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Effect of Nabho Mudra on the salivary lipid profile and well-being of adolescents: A pilot study

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Mudras are integral practices described in ancient Vedic texts. This feasibility study investigated the effects of Nabho Mudra (Yogic Mudra) practice on metabolism, assessed through salivary lipid profiles and the psychological well-being of adolescents. The study included 80 secondary school students from Central Delhi, randomized into experimental (n=40) and control (n=40) groups, with a mean age of 14.1 years. The experimental group underwent a structured 1 month Nabho Mudra practice protocol consisting of 10 min daily sessions, 6 days per week. Well-being assessment utilized the World Health Organization (WHO)-5 questionnaire, while salivary lipid profiles were analyzed in a subset of 20 students with Body Mass Index (BMI; kg/m²)> 22 (representing 85th-95th percentiles on the WHO BMI-for-age chart). Post-intervention analysis revealed statistically significant improvements in the WHO-5 well-being index among the experimental group ($p=0.05$), whereas the control group showed no significant variation ($p=0.2$). Additionally, significant changes were observed in BMI ($p=0.003$) and Low-density lipoprotein (LDL) levels ($p=0.05$), accompanied by marked alterations in other salivary lipid parameters. These findings demonstrate the potential efficacy of Nabho Mudra as an intervention for enhancing physical and psychological well-being, while the observed changes in salivary lipid profiles warrant further investigation to elucidate the underlying mechanisms and broader health implications. Future longitudinal studies with larger cohorts are recommended to validate these preliminary findings and explore the therapeutic applications of this traditional yogic practice.

Keywords: Adolescents, Nabho mudra, Salivary lipid profile, Well-being, Yoga, Yogic mudra

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Yoga Mudras have their origin from the Vedas and Upanishads. According to tantric texts, Lord Shiva is regarded as the original exponent of mudras. Tantra views the use of mudras as a way to awaken dormant faculties, connect with divine energy, and undergo spiritual transformation[1]. There are innumerable mudras but classical yoga mudras are categorized into five groups: hasta mudra or hand mudra, shirsha mudra or head mudra, kaya mudra or postural mudra, bandha mudra or lock mudra and adhara mudra or perineal mudra[2]. Nabho Mudra is classified as a type of adhara mudra, highlighting its unique position in the yogic tradition. According to yogic texts, Nabho Mudra is a raja yoga practice and a simple form of Khechari Mudra. The term “Nabha” originates from Sanskrit meaning “Akash” or “sky” while “Mudra” signifies a gesture or posture[3].

The significance and practice of Nabho Mudra are elaborately described in ancient yogic texts. The Gherand Samhita (verse 32) provides detailed instructions and benefits, which translated from Sanskrit states: "Whenever one is and during all activities, a yogi should keep the tongue turned upward and retain the breath. Nabho Mudra destroys all the disorders of a yogi"[3]. The profound benefits of this practice are further emphasized in the Hatha Yoga Pradipika (verse 39), which provides this description when translated from the original Sanskrit: "He who knows the Khechari Mudra is not afflicted with disease, death, sloth, sleep, hunger, thirst, and swooning"[4].

The Hatha yogic texts define Khechari mudra as Nabho Mudra. The latter is considered an easy practice for Sadhaks[4]. Recent studies, such as those by Vivek Kumar *et al.* assess the multifaceted benefits of Khechari mudra in obstructive sleep apnea, including rejuvenation of oral muscles, reduced Basal Metabolic Rate (BMR), obesity mitigation, anti-aging effects, and decreased thirst and hunger[5]. A similar study states that Nabho Mudra impacts the heart, lungs, brain, and

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blood pressure, regulates anxiety and stress, decelerates heart rate, boosts metabolism, and alleviates insomnia[6]. An article on Kundalini by Stuart Sovatsky, also explains that Nabho Mudra, a precursor to Khechari mudra, activates the hypoglossal-larynx, hypothalamus, pituitary, and pineal glands. It also explores the concept of Anahata-nada, rudimentarily akin to "speaking in tongues," and its significance in the sacred chants of various cultures[7].

