ORIGINAL ARTICLE

Journal of Ethnomedicine and Medical Wellness (*JEMEDWELL*) 2025, Volume 1, Number 1: 12-17

Sheetali Pranayama for Lowering Blood Pressure in Healthy and Hypertensive Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Received: 2024-12-20
Accepted: 2025-02-13
Published: 2025-03-12

ABSTRACT

Introduction: Hypertension remains a prevalent condition among adults globally, contributing to increased mortality risk. Yoga is suggested as an alternative method for managing hypertension. Among yoga practices, Sheetali pranayama has not been extensively studied for its potential to reduce blood pressure (BP). This research intends to perform a systematic review and meta-analysis on the impact of Sheetali pranayama on blood pressure and heart rate (HR).

Method: We performed a comprehensive literature search in PubMed, Google Scholar, ProQuest, Web of Science, Cochrane Library, and clinicaltrials.gov to identify randomized controlled trials (RCTs) or observational studies on sheetali pranayama and blood pressure up to February 26, 2024. The primary outcomes assessed included post-intervention systolic blood pressure (SBP), diastolic blood pressure (DBP), HR, mean arterial pressure (MAP), pulse pressure (PP), rate pressure product (RPP), and double product (DoP).

Results: Three RCTs were included in the analysis. Sheetali pranayama significantly reduce SBP (MD = -9.33; 95%CI = -15.38 to -3.29; p = 0.002), DBP (MD = -6.83; 95%CI = -10.82 to -2.84; p = 0.0008), MAP (MD = -4.82; 95%CI = -6.67 to -2.96; p = 0.00001), HR (MD = -4.74; 95%CI = -7.44 to -2.05; p = 0.0006), and PP (MD = -4.58; 95%CI = -7.56 to -1.60; p = 0.003) compraed to the control groups.

Conclusion: Sheetali pranayama effectively lowers SBP, DBP, HR, MAP, and PP. It is safe and cost-effective as a complementary therapy for hypertension

Keywords: Sheetali Pranayama, blood pressure, hypertension.
Cite This Article: Brahmantya, I.B.Y., Santosa, I.G.N.P.E., Kertia, N. 2025. Sheetali Pranayama for Lowering Blood Pressure in Healthy and Hypertensive Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Journal of Ethnomedicine and Medical Wellness* 1(1): 12-17

INTRODUCTION

In 2010, approximately 31.1% of the world's 1.39 billion adults were affected by hypertension.[1] Hypertension is a controllable risk factor for several serious diseases, including cardiovascular disease (especially ischemic heart disease), hemorrhagic and ischemic stroke, and chronic kidney disease.[2] It is also a global risk factor for all-cause mortality.[3] As a result, hypertension management efforts continue to be a widely researched topic.

Recently, the use of traditional and complementary medicine (T&CM) has grown worldwide,[4] including its use in treating hypertension.[5] The World Health Organization has developed a strategy to integrate T&CM into national health systems to increase access and expand understanding of its safety, efficacy, and quality.[6] In 2018, data from Indonesia showed that 45.6% of 58,621 surveyed patients did not adhere to antihypertensive medication, and 14.5% of 26,848 hypertensive patients interviewed opted for traditional medicine.[7] The high demand for traditional and complementary medicine (T&CM) is attributed to the influence of local culture and history (ethnomedicine) and the desire for a comprehensive range of treatment options (integrative medicine).[6]

Since 2017, the American Heart Association (AHA) has recommended yoga as an alternative lifestyle intervention for hypertension.[8] Yoga may be a safer option to accompany antihypertensive therapy, as interactions with herbal medicines can potentially cause uncomfortable side effects for patients and limit its continued use in hypertension management.[9] Pranayama, one of the eight limbs of yoga, is being intensively studied for its benefits in hypertension.[10] According to Patanjali, It is an effort to regulate the breath and connect the mind and body, expanding the life force (prana) throughout the body.[10,11] Different breathing exercises have been examined for their effectiveness in lowering high blood pressure.[10] However, little attention has been paid specifically to the sheetali pranayama.

