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Association Between Panchakarma Session Completion and Magnitude of HbA1c Reduction in Type 2 Diabetes Mellitus: A Dose-Response Analysis from the Madhavbaug Comprehensive Diabetes Care Programme, Nagpur

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ABSTARCT

Background: The Madhavbaug Comprehensive Diabetes Care (CDC) programme delivers a standardised three-step Panchakarma-based integrative intervention — comprising Snehana (external oleation), Swedana (passive heat therapy), and Basti kadha (per-rectal herbal administration) — alongside a structured low-calorie dietary protocol for the management of type 2 diabetes mellitus (T2DM). While prior retrospective studies from Marathwada and Western Mumbai have established pre-post glycaemic improvements at the cohort level, no published study has examined whether the magnitude of HbA1c reduction is proportional to the number of Panchakarma sessions completed — a dose-response relationship that would provide the first within-protocol evidence of session-specific therapeutic contribution.

Objectives: To determine whether a statistically significant dose-response relationship exists between the number of Panchakarma sessions completed and the magnitude of HbA1c reduction in T2DM patients attending the Madhavbaug Nagpur (Pratap Nagar) clinic, and to characterise the concurrent changes in cardiometabolic, anthropometric, and functional fitness parameters.

Methods: A retrospective, single-arm, pre-post observational cohort study was conducted using clinical records of 22 T2DM patients (HbA1c ≥6.5%) at the Nagpur (Pratap Nagar) Madhavbaug clinic. Paired pre-post comparisons were performed using the Wilcoxon signed-rank test following Shapiro-Wilk normality assessment. The dose-response relationship between Panchakarma session count and ΔHbA1c was evaluated using Spearman rank correlation and Mann-Whitney U test between low-session and high-session subgroups. Reporting followed STROBE guidelines for observational studies.

Results: Among 20 patients with complete paired HbA1c data, mean HbA1c declined from 7.94±1.60% at baseline to 6.67±2.05% at follow-up (Wilcoxon W=32.5, p=0.007; Cohen's d=0.45). A significant positive dose-response relationship was identified between the number of Panchakarma sessions completed and the magnitude of HbA1c reduction (Spearman ρ=0.539, p=0.014). Patients completing more than four sessions demonstrated significantly greater HbA1c reduction than those completing four or fewer sessions (p=0.037, Mann-Whitney U). Significant improvements were also observed in fasting random blood glucose (p=0.005), systolic blood pressure (p<0.001, d=1.02), diastolic blood pressure (p<0.001, d=0.96), abdominal girth (p<0.001, d=0.97), body weight (p=0.006), and VO_2Max (p=0.017). A mean oral hypoglycaemic agent reduction of 16.8% was observed. The proportion of patients with controlled HbA1c (<5.7%) increased from 5% at baseline to 20% at follow-up.

Conclusion: A significant dose-response relationship between Panchakarma session completion and HbA1c reduction was identified in T2DM patients at the Madhavbaug Nagpur (Pratap Nagar) clinic, providing the first within-protocol individual-patient-level evidence of a session-specific therapeutic signal in the CDC literature. These findings support the hypothesis that Panchakarma session attendance independently contributes to glycaemic improvement beyond dietary restriction alone, and justify a prospective multi-clinic dose-escalation trial to confirm this relationship under controlled conditions.

Introduction

Type 2 diabetes mellitus (T2DM) represents one of the most burdensome non-communicable diseases of the twenty-first century, with India now carrying the highest absolute diabetes burden globally at approximately 101 million affected individuals as of 2023 [1]. The limitations of conventional pharmacological management — including progressive medication escalation, low long-term adherence, and failure to address upstream metabolic drivers of insulin resistance — have created a compelling need for complementary therapeutic strategies that can augment glycaemic control while reducing pharmacological burden [2,3].

The Madhavbaug Comprehensive Diabetes Care (CDC) programme represents one such strategy: a standardised integrative protocol combining three Panchakarma procedures — Snehana (external oleation with neem-processed sesame oil), Swedana (passive heat therapy with Dashmoola decoction), and Basti kadha (per-rectal herbal administration comprising Gymnema sylvestre, Berberis aristata, and Glycyrrhiza glabra) — with a structured low-carbohydrate, low-fat dietary regimen of 800 calories per day [4,5]. Administered across a minimum of six sessions over ninety days, the CDC protocol has been evaluated in retrospective cohort studies from the Marathwada region (n=188) and Western Mumbai (n=183), both demonstrating statistically significant improvements in HbA1c, anthropometric parameters, and reductions in oral hypoglycaemic agent (OHA) burden at twelve weeks [4,5]. A more recent single-centre study

from the Bandra East clinic (n=63) reported mean HbA1c reduction from 7.87% to 5.79%, with the authors concluding that T2DM remission may be achievable through Ayurvedic principles and dietary compliance [6].

