ORIGINAL ARTICLE

Effects of 6-weeks Bhastrika Pranayama Intervention on health-related components of physical fitness

Baljinder S. Bal[1ABCDE], Parmjit Kaur[2ABCD], Davinder Singh[3ABCD], Manoj Bhardwaj[4ABCD]

[1]*Department of Physical Education (T), Guru Nanak Dev University, Amritsar, Punjab, India*
[2]*Department of Physical Education, PCM S.D. College for Women, Jalandhar, Punjab, India*
[3]*Department of Physical Education, Kanya Maha Vidyalaya (Autonomous), Jalandhar Punjab, India*
[4]*Department of Physical Education (T), Guru Nanak Dev University, Amritsar, Punjab, India*

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Background and Study Aim	The present study investigated the effects of 6-weeks bhastrika pranayama intervention (BPI) program on health-related components of physical fitness.
Material and Methods	We used a quasi-experimental design with fifty-two healthy girls (Mean ± SD; age, 23.6346±1.1551 yrs; body height, 158.0961±3.8616 cm; body weight, 55.6826±3.4002 kg) from Guru Nanak Dev University, Amritsar, Punjab, India. The subjects were divided into two groups: Group-A: Bhastrika Pranayama Intervention (BPI); (n_1=26) and Group-B: Control; (n_2=26). The sample size (N=52) was calculated using the G*Power 3.1.9.7 software. A power of 0.80 (1-β err prob) and significance level (α) of 0.05. Subjects from both groups (pranayama and control) were assessed at baseline and right after 6-weeks. Group-A: (n_1=26) subjected to BPI and Group-B: (n_2=26) with no training.
Results:	As compared BPI with the control group, the BPI group had a positive effect on selected health-related components of physical fitness (maximal oxygen consumption - VO2 max 1.3%; flexibility 1.8%; muscle strength 0.2.%). The 6-weeks Bhastrika Pranayama intervention program had no effect on the BPI group with respect to the parameter muscular endurance.
Conclusions:	Daily practice of Bhastrika pranayama helps to keep lungs more efficient. Additional research is required to completely comprehend the consequences of this breathing exercise. Bhastrika pranayama is known for oxygen-based breathing exercise which helps to fill up the lungs with more oxygen. Bhastrika pranayama interventions with short as well as long duration in future research studies could be beneficial for healthy individuals with respect to health-related fitness components.
Keywords:	bhastrika pranayama, maximal oxygen, flexibility, muscular strength, muscular endurance.

Introduction

Yoga is a traditional Indian culture practice that is regarded to be the science of holistic life. Disciplined living (Yama and Niyama), cleaning procedures (Kriya), bodily postures (Asana), breath management (Pranayama), concentration (Dharana), and meditation are all part of the Yoga tradition (Dhyana) [1, 2]. In recent years, there has been a surge in interest in learning more about the advantages of the various Yoga practices. [3, 4]. There have been scientific researches on the effects of individual Yoga practises or their combinations on both healthy people and persons with various diseases. [5]. Yoga practice can be performed by people of any age group and gender and can be applied to children during their developmental phase of life [6].

A recent study suggested that yoga practice in school children may be an effective way to improve their health [7, 8]. It has been observed that yogic exercise practice in school setups may be useful to develop flexibility, mood and self-regulation skills related to emotion and stress among children [9]. Maharishi Patanjali, in his Ashtanga yoga, has given more importance to pranayama than

asana for good health [10]. Purak (inhalation), Kumbhak (retention), and Rechak (exhalation) are the three phases of Pranayama. [11]. Thus, Pranayama means "breathing techniques" or "breathe control". The important aspects of breathing utilized in pranayama include: Puraka – Inhalation, Rechaka – Exhalation, Kumbhaka - Retention, which is further divided into Antar Kumbhaka - Inhalation Retention (after Inhaling) and Bahir Kumbhaka - Exhalation Retention (after exhaling). According to Maharshi Patanjali's Yoga Sutras state (2:49) "Pranayama is the pause in the movement of inhalation and exhalation when that is secured" (Fig. 1) [12].