Sheetali pranayama is a breathing technique where one inhales through a rolled tongue to create a tube, then exhales slowly through the nostrils.[12,13]

This technique, like other pranayama techniques, can lower blood pressure by increasing the sensitivity of baroreceptors and causing equilibrium changes in the autonomic nervous system.[14,15] However, no studies have examined the effects of sheetali pranayama on blood pressure. Therefore, this study aims to evaluate its impact on blood pressure and pulse rate using online sources. We hypothesized that sheetali pranayama could reduce blood pressure in healthy and hypertensive individuals.

METHODS

Search strategy

This review was reported using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. We searched articles in databases such as PubMed, Google Scholar, ProQuest, Web of Science, Cochrane Library, and clinicaltrials.gov from inception to February 26, 2024. The search keywords and boolean operators were "Sheetali pranayama" AND "blood pressure." No filters were applied during the article search. This review protocol has been registered in PROSPERO with the record ID CRD42024518894.

Selection criteria

The inclusion criteria for the article were formulated using the PICOS criteria. The population studied consisted of adults with or without hypertension or healthy adults. The intervention studied was sheetali pranayama, while the control group did not undergo the sheetali pranayama program. The study outcome was blood pressure and pulse rate, and the study design included in this review was a randomized controlled trial (RCT) and observational study. Exclusion criteria were applied to studies that examined the effect of sheetali pranayama on blood pressure in conjunction with other types of pranayama techniques and studies with no control group for comparison. No criteria were applied for article language or year of publication. Two reviewers independently screened the articles for eligibility based on title, abstract and full text. Disagreements were resolved by consensus with the other reviewers.

Literature screening and data extraction

Two reviewers extracted study characteristics and outcomes from selected articles. Any conflicts during this process were resolved by consulting a third reviewer for comparison and discussion. The extracted study characteristics included the first author's name, publication year, country, number of research subjects per group, duration of each sheetali pranayama session, frequency of sheetali pranayama implementation, and outcome measurements. This study observed the following outcomes: resting systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), mean arterial pressure (MAP), pulse pressure (PP), rate pressure product (RPP), and double product (DoP).

Quality assessment

Two reviewers evaluated the risk of bias in the publications using the Cochrane Collaboration risk of bias tool for RCTs[16] and the Newcastle-Ottawa Scale for observational studies. The evaluations were carried out autonomously to guarantee impartiality. The risk of bias charts for RCTs were generated and finalized using the Microsoft Excel version of the risk of bias 2 tool offered by the Cochrane Collaboration. The risk of bias evaluation for RCT studies encompassed five domains: randomization process (D1), deviations from intended interventions (D2), missing outcome data (D3), measurement of the outcome (D4), and selection of reported outcomes (D5). These domains were utilized to ascertain the total risk of bias for each study. The risk of bias was assessed using the risk of bias 2 method developed by the Cochrane Collaboration and calculated in Microsoft Excel. Any divergences of opinion between the two reviewers were resolved through deliberations including a third reviewer.

Statistical Analysis

The statistical heterogeneity and forest plots for meta-analysis summaries were generated using Review Manager® software version 5.4. I^2 statistics were employed to evaluate the heterogeneity of findings across research, where I^2 values greater than 50% indicate significant heterogeneity. The selected meta-analysis model depended on this I^2 value; a fixed effect model was employed if no major heterogeneity was identified; otherwise, a random effect model was chosen. We employed mean difference (MD) technique to investigate continuous variables. Statistically significant result was set at a p-value of less than 0.05. As outcomes measurements were largely taken pre- and post-intervention, we simply considered the post-intervention outcome in our meta-analysis.

RESULTS

Search Results

The search yielded 2729 results from six databases, as illustrated in Figure 1. After reviewing the titles and abstracts, two reviewers agreed that five articles met the criteria for full-text review. One study conducted sheetali pranayama intervention along with other pranayama techniques.[13] One other study has no control group for comparison.[17] Finally, three RCT articles[12,18,19] were deemed eligible for qualitative and quantitative analysis and included in the study sample.