These documented physical and psychological benefits suggest particular promise for adolescent populations, especially in addressing developmental challenges. Adolescent mental health represents a critical global concern, with anxiety and depression affecting 6.5% and 2.6% of adolescents worldwide, respectively. A growing body of evidence demonstrates that adolescents with higher BMI face significant challenges in emotional regulation and peer relationships, creating a self-perpetuating cycle that adversely affects both their physical and psychological well-being[8]. Longitudinal research by Park *et al.*[9] has revealed that early intervention in adolescents with rising BMI trajectories proves particularly effective in preventing obesity-related metabolic complications in adulthood. While the WHO defines overweight as a BMI greater than 25 or more than +1 Standard Deviation (SD) approximately the 95th percentile for children and adolescents[10], our study strategically focused on participants with a BMI above 22, corresponding to the 85th-95th percentiles on WHO BMI-for-age charts for our study population (mean age 14.1 years). This specific range targets adolescents approaching, but not yet reaching, the WHO-defined overweight threshold, providing a unique opportunity to evaluate early intervention effectiveness.

Various studies have established the efficacy of yoga in promoting adolescent health. Vaishnav *et al.*[11] demonstrated significant improvements in psychological well-being through a 4-week Yoga-Nidra intervention among adolescents aged 13-15 years. Cerdá *et al.*[12] successfully integrated yoga and mindfulness practices into physical education, examining their impact on emotional awareness. Nidhi *et al.*[13] showed improvements in glucose metabolism and lipid profiles through a comprehensive 12-week yoga program, while Shelke *et al.*[14] reported enhanced cardiometabolic functions following an 8-week intervention, despite sample size limitations.

The present study addresses previous methodological challenges by introducing Nabho Mudra as a specific yogic technique designed for efficient school routine integration. The intervention's novelty lies in its time-efficient protocol and use of salivary lipid profiling instead of traditional serum analysis[15]. This non-invasive sampling approach maintains diagnostic validity while being particularly suitable for adolescents. Given the developmental sensitivity of adolescents, a non-invasive assessment method was employed through saliva for metabolic evaluation and the WHO-5 questionnaire for psychological assessment[15,16]. This methodological approach ensures participant comfort while maintaining robust scientific standards and data reliability. While Nabho Mudra shows promise for both physical and psychological health benefits, it remains relatively unexplored in scientific research. Unlike more demanding yoga practices, it offers a simpler, time-efficient approach particularly suited to school environments. This study systematically investigates both the feasibility of Nabho Mudra and its potential health impacts, specifically focusing on enhancing physical and psychological well-being among school-going adolescents.

Material and Methods

The participants were randomized into the experimental and the control group. This study included a pre-test and post-test control group design, conducted to understand the feasibility of Nabho Mudra on adolescents. The study was conducted in person through offline mode from November 18, 2022 to December 18, 2022.

Participants and study design

The study was conducted at a secondary school in Central Delhi, where the majority of the population belonged to a lower socio-economic background. This demographic context contributed to a higher proportion of male students compared to female students within the study population. This sample included 80 adolescents (30 females, 50 males). The age range of 13-16 years was selected as it represents middle adolescence, a period characterized by heightened academic stress alongside physical and psychological changes while possessing sufficient cognitive maturity to follow structured interventions[17]. The study protocol was approved by the institutional research board (MDNIY/202-21/RES/IR/EC/001/A13), and permission was

obtained from the school administration. Written informed consent from parents and assent from participants was obtained before enrollment.

A comprehensive three-tier health screening process was implemented. First, participants completed a structured information sheet under teacher supervision, documenting age, diet, sleep, physical activity, and health status. Second, written confirmation was obtained from parents/guardians regarding their child's health status, including existing medical conditions and current medications. Third, class teachers were consulted to verify student records maintained as per school policy. All 80 participants met the health criteria through this screening process and were eligible for randomization. The eligible adolescents were randomly assigned to either experimental (n=40) or control (n=40) groups using computer-based randomization through the Python library[18]. Each participant was assigned a number from 1 to 80, and the computer program randomly selected 40 numbers for the experimental group. The remaining participants were automatically assigned to the control group.