Therefore, the significant parts of pranayama are essentially kumbhaka or breathe retention. In order to achieve kumbhaka effectively, the function of respiration must be gradually controlled. As a result, inhalation and exhalation are given more emphasis in the beginning of pranayama practises in order to strengthen the lungs and balance the neurological and pranic systems in preparation for the practice of kumbhaka. Prana is a subtle aspect of the body. It has a visible aspect which is the air we breathe and an invisible aspect, which is the energy that flows in the body through various channels and sustains it. Prana also connects the gross body (annamaya kosa) with the

mental body (manomaya kosa). Hence the Upanishads describe it often as the soul of the gross body and equate it with Atman or the essence of Brahman. According to Kathopanishad (2:3:2): "This whole world- whatever there is- vibrates having originated from prana" [12]. Hence, prana controls all physical tasks including the breath, supply of oxygen, digestion and elimination. The function of the human body is much like a transformer, receiving energy from the universal flow of prana, distributing that energy, and then eliminating it. Figure 2.

In human beings, the breath is an active connection between the body and mind while the Pranayama is considered as manipulation of one own breathing [13]. Different types of pranayama produce specific physiological responses and it greatly depends on the type and duration of the practice [14, 15, 16]. Nadisuddhi, Savitri, Kapalbhati, Bhastrika, Bhramari Pranayama, and so on are well known among them. Many physiological variables are influenced by pranayama practice. Evidence suggests that it has a beneficial effect on the cardiorespiratory system. [17, 18] on the other side with slow breathing resulting in a lower heart rate and lower systolic and diastolic blood pressure. [19], while fast breathing leads to a less robust, but consistent increase in heart rate [20, 21]. In fact, a prior study found that practising Bhastrika pranayama with a low respiratory rate (RR) reduced both systolic and diastolic blood pressure while also lowering heart rate slightly. [22]. In addition, variations in heart rate variability (HRV) support the indication that pranayama improves respiratory function and cardiac sympathovagal balance, both of which are vital psycho-physiological stress-related factors. [23, 24].

Physical exercise at work has decreased significantly in emerging countries like India as the work environment has become increasingly computerised among young adults. In addition, sedentary lifestyles and eating habits have been linked to a variety of health problems. Pranayama is one of the most often practiced supplemental or alternative interventions to obtain the greatest possible physical and mental health, according to recorded studies and data. To reduce the burden of non-communicable diseases and to improve the status of health and wellness in young female adults we designed the study to observe the effects of 6-weeks bhastrika pranayama intervention (BPI) program on health-related components of physical fitness.

Material and Methods

Participants.

We used a quasi-experimental design with fifty-two healthy girls (Mean±SD; age, 23.6346±1.1551 yrs; body height, 158.0961±3.8616 cm; body weight, 55.6826±3.4002 kg) from Guru Nanak Dev University, Amritsar, Punjab, India. The subjects were divided into two groups: Group-A: Bhastrika Pranayama Intervention (BPI); (n_1=26), and Group-B: Control; (n_2=26). The sample size (N=52) was calculated using the G*Power 3.1.9.7 software. A power of 0.80 (1-β err prob) and significance level (α) of 0.05. Subjects from both groups (pranayama and control) were assessed at baseline and right after 6-weeks. Group-A: (n_1=26) subjected to BPI program and Group-B: (n_2=26) with no training.

Research Design

Procedure:

Cooper's 12-minute run test was used to measure maximal oxygen consumption (VO_2 max), sit, and reach test was used to measure flexibility, handgrip strength test was used to measure muscular strength, while 1-minute sit-up test was used to measure muscular endurance. Subjects from both groups (pranayama and control) were assessed at baseline and right after 6-weeks.

