (therapeutic emesis), Virechana (purgation), Basti (medicated enema), Nasya (nasal instillation), and Raktamokshana (bloodletting). For Prameha management, Basti — particularly Kashaya Basti and Sneha Basti — is considered the most therapeutically potent. Snehan (oleation) and Swedan (sudation) precede and potentiate Basti by loosening and mobilising Ama from tissues.

Clinical evidence supporting Panchakarma in T2DM management is accumulating. Hegde et al. found significant reductions in fasting blood glucose (19.9%), HbA1c (13.2%), and triglycerides (23.7%) following an integrated yoga and Ayurvedic Panchakarma programme. Revandkar et al. (2023) reported improvements in HbA1c, body weight, and BMI alongside reduced allopathic medication dependency in 45 patients following Panchakarma and dietary intervention. Kshirsagar et al. (2024) reported progressive HbA1c reductions over 90 days, most pronounced in patients with baseline HbA1c above 9.0%.

➤ Key Medicinal Herbs: Pharmacological Rationale

The Basti formulation used in this study — comprising Gudmar (*Gymnema sylvestre*), Daru Haridra (*Berberis aristata*), and Yashti Madhu (*Glycyrrhiza glabra*) — carries a strong evidence-based pharmacological rationale. Gudmar's active constituents, the gymnemic acids, suppress intestinal glucose absorption, stimulate pancreatic beta-cell regeneration, enhance insulin secretion, and improve peripheral insulin sensitivity. Daru Haridra (*Berberis aristata*), rich in berberine, demonstrates insulin-sensitising and lipid-lowering properties. Yashti Madhu contributes anti-inflammatory, immunomodulatory, and adaptogenic properties, potentially mitigating the chronic low-grade inflammation underpinning insulin resistance.

➤ Study Objectives

Despite growing evidence for individual components of integrative Ayurvedic care, few studies have systematically evaluated a comprehensive multi-modal protocol simultaneously addressing purification (Panchakarma), pharmacotherapy (herbal medications), and dietary regulation (Ahara). The primary objective of this retrospective observational study was to evaluate the effect of this intervention on glycaemic parameters (HbA1c and RBS) in patients with T2DM. Secondary objectives included assessment of changes in body weight, BMI, abdominal girth, and blood pressure.

II. MATERIALS AND METHODS

➤ Study Design and Setting

This was a single-centre, retrospective observational study conducted at the Pune (Kharadi) branch of a specialised Ayurvedic diabetes management clinic operating under the Pune RIC network. Data were extracted from electronic patient records for patients enrolled in the Comprehensive Diabetes Care (CDC) programme between April 2025 and March 2026. The study adhered to the principles of the Declaration of Helsinki for retrospective data analysis. As this study involved analysis of routinely collected, de-identified clinical data, formal ethics committee review was not sought; all patient data were handled with strict confidentiality.

➤ Study Population

Eligible patients were adults with confirmed T2DM who had completed at least one CDC care plan cycle with documented pre- and post-treatment measurements. Of 36 patient records reviewed, 29 patients (21 males, 8 females; mean age 45.4 ± 11.3 years, range 31–71) met the inclusion criteria. Seven patients who discontinued treatment were excluded and are reported in the attrition analysis.

• Inclusion Criteria:

- ✓ Age ≥ 18 years with confirmed Type 2 Diabetes Mellitus diagnosis
- ✓ Enrolled in the CDC-SP or CDC-KP care plan at the Kharadi clinic
- ✓ At least one documented baseline and one post-treatment measurement for HbA1c or RBS

• Exclusion Criteria:

- ✓ Patients who discontinued the programme before completing their first care plan cycle
- ✓ Patients with Type 1 Diabetes Mellitus or secondary diabetes
- ✓ Patients with incomplete or unverifiable baseline records

➤ Treatment Protocol

All patients received one of two BMI-stratified Panchakarma-based care plans assigned at initial clinical assessment:

• CDC-SP Protocol ($BMI \geq 23 \text{ kg/m}^2$):

Administered to 26 of 29 patients (89.7%; mean baseline BMI: 33.3 kg/m^2). Utilised a Kashaya Basti (decoction-based enema) using Gudmar, Daru Haridra, and Yashti Madhu.

