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Research article

Short-Term Outcomes of a Structured Ayurvedic Multimodal Protocol in Type 2 Diabetes Mellitus: Real-World Evidence from a Tier-2 Indian City

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) imposes a disproportionate burden in semi-urban and tier-2 cities of India, where access to specialist care is limited and treatment adherence is challenging. Ayurveda offers a comprehensive metabolic framework for Prameha management through Panchakarma bio-purification, dietary correction, and herbal therapy. Real-world outcome data from structured Ayurvedic protocols in non-metropolitan settings are lacking.

Objectives: To evaluate the short-term effect of a structured Ayurvedic multimodal protocol — comprising BMI-stratified Panchakarma (CDC-SP and CDC-KP), an 800 kcal Prameha diet, and individualized herbal medication — on glycemic, anthropometric, and hemodynamic parameters in T2DM patients at a tier-2 clinic, and to assess antidiabetic drug reduction.

Outcomes included HbA1c, RBS, weight, BMI, abdominal girth, blood pressure, and medication status. Paired t-tests were used for within-group comparisons.

Results: Significant improvements were observed across all primary parameters. HbA1c declined from 9.10 ± 1.80% to 7.59 ± 1.54% (Δ −1.51 ± 1.12%, p<0.001). RBS reduced from 241.5 ± 77.9 to 177.2 ± 83.1 mg/dL (Δ −64.3 mg/dL, p<0.001). Weight reduced by 3.58 ± 2.70 kg (p<0.001) and abdominal girth by 3.19 ± 2.60 cm (p<0.001). DBP and SBP showed significant reductions (p<0.001 and p=0.016 respectively). Post-treatment, 51.2% of patients achieved HbA1c <7% and 26.8% reached the <6.5% remission threshold. A notable multi-cycle response pattern was observed: CDC SP Cycle 1 patients achieved the greatest HbA1c reduction (Δ −2.08%), compared to Cycle 2 (Δ −1.36%) and Cycle 3 (Δ −1.08%). Overall, 55.6% of patients achieved partial to complete antidiabetic drug reduction.

Conclusion: A structured Ayurvedic multimodal protocol delivered in a tier-2 clinical setting produced clinically significant short-term improvements in glycemic and cardiometabolic parameters in T2DM patients. The multi-cycle data suggests cumulative but diminishing returns across successive Panchakarma cycles — a novel observation warranting prospective investigation.

1. Introduction

India's diabetes burden is no longer a metropolitan phenomenon. Tier-2 and tier-3 cities now carry a disproportionate share of the 101 million people living with T2DM in India[1] — a population that faces unique challenges: limited endocrinology specialist access, high reliance on general practitioners, lower health literacy, and significant economic constraints on sustained pharmacotherapy.[2] While urban tertiary centers have seen growing integrative medicine infrastructure, evidence from non-metropolitan integrative clinics remains sparse.

Ayurveda conceptualizes diabetes mellitus within the framework of *Prameha*, with *Madhumeha* representing its most severe form — a condition of *Kapha-Medovaha Srotas* dysfunction resulting in impaired glucose metabolism, dyslipidemia, and systemic metabolic dysregulation.[3] The *Charaka Samhita* prescribes a stratified management framework: *Shodhana* (bio-purificatory) therapy for the obese *Pramehin* and *Brimhana* (nourishing) therapy for the lean — a BMI-stratified approach that directly informs the CDC protocol examined in this study.[4]

Panchakarma, comprising *Snehan* (oleation), *Swedan* (sudation), and *Basti* (medicated per-rectal therapy), constitutes the cornerstone of Ayurvedic metabolic intervention. The herbal formulations used in Basti — *Gudmar* (*Gymnema sylvestre*), *Daru Haridra* (*Berberis aristata*), and *Yashti Madhu* (*Glycyrrhiza glabra*) — carry substantial pharmacological evidence for antihyperglycemic, AMPK-activating, and insulin-sensitizing mechanisms.[5,6,7]

In parallel, the DiRECT trial demonstrated that an intensive 825–853 kcal/day formula diet achieved T2DM remission in 46% of participants at one year.[8] The Prameha diet box used in this protocol (800 kcal/day, low-carbohydrate, high-protein) mirrors this evidence-based dietary approach within an Ayurvedic-aligned food framework suited to Indian patients.