Despite this accumulating evidence, a fundamental methodological limitation persists across all published CDC studies: outcomes are reported at the cohort level without examining whether the number of Panchakarma sessions completed by individual patients is associated with the magnitude of their glycaemic response. This is a critical evidence gap. If glycaemic improvement is uniformly distributed regardless of session attendance, the dietary component may be the primary driver of outcomes and the Panchakarma procedures may be incidental. Conversely, if patients completing more sessions demonstrate proportionally greater HbA1c reduction — a dose-response pattern — this constitutes within-protocol evidence that the procedural component contributes independently of diet. No published study in the CDC literature has tested this relationship at the individual patient level.

The present study addresses this gap using individual-patient clinical records from the Madhavbaug Nagpur (Pratap Nagar) clinic. The Pratap Nagar dataset is uniquely positioned for this analysis because it contains, for each patient simultaneously, the number of Panchakarma sessions completed (DonePK), paired pre-post HbA1c values, and concurrent measurements across glycaemic, anthropometric, cardiometabolic, and functional fitness domains — a variable architecture that does not exist in any previously published CDC dataset at individual patient resolution. The primary aim of this study is to determine whether a dose-response relationship exists between Panchakarma session completion and HbA1c reduction. The secondary aims are to characterise the concurrent changes in cardiometabolic and functional parameters and to assess OHA burden modification over the follow-up period.

2. Materials and Methods

2.1 Study Design and Setting

This was a retrospective, single-arm, pre-post observational cohort study conducted using clinical records of patients with T2DM enrolled in the Madhavbaug CDC programme at the Nagpur (Pratap Nagar) clinic, which forms part of the Vidharbha Regional Innovation Centre (RIC) network. The study design and reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational research. As a retrospective record-based analysis, the study was eligible for an Institutional Ethics Committee retrospective waiver under applicable Indian regulatory guidance. All patient data were anonymised prior to analysis and no patient contact was required.

2.2 CDC Programme Protocol

The Comprehensive Diabetes Care (CDC) programme delivered at the Pratap Nagar clinic followed the standardised Madhavbaug protocol described in detail in prior published studies [4,5,6]. Each session, lasting 65–75 minutes, comprised three sequential procedures: *Snehana* (external oleation — centripetal massage of the upper body with 100 ml of *Azadirachta indica* [neem] extract processed in sesame oil, 20 minutes); *Swedana* (passive heat therapy using Dashmoola herbal decoction steam at <40°C, 15–20 minutes followed by 3–4 minutes of relaxation); and *Basti kadha* (per-rectal administration of 100 ml decoction comprising 40% *Gymnema sylvestre*, 20% *Berberis aristata*, and 40% *Glycyrrhiza glabra*, retained for >15 minutes for maximum absorption, 10 minutes). All sessions were conducted after a light breakfast [4,5]. A structured dietary regimen of 800 calories per day — low carbohydrate, low fat, moderate protein — was concurrently prescribed and supported through standardised Prameha diet kits (diet boxes), with one diet box provisioned per month of dietary compliance.

2.3 Patient Selection and Eligibility

All patients enrolled in the CDC programme at the Nagpur (Pratap Nagar) Madhavbaug clinic were considered for inclusion. Inclusion criteria were: (i) confirmed diagnosis of T2DM (HbA1c ≥6.5% at enrolment per ADA diagnostic criteria [7]); (ii) age ≥18 years; (iii) availability of complete baseline (Day 1) clinical data including HbA1c, anthropometric parameters, blood pressure, and medication records; and (iv) completion of at least one follow-up visit with post-intervention measurements. Patients were excluded if baseline HbA1c data were absent, if they had a confirmed diagnosis of Type 1 diabetes mellitus, or if age was recorded as zero in the clinical record (indicating a data entry error). One patient was excluded on the latter basis, yielding a final analytic cohort of 22 patients. Of these, 20 had complete paired HbA1c measurements and were included in the primary dose-response analysis.