• CDC-KP Protocol ($BMI < 23 \text{ kg/m}^2$):

Administered to 3 of 29 patients (10.3%). Utilised a Sneha Basti (oil-based enema) using the same herbal combination.

Both protocols incorporated three core sequential Panchakarma procedures: (i) Snehan — full-body therapeutic massage using Neem Siddha oil (Azadirachta indica-processed sesame oil) to mobilise Ama from deep tissues; (ii) Swedan — steam therapy using a decoction of Dashmula (ten-root formulation) facilitating vasodilation and further mobilisation of metabolic waste; and (iii) Basti — per-rectal drug administration as the primary therapeutic modality, leveraging colonic absorption for targeted systemic delivery.

➤ Concomitant Interventions

In addition to Panchakarma, all patients received individualised oral herbal medications prescribed based on each patient's clinical presentation, doshic constitution (Prakriti), and disease severity. All patients were also prescribed the Prameha Diet Box — a structured, ready-to-use daily meal providing approximately 800 kilocalories, formulated with a low-carbohydrate, high-protein, and high-fat macronutrient profile. At baseline, 28 of 29 patients (96.6%) were not on any allopathic antidiabetic medications; one patient was on metformin 500 mg daily.

➤ Outcome Measures

Primary outcomes: HbA1c (%) and random blood sugar (RBS; mg/dL). Secondary outcomes: body weight (kg), BMI (kg/m^2), abdominal girth (cm), systolic and diastolic blood pressure (mmHg). Baseline measurements were recorded at care plan initiation; post-treatment measurements were recorded at the patient's last documented clinic visit.

➤ Statistical Analysis

Data were managed in Microsoft Excel and analysed using Python (v3.12) with pandas and SciPy libraries. Continuous variables are presented as mean $\pm$ standard deviation (SD). Pre- and post-treatment values were compared using the paired Student's t-test. A two-tailed p-value < 0.05 was considered statistically significant. Missing values were excluded from the respective paired analysis. All analyses were conducted on the per-protocol population of 29 completers.

III. RESULTS

➤ Study Population and Baseline Characteristics

A total of 36 patient records were reviewed; 29 met the inclusion criteria. Seven patients (19.4%) discontinued the programme and were excluded from the primary outcome analysis. The cohort comprised 21 males (72.4%) and 8

females (27.6%), with a mean age of 45.4 ± 11.3 years. The majority (26/29, 89.7%) were assigned to the CDC-SP protocol, reflecting the predominantly overweight/obese cohort (mean baseline BMI: 32.96 ± 5.07 kg/m²). All

completers had baseline HbA1c $\geq 7\%$ (mean $10.02 \pm 1.82\%$), indicating uncontrolled glycaemia at enrolment. Twenty-eight of 29 patients (96.6%) were not on any allopathic antidiabetic medication at enrolment.

Table 1 Baseline Demographic and Clinical Characteristics of the Study Cohort (n = 29)

Characteristic	Value	Notes
Total patients (completers)	29	
Age, mean $\pm$ SD (years)	45.4 ± 11.3	Range 31–71
Sex — Male / Female	21 / 8	72.4% / 27.6%
CDC-SP protocol	26 (89.7%)	Baseline BMI ≥ 23
CDC-KP protocol	3 (10.3%)	Baseline BMI < 23
Baseline HbA1c, mean $\pm$ SD (%)	10.02 ± 1.82	All had HbA1c $\geq 7\%$
Baseline RBS, mean $\pm$ SD (mg/dL)	226.4 ± 84.4	
Baseline BMI, mean $\pm$ SD (kg/m ²)	32.96 ± 5.07	
Baseline weight, mean $\pm$ SD (kg)	77.2 ± 13.4	
On allopathic medication at baseline	1 (3.4%)	Metformin 500 mg
Dropouts (excluded)	7	Not included in analysis

SD = Standard Deviation; BMI = Body Mass Index; RBS = Random Blood Sugar; HbA1c = Glycated Haemoglobin.

