EFFECTS OF SLOW BREATHING ON HEART RATE, BLOOD PRESSURE AND OXYGEN SATURATION: A COMPARATIVE STUDY BETWEEN HEALTHY NON-YOGIC ADULTS AND YOGIC ADULTS

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ABSTRACT

Slow breathing is an intentional practice of deep and slow breathing which helps to connect the mind and body to calm and increase mindfulness. This study aims to assess the effects of slow breathing on heart rate, blood pressure, and oxygen saturation and to compare its effects in yogic and other normal people. Sixty healthy female subjects of age group 18-40 years were taken by simple random technique and consists of two groups: (i) Yogic – healthy adults practicing yoga and meditation for at least 3 months (ii) non-yogic – healthy adults not practicing yoga and meditation. Mean values of basal pulse rate, systolic blood pressure, diastolic blood pressure, and oxygen saturation for non-yogic and yogic were observed and compared. Then after the slow breathing maneuverer the same parameters in two groups were observed and compared. This study showed that slow breathing was negatively associated with pulse rate and systolic blood pressure, and positively associated with oxygen saturation. There was significant difference in basal pulse rate (p=0.000) as well as after slow breathing pulse rate (p=0.000) between non-yogic and yogic group. Less significance is seen in basal systolic blood pressure (p=0.012) between groups while no significance after slow breathing. There was significant difference of oxygen saturation before and after slow breathing (p=0.000) between two groups. This study showed that practice of regular slow breathing helps to decrease in basal pulse rate, decrease in systolic blood pressure and increase in oxygen saturation.

KEYWORDS

Non-yogic, oxygen saturation, pulse rate, slow breathing, systolic blood pressure

***Received on**: May 09, 2025*
***Accepted for publication**: June 10, 2025*

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DOI: https://doi.org/10.3126/nmcj.v27i3.84416

Cite this paper as: Amatya N, Prajapati R, Shrestha R. Effects of slow breathing on heart rate, blood pressure and oxygen saturation: a comparative study between healthy non-yogic adults and yogic adults. *Nepal Med Coll J* 2025; 27: 159-64.

INTRODUCTION

In the context of ancient *Hindu* practice "slow breathing" in *pranayama* refers to a deliberate and conscious practice of taking deep, extended breaths at a significantly slower pace than normal, often with a focus on inhaling and exhaling smoothly through the nose, aiming to calm the mind and promote inner balance by controlling the flow of *prana* (life force) within the body. There should be two things in consideration in slow breathing in *pranayama* – (i) intentional control: unlike casual breathing, *pranayama* emphasizes actively managing the breath, slowing down both inhalation and exhalation with awareness. (ii) mind-body connection: by focusing on the breath, practitioners aim to connect the physical act of breathing with their mental state, leading to relaxation and increased mindfulness.[1]

Pranayama is an ancient breath technique that originates from yogic practices in India. It involves controlling your breath in different styles and lengths. It has been applied for thousands of years amongst eastern cultures for the purpose of restoring or enhancing one's health. It is often performed in conjunction with meditation or yoga, for its spiritual and perceived health-enhancing effects.[2]

Slow breathing has recently gained more popularity and has been adopted in the western world because of the many health benefits. Breathing rate plays a major role in the regulation of heart rate and blood pressure which are proved by several studies.[3-5] Slow breathing also leads to an increase in oxygen saturation levels, meaning more oxygen is being delivered to the bloodstream, as it improves ventilation efficiency by allowing for deeper breaths and better utilization of lung capacity. This effect is particularly noticeable in situations like high altitude where oxygen levels are lower, and can also benefit individuals with conditions like heart failure where oxygen saturation might be compromised.[6]

Heart rate variability (HRV) is a valuable parameter that reflects the nature of autonomic regulation,[7] while blood pressure variability (BPV) serves as a reliable indicator of the balance between neurohumoral and endocrine control,[8] both of which are closely linked to the risk of cardiovascular complications. The growing interest in slow breathing techniques has provided therapeutic benefits for a variety of medical conditions. Research has shown that slow breathing can reduce blood pressure and improve baroreflex sensitivity in hypertensive individuals, effects that may be advantageous for managing hypertension.[9] Hypertension, a prevalent and chronic condition worldwide, is a significant risk factor for cardiovascular and cerebrovascular diseases. The longer the duration of elevated blood pressure, greater the risk of associated complications, such as myocardial infarction, renal failure, stroke, and heart failure.[10] This study aims to explore the impact of slow breathing on heart rate (HR), blood pressure (BP), and oxyhemoglobin saturation in two distinct groups: one consisting of healthy adults who regularly practice yoga and meditation – Yogic and another group of healthy adults who do not engage in these practices – Non-yogic individuals.