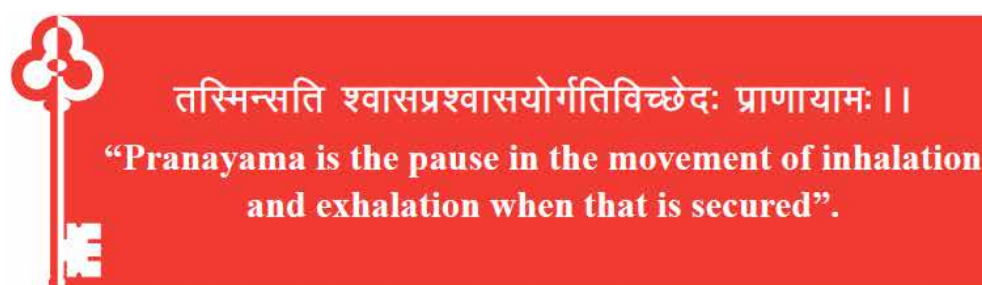*Bhastrika Pranayama Intervention (BPI) Program:*

Figure 1. The actual pranayama is kumbhaka, the period of breath retention.
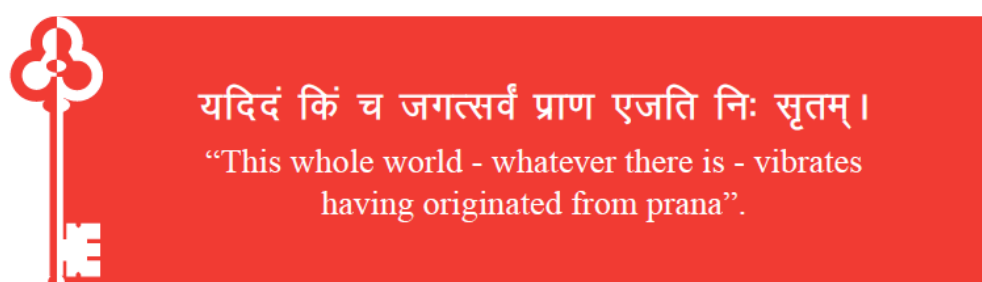

Figure 2. All this universe evolved (from prana) moves while Prana is a mighty terror, the thunderbolt uplifted; those who know this become immortal.

Participants of the Bhastrika Pranayama Intervention (BPI) group were asked to sit in a comfortable meditative posture, with their hands resting on the knees in chin mudra. Then asked to keep the head and spine straight, close the eyes and relax the whole body. They were asked to take a deep breath in through both the nostrils while making sure that their mouth does not open at all while doing this pranayama. After this, they were asked to release the filled breath through both the nostrils rapidly. They continued in this manner, counting ten breaths. They took a deep breath in and breathe out rapidly. This is one round. Participants practiced up to five rounds.

Statistical Analysis.

This study's data analysis procedure was divided into four sections: - The G*Power 3.1.9.7 software was used in the first section. The normality of data was checked by using the Shapiro-Wilk test of normality in the second section. A descriptive analysis was used in the third section to describe the data distribution. The hypothesis testing with analysis of covariance (ANCOVA) test was included in the fourth section. The level of significance was set at 0.05. The statistical techniques were used to analyze the data on Statistical Package for Social Science (SPSS) version 26.0.

The Protocol of power analysis and demographics of subjects (age, body height and body weight) is brought forth in Figure 3 & Figure 4 respectively.

Protocol of power analysis was done to get the required number of sample (n=52) for the experimental study with large effect size (0.40), as to obtain the strong impact on power (1-β err prob=0.80) of the study at α err prob=0.05 (fig.3).

Demographics of subjects showing Mean±SD; age, 23.6346±1.1551 yrs; body height, 158.0961±3.8616 cm; body weight, 55.6826±3.4002 kg (fig.4).

Table 1 shows that the pre-test & post-test data of health-related components of physical fitness including maximal oxygen consumption (VO_2 max): BPI (p = .128 & .354) and Control (p = .280 & .541), flexibility: BPI (p = .178 & .094) and Control (p = .123 & .163), muscular strength: BPI (p = .270 & .241) and Control (p = .544 & .188), muscular endurance: BPI (p = .275 & .113) and Control (p = .653 & .295) of subjects were normally distributed as evident from Shapiro-Wilk test for normality. As a result, the p-values of the bhastrika pranayama intervention (BPI) and control groups' pre-test and post-test data were statistically insignificant (p >.05), indicating that the data were normally distributed.