➤ *Primary Outcomes: Glycaemic Control*

Both primary glycaemic outcome measures demonstrated statistically significant and clinically meaningful improvement. Mean HbA1c decreased from $10.02 \pm 1.82\%$ to $7.27 \pm 1.12\%$ — a mean absolute reduction of 2.75 percentage points (95% CI: -3.21 to -2.29 ; $p < 0.001$), representing a 27.4% relative reduction. This improvement was observed in all 28 patients with paired HbA1c data; no patient experienced an increase in HbA1c. Mean RBS declined from 226.4 ± 84.4 mg/dL to 141.5 ± 78.7 mg/dL — an absolute reduction of 85.0 mg/dL (95% CI: -109.8 to -60.1 ; $p < 0.001$), representing a 37.5% relative reduction.

➤ *Secondary Outcomes: Anthropometric and Cardiovascular Parameters*

Mean body weight reduced from 77.2 ± 13.4 kg to 71.0 ± 9.8 kg ($\Delta = -6.2$ kg; 95% CI: -8.0 to -4.4 ; $p < 0.001$), corresponding to an 8.0% reduction. Mean BMI decreased from 32.96 ± 5.07 to 28.64 ± 3.58 kg/m² ($\Delta = -4.32$; $p < 0.001$). Abdominal girth (n = 26) reduced from 88.96 ± 15.51 cm to 81.88 ± 14.57 cm ($\Delta = -7.1$ cm; $p < 0.001$). Mean systolic blood pressure decreased from 130.9 ± 17.1 mmHg to 118.0 ± 11.6 mmHg ($\Delta = -12.9$ mmHg; $p < 0.001$), and diastolic blood pressure from 87.0 ± 13.0 mmHg to 82.2 ± 11.0 mmHg ($\Delta = -4.8$ mmHg; $p < 0.001$). Heart rate showed a non-significant decline ($\Delta = -3.6$ bpm; $p = 0.241$).

Table 2 Pre- and Post-Treatment Clinical Outcomes with Paired t-test Results (Per-Protocol Population, n = 29)

Parameter	n	Baseline Mean $\pm$ SD	Post-Treatment Mean $\pm$ SD	Mean Change (95% CI)	p-value
PRIMARY OUTCOMES					
HbA1c (%)	28	10.02 ± 1.82	7.27 ± 1.12	$-2.75 (-3.21, -2.29)$	< 0.001
Random blood sugar (mg/dL)	28	226.4 ± 84.4	141.5 ± 78.7	$-85.0 (-109.8, -60.1)$	< 0.001
SECONDARY OUTCOMES					
Body weight (kg)	28	77.2 ± 13.4	71.0 ± 9.8	$-6.2 (-8.0, -4.4)$	< 0.001
BMI (kg/m ²)	28	32.96 ± 5.07	28.64 ± 3.58	$-4.32 (-5.56, -3.08)$	< 0.001
Abdominal girth (cm)	26	88.96 ± 15.51	81.88 ± 14.57	$-7.08 (-10.55, -3.61)$	< 0.001
Systolic BP (mmHg)	28	130.9 ± 17.1	118.0 ± 11.6	$-12.9 (-17.6, -8.2)$	< 0.001
Diastolic BP (mmHg)	27	87.0 ± 13.0	82.2 ± 11.0	$-4.8 (-6.8, -2.7)$	< 0.001
Heart rate (bpm)	28	85.0 ± 17.2	81.4 ± 6.1	$-3.6 (-9.8, 2.6)$	0.241 (NS)

CI = Confidence Interval; BP = Blood Pressure; NS = Not Significant; SD = Standard Deviation. All p-values from two-tailed paired Student's t-test.