MATERIALS AND METHODS

This is a comparative cross-sectional study conducted in the Department of Physiology, Gandaki Medical College, Lekhnath, Pokhara and *Bramha Kumari* Meditation Centre, Pokhara (Kaski). The study was carried out from October to December 2024. This study included healthy female subjects between the age groups 18-40 years and consists of two groups: (i) Yogic – normotensive healthy adults practicing yoga and meditation for at least 3 months which includes people from *Bramha Kumari* Meditation Centre and (ii) Non-yogic – normotensive adults not practicing yoga and meditation subjects which includes medical students of 1st year and 2nd year MBBS and non-teaching staffs of Gandaki Medical College, Pokhara.

Ethical clearance (Ref. No.: 07-081-082) was obtained from Institutional Review Committee of Gandaki Medical College prior to data collection. The sample size was calculated using the formula:

$N = 2(Z_{\alpha} + Z_{1-\beta})^2\sigma^2/\Delta^2$. Based on the study by Kuppusamy M[11]

Standard deviation SD = 5.6,

estimated effect size Δ= 4.2

Z_{α}=1.96 (at 5% level of significance)

$Z_{1-\beta}$= 0.8416 (at power of 80%).

Simple random sampling was applied to select the sample size in this study. Sample size came to be 30, so total 60 participants – 31 in non-meditating group and 29 in meditating group were enrolled.

All 60 subjects after fulfilling the eligibility criteria, were prepared for the study after obtaining the consent. Thorough explanation about the study, its aim, purpose, benefit of the study, and method of study was conveyed to all the participants. All participants were tested under similar laboratory conditions in comfortable environment. They were asked not to take tea, coffee, heavy meals or do exercise prior to this test. Subjects were asked to sit on yoga mat on ground in *Sukhasana* position (crossed leg with cervical and lumbar spine extended; wrists placed on knees and fist closed) in ambient, well-ventilated, quiet room at room temperature. The basal pulse rate (PR), blood pressure and oxygen saturation of all the subjects were measured. The blood pressure was recorded by using sphygmomanometer with cuff tied to the right arm. The systolic blood pressure (SBP) and diastolic blood pressure (DBP) were noted. Pulse rate was measured manually on radial artery by examiner's three fingers. Oxygen saturation was measured by pulse oximeter placed on the pulp of right thumb then subjects was asked to breathe in through both nostrils over a period of 5 seconds then hold their breath for 5 seconds and exhale through both nostrils over a period for 5 seconds. This inhale, hold and exhale make one breathing cycle. The subjects performed 20 such cycles for 5 minutes. Then pulse rate, blood pressure, and oxygen saturation were recorded.

All the data were collected, entered in Microsoft Excel sheet. Statistical analysis of the records were done using the SPSS-17 and Independent t-test was applied for between group comparision and paired t-test was applied within group comparision, p value <0.05 was considered significant.

RESULTS

A total of 60 female subjects were included in the study (31 non-yogic and 29 yogic). In both the groups, age and BMI of all subjects were comparable. In the non-yogic group, the mean age was 25.7±7.7 year and mean BMI was 23.38±2.16 kg/m^2. In yogic group, the mean age was 29 ± 5.02 year and mean BMI was 23.70± 2.28 kg/m^2. There was no significant difference in age (p=0.06) and BMI (p=0.57). Statistically significant difference was found in basal PR (p=0.000), basal SBP (p=0.012) and basal SpO_2 (p=0.000) between yogic and non-yogic subjects. After doing the maneuver of slow breathing for 5 minutes, in the non-yogic group, there was a significant fall in PR, SBP, and DBP and increase in SpO_2. In contrary to this, there were not much changes in yogic subject in terms of PR, SBP and SpO_2. There were statistically significant changes in PR (p=0.000) and SpO_2 (p=0.0001) between yogic and non-yogic after slow breathing (Fig. 1, 2), however no significant change was seen in SBP and DBP (Table 1).