The summary of the descriptive statistics regarding the health-related components of physical fitness of pre-test & post-test of BPI group and pre-test & post-test of a control group for subjects is brought forth in Table 2 and Table 3 respectively.

Results

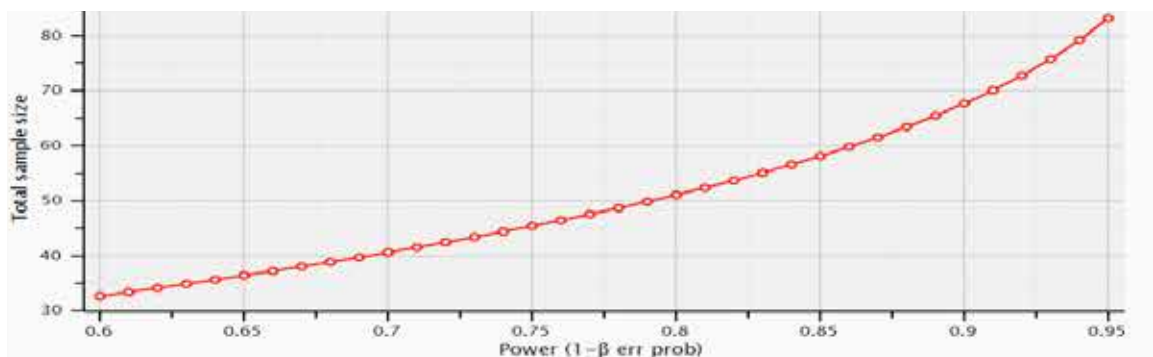*Maximal Oxygen Consumption (VO_2 max):*

Figure 3. Protocol of power analysis

Table 1. Normal distribution of data by utilizing Shapiro-Wilk Test of Normality of bhastrika pranayama intervention (BPI) group and control group of health-related components of physical fitness.

Shapiro-Wilk Test of Normality				
Maximal Oxygen Consumption (VO_2 max) (ml/kg/min)				
	Bhastrika Pranayama Intervention (BPI) Group Pre-Test	**Bhastrika Pranayama Intervention (BPI) Group Post-Test**	**Control Group Pre-Test**	**Control Group Post-Test**
Sig.	.128	.354	.280	.541
Flexibility (cm)				
Sig.	.178	.094	.123	.163
Muscular Strength (kg)				
Sig.	.270	.241	.544	.188
Muscular Endurance (min)				
Sig.	.275	.113	.653	.295

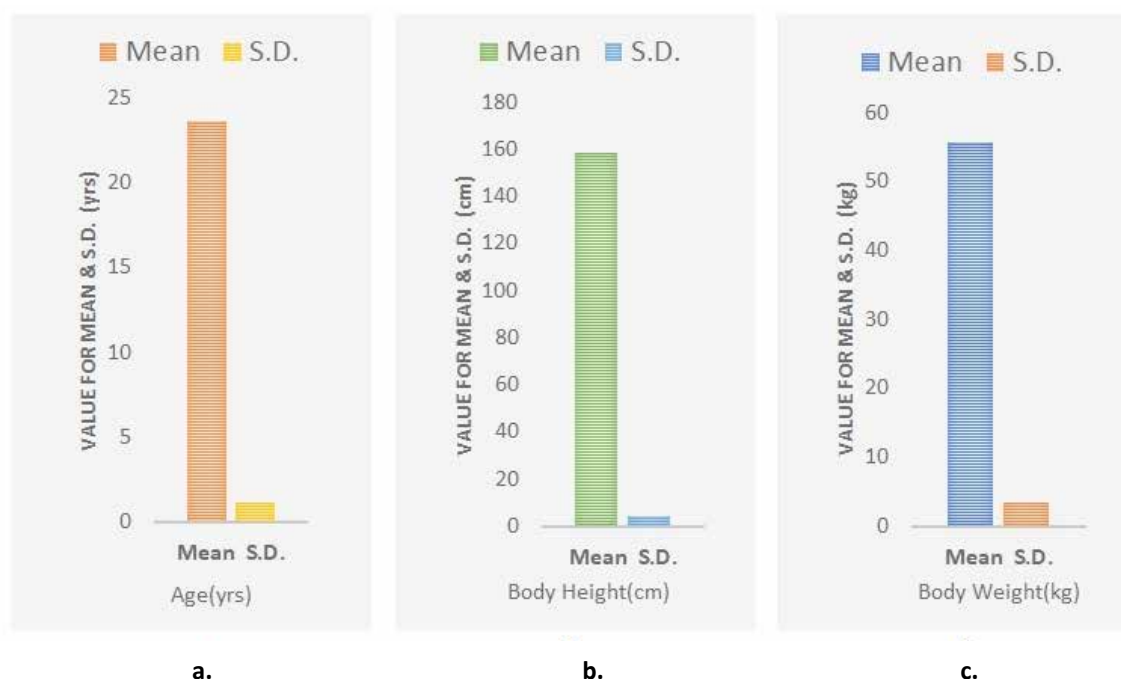a.   b.   c.