Study characteristics

The study characteristics are summarized in Table 1, while Table 2 presents the measured outcomes. The combined sample size of all studies is 220. The studies analyzed in this research were primarily conducted in India,[12,18] with one study from Egypt.[19] Two studies involved hypertensive patients,[12,19] while one focused on a healthy young adult population.[18] Although there were variations in the recommended session duration and frequency of sheetali pranayama between RCTs, two studies evaluated the long-term effects of sheetali pranayama for 12 weeks in hypertensive patients.[12,19] Furthermore, there were differences in how the BP is measured and recorded. While all studies utilized digital devices to measure the BP, only one reported calibrating their BP measurement device.[12]

Risk of bias assessment

The risk of bias assessment of the three RCTs is shown in Figure 2. All studies had a potential risk of bias in the randomization process domain (D1), mainly because the

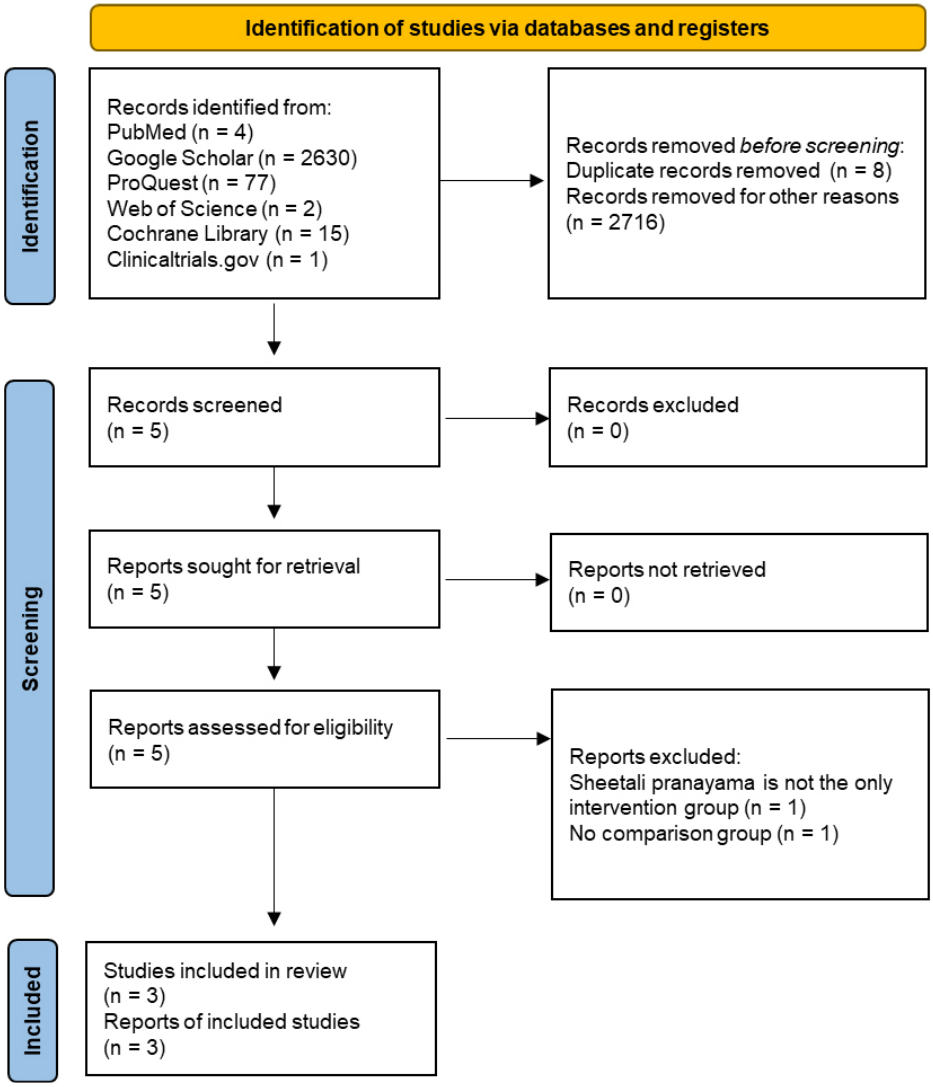

Figure 1. PRISMA flowchart.

sheetali pranayama intervention could not be concealed from the sample.[12,18,19] The study by Rohini et al. also had a risk of bias in the deviations from the intended interventions domain (D2), as it did not conduct an appropriate analysis to compare baseline characteristics between the intervention and control groups.[18] Overall, all studies had some concerning risk of bias, although none had a high risk of bias in each domain.