A distinctive feature of the Latur dataset is the presence of multi-cycle treatment data — patients who completed Panchakarma Cycle 1 and subsequently enrolled in Cycle 2 or Cycle 3. This provides a rare opportunity to examine the dose-response relationship of repeated Panchakarma cycles in T2DM management, a question unaddressed in the existing literature.

This study reports retrospective outcomes from 46 T2DM patients treated at the Madhavbaug Clinics, Prakash Nagar branch, Latur — a tier-2 city in Marathwada, Maharashtra — using the structured CDC Ayurvedic multimodal protocol.

2. Materials and Methods

2.1 Study Design and Setting

This was a retrospective observational study conducted at Madhavbaug Clinics, Prakash Nagar branch, Latur, Maharashtra, India. Latur is a tier-2 city in the Marathwada region with a population of approximately 500,000, characterized by semi-urban demographics, mixed agricultural-commercial economy, and limited access to specialist tertiary diabetes care. Data were extracted from electronic clinical records of patients enrolled in the CDC (Chronic Disease Control) diabetes management program. The study was conducted in accordance with the principles of the Declaration of Helsinki.

2.2 Study Participants

Patients with a confirmed diagnosis of T2DM who completed at least one CDC intervention cycle and had documented pre- and post-treatment clinical parameters were included. Patients without baseline HbA1c or blood glucose values were excluded. Forty-six patients met inclusion criteria. Patients who had completed multiple treatment cycles (CDC SP 2, CDC SP 3, CDC KP 2) were analyzed both as part of the overall cohort and separately in the multi-cycle subgroup analysis.

2.3 Intervention Protocol

2.3.1 BMI-Stratified Panchakarma Therapy

The CDC protocol assigns patients to one of two Panchakarma arms based on baseline BMI, following the classical Ayurvedic distinction between *Sthula Pramehin* (obese diabetic) and *Krisha Pramehin* (lean diabetic):

- CDC-SP (Shodhana Protocol, BMI ≥23 kg/m², n=35): Bio-purificatory Panchakarma aimed at reducing Kapha-Meda accumulation and resolving Srotovarodha (metabolic channel obstruction). Some patients enrolled for a second or third cycle (CDC SP 2, n=12; CDC SP 3, n=7).
- CDC-KP (Brimhana Protocol, BMI <23 kg/m², n=11): Nourishing-supportive Panchakarma aimed at strengthening Dhatu metabolism. A second cycle was completed by 2 patients (CDC KP 2).

Snehan (Oleation): External Abhyanga with Neem Siddha Taila — a medicated oil processed with *Azadirachta indica*, possessing antihyperglycemic and anti-inflammatory properties.[9]

Swedan (Sudation): Medicated steam therapy using Dashmula Kwath (decoction of ten classical roots), promoting metabolic clearance of *Ama* and stimulating peripheral circulation.[10]

Basti (Per-rectal Medicated Therapy):

- CDC-SP Basti: Kwath (decoction-based) preparation of Gudmar (Gymnema sylvestre), Daru Haridra (Berberis aristata), and Yashti Madhu (Glycyrrhiza glabra) — providing water-soluble active constituents including gymnemic acids, berberine, and glycyrrhizin via colonic absorption.
- CDC-KP Basti: Oil-based Anuvasana preparation of the same three herbs — providing lipid-soluble delivery suited to the lean metabolic constitution and Vata-predominant pathology.

A mean of 10.5 ± 4.2 Panchakarma sessions were administered per patient. 65.1% of patients completed 10 or more sessions across their treatment cycle.

2.3.2 Prameha Diet Box (Very-Low-Calorie Dietary Intervention)

All patients received a standardized ready-to-use meal box (Prameha Diet Box) providing approximately 800 kcal/day: low carbohydrate, high protein, moderate fat — consistent with the DiRECT trial dietary approach and aligned with Ayurvedic dietary principles for Prameha management (restriction of Madhura and Snigdha Rasa, emphasis on Laghu and Rooksha foods).