The experimental group received a structured yoga intervention consisting of Nabho Mudra practice for 10 min per session, 6 times per week, over 4 weeks. All sessions were conducted under the supervision of a certified yoga instructor during regular school hours. The control group maintained their regular school schedule without any yoga intervention during this period. Assessments for psychological well-being and salivary lipid profile were conducted at baseline and post-intervention (4 weeks) for both groups.

Inclusion and exclusion criteria

The sample size consisted of 80 participants. Inclusion criteria were as follows: (1) Healthy adolescents, (2) 13-16 years of age who are willing to participate in the study, whereas exclusion criteria included: (1) pre-existing yoga practice; (2) presence of any medical conditions; (3) use of any concomitant medications. Additionally, participants who demonstrated irregular attendance (<90% of sessions) during the intervention were excluded from the final analysis.

Ethical consideration

The research proposal was presented to the Institutional Research Board (IRB) on 30/09/2022 and the study was approved (MDNIY/202-21/RES/IR/EC/001/A13). Signed consents were received from the parents after thoroughly explaining the study. Participants were informed of their right to withdraw at any time and assured of the confidentiality of their data. The school authority provided a permission letter. All 80 participants declared their voluntary participation.

Assessment methods

Psychological parameters

Quality of life was measured using the (WHO-5) Well-being Index. The 5-item World Health Organization Well-Being Index (WHO-5) is among the most widely used questionnaires assessing psychological well-being. The scale demonstrates strong validity both as a depression screening tool and as an outcome measure in clinical trials, proving effective across a diverse array of study disciplines[16].

Biochemical parameters

Salivary lipid profiles (Cholesterol, Triglycerides, LDL, High-Density Lipoprotein (HDL)) were analyzed using Erba Kit and Erba Chem 5x (Transasia Bio-Medicals Ltd.). Pre- and post-intervention assessments were conducted on a subset of 20 participants with a BMI above 22, equally distributed between the experimental (n=10) and control (n=10) groups[15].

Intervention

The experimental group underwent a practice session to acquire a thorough understanding of the correct Nabho Mudra technique. This was a morning intervention of Nabho Mudra, delivered in person (offline mode) every morning at 8:00 AM for 4 weeks (excluding Sundays), while each session lasted for 10 minutes. A total of 9 rounds were practiced for 20 seconds each (Fig. 1).

The participants were advised to focus on their tongues throughout the session. The practice of Nabho Mudra was designed according to the Hatha yogic text "Gherand Samhita". Nabho Mudra is performed by touching the upper palate with the tongue[3] (Table 1) (Annexure IV).

1. Fold the tongue upward and backward so it lies in contact with the upper palate.
2. Inhale, and practice internal breath retention (also called ‘Antara Kumbhaka’). Intake of air can easily be stopped when the tongue is reversed back in Nabho Mudra.
3. Hold the mudra for 20 seconds, release the tongue, and Exhale.
4. Relax the tongue for 10 seconds. Repeat the mudra.