Meta-analysis of outcomes

The results of the meta-analysis comparing MD between the sheetali pranayama group and the control group are shown in Figure 3. Significant differences were found in resting SBP (MD = -9.33; 95%CI = -15.38 to -3.29; p = 0.002), DBP (MD = -6.83; 95%CI = -10.82 to -2.84; p = 0.0008), MAP (MD = -4.82; 95%CI = -6.67 to -2.96; p = 0.00001), HR (MD = -4.74; 95%CI = -7.44 to -2.05; p = 0.0006), and PP (MD = -4.58; 95%CI = -7.56 to -1.60; p = 0.003) between the sheetali pranayama and control groups. Across studies involving hypertensive patients and normal populations, the SBP, DBP, HR, MAP, and PP consistently showed lower values in the sheetali pranayama group compared to the control group. However, substantial heterogeneity was found when analyzing SBP (I^2 = 93%; p < 0.00001) and DBP (I^2 = 84%; p = 0.002) parameters, indicating high MD variation between studies. Therefore, a meta-analysis was performed using a random effects model.

DISCUSSION

This study aimed to evaluate the benefits of sheetali pranayama on blood pressure and pulse rate. To the best of our knowledge, this is the first meta-analysis to evaluate the efficacy of sheetali pranayama, specifically on blood pressure. The results showed that all mean blood pressure and pulse rate-related parameters, including SBP, DBP, HR, MAP, and PP, were significantly lower in the sheetali pranayama group compared to the control group after a long-term intervention.

Previous studies have compared the effectiveness of various breathing exercises and have found significant reductions in SBP (MD = -12.24; 95% CI = -21.99 to -2.48; p < 0.001), DBP (MD = -4.93; 95% CI = -6.91 to -2.96; p < 0.001), and HR (MD = -3.16; 95% CI = -5.11 to -1.20; p < 0.001).[10] Similar to the current study, the meta-analysis models for SBP and DBP showed substantial heterogeneity.[10] Earlier studies investigating the effects of yoga on blood pressure also reported similar findings.[20–22] The groups that performed breathing exercises showed even greater reductions (~8 mmHg) than those that did not (~2 mmHg).[21] However, these studies combined different types of yoga and breathing exercises, making the results incomparable to the current study.

The sheetali pranayama in the included studies was mostly performed by qualified yoga instructors and naturopathy doctors.[12,18] To ensure the expected efficacy of sheetali pranayama in different practices, it may be necessary to standardize or certify doctors specializing in yoga. Furthermore, it is necessary to establish universal, evidence-based protocols for sheetali pranayama, including the duration and frequency of each session and consistent methods for measuring blood pressure. It is important to note that the studies included in this meta-analysis have shown variations in these aspects.[12,18,19]

The two studies included in this study involved hypertensive populations who routinely took antihypertensive medication.[12,19] Therefore, sheetali pranayama serves as a complementary therapy in this study. Future studies should focus more on comparing the

Table 1. Characteristics of included RCTs

Author (Year)	Country	Age	Subject Groups	N	Sheetali Pranayama			BP Measurement
					Method	Session Duration	Frequency	
Thanalakshmi et al. (2020)	India	37.80±12.21 years	HTN with pranayama	50	Instructed by a qualified yoga and naturopathy doctor, conducted on an empty stomach.	10 rounds followed by 2 minutes rest, minimum 20 rounds or 30 minutes, between 7 to 9 AM.	Daily, for three months.	Recorded using a calibrated digital blood pressure monitoring device (Omron Hem 7130L®) over the brachial artery, in a supine position, between 9 AM and 12 PM. Three trials of measurements were conducted with 5-minute intervals, and the lowest reading was included.
		39.20±10.80 years	HTN without pranayama	50				
Rohini et al. (2022)	India	18.74±3.93 years	Healthy pranayama	30	Instructed by a qualified yoga and naturopathy doctor, conducted in *padmasana* posture.	10 cycles followed by 2 minutes rest, minimum 20 cycles for 5 minutes.	Not available.	Recorded using eight non-invasive blood pressure control channels of the RMS POLYRITE® version 2.4, measured in *padmasana* posture (legs are crossed on the floor with the feet on the thighs and soles facing upwards).
		17.30±4.83 years	Healthy control	30				
Elsheikh et al. (2023)	Egypt	65.23±3.97 years	HTN with Sheetali pranayama	30	Not available.	10 minutes.	Twice a day, every morning and at night, for 12 weeks.	Recorded using a digital sphygmomanometer (Granzia® device, made in Italy).
		66.46±4.07 years	HTN with Bhramari pranayama	30				

BP, blood pressure; HTN, hypertension.