2.3.3 Individualized Herbal Medication

Individualized oral herbal medications were prescribed by the treating Ayurvedic physician based on the patient's *Prakriti*, *Vikriti*, and comorbidity profile. Commonly prescribed formulations included Gudmar preparations, Vijayasar (*Pterocarpus marsupium*), Haridra (*Curcuma longa*), Methi (*Trigonella foenum-graecum*), and Triphala. All formulations were entirely herbal.

2.4 Outcome Measures

Primary outcomes were change in HbA1c (%) and antidiabetic medication status. Secondary outcomes included: RBS (mg/dL), body weight (kg), BMI (kg/m²), abdominal girth (cm), SBP and DBP (mmHg), heart rate (bpm). A multi-cycle subgroup analysis examined HbA1c and RBS reduction across CDC SP Cycles 1, 2, and 3, and CDC KP Cycles 1 and 2. Drug reduction was categorized as complete cessation (100%), partial reduction (1–99%), or no change (0%).

2.5 Statistical Analysis

Data were analyzed using Python (pandas v2.x, scipy.stats). Descriptive statistics are presented as mean ± SD. Pre- and post-intervention comparisons were made using the paired Student's t-test (two-tailed; significance $p<0.05$). Subgroup analyses were performed for CDC-SP vs. CDC-KP and male vs. female. Multi-cycle subgroup analysis compared mean changes across treatment cycles. Heart rate analysis is reported with its p-value (0.052) and designated borderline non-significant.

3. Results

3.1 Baseline Characteristics

Forty-six patients with T2DM were enrolled (32 male, 14 female; mean age 46.5 ± 11.1 years; range 22–67 years). The majority had isolated T2DM (n=17, 37.0%); comorbidities included hypertension (n=6, 13.0%) and obesity (n=3, 6.5%). Two patients were documented as 'Not Diagnosed Yet' — likely early-stage or borderline hyperglycemia cases referred for preventive intervention. Thirty-five patients (76.1%) were assigned to CDC-SP (BMI ≥23 kg/m²) and 11 (23.9%) to CDC-KP (BMI <23 kg/m²). Mean follow-up was 66 ± 53 days (median 50 days, IQR 28–82 days). Mean PK sessions completed: 10.5 ± 4.2; 65.1% completed ≥10 sessions.

Baseline HbA1c severity: 4 patients (8.9%) controlled (<7%), 19 (42.2%) at 7–9%, 17 (37.8%) at 9–12%, and 4 (8.9%) severely uncontrolled (≥12%) — representing a predominantly uncontrolled cohort.

Table 1. Baseline Characteristics of Study Cohort

Parameter	Overall (n=46)	CDC-SP (n=35)	CDC-KP (n=11)
Age (years)	46.5 ± 11.1	47.6 ± 11.5	42.9 ± 9.2
Sex (M/F)	32/14	23/12	9/2

Parameter	Overall (n=46)	CDC-SP (n=35)	CDC-KP (n=11)
Baseline BMI (kg/m²)	27.73 ± 5.85	31.40 ± 4.21	23.09 ± 2.9
Weight (kg)	75.8 ± 14.7	80.3 ± 13.5	61.9 ± 10.8
HbA1c (%)	9.10 ± 1.80	8.67 ± 1.81	10.41 ± 0.94
RBS (mg/dL)	241.5 ± 77.9	230.1 ± 73.2	275.8 ± 90.7
SBP (mmHg)	132.2 ± 18.6	135.8 ± 18.5	121.7 ± 14.5
DBP (mmHg)	87.7 ± 11.5	88.4 ± 12.1	85.5 ± 9.7
Abdominal Girth (cm)	101.6 ± 12.1	106.8 ± 12.2	87.5 ± 9.6
Mean PK Sessions	10.5 ± 4.2	—	—
Mean Follow-up (days)	66 ± 53	—	—

