

Body Temperature in Practitioners of a Yoga Breathing Technique Considered to be Heat Generating

Abstract

Context: *Suryabheda pranayama* is traditionally described as “increasing the inner fire” and is believed to be heat generating. **Aims:** The present study aimed at determining whether the surface body temperature would increase after *Suryabheda pranayama* practice compared with sitting quietly for the same duration as a control. **Materials and Methods:** Nineteen participants with experience of *Suryabheda pranayama* practice (group mean experience \pm standard deviation, 30.2 ± 22.8 months) were assessed in 3 sessions on separate days. The sessions were (i) *Suryabheda pranayama* with physiological locks or breath retention, (ii) *Suryabheda pranayama* without physiological locks or breath retention, and (iii) quiet sitting (control session). The axillary surface body temperature was monitored in all three sessions before (5 min), during (15 min), and after (5 min) the intervention. Ambient temperature and humidity in the recording cabin used for testing were noted. From the ambient temperature and humidity, the heat index was derived. **Statistical Analysis:** Repeated measures analyses of variance were performed to compare values before, during, and after the 3 sessions, using SPSS version 24.0. **Results:** The surface body temperature increased during and after *Suryabheda pranayama* with physiological locks ($P < 0.001$; $P < 0.001$), *Suryabheda pranayama* without physiological locks ($P < 0.01$; $P < 0.001$), and quiet sitting ($P < 0.001$; $P < 0.001$) compared to the respective before values. **Conclusion:** The control (i.e., quiet sitting) and experimental sessions (i.e., *suryabheda* with locks and *suryabheda* without locks) showed a comparable increase in the surface body temperature. Hence, the increase in surface body temperature during and after experimental sessions does not appear to be related to the *pranayama* techniques. The possible factors which may have contributed to increased surface body temperature in the control and experimental sessions have been discussed.

Keywords: Body temperature, heat index, room temperature, *Suryabheda pranayama*, unilateral nostril breathing, yoga breathing

Introduction

Voluntary yoga breath regulation (called *pranayama* in Sanskrit) is a way to modify specific physiological functions through the respiration.^[1] Among *pranayamas*, breathing through a particular nostril is considered important to alter the functioning of the body and the mental state. Breathing through the right nostril is traditionally called *Suryabheda pranayama* (= “piercing like the sun” yoga breathing, in Sanskrit). The notion that *Suryabheda pranayama* is heat generating is supported by a verse in a yoga text, i.e., the *Gheranda Samhita* (Circa 1700, A. D.), Chapter V, Verse 69. The verse states that the practice of *Suryabheda pranayama* reduces aging and can even delay death (*Gheranda Samhita*, Chapter V, Verse 69).^[2] This verse continues to

state that the practice of *Suryabheda pranayama* augments the inner digestive fire (in Sanskrit; *Bodhayetkundaleem shaktim dehaanalavivardhanam*; *Gheranda Samhita*, Chapter V, Verse 69; where *deha* = body and *anal* = inner fire).^[3] Based on this verse, commentators have stated that *Suryabheda pranayama* can increase the body temperature.^[2,4]

When both inhalation and exhalation were practiced through the right nostril, there was an increase in oxygen consumption both as an immediate effect of 45 min of practice, where the oxygen consumption increased by 17%,^[5] and as a longitudinal effect following 1 month of *Suryabheda pranayama* practice every day, where the oxygen consumption increased by 37%.^[6]

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How to cite this article: Telles S, Gandharva K, Gupta RK, Sharma SK, Balkrishna A. Body temperature in practitioners of a yoga breathing technique considered to be heat generating. *Int J Yoga* 2020;13:168-72.

Submitted: 17-Sep-2019 **Revised:** 17-Feb-2020.
Accepted: 24-Feb-2020 **Published:** 01-May-2020.

