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Research Article

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Comparative Study of the Immediate Effects of Deep Breathing Exercise Coupled with Breath Holding up to the Breaking Point, on Respiratory Rate, Heart Rate, Mean Arterial Blood Pressure and Peak Expiratory Flow Rate in Young Adults

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A b s t r a c t

Background: There are many studies on the immediate effects of deep breathing and breath holding separately, but no studies reported on the immediate effects of deep breathing coupled with breath holding on the Respiratory rate [RR], Heart rate [HR], Mean arterial blood pressure [MAP] & Peak Expiratory flow rate [PEFR]. A comparative study was carried out to evaluate the immediate effects of deep breathing exercise coupled with breath holding up to breaking point, on RR, HR, MAP and PEFR.
Methods: RR, HR, MAP & PEFR of volunteers were recorded in I year MBBS students of both genders [n=99; female 59; male 40]. The subject was directed to inhale slowly up to the maximum of 5 seconds and then to exhale slowly up to the maximum of 5 sec. [i.e. at the rate of 6 breaths /min] for 5 minutes. Immediately after this exercise, the subject was instructed to take deep inspiration & then hold the breath upto breaking point. RR, HR, MAP & PEFR were recorded again. Statistical analysis was done with the help of SPSS 16 by both Paired & Unpaired Students''t' test; and correlation. $P<0.05$ is considered as significant.
Results: PEFR is found to be significantly increased by 5%, with insignificant decrease in respiratory rate, heart rate, and mean arterial blood pressure in young adults of both sexes. Breath holding time significantly increase after deep breathing exercise.
Conclusion: The result indicates that the parasympathetic dominance claimed as an immediate effect of deep breathing exercise is nullified by the opposing effects of breath holding upto breaking point. The increase in PEFR can be due to a decrease in small airways resistance, which is not influenced by central autonomic regulation.

Keywords: Deep breathing, Breath holding, Breaking point

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Background

Mental health is a state of wellbeing, which is essential for coping with normal stresses, helps to work productively. The relaxation response is a mentally active process that leaves the body relaxed, calm, and focused by various means like prayer, meditation, deep breathing, exercise, whole body muscle relaxation & many other different techniques. Deep breathing is one of the simple, powerful, relaxation technique used from ancient time and can be practiced almost anywhere also used for conditioned learning i.e. Biofeed back mechanism [1]. The immediate effects of deep breathing exercises have different types of benefits like significant decrease of atelectatic area, increase in aerated lung area and a small increase in PaO_2 is well known [2,3]. Voluntary deep breathing at slower rate helps to minimize the wastage of breathing through dead space and increases minute ventilation, in turn increasing the alveolar PO_2 & decreasing PCO_2. This will decrease the central stimulatory effect on respiration mediated through both peripheral & central chemoreceptor mechanism. Breath holding upto breaking point causing zero ventilation reverses the above said effects [1, 4]. As the regulation of Respiration is both automatic & under voluntary control, it is possible to modulate HR and thus in turn BP by voluntary control of respiration. But there is a limit for it, as testified by "voluntary apnoea [breath holding] is followed by involuntary hyperpnoea" & "voluntary hyperpnoea is followed by involuntary apnoea" mainly due to strong involuntary stimulatory control of respiratory centers by chemoreceptors mediated through arterial concentrations of $\uparrow PCO_2$, $\uparrow H+$ ions , $\downarrow PO_2$ [1, 4].

There exists an interrelationship in normal healthy persons between resting HR, RR & BP as follows.

a] Interrelationship between resting HR & respiration [sinus arrhythmias]; i.e. sinus arrhythmia is a normal phenomenon and is primarily due to fluctuations in parasympathetic output to the heart. During inspiration, impulses in the vagi from the stretch receptors in the lungs inhibit the cardioinhibitory area in the medulla oblongata. The tonic vagal discharge that keeps the heart rate slow decreases and the heart rate rises [2].

b] There is linear relation between systolic blood pressure and lowering of heart rate [greater RR interval] i.e. Inverse relationship between HR & BP [Marey's law] mediated through Baroreceptors [5].

PEFR –MMEF (maximum mid-expiratory flow) or MEF stands for maximal mid expiratory flow. It is the peak of expiratory flow as taken from the flow–volume curve which is measured in liters per second. It should theoretically be identical to Peak Expiratory Flow [PEF], which is generally measured by a peak flow meter and given in liters per minute. A decrease in PEFR indicates an increase in airway resistance and vice versa. It is a sensitive parameter and is useful for serial measurement because it will be affected before FEV, so can act as an early warning sign of small airway disease [6, 7]. The main objective of the study was to evaluate the effects of breath holding upto breaking point on the claimed parasympathetic dominance caused by deep breathing.