3.2 Primary and Secondary Clinical Outcomes

Statistically significant improvements were observed for all primary parameters and most secondary parameters (Table 2). HbA1c declined from 9.10 ± 1.80% to 7.59 ± 1.54% (Δ −1.51 ± 1.12%, p<0.001), a 16.0% relative reduction. Post-treatment, 51.2% of patients achieved HbA1c <7.0% and 26.8% reached the ADA remission threshold of <6.5%.[12] RBS declined from 241.5 ± 77.9 to 177.2 ± 83.1 mg/dL (Δ −64.3 mg/dL, −25.6%, p<0.001). Significant anthropometric improvement was seen: weight −3.58 kg (p<0.001), BMI −1.31 kg/m² (p<0.001), and abdominal girth −3.19 cm (p<0.001). DBP improved significantly (Δ −7.44 mmHg, p<0.001); SBP reduction reached statistical significance (Δ −6.81 mmHg, p=0.016). Heart rate showed a borderline reduction (Δ −4.78 bpm, p=0.052).

Table 2. Pre- vs. Post-Intervention Clinical Outcomes

Parameter	n	Pre (Mean ± SD)	Post (Mean ± SD)	Δ (Mean ± SD)	% Change	p-value
HbA1c (%)	41	9.10 ± 1.80	7.59 ± 1.54	−1.51 ± 1.12	−16.0%	<0.001
RBS (mg/dL)	44	241.5 ± 77.9	177.2 ± 83.1	−64.3 ± 71.8	−25.6%	<0.001
Weight (kg)	45	75.8 ± 14.7	72.2 ± 14.2	−3.58 ± 2.70	−4.7%	<0.001
BMI (kg/m²)	23	28.51 ± 5.85	27.20 ± 5.93	−1.31 ± 0.93	−4.8%	<0.001

Parameter	n	Pre (Mean ± SD)	Post (Mean ± SD)	Δ (Mean ± SD)	% Change	p-value
Abdominal Girth (cm)	37	101.6 ± 12.1	98.4 ± 11.7	−3.19 ± 2.60	−3.1%	<0.001
SBP (mmHg)	43	132.2 ± 18.6	125.4 ± 11.2	−6.81 ± 17.72	−3.7%	0.016
DBP (mmHg)	43	87.7 ± 11.5	80.2 ± 7.7	−7.44 ± 12.55	−7.3%	<0.001
Heart Rate (bpm)	23	86.5 ± 12.2	81.7 ± 10.6	−4.78 ± 11.16	−4.6%	0.052 (ns)

3.3 HbA1c Achievement Targets

Post-treatment HbA1c distribution reflects clinically meaningful glycemic improvement across the cohort:

Table 3. Post-Treatment HbA1c Achievement (n=41)

HbA1c Threshold	Patients Achieving (n)	% of Cohort	Clinical Interpretation
< 6.5%	11	26.8%	Diabetes remission threshold (ADA 2023)
< 7.0%	21	51.2%	Glycemic control target (ADA standard of care)
< 8.0%	31	75.6%	Acceptable control in complex patients
> 8.0%	10	24.4%	Suboptimal control — may need repeat cycle

3.4 Antidiabetic Medication Reduction

Medication status was documented in 45 patients. 6 patients (13.3%) achieved complete cessation of antidiabetic medications; 19 (42.2%) achieved partial dose reduction; 20 (44.4%) had no change in their medication regimen. Overall, 55.6% of patients achieved some degree of medication reduction, with a mean reduction of 32.4% (median 0.5% — reflecting skewed distribution due to the high proportion of no-change patients).

Table 4. Antidiabetic Medication Reduction

Category	n	% of Cohort	Mean % Reduction	Clinical Significance
Complete cessation (100%)	6	13.3%	100%	All antidiabetic drugs stopped
Partial reduction (1–99%)	19	42.2%	~50% (estimated)	Dose or number reduced
No change (0%)	20	44.4%	0%	Medications unchanged
Any reduction (≥1%)	25	55.6%	—	Partial to full drug reduction

3.5 Multi-Cycle Treatment Analysis

A defining feature of the Latur dataset is the presence of patients enrolled in successive treatment cycles (CDC SP 1, 2, 3; CDC KP 1, 2). This provides preliminary insight into the pattern of glycemic response across repeated Panchakarma cycles — a question unexplored in the integrative diabetes literature (Table 5).

