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Immediate Effect of *Uddiyana Bandha* on Heart Rate Variability in Patients with Hypertension: A Randomised Controlled Study

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Abstract

Background: Hypertension, a prevalent cardiovascular condition, is linked to autonomic nervous system dysregulation, often evidenced by reduced heart rate variability (HRV). Yoga, particularly *Uddiyana Bandha*, may influence autonomic control and improve HRV, thus offering potential benefits for hypertension management.

Purpose: This study intended to assess the impact of the regular use of *Uddiyana Bandha* practice on HRV among hypertensive patients.

Methods: This randomised controlled study included 60 hypertensive patients aged between 40 and 60. Participants were randomised into an intervention group practicing *Uddiyana Bandha* ($n = 30$) and a control group with no intervention ($n = 30$). The outcome measures included time and frequency domain HRV variables, specifically the standard deviation of NN intervals (SDNN), the square root of the mean squared differences of successive NN intervals (RMSSD), high-frequency (HF) and low-frequency (LF) components in normalised units (n.u), and the LF/HF ratio. These were assessed both before and immediately after the intervention. The intervention group performed three rounds of *Uddiyana Bandha* under supervision, while the control group rested quietly for an equivalent duration.

Results: The *Uddiyana Bandha* group demonstrated significant ($p < .05$) improvements in HRV parameters post-intervention compared to the control group. Mean RR interval, SDNN and RMSSD increased immediately after *Uddiyana Bandha* practice. The HF component (n.u) increased, while the LF component (n.u) and LF/HF ratio decreased ($p < .05$), indicating enhanced parasympathetic activity. No significant changes were observed in the control group.

Conclusion: *Uddiyana Bandha*'s practice immediately has notable effects on HRV in hypertensive patients, showing better autonomic balance and cardiovascular performance. These results suggest *Uddiyana Bandha* as a possible non-pharmacological strategy for hypertension management. Future studies with larger sample sizes and longer durations are needed to support these results and explore long-term effects.

Keywords

Hypertension, *Uddiyana Bandha*, heart rate variability, autonomic function, yoga, cardiovascular health

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Introduction

Hypertension is a prevalent cardiovascular disease affecting an estimated 1.28 billion adults worldwide, with a global prevalence of 31.1% in 2019.¹ In 2010, around 1.4 billion individuals worldwide were affected by hypertension, a number projected to surpass 1.6 billion by 2025. However, the worldwide blood pressure control rate among patients receiving treatment for hypertension was only around 32.5%.² It is suggested that superior sympathetic activity at the start of essential hypertension could be evidence that neurohormonal firewall dysfunction could be all-important in condition development.³ Heart rate variability (HRV), a marker of cardiac autonomic function that measures the variation in time intervals between consecutive heartbeats, is often reduced in individuals with hypertension.⁴ This reduction in HRV reflects an imbalance in autonomic nervous system activity, characterised by increased sympathetic and decreased parasympathetic tone.⁵ Lowered HRV is not only a marker of autonomic dysfunction in hypertension but also an independent predictor of cardiovascular morbidity and mortality.⁶ Research has indicated that reduced HRV in hypertensive patients is linked to a two- to three-fold higher risk of sudden cardiac death and a six- to eight-fold greater risk of ventricular arrhythmias.⁷

Yoga, an ancient mind-body practice, has emerged as a potential complementary approach to managing hypertension and improving cardiovascular health.^{8,9} Cross-sectional and intervention studies have shown that yoga practice, when done regularly, can cause a reduction in systolic and diastolic blood pressure, with reductions averaging 5–10 mm Hg and 3–8 mm Hg respectively.^{10,11} These effects are thought to be mediated, in part, through improvements in autonomic function and increases in HRV. *Uddiyana Bandha*, a specific yogic technique involving abdominal muscle contraction and controlled breath manipulation, is hypothesised to have particularly potent effects on autonomic function and cardiovascular health.¹² While the general benefits of yoga for hypertension management are well-documented,^{13,14} research specifically examining the acute physiological effects of *Uddiyana Bandha* on HRV in hypertensive individuals is limited. So, this study aims to examine the immediate effects of *Uddiyana Bandha* on HRV parameters in patients with hypertension.