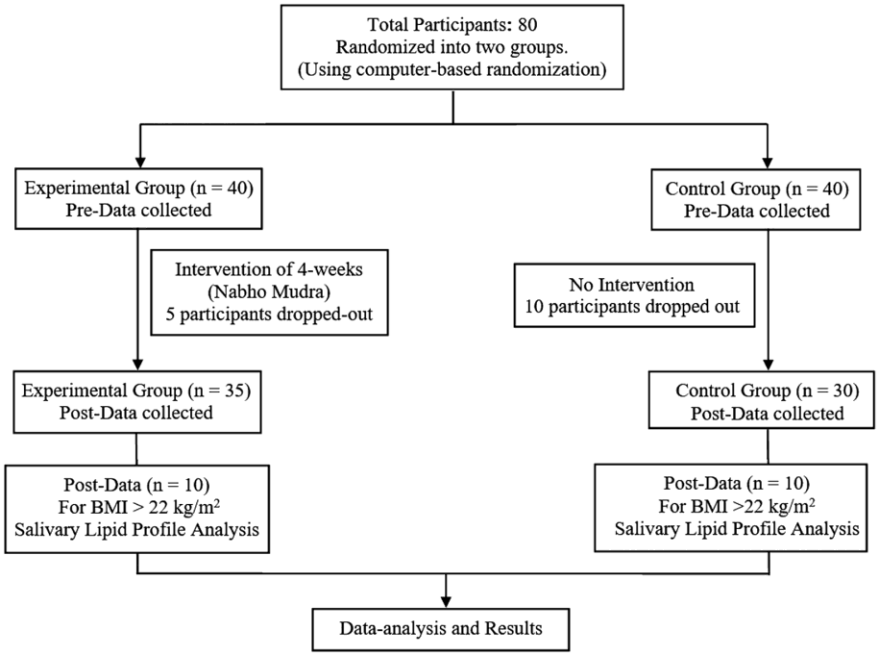

Fig. 1 — Allocation of Participants

Table 1 — Intervention table

No.	Yoga practice	Duration (10 min)	Benefits
1.	Prayer	1 min	To prepare the mind and body for yoga practice.
2.	Nabho Mudra (With antar kumbhaka)	8 min (9 rounds, each of 20 seconds)	It may improve psychological well-being and reduce stress.
3.	Prayer	1 min	It brings a peaceful end to the yoga practice.

Data analysis

The psychological well-being data are presented as mean and standard deviations. As the data was normally distributed, a paired sample t-test was used to measure pre-data and post-data changes. A p-value of <0.05 was considered statistically significant. Data analysis was done using Microsoft Excel.

Results

In the experimental group, of the 40 adolescents initially enrolled, 35 completed the study. Attrition was noted in 5 cases: 1 due to the diagnosis of Polycystic Ovary Syndrome (PCOS), and 4 others attributed to inadequate attendance records. In the control group, out of the 40 original participants, 30 completed the study as required. The remaining 10 adolescents were unable to submit their data within the stipulated time frame, leading to their exclusion from the final analysis. Despite the dropout, the retained sample size preserved the study's statistical robustness, allowing for valid conclusions. Potential biases were rigorously addressed, ensuring the dropout was random and unrelated to individual traits. No adverse effects or safety concerns were reported during the study period in either group.

Demographic characteristics

The majority of the participants originated from a community characterized by lower socio-economic circumstances. The age group was 13-16 years. The sample included 80 participants from a secondary school in Central Delhi. All healthy participants were included in the intervention, out of which 65 participants (28 females and 37 males) completed the study (Table 2). The dietary habits of the participants were assessed. The sample included both vegetarian and non-vegetarian participants (96.9% and 3.1% respectively) (Table 3).

Psychological characteristics

The well-being index (WHO-5) was used to determine the quality of life. The results were calculated for both groups. A score below 13 indicates poor well-being and is an indication for testing for depression using the International Classification of

Diseases, tenth revision (ICD-10)[16]. There was a statistically significant change observed during the pre-post analysis of the data between the experimental and control groups (Table 4).

Biochemical parameters

The salivary lipid profile of 20 participants with BMI above 22 from the experimental group (n=10) and control group (n=10), was evaluated before and after the intervention. The control group showed no significant change within the group. However, in the experimental group, the results indicated a significant decrease in BMI (p=0.003)*, and LDL levels (p=0.05)*. Changes in HDL were also notable p=0.06. However, the changes in other parameters of the salivary lipid profile (Cholesterol, Triglycerides, HDL) did not show significant differences. It was noted that the measured concentration of triglyceride is below the detectable limit of the assay. The triglyceride concentrations in saliva may be too low for the test to detect accurately, leading to an erroneous result (Table 5).

Discussion

This pilot study demonstrates the therapeutic potential of Nabho Mudra in adolescent health through significant improvements in both salivary lipid profiles and psychological well-being. While

Table 2 — Demographic characteristics of the participants

No.	Variables	Subject (%)	Experimental group (%)	Control group (%)	p value
	Total	65 (100%)	53.8 (35 participants)	46.2 (30 participants)	-
1.	Age (in Years)	13-16 years	14.3±0.8 (Mean±SD)	13.9±1.0 (Mean±SD)	0.08*
2.	Gender				
	Female	43.1	45.7	40.0	
	Male	56.9	54.3	60.0	0.65*
3.	BMI (18.5-24.9)	Normal	21.3±1.9 (Mean±SD)	21.6±1.7 (Mean±SD)	0.52*
4.	Health Status	Healthy	Healthy	Healthy	-
5.	Diet				
	Non-vegetarian	96.9	68.6	53.3	
	Vegetarian	3.1	31.4	46.7	0.37*