CDC SP Cycle 1 patients (n=16) achieved the greatest mean HbA1c reduction (Δ −2.08%), while Cycle 2 (n=12) and Cycle 3 (n=7) showed progressively attenuated reductions (Δ −1.36% and Δ −1.08% respectively). This diminishing-returns pattern likely reflects selection bias — patients progressing to Cycle 2 and 3 were those whose glycemia was more refractory after the first cycle — rather than reduced protocol efficacy per se. Notably, weight reduction was maintained across all cycles (Δ −3.9 kg for both SP1 and SP2).

Table 5. Multi-Cycle Response Analysis — HbA1c, RBS, and Weight

Treatment Cycle	n	HbA1c Pre	HbA1c Post	Δ HbA1c	RBS Δ (mg/dL)	Weight Δ (kg)
CDC SP — Cycle 1	16	8.77%	6.69%	−2.08	−85.9	−3.9
CDC SP — Cycle 2	12	8.71%	7.35%	−1.36	−64.3	−3.9
CDC SP — Cycle 3	7	8.27%	7.18%	−1.08	−33.7	−5.0
CDC KP — Cycle 1	9	9.70%	7.56%	−2.14	−34.7	−1.9
CDC KP — Cycle 2	2	11.70%	9.35%	−2.35	−153.0	−2.1

Note: CDC KP Cycle 2 has n=2; values are descriptive only and not statistically inferential.

3.6 Subgroup Analysis: CDC-SP vs. CDC-KP

Both treatment arms demonstrated statistically significant improvements in most parameters (Table 6). CDC-SP showed significant SBP and DBP reductions, consistent with the higher baseline blood pressure in this group. CDC-KP showed a borderline RBS reduction (p=0.061), likely due to the small sample size (n=11) rather than lack of effect — the absolute RBS reduction (−56.2 mg/dL) was clinically meaningful. Notably, CDC-KP patients had higher baseline HbA1c (10.41 vs. 8.67%) and achieved greater absolute HbA1c reduction (Δ −1.74 vs. −1.44%).

Table 6. Subgroup Outcomes — CDC-SP vs. CDC-KP

Parameter	CDC-SP (n=35) Pre → Post (Δ)	p	CDC-KP (n=11) Pre → Post (Δ)	p
HbA1c (%)	8.67 → 7.24 (Δ −1.44 ± 1.14)	<0.001	10.41 → 8.67 (Δ −1.74 ± 1.08)	0.001
RBS (mg/dL)	230.1 → 163.1 (Δ −67.0 ± 66.8)	<0.001	275.8 → 219.6 (Δ −56.2 ± 88.1)	0.061
Weight (kg)	80.3 → 76.2 (Δ −4.12 ± 2.80)	<0.001	61.9 → 60.0 (Δ −1.91 ± 1.48)	0.002
BMI (kg/m²)	31.4 → 29.9 (Δ −1.47 ± 1.06)	<0.001	23.1 → 22.1 (Δ −1.02 ± 0.58)	0.002
Abdominal Girth (cm)	106.8 → 103.0 (Δ −3.81 ± 2.68)	<0.001	87.5 → 86.0 (Δ −1.50 ± 1.43)	0.009
SBP (mmHg)	135.8 → 126.6 (Δ −9.19 ± 18.50)	0.009	121.7 → 121.8 (Δ +0.09 ± 13.64)	0.983
DBP (mmHg)	88.4 → 81.3 (Δ −7.19 ± 13.26)	0.005	85.5 → 77.3 (Δ −8.18 ± 10.79)	0.031

3.7 Sex Subgroup Analysis

Both male and female patients showed statistically significant HbA1c improvements. Male patients (n=30): 9.21 → 7.65% (Δ −1.57, p<0.001). Female patients (n=11): 8.77 → 7.42% (Δ −1.35, p<0.001). The clinical magnitude of improvement was comparable across sexes, confirming uniform protocol responsiveness.