Methods

Study Design

This randomised controlled trial utilised a computer-generated sequence to assign participants randomly to either the intervention group, which practiced *Uddiyana Bandha*, or the control group, which received no intervention.

Subjects

The study included 40 hypertensive patients aged between 40 and 60 recruited from tertiary care hospitals. Males or females between the ages of 40 and 60 who had no prior practice in yoga over the past three months and were no current smokers were chosen. Exclusion criteria included history of major cardiac, renal, or pulmonary disease, recent surgery or major medical illnesses like tuberculosis, diabetes mellitus and bronchial asthma. Additionally, individuals with systolic blood pressure above 159 mm Hg, diastolic blood pressure above 99 mm Hg and those taking more than two groups of anti-hypertension medications were excluded. Written informed consent was obtained from all the participants, and institutional ethical committee approval was also exercised (SRM MCH&RC/IEC/8516/2022).

Sample Size

Sample size calculations were performed using open epi software. Based on a predetermined effect size of 0.60 from existing literature, a significance level of 0.05, and equal group allocation (1:1), the total required sample size was determined to be 80 participants (40 per group—*Uddiyana Bandha* and control).¹⁴

Randomisation

Eligible patients ($n = 80$) were randomly allocated to either the *Uddiyana Bandha* group ($n = 40$) or the control group ($n = 40$) using computerised random allocation software. Allocation concealment used sequentially numbered, opaque sealed envelopes (SNOSE).

Blinding/masking

Due to the nature of the yoga intervention, complete blinding was not feasible. However, the investigator remained blinded to group assignments, while an independent researcher administered the *Uddiyana Bandha* intervention and evaluated HRV.

Uddiyana Bandha

A qualified yoga person has delivered the *Uddiyana Bandha* to the intervention group. The intervention process was explained to the patients, and verbal and written consent was obtained before the session began. Participants were instructed in *Uddiyana Bandha* a day prior to the intervention under the supervision of a qualified Yoga and Naturopathy physician.¹⁵ On the intervention day, patients practiced *Uddiyana Bandha* on an empty stomach. They were taught to stand with their legs about hip apart, take a deep breath through the nose, bend at the waist and blow out air through

the mouth. Once their lungs were emptied, they held their breath, placed their palms on their thighs just above the knees with fingers pointing downward and kept their arms straight, naturally engaging their abdominal muscles. The patients were then told to lower their heads, make a false inspiratory movement and open the chest, triggering the *Uddiyana Bandha* as the abdomen pulled in towards the spinal column. They held this position as long as comfortably possible before releasing the abdominal lock. This procedure was continuously repeated for five minutes without interruption.¹²

Control Group

The control group participants were given the usual care without involving the *Uddiyana Bandha*. They were also instructed to continue their usual daily routine and take their prescribed medicines. To manage the information biases arising from attention and time factors, control group respondents underwent similar sessions as the subjects in the intervention group, but they fed back on general health knowledge other than yoga or breathing exercises. These sessions were given by another healthcare professional who was not conducting the yoga intervention.

Outcome Measurements

For short-term HRV, electrocardiogram (ECG) was recorded in the morning between 9 am and 11 am using an analogue-to-digital converter in supine rest position,^{16,17} HRV analysis was performed using Kubios HRV analysis software. A linear model assessed HRV in both the time and frequency domains. In the time domain, two metrics were analysed: the standard deviation of NN intervals (SDNN) and the square root of the mean squared differences of successive NN intervals (RMSSD). Power spectral density (PSD) analysis was performed for the frequency domain using a non-parametric method, specifically fast Fourier transform (FFT). The frequency bands analysed included low frequency (LF, 0.04–0.15 Hz) and high frequency (HF, 0.15–0.40 Hz), both expressed in normalised units (LF nu and HF nu respectively), as well as the LF/HF ratio.

Statistical Analysis

Data are presented as means with SD. Normality was evaluated using the Kolmogorov–Smirnov test. For normally distributed data, paired and unpaired t-tests were conducted. In contrast, non-normally distributed HRV data were analysed using the Wilcoxon signed-rank and Mann–Whitney U tests. All statistical analyses were performed with R software, version 3.1.1.

Result

The study included 80 patients with hypertension, 40 in the *Uddiyana Bandha* group and 40 in the control group (Figure 1). Both groups started with similar age, gender distribution and medical history, showing that sampling matched (Table 1). Throughout the study period, no adverse events were reported by the patients.