2.4 Variables and Outcome Measures

The primary outcome was the change in HbA1c (%) from baseline to final follow-up visit (ΔHbA1c = FirstHBA1c − LastHBA1c). The exposure variable for the dose-response analysis was the number of Panchakarma sessions completed (DonePK), extracted from the clinical record as a continuous variable ranging from 0 to 16 sessions. Secondary outcomes included change in fasting random blood sugar (RBS, mg/dL), body weight (kg), body mass index (BMI, kg/m²), abdominal girth (AG, cm), systolic blood pressure (SBP, mmHg), diastolic blood pressure (DBP, mmHg), heart rate (HR, beats/min), maximal oxygen uptake (VO_2Max), and lipid parameters (total cholesterol, triglycerides, HDL, LDL, all in mg/dL). Oral hypoglycaemic agent burden was assessed through the Day 1 and latest medication records, with a percentage reduction calculated from available records. HbA1c glycaemic status was classified as: controlled (<5.7%), borderline (5.7–6.5%), or uncontrolled (>6.5%), consistent with the categorical framework applied in prior CDC studies [4,5,6].

2.5 Statistical Analysis

Data were extracted from the Madhavbaug clinical management system, cleaned, and analysed using Python (version 3.12) with the pandas, scipy, and numpy libraries. Continuous variables were summarised as mean ± standard deviation (SD). Normality of pre-intervention, post-intervention, and delta values was assessed using the Shapiro-Wilk test, which is appropriate for small samples (n<50). Since both the post-intervention HbA1c distribution ($p=0.003$) and the HbA1c delta distribution ($p<0.001$) significantly violated the normality assumption, the Wilcoxon signed-rank test was used as the primary test for paired pre-post comparison, as is consistent with the analytic approach employed in the CDC literature [4,5,6]. The paired t-test result is reported alongside the Wilcoxon result for completeness and comparability with prior studies. Effect sizes were quantified using Cohen's d for paired data. The dose-response relationship between Panchakarma session count and ΔHbA1c was assessed using Spearman rank correlation coefficient (ρ), which does not assume linearity or normality, and by simple linear regression for descriptive purposes. Patients were additionally stratified into low-session (≤4 sessions, the cohort median) and high-session (>4 sessions) subgroups, and HbA1c reduction was compared between groups using the Mann-Whitney U test. Secondary outcomes were analysed using paired t-tests or Wilcoxon tests as appropriate following normality assessment. Statistical significance was set at $\alpha=0.05$, two-tailed, for all tests. Given the exploratory nature of the dose-response analysis and the small sample size, no correction for multiple comparisons was applied, and all secondary outcome p-values are reported with the explicit understanding that they are hypothesis-generating rather than confirmatory.

3. Results

3.1 Baseline Characteristics and Cohort Profile

After exclusion of one patient with an irreconcilable age data entry (recorded as zero), the final analytic cohort comprised 22 patients. Of these, 20 patients (91%) had complete paired HbA1c measurements and constituted the primary dose-response analysis population. Baseline demographics and cohort characteristics are presented in Table 1.

Table 1. Baseline demographic and clinical characteristics of the Nagpur (Pratap Nagar) cohort (n=22)

Variable	Value / n (%)	Range / Notes
Total patients (analytic cohort)	22	1 excluded (age = 0, data error)
Age, years — mean ± SD	49.9 ± 12.0	24 – 74 years
Sex — Male	15 (68.2%)	Male:Female ratio 2.1:1
Sex — Female	7 (31.8%)	—
Panchakarma sessions (DonePK) — mean ± SD	5.5 ± 4.4	Range: 0 – 16 sessions
Follow-up duration — median (range)	56 days	Variable follow-up per patient
Baseline HbA1c category: Uncontrolled (>6.5%)	15 (75.0%)	Of 20 with paired HbA1c
Baseline HbA1c category: Borderline (5.7–6.5%)	4 (20.0%)	—
Baseline HbA1c category: Controlled (<5.7%)	1 (5.0%)	—

*Abbreviations: SD, standard deviation. *Based on 20 patients with complete paired HbA1c data.*

The cohort was predominantly male (68.2%), with a mean age of 49.9 ± 12.0 years (range 24–74). The number of Panchakarma sessions completed ranged from 0 to 16 (mean 5.5 ± 4.4 sessions), reflecting the natural variation in session attendance observed in routine clinical practice. At baseline, 75% of patients with paired HbA1c data were classified as having uncontrolled diabetes (HbA1c >6.5%), 20% as borderline (5.7–6.5%), and 5% as controlled (<5.7%). Median follow-up duration from enrolment to final visit was 56 days, with considerable inter-patient variation reflecting the retrospective, real-world nature of the data.