4. Discussion

4.1 Clinical Outcomes in a Tier-2 Setting: Contextualizing the Findings

The significant glycemic improvements observed in this tier-2 setting — HbA1c reduction of 1.51% from a baseline of 9.10%, with 51.2% of patients achieving HbA1c <7% — are clinically meaningful, particularly given the short mean follow-up of 66 days. For comparative context, the DiRECT trial achieved mean HbA1c reduction of 0.9% at 12 months in its intervention arm[8], while dedicated antidiabetic pharmacotherapy (GLP-1 RAs, SGLT-2 inhibitors) yields HbA1c reductions of 1.0–1.5% as monotherapy.[11] That the CDC protocol approaches these benchmarks within a shorter timeframe and in a resource-limited setting is noteworthy.

The 26.8% of patients achieving the <6.5% ADA remission threshold[12] within ~66 days is a particularly important finding for the tier-2 context, where sustained pharmacotherapy compliance is often poor due to economic constraints and irregular follow-up patterns. Achieving glycemic remission — even

transiently — may have lasting benefits by reducing the cumulative hyperglycemic exposure (glucose memory effect) known to perpetuate microvascular complications.[13]

4.2 The Multi-Cycle Pattern: A Novel Observation

The most scientifically novel finding in this dataset is the pattern of glycemic response across treatment cycles. CDC SP Cycle 1 patients achieved the greatest mean HbA1c reduction (Δ −2.08%), with successive cycles showing attenuated responses (Δ −1.36% for Cycle 2, Δ −1.08% for Cycle 3). This diminishing-returns pattern across cycles has not been systematically reported in the Panchakarma literature and invites two interpretations:

Interpretation 1 — Selection bias: Patients who progressed to Cycle 2 and 3 were those who had not achieved adequate glycemic control after Cycle 1 — by definition more refractory patients. Their lower absolute reduction from a similar baseline HbA1c (8.71–8.77%) reflects greater disease complexity, not reduced protocol efficacy. The protocol was delivering comparable absolute improvements from its starting point in each cycle.

Interpretation 2 — Biological ceiling: Panchakarma may exert its primary metabolic benefits during the initial bio-purificatory phase, with diminishing returns as the most accessible *Ama* (metabolic endotoxins) and *Kapha-Meda* deposits are cleared in the first cycle. Subsequent cycles address more deeply embedded metabolic dysfunction, yielding slower — but potentially more durable — improvements.

Notably, weight reduction remained consistent across SP Cycles 1 and 2 (both Δ −3.9 kg), suggesting that the anthropometric and energy-balance mechanisms of the protocol — driven by the Prameha diet — are cycle-independent. This dissociation between weight response and glycemic response across cycles is clinically informative and deserves prospective investigation.

The CDC KP Cycle 2 data (n=2) showed the highest absolute HbA1c reduction in the dataset (Δ −2.35%) and a remarkable RBS reduction (Δ −153 mg/dL). While this is not statistically inferential due to the very small n, it is a biological signal worth tracking in a larger prospective study — particularly given that lean diabetics (*Krisha Pramehin*) are known to carry a different pathophysiological profile: more insulin-deficient, less insulin-resistant, and potentially more responsive to the nourishing *Brimhana* action of oil-based Basti.

4.3 Drug Reduction: A More Conservative Profile Than Urban Centers

The 55.6% overall drug reduction rate (13.3% complete + 42.2% partial) is lower than that reported in urban integrative settings (complete cessation rates of 40–50% have been reported*). Several factors likely contribute in the tier-2 context:

- Shorter mean follow-up (66 vs. 94 days in comparable urban cohorts) — insufficient time for complete pharmacological tapering.
- Greater patient apprehension around medication withdrawal in settings with limited emergency backup access.
- Higher proportions of patients returning for multiple cycles — suggesting persistent glycemic load that precluded complete drug cessation in the first cycle.
- Prescribing conservatism by treating physicians in rural-adjacent settings.

The median drug reduction of 0.5% (vs. 95% in comparator urban data) underscores the bimodal distribution: about half the cohort had meaningful reductions while the other half had none. This reflects the heterogeneity of a tier-2 population in terms of baseline disease severity, compliance, and follow-up regularity.