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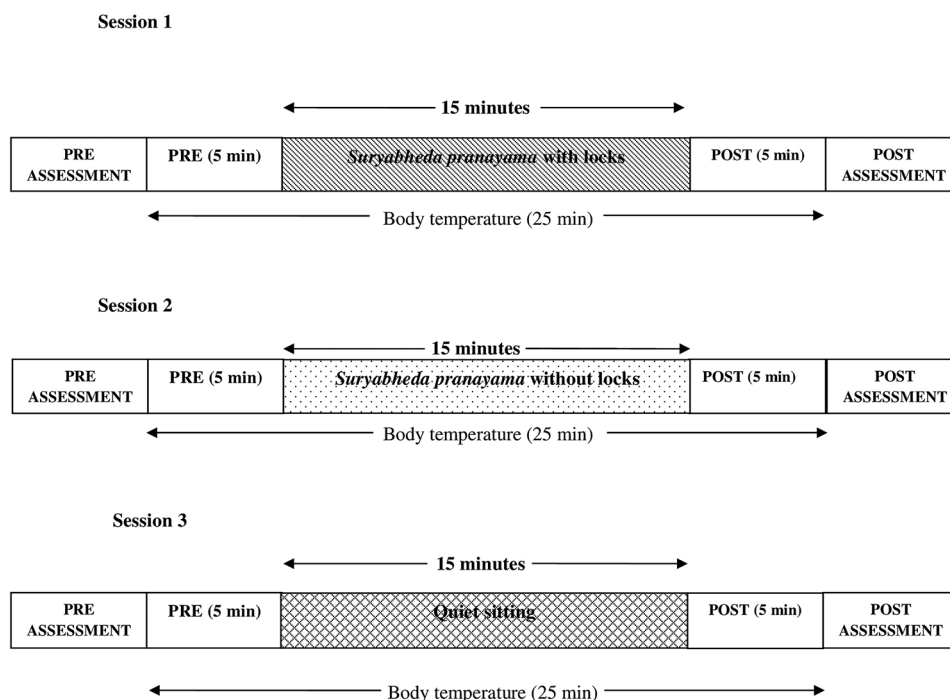
Access this article online

Website: www.ijoy.org.in

DOI: 10.4103/ijoy.IJOY_70_19

Quick Response Code:





Assessment: (i) Humidity and room temperature were assessed pre and post intervention sessions.
 (ii) Body temperature was assessed at one minute interval for all three states (i.e., pre, during and post) for 25 minutes (average values of each state post was used for analysis).

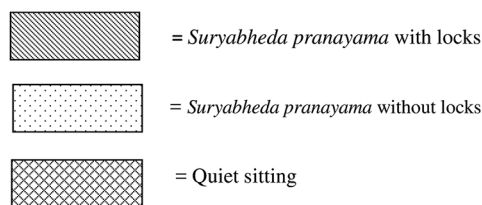


Figure 1: Schematic presentation of the study design

Oxygen consumption is an indicator of energy expenditure.^[7] These effects of increased energy expenditure are compatible with the traditional descriptions of *Suryabheda pranayama* in the yoga texts. The effects of specific *pranayamas* as heat generating or heat dissipating^[8] are not related to thermoregulation. The normal expectation based on traditional descriptions of the ideal conditions to practice yoga is that yoga is practiced under conditions which are not physically or mentally challenging (*Hatha Pradipika*, Chapter I, Verses 12–14).^[4] Hence, the expectation is that irrespective of environmental conditions, if *Suryabheda pranayama* is actually heat generating, it would raise the body surface temperature within the normal range.

However, the effect of *Suryabheda pranayama* on the body temperature has not been assessed. Hence, the present study aimed at determining whether the surface body temperature would increase after *Suryabheda pranayama* practice

compared with sitting quietly for the same duration as a control for comparison.