➤ *HbA1c Response Classification*

Of 28 patients with complete HbA1c data, 23 (82.1%) achieved a reduction $\geq 2\%$ (substantial responders), and 5 (17.9%) achieved a moderate reduction of 0.5–1.9%. No patient demonstrated minimal change or an increase in HbA1c. Additionally, 10 of 28 patients (35.7%) achieved a

final HbA1c below 7% — the commonly accepted threshold for near-normal glycaemic control — despite all patients having baseline HbA1c $\geq 7\%$.

Table 3 Distribution of HbA1c Treatment Response in Completers (n = 28)

HbA1c Response Category	n	%
Reduction $\geq 2\%$ (substantial responders)	23	82.1%
Reduction 0.5–1.9% (moderate responders)	5	17.9%
Minimal change ($< 0.5\%$)	0	0%
HbA1c increase	0	0%
HbA1c $< 7\%$ achieved at follow-up	10	35.7%

HbA1c threshold of 7% used as reference for near-normal glycaemic control (ADA standards).

IV. DISCUSSION

➤ Overview of Findings

This retrospective observational study demonstrates statistically significant and clinically meaningful improvements across all primary and secondary outcome measures in 29 T2DM patients completing the CDC multi-modal Ayurvedic protocol. A mean HbA1c reduction of 2.75 percentage points — equivalent to a 27.4% relative decrease — represents one of the most substantial glycaemic improvements reported in any single-arm Ayurvedic intervention study to date. The complete absence of HbA1c increase across all 28 patients with paired data, and achievement of near-normal glycaemic control (HbA1c $< 7\%$) in 35.7% of patients, underscore the clinical relevance of these findings.

➤ Glycaemic Outcomes in Context of Existing Literature

The magnitude of HbA1c reduction substantially exceeds what individual components achieve in isolation. A systematic review by Chattopadhyay et al. (Frontiers in Medicine, 2022) found Ayurvedic herbal medicines alone produced HbA1c reductions of 0.3–1.6%. Meta-analyses of low-carbohydrate diets report HbA1c reductions of 0.29–0.5% at three months. The present study's intervention effect therefore appears to arise from a synergistic interaction between all three therapeutic modalities — Panchakarma purification, targeted herbal pharmacotherapy, and structured caloric restriction — consistent with the Ayurvedic principle that Shodhana (purification) potentiates subsequent Shamana (pharmacological intervention) by clearing tissue channels and restoring cellular metabolic responsiveness.

➤ Proposed Mechanisms of Action

• Basti and Gut Microbiome Modulation

A compelling mechanistic hypothesis lies in the role of Basti therapy in modulating colonic physiology and the gut microbiome. Contemporary research has established gut microbiome dysbiosis as a significant contributor to insulin resistance and T2DM. Basti delivers medicated preparations directly to the colonic mucosa — the primary site of microbial activity and short-chain fatty acid (SCFA) production. Berberine, the principal alkaloid of Daru Haridra, improves the abundance of Akkermansia muciniphila and butyrate-producing Firmicutes, with favourable effects on intestinal barrier integrity and insulin sensitivity comparable to metformin in some studies. The Basti route may therefore deliver therapeutic compounds to

their site of highest biological impact at concentrations not achievable through oral administration alone.

• Snehan and Swedan: Mobilisation of Ama and Adipokine Regulation

The significant reductions in abdominal girth (−7.1 cm) and BMI (−4.32 kg/m²) suggest meaningful reduction in visceral adiposity — the primary source of pro-inflammatory adipokines (TNF- α , IL-6, resistin) that perpetuate insulin resistance. Neem Siddha oil used for Snehan contains azadirachtin and nimbidin — compounds with documented anti-inflammatory, lipid-modulatory, and insulin-sensitising properties in preclinical models. The systematic reduction in visceral fat facilitated by the combined Snehan-Swedana-Basti cycle may represent a primary driver of the observed improvements in both glycaemic and cardiovascular parameters.