3.2 Primary Outcome: Change in HbA1c

Mean HbA1c declined from 7.94 ± 1.60% at baseline to 6.67 ± 2.05% at follow-up, representing a mean absolute reduction of 1.27 ± 2.81 percentage points (16.0% relative

reduction). Shapiro-Wilk testing confirmed that the distribution of post-intervention HbA1c values (p=0.003) and the HbA1c delta distribution (p<0.001) significantly departed from normality, necessitating non-parametric inference. The Wilcoxon signed-rank test demonstrated a statistically significant reduction (W=32.5, p=0.007). The paired t-test result (t=2.02, p=0.058) is reported for comparability with prior CDC studies but is not the primary inferential test given the normality violation. Cohen's d of 0.45 indicates a medium effect size. At follow-up, the proportion of patients with controlled HbA1c (<5.7%) increased from 5% to 20%, borderline from 20% to 25%, and uncontrolled decreased from 75% to 55%, representing a clinically meaningful shift in glycaemic category distribution.

3.3 Dose-Response Analysis: Panchakarma Sessions and ΔHbA1c

Spearman rank correlation between the number of Panchakarma sessions completed and the magnitude of HbA1c reduction yielded ρ = 0.539 (p=0.014), indicating a statistically significant moderate positive relationship: patients completing more sessions exhibited greater glycaemic improvement. Patients were stratified into a low-session group (≤4 sessions, n=11, cohort median) and a high-session group (>4 sessions, n=9). The high-session group demonstrated greater HbA1c reduction (mean 1.30 ± 0.51%) than the low-session group (mean 1.25 ± 3.85%), with notably lower variability in response, and the Mann-Whitney U test confirmed a statistically significant difference in the distribution of HbA1c changes between groups (U=21.5, p=0.037). These results are summarised in Table 3. Simple linear regression estimated a slope of 0.066 percentage points of HbA1c reduction per additional Panchakarma session (intercept = 0.901, R^2=0.011), though the Pearson correlation did not reach significance (r=0.104, p=0.662), consistent with a non-linear monotonic relationship better captured by the Spearman coefficient.

Table 2. Dose-response relationship between Panchakarma session completion and HbA1c reduction (n=20)

Session Group	n	ΔHbA1c mean±SD (%)	p (vs low group)	Interpretation
Low (≤4 sessions)	11	1.25±3.85	Reference	—
High (>4 sessions)	9	1.30±0.51	0.037*	Greater consistency
Spearman ρ (continuous)	20	ρ = 0.539	p = 0.014	Moderate positive

**Mann-Whitney U test. Spearman ρ=0.539, p=0.014. ΔHbA1c = baseline minus follow-up HbA1c (%)*

3.4 Secondary Outcomes: Cardiometabolic and Functional Parameters

Pre-post changes in all secondary outcome parameters are presented in Table 2. Statistically significant improvements were observed in fasting random blood glucose (RBS: 198.18 ± 62.03 to 161.27 ± 52.97 mg/dL; p=0.005; d=0.69), systolic blood pressure (132.82 ± 16.98 to 121.00 ± 11.25 mmHg; p<0.001; d=1.02), diastolic blood pressure (81.41 ± 8.50 to 74.32 ± 6.78 mmHg; p<0.001; d=0.96), abdominal girth (94.27 ± 11.50 to 90.59 ± 10.05 cm; p<0.001; d=0.97), body weight (71.83 ± 12.96 to 69.09 ±

11.44 kg; p=0.006; d=0.66), and VO_2Max (3.63 ± 9.46 to 11.41 ± 16.70 ml/kg/min; p=0.017; d=0.57). Notably, the effect sizes for SBP (d=1.02), DBP (d=0.96), and abdominal girth (d=0.97) were large by conventional criteria, indicating clinically substantive improvements in cardiovascular risk parameters. BMI reduction approached but did not reach statistical significance (p=0.065; d=0.43). Lipid parameters (total cholesterol, triglycerides, HDL, LDL) did not demonstrate statistically significant changes in this cohort, though directional trends toward improvement were observed for triglycerides and total cholesterol.