Immediately after the intervention, no significant changes were observed in the control group. Meanwhile, the *Uddiyana Bandha* group showed significant improvements. The RR interval (Figure 2) increased from 719.05 ± 63.19 to 788.90 ± 71.55 , SDNN (Figure 3) from 68.03 ± 15.14 to 85.76 ± 12.83 , RMSDD (Figure 4) from 49.71 ± 23.50 to 61.05 ± 16.13 . Following *Uddiyana Bandha*, the HF component increased (Figure 5) from 40.12 ± 7.95 to 49.17 ± 10.22 in normalised units; the LF component (Figure 6) dropped from 63.16 ± 13.7 to 52.12 ± 13.9 n.u. The LF/HF ratio (Figure 7) decreased from 1.62 ± 0.42 to 1.32 ± 0.40 , indicating a shift toward parasympathetic dominance.

Discussion

This randomised controlled study is the first to investigate the immediate effects of *Uddiyana Bandha*, a specific yogic practice, on HRV parameters in patients with hypertension. The findings demonstrate that a single session of *Uddiyana Bandha* practice significantly improves various HRV variables, indicating enhanced parasympathetic activity and better autonomic balance in patients with hypertension. The intervention group showed a notable increase in the HF component of HRV, a marker of parasympathetic nervous system activity. Additionally, there was a significant increase in the SDNN, reflecting overall HRV. Additionally, the LF component and the LF/HF ratio, associated with sympathetic dominance, decreased considerably in the *Uddiyana Bandha* group. These changes suggest a shift towards improved parasympathetic control and reduced sympathetic tone, crucial for better cardiovascular regulation in hypertensive individuals.¹⁸

The observed effects of *Uddiyana Bandha* on HRV are consistent with previous research highlighting the beneficial influence of yoga and related practices on autonomic function.^{14,19} Studies have shown that various yogic techniques, such as *Jalandhara Bandha* and *Vipareet Karni Mudra*, can positively impact respiratory parameters, including vital and breath-holding capacity, in healthy and hypertensive populations.^{20,21} However, this study is the first to demonstrate the immediate impact of *Uddiyana Bandha*, a specific abdominal lock practice, on HRV in hypertensive adults.

The mechanisms underlying the effects of *Uddiyana Bandha* on autonomic function are thought to involve the stimulation of the vagus nerve, a key component of the parasympathetic nervous system. The practice of *Uddiyana*