Effects of slow breathing on PR, SBP, DBP, and SpO_2 within the group was studied in the non-yogic group, there was a significant fall in pulse rate after slow breathing mean difference before and after is 6.839 (p=0.000), significant decrease in SBP mean difference is 6.645 (p=0.000) decrease in DBP mean difference is 5.903 (p=0.000) and significant increase in SpO_2 mean difference is -0.968 (p=0.001) (Table 1). In contrary to this within yogic group, significant

Table 1: Effects of slow breathing on pulse rate (PR), systolic blood pressure (SBP), diastolic blood pressure (DBP), oxygen saturation (SpO_2)

Parameters	Basal				After slow breathing			
	Non-yogic Mean±SD	Yogic Mean ±SD	MD	P value	Non-yogic Mean±SD	Yogic Mean±SD	MD	P value#
Age (years)	25.7±7.72	29 ± 5.02	3.3±2.6	0.06				
BMI (kg/m^2)	23.38±2.16	23.70± 2.28	0.32±0.02	0.578				
PR (beats/min)	86.06±8.74	75.21± 5.77	11.202	0.000	79.22± 8.57	70.96± 6.98	8.260	<0.0001*
SBP (mmHg)	118.48±5.84	114.17± 6.97	4.311	0.012	111.83± 7.81	111.20± 9.74	0.632	0.782
DBP (mmHg)	77±9.34	75.24± 11.43	1.759	0.515	71.09± 8.18	69.03± 10.03	2.062	0.385
SpO_2	96.41±1.36	98.06± 1.16	1.650	0.000	97.38± 1.20	98.44± 0.78	1.061	<0.0001*

*MD Mean difference # P values derived from independent t test *Significant value*

Table 2: Effects of slow breathing on pulse rate (PR), systolic blood pressure (SBP), diastolic blood pressure (DBP), oxygen saturation (SpO_2) within the group.

Parameters	Non-yogic				Yogic			
	Basal	After slow breathing			Basal	After slow breathing	MD	P value
	Mean±SD	Mean±SD	MD	P value	Mean±SD	Mean ±SD		
PR	86.06±8.74	79.22±8.57	6.839	0.000	74.22±5.9	70.96±6.98	3.897	<0.0001*
SBP	118.48±5.84	111.83±7.814	6.645	0.000	114.17±6.97	111.20±9.74	2.966	0.79
DBP	77±9.34	71.09±8.18	5.903	0.000	75.24±11.43	69.03±10.03	6.207	0.001*
SpO_2	96.41±1.36	97.38±1.20	-0.968	0.001	98.06±1.16	98.44±0.78	-0.379	0.155

*MD Mean difference # P values derived from Paired t test *Significant value*

decrease in PR mean difference before and after is 3.897 (p=0.000) and DBP mean difference is 6.207 (p=0.001) however no significance is seen in SBP mean difference is 2.966 (p =0.79) and SpO_2 mean difference is -0.379 (p=0.155) (Table 2).

Result of the study was statistical significance in pulse rate at basal level as well as after slow breathing pulse rate between non-yogic and yogic group. Significance association is seen in basal SBP between non-yogic and yogic group while no significance of SBP after slow breathing. No significance was seen in case of DBP before and after slow breathing between non-yogic and yogic group. There was also statistical significance of SpO_2 before and after slow breathing between non-yogic and yogic group. Slow breathing was associated with significant decrease in pulse rate, and SBP and an increase in oxygen saturation.