Figure 4. Demographics of subjects showing

It is evident from the results that insignificant differences were noted between BPI and Control groups of girls on Maximal Oxygen Consumption (VO_2 max) since the p-value .431 was greater than (p>0.05). In addition, the Partial Eta Squared value showed that 6-weeks of bhastrika pranayama intervention had a positive effect of 1.3% on the BPI group regarding the parameter Maximal Oxygen Consumption (VO_2 max).

Flexibility:

It is evident from the results that insignificant differences were noted between BPI and Control groups of girls on Flexibility since the p-value .351 was greater than (p>0.05). In addition, the Partial Eta Squared value showed that 6-weeks of bhastrika pranayama intervention had a positive effect of 1.8% on the BPI group regarding the parameter Flexibility.

Muscular Strength:

It is evident from the results that insignificant differences were noted between BPI and Control groups of girls on Muscular Strength since the p-value .784 was greater than (p>0.05). In addition, the Partial Eta Squared value showed that 6-weeks of bhastrika pranayama intervention had a positive effect of 0.2% on the BPI group regarding the parameter Muscular Strength.

Muscular Endurance:

It is evident from the results that insignificant differences were noted between BPI and Control groups of girls on Muscular Endurance since the p-value .917 was greater than (p>0.05). In addition, the Partial Eta Squared value showed that 6-weeks of bhastrika pranayama intervention had no effect on the BPI group regarding the parameter Muscular Endurance. The statistical analysis of results regarding health-related components of physical fitness including maximal oxygen consumption (VO2 max), flexibility, muscular strength, and muscular endurance have presented in Table 4 & percentage increase shown in Figure 5.

Discussion

Our results open an exciting new avenue of study focused on short-term effects of bhastrika pranayama intervention of six weeks on healthy girls with positive effect on health-related components of physical fitness including Vo_2 max=1.3%, flexibility 1.8%, muscle strength 0.2.%. As our study results with the positive impact of bhastrika pranayama intervention (BPI) are supported by other studies i.e., the bhastrika pranayama practiced on daily basis benefits in the maintenance of healthy lungs and can be easily incorporated into an athletic training program. This pranayama helps to strengthen the lungs' immunity [25]. Bhastrika Pranayama (breathing techniques/exercises) can be said to be advantageous to respiratory parameters for better functioning. Even in normal healthy participants, the functions of respiratory parameters, notably, were improved who participated voluntarily in this study [26]. Bhastrika exercises the diaphragm, the primary respiratory muscle that renews the residual air in the lungs [27]. In healthy University students, Anuloma-Viloma and Bhastrika Pranayama appear to be useful in enhancing physical health indices [28]. In addition, another study results showed that both slow and fast pranayamas for 12-weeks improve handgrip dynamometry characteristics, with fast pranayama being more effective than slow pranayama [29]. According to the literature, consistent hatha yoga practice can lead to enhancements in health-related aspects and could benefit to improve status of health and wellness [30]. Moreover, the present study findings acknowledged the beneficial effects of bhastrika pranayama besides the limitation of short duration in relation to health and wellness. Bhastrika

Table 2. Distribution of subject's statistics regarding the health-related components of physical fitness including maximal oxygen consumption (VO2 max), flexibility, muscular strength, and muscular endurance of pre-test & post-test of BPI group.