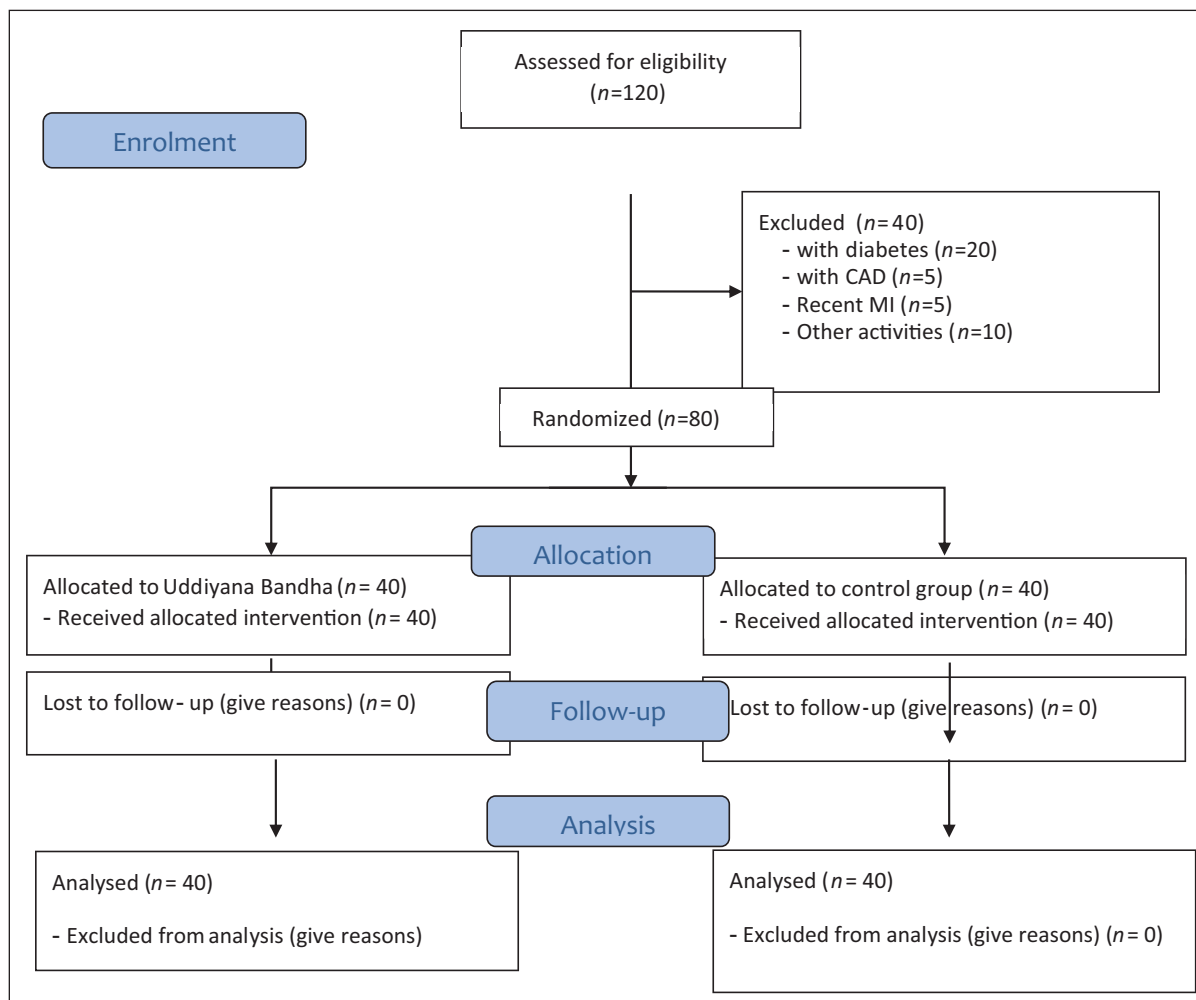


Figure 1. Subjects' Recruitment Flow Diagram. CAD, coronary artery disease; MI, myocardial infarction.

Table 1. Demographical Details of the Patients.

| Variables | Uddiyana Bandha Group n = 40 | Control Group n = 40 |
|----------------------------------|---------------------------------|-------------------------|
| Age (years) | 40.15±12.25 | 39.88±10.54 |
| Sex (M/F) | 19/11 | 17/13 |
| BMI (kg/m ²) | 30.56±4.22 | 28.18±4.12 |
| Married (yes/no) | 32/8 | 36/4 |
| Duration of hypertension (yrs) | 4.56±1.22 | 5.89±2.50 |
| Systolic blood pressure (mm Hg) | 138.56±10.25 | 135.69±14.55 |
| Diastolic blood pressure (mm Hg) | 87.56±8.22 | 81.58±6.87 |

Note: BMI, body mass index.

Bandha, which involves a forceful exhalation and abdominal contraction, may trigger a reflex increase in vagal tone, leading to enhanced parasympathetic activity and improved cardiovascular regulation.²² This, in turn, can contribute to the observed increases in HRV parameters, such as the HF component and SDNN, as well as the decrease in the LF/HF ratio.

The results of this study contribute to the expanding evidence supporting yoga-based interventions, particularly those incorporating targeted breathwork and abdominal techniques, as a complementary approach to managing hypertension. By improving autonomic balance and reducing sympathetic dominance, practices like *Uddiyana Bandha* may offer a

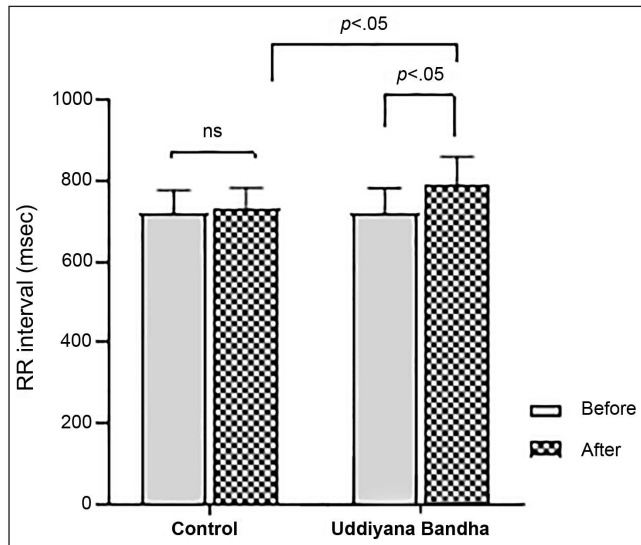


Figure 2. RR Interval Before and After Intervention Between the Group.