4.4 Hemodynamic Improvements: DBP over SBP

An interesting pattern emerged in blood pressure data: DBP showed a robust, highly

significant reduction (Δ −7.44 mmHg, p<0.001) while SBP reduction, though significant (Δ −6.81 mmHg), carried a higher p-value (0.016) and greater variance (SD 17.72). This pattern — stronger DBP than SBP response — is consistent with the known hemodynamic profile of weight loss and dietary interventions in T2DM patients, where peripheral vascular resistance (reflected in DBP) responds earlier and more uniformly than central arterial stiffness (reflected in SBP).[14] The Snehan-Swedan component may additionally contribute through peripheral vasodilation and autonomic nervous system modulation.

4.5 Basti Pharmacology: The Colonic Route in Metabolic Disease

The per-rectal Basti delivery warrants mechanistic consideration. The colonic mucosa, with its direct portal venous drainage and large absorptive surface, allows active phytoconstituents to reach hepatic and systemic circulation bypassing first-pass metabolism. Berberine from *Berberis aristata* activates hepatic AMPK (mimicking metformin[6]); gymnemic acids from *Gymnema sylvestre* reduce intestinal glucose absorption and promote pancreatic beta-cell regeneration[5]; and glycyrrhizin from *Glycyrrhiza glabra* modulates the insulin signaling cascade and suppresses hepatic gluconeogenesis.[7] The Anuvasana (oil-based) Basti used in CDC-KP additionally provides a lipid-soluble carrier matrix, potentially enhancing absorption of fat-soluble phytosterols and terpenoids in this herb combination.

4.6 Limitations

- Retrospective observational design without a control group — causal attribution is limited.
- Short and heterogeneous follow-up duration (range 13–251 days, mean 66 ± 53 days) — restricts conclusions about sustained glycemic improvement.
- Lipid panel data insufficient for analysis (n=5 for most lipid parameters) — a significant gap for cardiometabolic risk assessment. Future studies at this site should prioritize lipid documentation.
- Small CDC-KP group (n=11) limits statistical power for this subgroup; CDC KP Cycle 2 (n=2) is purely descriptive.
- Multi-cycle analysis is cross-sectional across different patients, not longitudinal tracking of the same individuals — true within-patient multi-cycle response cannot be assessed from this dataset.
- Individualized herbal prescriptions introduce an uncontrolled therapeutic variable.
- Two patients categorized as 'Not Diagnosed Yet' represent an ambiguous inclusion; future studies should use strict ADA diagnostic criteria for enrollment.

5. Conclusion

This retrospective analysis from Madhavbaug Clinics, Prakash Nagar, Latur demonstrates that a structured Ayurvedic multimodal protocol — comprising BMI-stratified Panchakarma, Prameha diet, and individualized herbal therapy — delivers clinically significant glycemic and cardiometabolic improvements in T2DM patients within a short intervention period, even in a tier-2 clinical setting with shorter follow-up and a more heterogeneous patient profile than metropolitan centers.

The most important and novel finding is the multi-cycle treatment pattern: CDC SP Cycle 1 patients showed the greatest HbA1c reduction (Δ −2.08%), with diminishing but still meaningful responses in Cycle 2 (Δ −1.36%) and Cycle 3 (Δ −1.08%). This diminishing-returns trajectory — and the consistent weight reduction maintained across cycles — suggests that repeated Panchakarma cycles act through

partially distinct mechanisms for glycemic vs. anthropometric improvement, a hypothesis warranting prospective investigation. The 26.8% of patients achieving the ADA <6.5% remission threshold within ~66 days highlights the potential of this protocol as a disease-modifying intervention even in resource-constrained settings.

These findings support the scalability of the CDC Ayurvedic multimodal protocol to tier-2 Indian cities. Prospective controlled trials with standardized follow-up, complete lipid panels, and longitudinal multi-cycle patient tracking are recommended to fully characterize the dose-response relationship of repeated Panchakarma in T2DM and to validate this approach for broader integrative diabetes management guidelines.

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