Statistics	Maximal Oxygen Consumption (VO_2 max)		Flexibility		Muscular Strength		Muscular Endurance	
	pre-test	post-test	pre-test	post-test	pre-test	post-test	pre-test	post-test
Minimum	min =22.23	min =24.47	min =12.00	min =12.00	min =20.00	min =21.00	min =22.00	min =23.00
Maximum	max =42.35	max =43.47	max =17.00	max =17.00	max =27.00	max 28.	max =31.00	max =29.00
Range	R =20.12	R =19	R =5	R =5	R =7	R =7	R =9	R =6
Size	n =26	n =26	n =26	n =26	n =26	n =26	n =26	n =26
Sum	sum =827.79	sum =843.86	sum =378	sum =387	sum =625	sum =626	sum =691	sum =681
Mean	$\bar{x}$ =31.838	$\bar{x}$ =32.456	$\bar{x}$ =14.538	$\bar{x}$ =14.884	$\bar{x}$ =24.038	$\bar{x}$ =24.076	$\bar{x}$ =26.576	$\bar{x}$ =26.192
Median	$\tilde{x}$ =31.18	$\tilde{x}$ =31.85	$\tilde{x}$ =14.5	$\tilde{x}$ =15	$\tilde{x}$ =24	$\tilde{x}$=24	$\tilde{x}$ =27	$\tilde{x}$ =26
Mode	mode =37.88, 35.65, 31.18, 24.47	mode =33.41, 35.64, 37.88, 28.49	mode =14.00	mode =15.00	mode =25.00	mode =23.00	mode =27.00	mode =24.00, 27.00
Standard Deviation	s =5.8161	s =5.229	s =1.333	s =1.451	s =1.821	s =1.647	s =2.468	s =1.789
Variance	s2 =33.828	s2 =27.349	s2=1.77846154	s2 =2.106	s2 =3.31846154	s2 =2.713	s2 =6.093	s2 =3.201
Mid-Range	MR =32.29	MR =33.97	MR =14.5	MR =14.5	MR =23.5	MR =24.5	MR =26.5	MR =26
Interquartile Range	IQR =11.18	IQR =8.28	IQR =1	IQR =2	IQR =2	IQR =2	IQR =3	IQR =3
Sum of Squares	SS =845.702	SS =683.726	SS=44.4615385	SS =52.653	SS =82.961	SS =67.846	SS =152.346	SS =80.038
Mean Absolute Deviation	MAD =5.028	MAD =4.456	MAD =1.076	MAD =1.142	MAD =1.426	MAD =1.325	MAD =1.982	MAD =1.514
Root Mean Square	RMS =32.344	RMS =32.858	RMS =14.597	RMS = 14.952	RMS =24.104	RMS =24.131	RMS =26.686	RMS =26.251
Std Error of Mean	$SE\bar{x}$ =1.140	$SE\bar{x}$ =1.025	$SE\bar{x}$ =0.261	$SE\bar{x}$ =0.284	$SE\bar{x}$ =0.357	$SE\ \bar{x}$ =0.323	$SE\bar{x}$ =0.484	$SE\bar{x}$ =0.350
Skewness	γ1 =0.058	γ1 =0.250	γ1 =-0.034	γ1 =-0.293	γ1 =-0.448	γ1 =0.332	γ1 =-0.333	γ1 =0.004
Kurtosis	β2 =2.139	β2 =2.449	β2 =3.096	β2 =2.926	β2 =3.140	β2 =3.198	β2 =2.812	β2 =2.276
Kurtosis Excess	α4 =-1.257	α4 =-0.947	α4 =-0.300	α4 =-0.469	α4 =-0.256	α4 =-0.198	α4 =-0.584	α4 =-1.120
Coefficient of Variation	CV =0.182	CV =0.161	CV =0.091	CV =0.097	CV =0.075	CV =0.068	CV =0.092	CV =0.068

Table 3. Distribution of subject's statistics regarding the health-related components of physical fitness including maximal oxygen consumption (VO2 max), flexibility, muscular strength, and muscular endurance of pre-test & post-test of control group.