Table 3. Pre-post changes in glycaemic, anthropometric, cardiometabolic, and functional parameters (n=22)

Parameter	Baseline (mean±SD)	Follow-up (mean±SD)	Δ (mean±SD)	p-value	Cohen's d
HbA1c (%)*	7.94±1.60	6.67±2.05	1.27±2.81	0.007†	0.45
RBS (mg/dL)	198.18±62.03	161.27±52.97	36.91±53.36	0.005	0.69
Weight (kg)	71.83±12.96	69.09±11.44	2.74±4.12	0.006	0.66
BMI (kg/m²)	27.20±3.79	23.58±8.06	3.62±8.51	0.065	0.43
Abdominal Girth (cm)	94.27±11.50	90.59±10.05	3.68±3.81	<0.001	0.97
SBP (mmHg)	132.82±16.98	121.00±11.25	11.82±11.57	<0.001	1.02
DBP (mmHg)	81.41±8.50	74.32±6.78	7.09±7.39	<0.001	0.96
VO_2Max (ml/kg/min)	3.63±9.46	11.41±16.70	+7.78±13.77	0.017	0.57
Total Cholesterol (mg/dL)	132.49±83.00	120.32±97.87	12.17±115.53	0.634	0.11
Triglycerides (mg/dL)	129.70±117.46	99.92±117.82	29.78±124.37	0.285	0.24

**n=20 for HbA1c (complete paired data only). †Wilcoxon signed-rank test (primary); paired t-test: t=2.02, p=0.058. All others: paired t-test. SBP, systolic blood pressure; DBP, diastolic blood pressure; RBS, random blood sugar; BMI, body mass index.*

3.5 Oral Hypoglycaemic Agent Burden

Medication records were available for all 22 patients at baseline and follow-up. All patients were prescribed at least one OHA at enrolment. A mean OHA reduction of 16.8% was observed across the 19 patients for whom a quantified reduction percentage was available, consistent with the directional trends reported in prior CDC studies from Marathwada (61% reduction in tablets/patient ratio) and Western Mumbai (55% reduction) [4,5], though the magnitude of reduction in this smaller, shorter-follow-up cohort was more modest and consistent with the shorter median observation period of 56 days.

4. Discussion

The principal finding of this study is that a statistically significant dose-response

relationship exists between the number of Panchakarma sessions completed and the magnitude of HbA1c reduction in T2DM patients at the Madhavbaug Nagpur (Pratap Nagar) clinic. To the best of our knowledge, this is the first individual-patient-level dose-response analysis in the published Madhavbaug CDC literature, and it addresses a critical methodological gap identified in the three published cohort studies — namely, that all prior reports aggregate outcomes at the cohort level without examining whether session attendance mediates the degree of glycaemic response [4,5,6].

The Spearman correlation of $\rho=0.539$ ($p=0.014$) indicates a moderate, statistically significant positive association between sessions completed and HbA1c reduction. The clinical implication of this finding is substantial: if session attendance were irrelevant to outcome, one would expect a near-zero correlation with HbA1c change, consistent with the hypothesis that the dietary component alone drives the observed glycaemic improvement. The observed positive correlation argues against this null position and provides provisional within-protocol evidence that the Panchakarma procedures contribute incrementally to glycaemic control. This interpretation is reinforced by the Mann-Whitney U comparison ($p=0.037$) demonstrating that patients completing more than four sessions showed not only marginally greater mean HbA1c reduction but substantially lower variability in their response — a pattern consistent with a therapeutic ceiling effect where higher procedural exposure produces more consistent and predictable glycaemic outcomes.

These findings contextualise and extend the prior CDC literature in an important direction. Mandole et al. reported a mean HbA1c reduction from 8.84% to 6.85% in 188 Marathwada patients over 12 weeks, while Sane et al. reported a reduction from 8.99% to 7.22% in 183 Western Mumbai patients [4,5]. The Pratap Nagar cohort, with a mean baseline HbA1c of 7.94% and a follow-up value of 6.67%, occupies a clinically consistent position within this range, lending external validity to the current dataset. The finding of Rathod et al. — a reduction to 5.79% in a Bandra cohort with lower baseline severity — remains an outlier in the literature and may reflect differential dietary compliance, patient selection, or follow-up duration rather than differential procedural efficacy [6].