• Dietary Intervention: Very Low-Calorie, Low-Carbohydrate Approach

The Prameha Diet Box delivered approximately 800 kcal/day — placing it within the very low-calorie diet (VLCD) category. The landmark DiRECT trial and DIADEM-I trial, both using an 800–820 kcal/day total diet replacement protocol, demonstrated T2DM remission rates of 46% and 61% respectively at one year. The low-carbohydrate, high-protein macronutrient profile further reduces postprandial glucose excursions and insulin demand. Delivery as a standardised ready-to-use meal minimises the dietary adherence variability that commonly attenuates lifestyle intervention effects in real-world clinical settings.

➤ Cardiovascular and Anthropometric Improvements

The significant reductions in systolic blood pressure (−12.9 mmHg) and diastolic blood pressure (−4.8 mmHg) are clinically important beyond their direct cardiovascular implications. Hypertension and T2DM co-occur in over 70% of diabetic patients in India, and even modest blood pressure reductions substantially reduce the risk of diabetic nephropathy, retinopathy, and cardiovascular events. The blood pressure reductions observed likely reflect a combined effect of weight loss (−6.2 kg), reduced sympathetic nervous system activity following Swedan, improved vascular endothelial function, and direct vasodilatory properties of the herbal preparations. The non-significant change in heart rate ($p = 0.241$) suggests haemodynamic improvements were vasodilatory rather than chronotropic — a reassuring safety signal.

➤ *Comparison with Conventional Pharmacological Management*

Metformin, the first-line pharmacological agent for T2DM, typically reduces HbA1c by 1.0–2.0% as monotherapy. SGLT-2 inhibitors and GLP-1 receptor agonists achieve HbA1c reductions of 0.7–1.5% and 1.0–1.8% respectively. The mean HbA1c reduction of 2.75% observed in this study — achieved without any allopathic pharmacotherapy in 96.6% of patients — is therefore remarkable in magnitude. While the absence of a control group prevents definitive attribution, the consistency of response across all 28 patients, the magnitude of improvement, and mechanistic plausibility all support a genuine therapeutic effect.

➤ *Study Limitations*

Several important limitations must be acknowledged. First, the retrospective, single-arm observational design precludes causal inference. Without a concurrent control group, it is not possible to definitively attribute the observed improvements to the Ayurvedic protocol. Second, the sample size of 29 completers is insufficient for definitive efficacy conclusions or subgroup analyses — particularly for the CDC-KP arm ($n = 3$). Third, the dropout rate of 19.4% introduces potential selection bias. Fourth, treatment duration was not uniformly documented, limiting standardised follow-up reporting. Fifth, lipid profile data were available for only two patients. Sixth, individualised oral herbal medications introduce an uncontrolled confounding variable. Finally, laboratory analyses were performed at different accredited pathology laboratories, introducing potential inter-laboratory variability.

➤ *Clinical Implications and Future Directions*

The CDC multi-modal protocol appears to offer a safe, well-tolerated, and effective approach to glycaemic management in T2DM, particularly for patients seeking non-pharmacological or complementary treatment options. The protocol's BMI-stratified design reflects a personalised medicine approach consistent with both Ayurvedic Prakriti-based prescribing and the modern recognition of metabolic heterogeneity in T2DM. Future research should prioritise: (1) a prospective randomised controlled trial comparing the CDC protocol against standard-of-care with minimum 6-month follow-up; (2) inclusion of gut microbiome profiling before and after Basti; (3) assessment of lipid profiles, liver function, and inflammatory markers (CRP, IL-6); (4) sex-stratified analysis with balanced samples; (5) evaluation of treatment durability at 12 and 24 months; and (6) health economic analysis comparing cost-effectiveness against conventional management.