Statistics	Maximal Oxygen Consumption (VO$_2$ max)		Flexibility		Muscular Strength		Muscular Endurance	
	pre-test	post-test	pre-test	post-test	pre-test	post-test	pre-test	post-test
Minimum	min =24.47	min =23.80	min =12.00	min =12.00	min =20.00	min =21.00	min =20.00	min =23.00
Maximum	max =37.88	max =39.00	max =17.00	max =18.00	max =28.00	max =28.00	max =30.00	max =30.00
Range	R =13.41	R =15.2	R =5	R =6	R =8	R =7	R =10	R =7
Size	n =26	n =26	n =26	n =26	n =26	n =26	n =26	n =26
Sum	sum =809.18	sum =818.99	sum =385	sum =383	sum =639	sum =630	sum =671	sum =678
Mean	x̄ =31.122	x̄ =31.499	x̄ =14.807	x̄ =14.730	x̄ =24.576	x̄ =24.230	x̄ =25.807	x̄ =26.076
Median	x̃ =31.17	x̃ =31.63	x̃ =15	x̃ =15	x̃ =24.5	x̃ =24.5	x̃ =26	x̃ =26
Mode	mode =31.17	mode =35.65	mode =16.00, 14.00	mode =15.00	mode =23.00, 24.00, 26.00	mode =25.00	mode =25.00, 26.00, 28.00, 27.00	mode =26.00
Standard Deviation	s =3.876	s =4.195	s =1.296	s =1.343	s =1.942	s =1.557	s =2.400	s =1.895
Variance	s2 =15.029	s2 =17.598	s2 =1.681	s2 =1.804	s2 =3.773	s2 =2.424	s2 =5.761	s2 =3.593
Mid-Range	MR =31.175	MR =31.4	MR =14.5	MR =15	MR =24	MR =24.5	MR =25	MR =26.5
Interquartile Range	IQR =4.47	IQR =7.61	IQR =2	IQR =1	IQR =3	IQR =2	IQR =4	IQR =3
Sum of Squares	SS =375.728	SS =439.970	SS =42.038	SS =45.115	SS =94.346	SS =60.615	SS =144.038	SS =89.846
Mean Absolute Deviation	MAD =3.05	MAD =3.272	MAD =1.068	MAD =1.023	MAD =1.576	MAD =1.230	MAD =1.914	MAD =1.479
Root Mean Square	RMS =31.353	RMS =31.767	RMS =14.862	RMS =14.789	RMS =24.650	RMS =24.278	RMS =25.914	RMS =26.143
Std Error of Mean	SEx̄ =0.760	SEx̄ =0.822	SEx̄ =0.254	SEx̄ =0.263	SEx̄ =0.380	SEx̄ =0.305	SEx̄ =0.470	SEx̄ =0.371
Skewness	γ1 =0.036	γ1 =0.01	γ1 =-0.209	γ1 =0.213	γ1 =-0.161	γ1 =-0.003	γ1 =-0.450	γ1 =0.186
Kurtosis	β2 =2.583	β2 =2.619	β2 =2.833	β2 =3.813	β2 =3.295	β2 =3.693	β2 =3.332	β2 =2.764
Kurtosis Excess	α4 =-0.813	α4 =-0.777	α4 =-0.563	α4 =0.416	α4 =-0.101	α4 =0.296	α4 =-0.064	α4 =-0.63
Coefficient of Variation	CV =0.124	CV =0.133	CV =0.0875	CV =0.091	CV =0.079	CV =0.064	CV =0.093	CV =0.072

Table 4. Analysis of covariance (ANCOVA) results regarding the health-related components of physical fitness including maximal oxygen consumption (VO2 max), flexibility, muscular strength, and muscular endurance.