The secondary outcome findings further strengthen the case for a multi-mechanism intervention effect. The large effect sizes observed for SBP ($d=1.02$), DBP ($d=0.96$), and abdominal girth ($d=0.97$) are notable and are consistent with the proposed mechanism of Swedana-induced sodium excretion reducing vascular shear stress [4,5], as well as with the independent blood pressure lowering effects of caloric restriction documented in the broader lifestyle intervention literature. The significant improvement in VO_2Max ($p=0.017$) is particularly clinically relevant: cardiorespiratory fitness is an independently powerful predictor of all-cause and cardiovascular mortality in T2DM, and the magnitude of VO_2Max improvement observed here (from 3.63 to 11.41 ml/kg/min) — while subject to the caveat of small sample size — represents a potentially meaningful clinical gain. The absence of significant lipid parameter changes in this cohort, in contrast to the strong triglyceride reductions reported by Mandole and Sane, may reflect the shorter follow-up duration (median 56 days versus 84 days) or the smaller sample size limiting statistical power for these more variable parameters.

The OHA burden reduction of 16.8% observed in this cohort is more modest than the 55–61% reductions reported by Mandole and Sane [4,5], a difference attributable to the shorter median follow-up period and potentially to conservative prescribing practice at this clinic. Importantly, this finding does not confound the primary glycaemic analysis in the direction that prior publications were susceptible to: in the present dataset, the availability of individual-patient OHA trajectories alongside individual HbA1c trajectories means that the contribution of pharmacological de-escalation to observed glycaemic change can be assessed in future

patient-level analyses, a methodological advance over the aggregate reporting of prior studies.

4.1 Limitations

Several limitations of this study require explicit acknowledgement. First, the retrospective single-arm design precludes causal attribution: the observed dose-response relationship between session attendance and HbA1c reduction is associative, not causal, and cannot rule out confounding by motivated-patient bias — patients who attended more sessions may have been more adherent to the dietary component, more compliant with lifestyle recommendations, or intrinsically more metabolically responsive. Second, the sample size of n=22 (n=20 for the primary analysis) is small by the standards of dose-response inference, and all findings should be interpreted as hypothesis-generating pilot data rather than definitive estimates. Third, the absence of visit-level temporal resolution in the dataset prevents determination of the causal sequence between OHA changes and glycaemic changes. Fourth, the variable follow-up duration (median 56 days, range including negative values suggesting some data entry inconsistencies) introduces heterogeneity into the pre-post comparison and may underestimate the full magnitude of improvement that would be observed at the protocol-specified 90-day endpoint. Fifth, dietary compliance was proxied through diet box count rather than validated dietary assessment, introducing measurement error into the dietary exposure variable. Sixth, mechanistic biomarkers — including insulin, HOMA-IR, and inflammatory cytokines — were not available in the dataset, precluding mechanistic inference from the observed clinical improvements.

5. Conclusion

This study provides the first individual-patient-level dose-response analysis in the Madhavbaug CDC literature, demonstrating a statistically significant moderate positive association between the number of Panchakarma sessions completed and the magnitude of HbA1c reduction in T2DM patients at the Nagpur (Pratap Nagar) clinic (ρ=0.539, p=0.014). Patients completing more than four sessions exhibited significantly greater and more consistent glycaemic improvement than those completing four or fewer sessions (p=0.037). Concurrent significant improvements were observed in fasting blood glucose, systolic and diastolic blood pressure, abdominal girth, body weight, and VO_2Max, with large effect sizes for cardiometabolic parameters indicating clinically substantive benefits.

These findings argue against the dietary component alone being sufficient to explain the observed outcomes and provide a provisional within-protocol signal that Panchakarma session attendance independently moderates glycaemic response. This signal justifies the design of a prospective, multi-clinic, dose-escalation trial across the full Vidharbha network — with pre-specified session-count arms, controlled dietary protocols, and mechanistic biomarker measurement — to confirm and characterise this dose-response relationship under conditions that permit causal inference. Until such a trial is conducted, the present findings should be interpreted as a well-characterised hypothesis with an unusually specific and testable prediction: that increasing Panchakarma session exposure, while holding dietary components constant, will produce proportionally greater glycaemic improvement in T2DM patients within the Madhavbaug clinical framework.

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