*p value shows the homogeneity (no significant difference) between experimental and control groups

Table 3 — Dietary information of the participants

No.	Food Habits	Experimental group % (35 participants)			Control group % (30 participants)		
		Often	Sometimes	Never	Often	Sometimes	Never
1.	Consume fresh fruits	57.1	42.9	0	43.3	56.7	0
2.	Consume green vegetables	57.1	40.0	2.9	50.0	50.0	0
3.	Prefer home-made food	77.1	22.9	0	83.3	13.4	3.3
4.	Not consuming fast/junk food	31.4	60.0	8.6	16.7	80.0	3.3
5.	Not consuming Tea/Coffee	45.7	34.3	20.0	73.3	16.7	10.0
6.	Not consuming late-night snacks	17.2	51.4	31.4	13.3	16.7	70.0

Table 4 — Well-being index scores for quality of life. Scores <13 indicate potential depression per ICD-10 criteria

Group	Intervention	Score < 13 (%)	Score ≥ 13 (%)	Mean ± SD	p-value
Experimental	Pre	11.4	88.6	17.2±3.6	
(35 participants)	Post	8.6	91.4	18.4±3.8	0.05*
Control	Pre	16.7	83.3	17.3±3.8	
(30 participants)	Post	26.7	73.3	17.4±4.6	0.80

*Significance at p<0.05

Table 5 — Salivary lipid profile of the experimental group (BMI > 22)

Parameters (n=10)	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	p-value
BMI ($kg/m^{2)}$	23.5±0.8	22.9±0.6	0.003*
Total Cholesterol (mg/dL)	3.0±1.5	3.2±1.9	0.71
Low-density Lipoprotein (mg/dL)	3.6±0.8	3.5±0.8	0.05*
High-density Lipoprotein (mg/dL)	3.2±0.4	3.5±0.4	0.06

*Significance at p<0.05

previous research has established the benefits of various yoga practices on lipid profiles and psychological well-being[11,12], this study uniquely investigates Nabho Mudra, a concise and accessible practice, using non-invasive assessment methods specifically tailored for adolescents. Through a structured 4-week intervention, systematic patterns of physiological adaptation and measurable health improvements were observed.

There were distinct phases of adaptation during the intervention. In the initial phase in week 1, participants reported mild physiological adaptations, including tingling sensations and tongue discomfort. Notably, participant engagement remained high despite these temporary discomforts, possibly due to the novelty of the practice. During week 2, participants reported increased thirst and mild throat dryness, which we addressed through controlled water consumption during sessions. This modification proved successful and maintained practice integrity while improving participant comfort. Week 3 marked a significant turning point, characterized by improved participant comfort, enhanced breath-holding capacity, and better respiratory control. The consistent practice patterns observed during this phase indicated successful adaptation to the technique. By week 4, the proficiency of participants improved, allowing for a more precise assessment of the effects of Nabho Mudra and suggesting potential additional benefits with extended practice duration.

During the practice of Nabho mudra, the tongue is turned upward, with internal retention (antara kumbhaka) of the breath. When Nabho mudra is practiced in the beginning it creates a stretch in the oral cavity along with a sensation of tingling at the sublingual glands and the floor of the mouth. This might result in the stimulation of the thyroid gland which is responsible for the metabolic processes of the body. The assessment of salivary lipid profiles yielded promising results among participants with a BMI above 22. The experimental group (n=10) showed significant reductions in both BMI ($p=0.003$)* and LDL levels ($p=0.05$)*. HDL levels approached statistical significance ($p=0.06$), while total cholesterol and triglycerides remained unchanged. These findings align with previous research demonstrating the positive effects of yoga on lipid profiles[12,13], though this study is distinctive in its use of salivary sampling rather than traditional serum analysis. While earlier studies have shown significant improvements in lipid profiles through comprehensive yoga programs[12], the investigation demonstrates that even a focused practice like Nabho Mudra can yield meaningful metabolic changes. The established correlation between salivary and serum lipid profiles supports the validity of our methodology[15]. The psychological outcomes were equally noteworthy, with the experimental group exhibiting statistically significant improvements in the WHO-5 Well-Being Index compared to the control group. These findings complement existing research on yoga's psychological benefits in adolescents while introducing a more time-efficient intervention. The WHO-5's recognition as a reliable tool for assessing adolescent psychological well-being further strengthens the validity of the observed improvements in mental health[16].