Maximal Oxygen Consumption (VO_2 max) (ml/kg/min)				
Group	**Mean± S.D.**	**F**	**Sig.**	**Partial Eta Squared**
BPI Post-Test	32.45 ± 5.22	.630	.431	.013
Control Post-Test	31.49 ± 4.19			
Flexibility (cm)				
BPI Post-Test	14.88 ± 1.45	.885	.351	.018
Control Post-Test	14.73 ± 1.34			
Muscular Strength (kg)				
BPI Post-Test	24.07 ± 1.64	.076	.784	.002
Control Post-Test	24.23 ± 1.55			
Muscular Endurance (min)				
BPI Post-Test	26.19 ± 1.78	.011	.917	.000
Control Post-Test	26.07 ± 1.89			

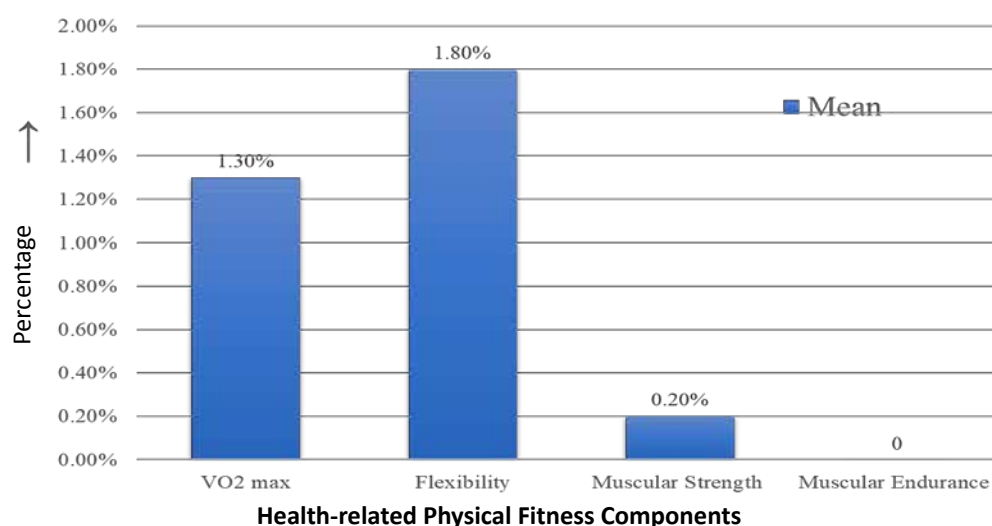NOTE: p value (p≥.05) considered as insignificant.

Figure 5. The increasing results in percentage % of 6-Weeks bhastrika pranayama intervention (BPI) on each variable of health-related components of physical fitness for BPI group as compared to control group.

pranayama is known for oxygen-based breathing exercise which helps to fill up the lungs with more oxygen and exhale carbon dioxide (CO_2) from the body through nostrils. In the nutshell, Bhastrika pranayama interventions with short as well as long duration in future research studies could be beneficial for healthy individuals with respect to health-related fitness components.

Conclusions

According to the findings of our study, the daily practice of Bhastrika pranayama helps to keep lungs more efficient, but additional research is required to completely comprehend the consequences of this breathing exercise. Bhastrika pranayama can be easily incorporated into an athletic training program. However, it may be necessary to practice, experience for longer than six weeks to experience improvements. It's also likely that the effects of bhastrika pranayama are restricted by one's fitness or activity level; future research should investigate this more in-depth and evaluate a longer duration of pranayama practice.

Consent

Informed consent was obtained from all individual participants included in the study.

Conflict of interests

The authors declare no conflict of interest.

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Information about the authors:

Baljinder Singh Bal; (Corresponding Author); https://orcid.org/0000-0003-2173-2748; bal_baljindersingh@yahoo.co.in; Department of Physical Education (T), Guru Nanak Dev University ; Amritsar, Punjab, India.

Parmjit Kaur; https://orcid.org/0000-0002-3370-7366; parmpurewal90@gmail.com; Department of Physical Education, PCM S.D. College for Women; Jalandhar, Punjab, India.

Davinder Singh; https://orcid.org/0000-0003-0833-6492; ds_rajput87@yahoo.in; Department of Physical Education, Kanya Maha Vidyalaya (Autonomous); Jalandhar Punjab, India.

Manoj Bhardwaj; https://orcid.org/0000-0003-0430-7408; manojthemaximus@yahoo.com; Department of Physical Education (T), Guru Nanak Dev University; Amritsar, Punjab, India.