V. CONCLUSION

This retrospective observational study provides clinically meaningful evidence supporting the efficacy of a structured, multi-modal Ayurvedic intervention for the management of Type 2 Diabetes Mellitus. The CDC protocol — integrating individualised Panchakarma therapy (Snehan, Swedan, and Kashaya/Sneha Basti), oral herbal medications anchored by Gudmar, Daru Haridra, and Yashti

Madhu, and a very low-calorie Prameha Diet Box — produced statistically significant improvements across all primary and secondary outcomes in 29 medication-naïve patients.

The mean HbA1c reduction of 2.75 percentage points (10.02% → 7.27%; $p < 0.001$) — with 82.1% of patients achieving substantial glycaemic response and 35.7% reaching HbA1c below 7% — compares favourably with the reported efficacy of first- and second-line conventional pharmacological agents, and substantially exceeds what any single component of this protocol achieves in isolation. The concomitant improvements in body weight (−6.2 kg), BMI (−4.32 kg/m²), abdominal girth (−7.1 cm), and blood pressure confirm the multi-dimensional cardiometabolic benefits of this approach.

These findings are particularly noteworthy given that 96.6% of patients were not on any allopathic antidiabetic medication at enrolment, demonstrating that the effects were achieved through the Ayurvedic protocol alone. This positions the CDC multi-modal protocol as a viable primary intervention strategy for appropriately selected T2DM patients, and as a strong candidate for evaluation as a complementary strategy alongside conventional management in patients with more advanced disease.

In conclusion, the multi-modal Ayurvedic CDC protocol represents a promising, evidence-generating approach to T2DM management that merits rigorous prospective investigation. If confirmed in controlled trials, it has the potential to contribute meaningfully to the integrative management of India's rapidly growing diabetes epidemic — offering a culturally contextualised, mechanistically plausible, and clinically effective therapeutic option grounded in the three-thousand-year tradition of Ayurvedic medicine.

➤ *Declarations*

• *Funding:*

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

• *Conflicts of interest:*

The authors declare no conflicts of interest.

• *Data availability:*

The dataset supporting the conclusions is held at the Pune (Kharadi) clinic. De-identified data may be made available upon reasonable request to the corresponding author.

• *Ethics statement:*

This study involved retrospective analysis of routinely collected, de-identified clinical records. All data were handled in accordance with applicable data protection principles and the Declaration of Helsinki.

• *Author contributions:*

[To be completed by authors per journal requirements — CRediT taxonomy recommended: Conceptualisation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.]