Table 2. Outcomes comparison between RCTs

Author (Year)	Subject Group	N	SBP (mmHg), mean±SD		DBP (mmHg), mean±SD		MAP (mmHg), mean±SD		HR (bpm), mean±SD		PP (mmHg), mean±SD		RPP (bpm-mmHg), mean±SD		DoP (bpm-mmHg), mean±SD	
			Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Thanalakshmi et al. (2020)[12]	HTN with sheetali pranayama	50	143.88±10.6	124.12±14.72	87.12±7.40	76.16±4.46	92.40±7.22	86.7±4.87	84.18±13.22	75.22±14.16	46.12±9.16	39.32±13.24	94.12±8.91	84.72±6.27	6982.16±357	6270.6±527
	HTN without sheetali pranayama	50	146.10±11.28	139.72±12.90	88.90±9.88	86.12±10.56	92.13±10.14	90.13±10.45	83.12±10.42	80.78±12.12	44.19±5.12	43.15±13.09	93.20±11.38	91.14±14.56	6809.3±443	6694.3±401
Rohini et al. (2022)[18]	Healthy pranayama group	30	117.10±6.6	109.92±3.26	76.79±7.02	70.69±9.74	92.70±4.84	87.56±5.78	82.31±8.56	76.48±7.85	46.24±5.40	41.80±4.88	NA	NA	NA	NA
	Healthy control group	30	119.80±5.92	120.20±3.82	78.34±6.36	77.80±5.72	91.63±4.38	93.08±2.68	78.17±6.36	80.92±4.02	48.76±4.04	46.76±8.97	NA	NA	NA	NA
Elsheikh et al. (2023)[19]	HTN with sheetali pranayama	30	147.2±4.65	127.43±3.14	94.1±2.78	86.86±2.34	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	HTN with bhramari pranayama	30	146.4±4.42	130.7±5.75	94.43±2.86	90.9±2.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Bpm, beats per minute; DBP, diastolic blood pressure; DoP, double product; HR, heart rate; HTN, hypertension; MAP, mean arterial pressure; PP, pulse pressure; RPP, rate pressure product; SBP, systolic blood pressure; SD, standard deviation.

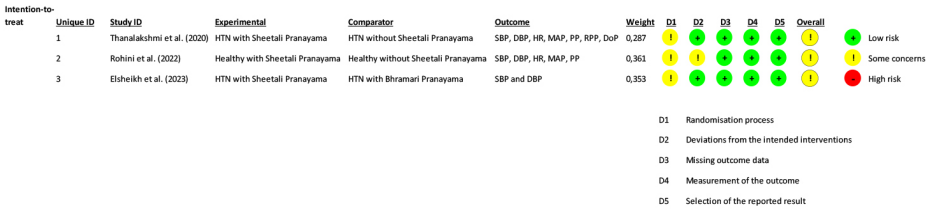

Figure 2. Risk of bias assessment of the RCTs.