Our approach offers several advantages over traditional yoga interventions. While previous studies typically employed comprehensive yoga programs ranging from 8-12 weeks[12,13], our 4-week Nabho Mudra intervention demonstrates significant benefits with a more focused and time-efficient practice. The use of non-invasive salivary sampling represents an innovation in adolescent research methodology, potentially increasing participation rates and reducing assessment-related stress. The practice proved safe, with only minor initial adaptation discomfort and no serious adverse events. This favorable safety profile, combined with the observed benefits, supports its potential integration into adolescent wellness programs.

While this feasibility study focused specifically on adolescents, the potential benefits of Nabho Mudra may extend to adults as well. As this represents the first scientific investigation of Nabho Mudra, it was strategically chosen to begin with adolescents due to their heightened stress vulnerability and the critical nature of early intervention during this developmental period. The positive findings in both metabolic and psychological parameters suggest promising therapeutic potential that warrants investigation across different age groups. The initial focus on adolescents served as a starting point to establish preliminary evidence for the effects of Nabho Mudra. Future studies examining adult populations would be valuable to understand its efficacy across different age groups. The traditional texts describing Nabho Mudra do not specify age restrictions, suggesting its potential applicability for various age groups, though this needs to be validated through systematic research.

Strength

This pioneering pilot study on Nabho Mudra distinguishes itself as the inaugural investigation of its kind. It assists in understanding the feasibility of Nabho Mudra. With a substantial sample size, the study serves as a promising starting point and sets a robust foundation for future research endeavors focused on Nabho Mudra or Khechari Mudra. Importantly, the study's outcomes hold significant implications as they illuminate the positive impact of Nabho Mudra on physical and psychological well-being.

Limitations

The study presents several opportunities for further exploration and enhancement. The sample was drawn from a single school, providing a focused but potentially expandable research setting. The study embraced an open dietary approach, avoiding restrictive controls, which could offer insights into naturalistic behaviors. Additionally, the research was designed as a short-term intervention, laying the groundwork for potential longitudinal studies to examine sustained effects over time.

Conclusion

Nabho Mudra proves its effectiveness in enhancing an individual's psychological well-being, as evidenced by the substantial improvements observed in the well-being index of the experimental group. While there were promising but statistically insignificant improvements in the salivary lipid profile, it is important to note that this study was primarily a feasibility assessment. To fortify and validate these initial findings, further research may be designed with a larger and more diverse sample size, employing a robust research design that incorporates objective variables. Such endeavors will undoubtedly provide a more comprehensive understanding of the potential benefits of Nabho Mudra.

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Conflict of Interests

Authors declare no competing or conflict of interest.

Author Contributions

YS: Conceptualized and designed the study; acquired, analyzed, and interpreted data. Drafted the manuscript and supplementary materials. Led yoga sessions, managed participant recruitment and follow-up, and facilitated communication. KJ: Designed the study, interpreted results, and critically revised the manuscript. Ensured methodological rigor, statistical analysis, and data integrity. Managed submissions and coordinated with co-authors. KS: Revision of the manuscript. Assisted with documents.

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Ethics Statement

The study was approved by the Institutional Research Board (IRB) on 30/09/2022. All procedures were conducted in accordance with ethical research standards (MDNIY/202-21/RES/IR/EC/001/A13).

Informed Consent

Written informed consent was obtained from parents of all participants. Students voluntarily participated after being informed of their rights and data confidentiality. School authorities provided permission to conduct the study. The informed consent form is available in supplementary data (Annexure VI).

Data Availability

The dataset generated and analyzed during the current study is available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions, as the study involves human participants.

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