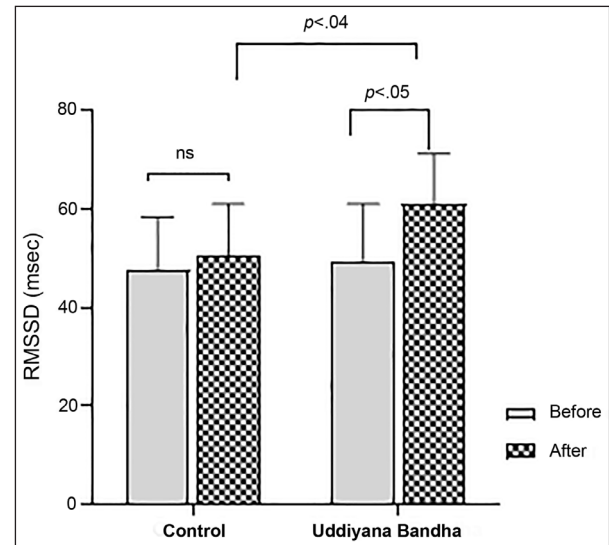


Figure 4. RMSSD Before and After Intervention Between the Group.

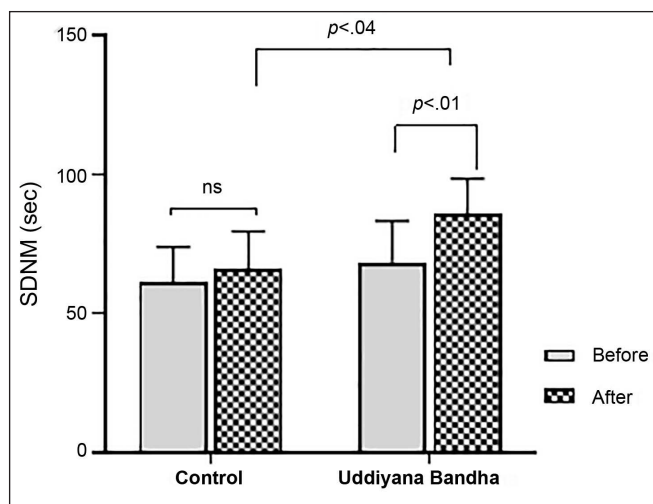


Figure 3. SDNN Before and After Intervention Between the Group.

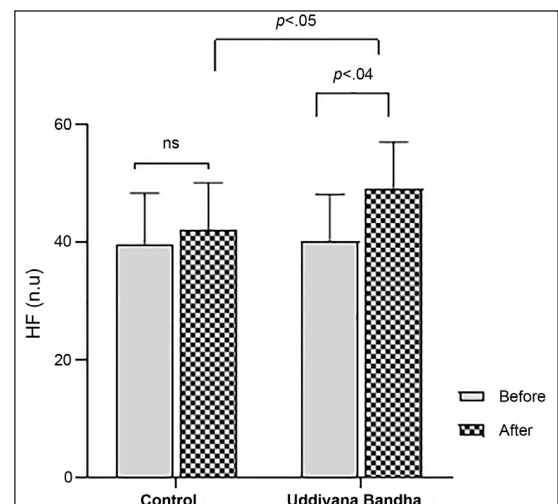


Figure 5. HF (n.u) Before and After Intervention Between the Group.

non-pharmacological strategy to support the treatment of hypertension and related cardiovascular conditions. Future research should explore the long-term effects of regular *Uddiyana Bandha* practice on blood pressure control, cardiovascular risk factors and overall health outcomes in hypertensive populations. Additionally, investigating the potential synergistic effects of combining *Uddiyana Bandha* with other yoga practices or lifestyle modifications may provide valuable insights into optimising the therapeutic potential of this ancient technique.