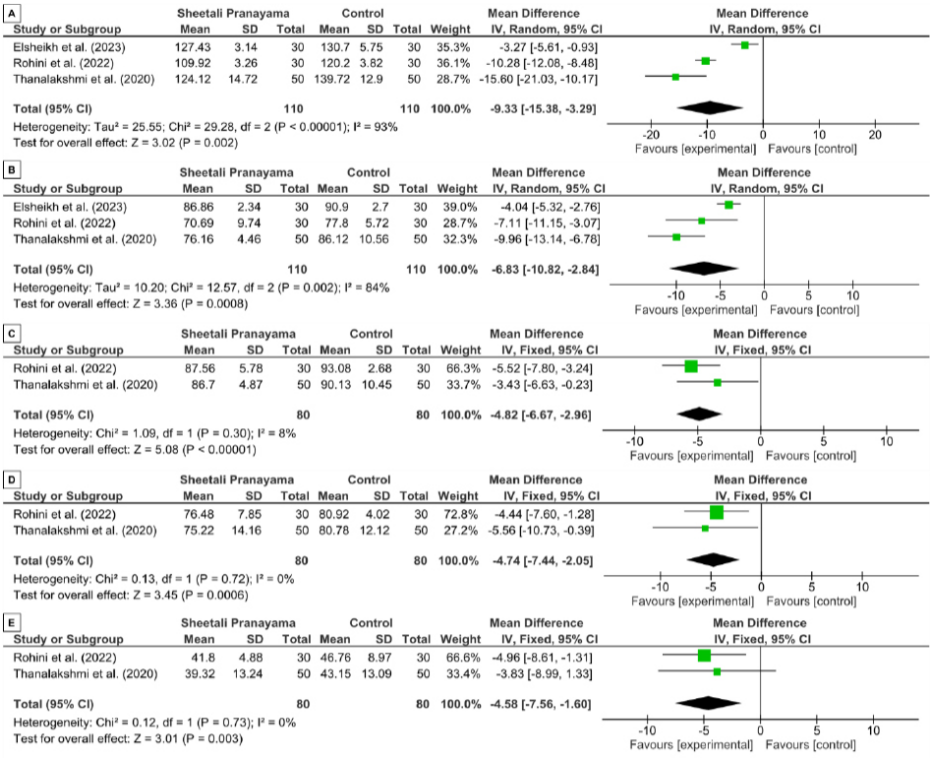

Figure 3. Forest plots of measured outcomes. Forest plot of systolic blood pressure (A), diastolic blood pressure (B), mean arterial pressure (C), heart rate (D), and pulse pressure (E).

blood pressure reduction achieved by a long-term sheetali pranayama program in hypertensive patients who are not taking antihypertensive drugs. Furthermore, no studies have been conducted on the immediate effects of sheetali pranayama, such as post-exercise blood pressure or moments after exercise. For instance, Nivethitha et al. reported increased blood pressure immediately after the Bahir Kumbhaka breathing exercise.[23] Therefore, it is yet to be determined whether the anticipated effects are only noticeable with long-term practice and how frequent the recommended practice should be. It is also essential to determine the duration of the blood pressure-lowering effect after performing sheetali pranayama.

Hypertension is strongly linked to an enhancement in sympathetic nervous system activity,[24] a reduction in parasympathetic nervous system activity,[24] and a disruption of baroreflex sensitivity.[25] Previous studies have proposed potential mechanisms for the blood pressure-lowering effects of slow and deep breath training. These mechanisms include an increase in the amount of oxygen entering the body with increased inhalation and exhalation volumes,[26–28] arteriolar dilatation through inhibition of the sympathetic nervous system and activation of cardiopulmonary mechanoreceptors,[28–30] a decrease in pulse rate through increased baroreflex sensitivity,[29,31] and changes in body biochemistry such as an increase in endorphins for a relaxing effect, a decrease in adrenaline, and a decrease in blood acidity.[32]

This study has limitations. The studies included are limited and have some concerning risk of bias. Therefore, definitive conclusions regarding sheetali pranayama's benefits on blood pressure are yet to be determined. Despite these limitations, sheetali pranayama can be proposed as a complementary therapy for high blood pressure. It is a safe, cost-effective, and relatively easy option to reduce health costs for patients or health insurance. However, proper instructions for performing sheetali pranayama exercises and patient adherence are needed to achieve the desired results.

CONCLUSION

The results of this study indicate that sheetali pranayama effectively reduces SBP, DBP, HR, MAP, and PP. It is a safe, inexpensive, and easy-to-perform complementary therapy to antihypertensives. However, there is a need to standardize the protocols for performing Sheetali Pranayama and the methods for measuring blood pressure across studies. Additional randomized controlled trials (RCTs) may be needed to validate these findings further in healthy, prehypertensive, essential, and even hypertensive urgency patients.

CONFLICT OF INTEREST

All authors declared that there is no conflict of interest regarding this article.

FUNDING

This article is self-funded by authors.

ETHICS APPROVAL

Not applied.

AUTHOR'S CONTRIBUTION

All authors contributed equally in the writing process of this article.

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