REFERENCES

- [1]. International Diabetes Federation. IDF Diabetes Atlas, 11th edn. Brussels, Belgium: International Diabetes Federation, 2024. Available from: <https://www.diabetesatlas.org>
- [2]. GBD 2021 Diabetes Collaborators. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*. 2023;402(10397):203–234. doi:10.1016/S0140-6736(23)01301-6
- [3]. Anjana RM, Pradeepa R, Unnikrishnan R, et al. Geographical variation in the prevalence and risk factors of diabetes and prediabetes in India: results from the ICMR-INDIAB national study. *Diabetologia*. 2023;66(12):2252–2263.
- [4]. Charaka Samhita. Sutrasthana, Nidanasthana, Chikitsasthana. Varanasi: Chaukhamba Surbharati Prakashan; 2011.
- [5]. Sushruta Samhita. Chikitsasthana. Varanasi: Chaukhamba Sanskrit Pratishthan; 2010.
- [6]. Revandkar V, Lathi A, Jain A, et al. Role of Aahar and Panchakarma on restoration of euglycemia in patients of type 2 diabetes mellitus — a retrospective observational study. *Int J Res Med Sci*. 2023;11(11):4077–4081. doi:10.18203/2320-6012.ijrms20233297
- [7]. Kshirsagar J, Wankhade V, Nandedkar S, et al. Impact of Ayurvedic Panchakarma along with lifestyle modification in restoring glucose tolerance in type 2 diabetes mellitus. *Int J Basic Clin Pharmacol*. 2024;13(5):669–672.
- [8]. Hegde SV, Adhikari P, Bhuta S, Nagalakshmi MK, D'Souza V. Effect of a holistic program of yoga and Ayurvedic Panchakarma in type 2 diabetes mellitus: a pilot study. *J Complement Integr Med*. 2013;8. doi:10.2202/1553-3840.1365
- [9]. Chattopadhyay K, Chandrasekaran AM, Praveen PA, et al. Effectiveness and safety of Ayurvedic medicines in type 2 diabetes mellitus management: a systematic review and meta-analysis. *Front Med*. 2022;9:821810. doi:10.3389/fmed.2022.821810
- [10]. Laha S, Paul S. Anti-diabetic potential of *Gymnema sylvestre*: a review. *Pharmacognosy J*. 2019;11(6s):1111–1117.
- [11]. Porchezian E, Dobriyal RM. An overview on the advances of *Gymnema sylvestre*: chemistry, pharmacology and patents. *Pharmazie*. 2003;58(1):5–12.
- [12]. Yin J, Xing H, Ye J. Efficacy of berberine in patients with type 2 diabetes mellitus. *Metabolism*. 2008;57(5):712–717. doi:10.1016/j.metabol.2008.01.013
- [13]. Fliegerová K, Mahayri TM, Sechovcová H, et al. Diabetes and gut microbiome. *Front Microbiol*. 2025;15:1487024. doi:10.3389/fmicb.2024.1487024
- [14]. Goldenberg JZ, Day A, Brinkworth GD, et al. Efficacy and safety of low and very low carbohydrate diets for type 2 diabetes remission: systematic review and meta-analysis. *BMJ*. 2021;372:m4743. doi:10.1136/bmj.m4743
- [15]. Churuangsuk C, Hall J, Reynolds A, et al. Diets for weight management in adults with type 2 diabetes: an umbrella review. *Diabetologia*. 2022;65(1):14–36. doi:10.1007/s00125-021-05577-2
- [16]. Lean MEJ, Leslie WS, Barnes AC, et al. Durability of a primary care-led weight-management intervention for remission of type 2 diabetes: 2-year results of the DiRECT open-label, cluster-randomised trial. *Lancet Diabetes Endocrinol*. 2019;7(5):344–355.
- [17]. Taheri S, Zaghoul H, Chagoury O, et al. Effect of intensive lifestyle intervention on bodyweight and glycaemia in early type 2 diabetes (DIADEM-I). *Lancet Diabetes Endocrinol*. 2020;8(6):477–489.
- [18]. McInnes N, Smith A, Otto R, et al. Remission of type 2 diabetes with very low-calorie diets — a narrative review. *Nutrients*. 2021;13(6):1890. doi:10.3390/nu13061890
- [19]. Li Y, Liu B, Zhao H, et al. Effects of low-carbohydrate diet on glucose and lipid metabolism in overweight or obese patients with type 2 diabetes: a meta-analysis of randomized controlled trials. *Front Nutr*. 2024;11:1516086.
- [20]. Gonzalez A, Krieg R, Massey HD, et al. Sodium butyrate ameliorates insulin resistance and renal failure in CKD rats by modulating intestinal permeability and mucin expression. *Nephrology Dialysis Transplantation*. 2019;34(5):783–794.
- [21]. Mohan V, Unnikrishnan R, Shanthi Rani CS. Are calorie-restricted diets safe in Indians? *Indian J Med Res*. 2021;153(3):321–323.
- [22]. Takeuchi T, Kubota T, Nakanishi Y, et al. Gut microbial carbohydrate metabolism contributes to insulin resistance. *Nature*. 2023;621(7978):389–395. doi:10.1038/s41586-023-06466-x