Strengths and Limitations

This study has several benefits. First, it is randomised controlled, so drop-out biases and other confounders are minimised. The measurements of HRV are objective and quantify the autonomic function. In addition, the study is based only on one yogic technique, *Uddiyana Bandha*, which enables a deeper analysis of its influence. However, certain limitations should be taken into consideration anyway. As with any session undertaken for this research, this study focused solely on

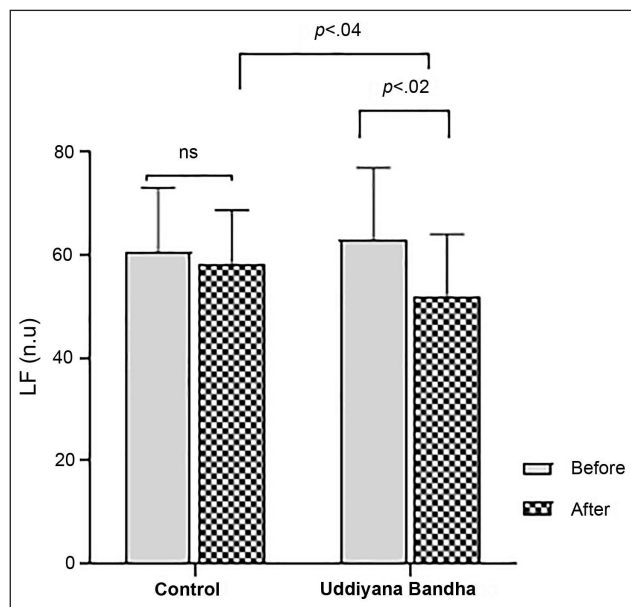


Figure 6. LF (n.u) Before and After Intervention Between the Group.

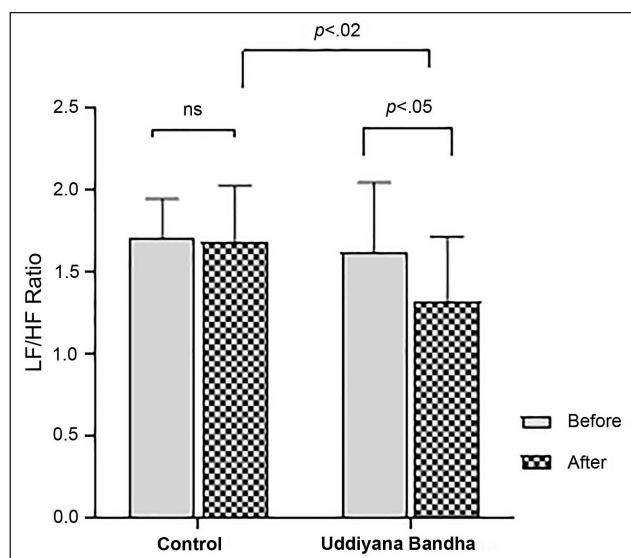


Figure 7. LF/HF Ratio Before and After Intervention Between the Group.

the effects of a single intervention. Therefore, long-term repetitions or regular exercise practice cannot produce results. Where this study is somewhat compromised is the sample size: although large enough to underscore statistically significant differences, not large enough to allow for generalisation. However, the study did not eliminate subjects with other comorbidities or offer control over aspects including medication intake, diet, or physical activity levels, which can affect HRV.

Conclusion

In conclusion, this study demonstrates that a single session of *Uddiyana Bandha* practice can immediately improve HRV parameters in patients with hypertension, suggesting enhanced parasympathetic activity and better autonomic regulation. These findings highlight the potential of this specific yogic practice as a complementary therapy for the management of hypertension and associated cardiovascular health concerns.

Authors' Contributions

KG: Conceptualization, methodology, investigation, data curation, writing- original draft; ME: Supervision, validation, writing- review & editing; DKa & DS: Formal analysis, data curation, visualization, writing- review & editing; SK: Investigation, resources, project administration; DeK: Methodology, investigation, data collection; BEO, YA and KP: Conceptualization, supervision, writing- review & editing.

All authors have read and agreed to the published version of the manuscript.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Statement of Ethics

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of the host institution (Ref: SRM MCH&RC/IEC/8516/2022). All participants provided written informed consent before participating in the study.

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