Materials and Methods

Participants

Nineteen healthy male participants between 18 and 30 years (group mean age \pm standard deviation (SD), 25.0 ± 3.7 years) were recruited for the study. With $n = 19$ and with an average effect size of 1.72 (based on the average of the change in body temperature in the three sessions), the power was 1.0 for $\alpha = 0.05$.^[9] Participants had at least 1-year experience of *Suryabheda pranayama* practice with and without physiological locks (called *bandhas* in Sanskrit). Participants with (i) any hormonal imbalance or nervous system disorder which could influence thermoregulation, (ii) a history of smoking, (iii) any recent surgery (which is a contraindication for practicing *bandhas*), and (iv)

taking medication or using other wellness strategies were excluded from the study. None of the participants had to be excluded for these reasons. Signed informed consent was obtained from the participants. The study was approved by the institution's ethics committee (approval number YRD/017/004).

Design

Participants were assessed in three sessions each. The three sessions were on three separate days at the same time of the day with 24 h between each session. The three sessions were (i) *Suryabheda pranayama* with both chin and perineal locks (*jalandhar bandha* and *mula bandha*, respectively, in Sanskrit), (ii) *Suryabheda pranayama* without the physiological locks, and (iii) quiet sitting. The sequence of the practices was randomized for the participants using a standard randomizer (www.randomizer.com). For all three sessions, the total duration of each session was 25 min, i.e., 5 min (before), 15 min (during), and 5 min (after). This study design is schematically depicted in Figure 1.

Assessments

Ambient room temperature and humidity

Assessments were carried out in a separate recording room which was temperature regulated. The study was conducted between June and October 2017. The ambient room temperature and humidity were monitored before and after each session using a digital wireless electronic hygrometer and a room temperature meter, respectively (HTC-1, HTC, Thailand). The room temperature meter had an accuracy of 0.1°C, while the hygrometer was accurate to 1% humidity.

Body temperature

The surface body temperature was recorded from the left axilla using a multi-utility patient monitor (TRUSCOPE II, Schiller, Switzerland), after cleaning the area with Savlon™ 2%. The thermometer was accurate to 0.1°C. The body temperature was recorded 5 min before, 15 min during, and 5 min after all three interventions, i.e., (i) *Suryabheda pranayama* with both

chin and perineal locks, (ii) *Suryabheda pranayama* without the physiological locks, and (iii) quiet sitting.

During all three sessions, participants were seated in a temperature regulated, dimly lit room. They were asked to close their eyes while seated in a comfortable pose keeping their spine and neck aligned and erect.

Intervention

Suryabheda pranayama with physiological locks

During *Suryabheda pranayama* with chin and perineal locks, participants were instructed to close their left nostril and inhale slowly and deeply through the right nostril. At the end of inhalation, participants were asked to close both nostrils and lower their head to perform two physiological locks while holding their breath; these were (i) the chin lock (= *jalandhara bandha* in Sanskrit) in which the chin rests on the suprasternal notch^[10] and (ii) the perineal lock in which the external urogenital organs are drawn upward toward the perineum called (*mulabandha* in Sanskrit).^[11] Participants were asked to hold their breath to the extent they could with comfort. This was approximately 15 s. The perineal lock was released first followed by the chin lock, and then, participants were asked to raise their head. After this, participants kept the right nostril closed and the left nostril patent and exhaled slowly through the left nostril. This was a complete cycle of *Suryabheda pranayama*.^[4] The cycle was repeated during the 15-min period.

Suryabheda pranayama without physiological locks

During *Suryabheda pranayama* without physiological locks or breath retention, participants were asked to close their left nostril and inhaling deeply through their right nostril, followed by exhalation through the right nostril without breath retention.^[4] This was a complete cycle of *Suryabheda pranayama*. The cycle was repeated during the 15-min period.