DISCUSSION

A significant decrease in pulse rate was observed following slow breathing in the non-yogic group, while a smaller decrease was noted in the yogic group. This difference may be attributed to the fact that individuals in the yogic group, such as those practicing meditation in *Brahma Kumari* Centre *Om Shanti* over an extended period, typically have a lower baseline pulse rate. Consequently, the effect of slow breathing may be less pronounced in this group, as their pulse rate is already reduced. In contrast, the non-yogic group, with a higher basal pulse rate, may exhibit a more significant decrease in pulse rate in response to slow breathing. Previous research reported a significant drop-in pulse rate in both groups; however, the study was conducted over a shorter duration (7 days), which may explain the differences observed in the current study. In that previous study which was conducted relatively in short duration, reported no significant changes in SBP, DBP, or MAP in either group.[12] However, in our study, a significant decrease in SBP, a small change in DBP, and a significant increase in SpO_2 were observed following slow breathing in the non-yogic group. In contrast, no significant changes in SBP, SpO_2, and only a minor change in DBP were observed in the yogic group. The yogic group, having lower baseline SBP and DBP, likely exhibited less change in these parameters due to their already reduced levels. Regarding SpO_2, individuals in the yogic group tend to have higher baseline oxygen saturation, resulting in a less pronounced increase after slow breathing. Conversely, the non-yogic group, with lower baseline SpO_2, showed a significant increase in oxygen saturation following slow breathing, highlighting a more noticeable effect in this group.

Another previous study conducted on hypertensive individuals, observed a temporary decrease in blood pressure following a ten-minute session of slow breathing and mental relaxation.[13] Another study on hypertensive participants also reported a reduction in blood pressure after performing slow breathing exercises.[14] In contrast, studies conducted on healthy normotensive volunteers, which reported a decrease in blood pressure, typically involved interventions lasting 4 weeks or more.[15] Additionally, one study reported a decrease in blood pressure after 5 minutes of pranayama; however, the slow breathing procedure used in that study differed from the protocol followed in the current research.[3]

A comparison of the basal PR, SBP, DBP, and SpO_2 between the non-yogic and yogic groups revealed high statistical significance, indicating substantial differences between the two groups.

The non-yogic group exhibited higher basal PR, SBP, and DBP, while the yogic group showed lower basal values for these parameters. In contrast, the non-yogic group had lower basal SpO_2, whereas the yogic group demonstrated higher baseline SpO_2 levels.

The regular practice of slow breathing techniques, such as Pranayama, leads to a decrease in sympathetic tone and an increase in parasympathetic tone that has been observed in various studies, which report an enhancement in vagal tone following slow breathing exercises,[1,10] an increase in baroreflex sensitivity,[9] improved tissue oxygenation,[10] and interactions between Pranayama and the nervous system that influence metabolism and autonomic functions.[16]

The investigation of slow breathing as a means to reduce HR while preserving BP is constrained by several notable limitations. There is no consensus on a standardized definition of "slow breathing," leading to variations in respiratory rate, technique, and inhalation-to-exhalation ratios across different studies. Further, an individual variability in the optimal breathing frequency may attenuate or exaggerate physiological responses when a fixed rate is applied uniformly. Accurate, non-invasive beat-to-beat BP monitoring remains technically challenging and susceptible to artifacts. Additionally, numerous confounding factors - such as psychological stress, body posture, and circadian influences - can independently affect HR and BP. Finally, without direct observation or specialized instrumentation, ensuring adherence to the prescribed breathing technique (e.g. diaphragmatic versus thoracic breathing) is difficult, compromising intervention fidelity and reproducibility. Addressing these limitations requires carefully designed studies with a well-designed and reliable process or approach that produces consistent and dependable results.

In conclusion, regular practice of slow breathing as in yogic people have low basal pulse rate, low basal systolic blood pressure and high basal oxygen saturation than that in non-yogic people. Hence, slow breathing practice enhances the parasympathetic tone and decreases the sympathetic tone. Habitual practice of slow breathing of five to ten minutes can be applied as non-pharmacological method for controlling hypertension.

ACKNOWLEGEMENT

I would like to express my sincere gratitude to all those who contributed to the creation of this article. I also appreciate the support from Gandaki Medical College and *Brahma Kumari* Center, Nayabazar, Pokhara, for providing the resources necessary for this research. Finally, I am grateful to my family and friends for their encouragement throughout this process.

Conflict of interest: None

Source of research fund: None

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