Quiet sitting

The participants allowed random thoughts to pass through their mind without modifying them, and they were instructed to avoid modifying their breath or being aware

Table 1: Analyses of variance table for the variables

Variables	Sources	F	Degree of freedom	Mean square	Partial η^2	Huynh-Feldt ϵ	P
Body temperature	Sessions	2.538	1,234, 22,210	1.576	0.124	0.693	0.120
	States	30.470	1,152, 20,744	15.667	0.629	0.590	<0.001
	Sessions \times States	1.082	1,164, 20,944	1.025	0.057	0.299	0.322
Room temperature	Sessions	3.205	1,128, 20,309	29.907	0.151	0.576	0.084
	States	32.080	1,18	9.322	0.641	1.000	<0.001
	Sessions \times States	1.554	1,647, 29,640	0.092	0.790	0.823	0.229
Humidity	Sessions	0.017	1,684, 30,312	1.636	0.001	0.842	0.971
	States	38.616	1, 18	72.64	0.682	1.000	<0.001
	Sessions \times States	2.048	1,845, 33,207	1.436	0.102	0.922	0.149
Heat index	Sessions	3.943	1,169, 21,049	41.692	0.180	0.601	0.055
	States	35.437	1, 18	15.474	0.663	1.000	<0.001
	Sessions \times States	1.053	2, 360	0.184	0.055	1.000	0.359

Table 2: Average values of body temperature, room temperature, humidity, and heat index in three sessions

Sessions	Before	During	After	<i>P</i> (during versus before)	<i>P</i> (after versus before)
<i>Suryabheda pranayama with physiological locks or breath regulation</i>					
Body temperature (°C)	35.83±0.39	36.46±0.36	36.62±0.37	<0.001	<0.001
Room temperature (°C)	24.19±3.67	-	24.67±3.35	-	<0.001
Humidity (%)	53.37±11.48	-	54.95±11.80	-	<0.001
Heat index (°C)	24.21±4.01	-	24.84±3.64	-	<0.001
<i>Suryabheda pranayama without physiological locks or breath regulation</i>					
Body temperature (°C)	35.99±0.34	36.90±1.55	36.67±0.31	<0.01	<0.001
Room temperature (°C)	24.43±3.80	-	25.03±3.48	-	<0.001
Humidity (%)	53.11±13.08	-	55.11±12.85	-	<0.001
Heat index (°C)	24.42±3.91	-	25.32±3.86	-	<0.001
Quiet sitting					
Body temperature	35.91±0.36	36.41±0.29	36.52±0.29	<0.001	<0.001
Room temperature (°C)	23.13±3.95	-	23.78±3.82	-	<0.001
Humidity (%)	53.16±10.38	-	54.42±11.36	-	<0.01
Heat index (°C)	23.00±4.31	-	23.68±4.19	-	<0.001

Values are group mean±SD. SD: Standard deviation

of their breathing. The participants were asked to sit cross-legged (*sukhasana*) with their spine erect and eyes closed. There was no other activity.

Data analysis

Data were analyzed with SPSS version 24.0 (IBM Corp., Armonk, N.Y., USA). Repeated measures analyses of variance were performed to analyze body temperature with two within-subjects factors, i.e., sessions (three) and states (before, during, and after). In the case of room temperature, humidity, and heat index for all three sessions, the states were two (before and after). Multiple comparisons were Bonferroni adjusted.

Results

Repeated measures analyses of variance

The *F*, *df*, Huynh–Feldt epsilon, partial eta squared, and *P* value for states, sessions, and sessions × states for different variables are provided in Table 1. A significant interaction between the sessions and states indicates the interdependence of the two.

Post hoc analyses

Body temperature

The surface body temperature increased during and after *Suryabheda pranayama* with physiological locks ($P < 0.001$; $P < 0.001$), *Suryabheda pranayama* without physiological locks ($P < 0.01$; $P < 0.001$), and quiet sitting ($P < 0.001$; $P < 0.001$) compared to the respective before values.

Room temperature

Room temperature increased after (i) *Suryabheda pranayama* with physiological locks ($P < 0.001$), (ii) *Suryabheda pranayama* without physiological

locks ($P < 0.001$), and (iii) quiet sitting ($P < 0.001$). Humidity increased after (i) *Suryabheda pranayama* with physiological locks ($P < 0.001$), (ii) *Suryabheda pranayama* without physiological locks ($P < 0.001$), and (iii) quiet sitting ($P < 0.01$).

Heat index

The heat index was also increased after (i) *Suryabheda pranayama* with physiological locks ($P < 0.01$), (ii) *Suryabheda pranayama* without physiological locks ($P < 0.001$), and (iii) quiet sitting ($P < 0.001$).

The details of the average values and SDs are given in Table 2.

Discussion

Suryabheda pranayama is associated with increased sympathetic nervous system activity and increased energy expenditure. The present study aimed at assessing the surface body temperature with *Suryabheda pranayama* practice.

The axillary surface body temperature increased after both experimental sessions of *Suryabheda pranayama* practice and the control session of quiet sitting. The magnitude of increase was comparable. Hence, these results do not support the speculation that *Suryabheda pranayama* may be a heat-generating practice. Since the surface body temperature increased after all three sessions, an attempt was made to understand why this may have happened.

Other physical factors which could have contributed to changes in body temperature were the room temperature and humidity. In both experimental sessions and the control session, the room temperature increased significantly after the session compared to before, by an average of 0.6°C. Ambient humidity also increased significantly after the three sessions by an average of 2%.

In all three sessions, there was a significant increase in the heat index. The heat index was obtained from the recorded room temperature and humidity using an algorithm.^[12] The heat index measures thermal comfort and is used often in environmental health in areas of environmental health research including air pollution exposure^[13] and to develop a warming system for changes in prevalent weather conditions.^[14]

Apart from the heat index, factors related to the posture of the participants during the sessions may have influenced their body temperature.

In all three sessions, participants sat in an upright yoga posture (i.e., *sukhasana*). This involved sitting on a flat noncompliant surface in an upright position, with their legs crossed. Rai *et al.* and others in 1994 studied the energy expenditure during a comparable upright seated yoga posture *siddhasana* “the accomplished posture” in Sanskrit which also involved crossing the legs but with the feet closer to the perineum.^[15] After sitting in *siddhasana* for 20 min, ten healthy practitioners showed a 21% increase in energy expenditure compared to an equal duration of sitting in a chair, possibly related to maintaining an upright posture. In the present study, the duration was almost comparable to the earlier study^[15] and sitting upright may have similarly increased energy expenditure, which could have been resulted in an increase in surface body temperature.

Earlier studies which demonstrated an increase in oxygen consumption and increased energy expenditure as an immediate effect of 45 min of practice of *Suryabhedha pranayama* (17% increase)^[16] or as a longitudinal effect over 1 month of practicing *Suryabhedha pranayama* every day (37% increase)^[17] did not measure surface body temperature.

Since the body temperature did not increase after *Suryabhedha pranayama* practice, the way in which the energy spent is utilized may be speculated upon. The increase in energy expenditure with *Suryabhedha pranayama* may be used for other internal functions such as the digestion. This is supported by the effects of *Suryabhedha pranayama* as described in yoga texts.^[8] Food is assimilated and converted to energy by an active process which is known as the specific dynamic action (SDA) of food.^[18] Out of the total energy consumed in a day, 10% of energy is utilized for SDA. Whether this proportion increased after the practice of *Suryabhedha pranayama* is not known. However, all participants resided in the university and had comparable levels of physical activity and a comparable diet which was plant-based lacto-vegetarian.

Conclusion

Multiple commentaries which describe *Suryabhedha pranayama* as heat generating or increasing the body temperature are not supported by the present findings.

This may mean that *Suryabhedha pranayama* increases energy expenditure as reported earlier to perform various vital functions optimally without increasing the body temperature.

Financial support and sponsorship

The authors gratefully acknowledge Patanjali Research Foundation for funding the study.

Conflicts of interest

There are no conflicts of interest.

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