Material and Methods

Study design and the participants

Parameters were recorded in apparently healthy I MBBS students [n=99: female 59, male 40] at 4 PM., after their regular class hours. The parameters include: Anthropometrical parameters [height in cms, weight in kg, BSA in sq. meters, BMI in kg/m2]; Cardiorespiratory parameters like Respiratory rate [in breaths /min], Heart rate [bpm], BP[in mm of Hg] by mercury sphygmomanometer , PEFR [in Liters/min] by PulmoPeak peak flow meter & Breath holding time [in seconds] up to breaking point.

Then subject was directed to inhale slowly up to the maximum of 5 seconds and exhale slowly up to the maximum of 5 sec. [i.e. at the rate of 6 breaths /min] for 5 minutes. Immediately after this exercise, the subject was instructed to take deep inspiration and hold the breath upto breaking point and Breath holding time was recorded. This was followed by recording of RR, HR, MAP & PEFR.

Study Period

Recordings of 25 students per day are done daily after 4 P.M. for 4 days in the month of April 2013.

Response Rate

All the 99 students selected from the study population of 99 giving a overall response rate of 100%.

Inclusion criteria

Students of Basic Sciences (MBBS I)18 years of age or older were included in the study.

Exclusion criteria

Students under medication, not willing to participate voluntarily were excluded to avoid bias.

Outcome variable

Breath holding time, respiratory rate, heart rate, mean arterial pressure, PEFR.

Explanatory variables

Demographic and other factors - age, height, weight, body surface area, body mass index

Ethical committee approval

The present research study was approved by Institutional ethics committee. After briefing the details of research project, written consent was taken from the participants.

Data management and statistical analysis

Analysis was done using SPSS 16th version for calculating & comparing the means both by paired & unpaired Student 't' test & by Correlation. P value < 0.05 is considered as significant.

Results

The mean age of our study population for males 19.85 yrs and females 18.94 years. Height, weight and body surface area of males were comparatively more 174.90 cms. and 63.57 kgs.1.82sq. meters than females. Body mass index was almost same for both the groups – table 1.

Table-1: Represents anthropometrical parameters in young adults of both genders [n =99].

Variable	Male [n=40]	Female [n=59]	P value by unpaired 't' test
Age [years]	19.15	18.94	0.80[×]
Height [cms]	174.90± 6.22	159.96±5.74	0.00001[†]
Weight [Kgs]	63.57± 8.44	53.23± 9.9	0.00001[†]
Body Surface Area [sq. meters]	1.82± 0.13	1.59± 0.14	0.00001[†]
Body mass index [kg/sq. meters]	20.77± 2.39	20.73±3.19	0.951[×]

[†]P<0.001, statistically significant
×p>0.05, statistically not significant

Respiratory rate, heart rate and mean arterial pressure was almost same before and after deep breathing coupled with breath holding among both genders and this is statistically insignificant table 2.

Table-2: depicts comparison of various physiological parameters before & after deep breathing coupled with breath holding among both genders (n=99).

Variable	Before deep breathing + breath holding [mean ± SD]	After deep breathing + breath holding [mean ± SD]	P value by paired 't' test
Respiratory Rate [cycles/min]	15.96±3.06	15.83±4.06	0.712[×]
Heart rate [bpm]	75.58± 6.56	74.93±9.16	0.301[×]
Mean Arterial pressure[mm Hg]	83.11± 7.52	82.18 ± 9.54	0.209[×]
PEFR [L/min]	411.41±137.60	430.39±130.09	0.000[†]

[†]P<0.001, statistically significant
×p>0.05, statistically not significant

There is significant increase of PEFR by 5% [Graph -1], after deep breathing coupled with breath holding, in young adults of both genders. As shown in Graph 2 there is significant linear correlation between height in cms of young adults of both sexes to PEFR [L/min] with R square = 0.514.

Table 3 showed that there is significant increase in breath holding time after deep breathing. Breath holding time increased 45%, immediately after the deep breathing for 5 minutes at the rate of 6 breaths/min in both genders.

Figure – 1

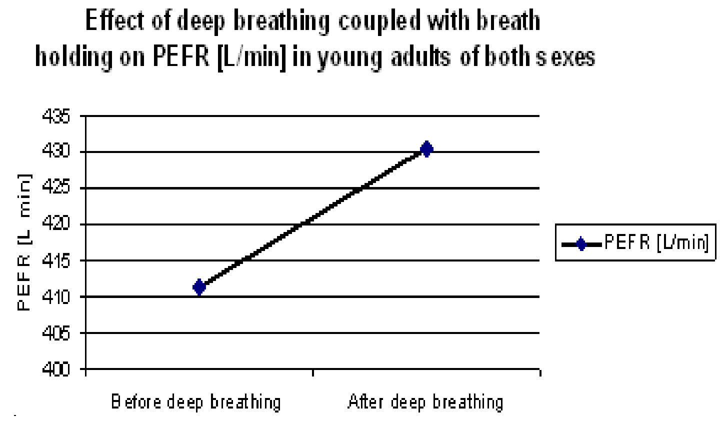

Figure – 2

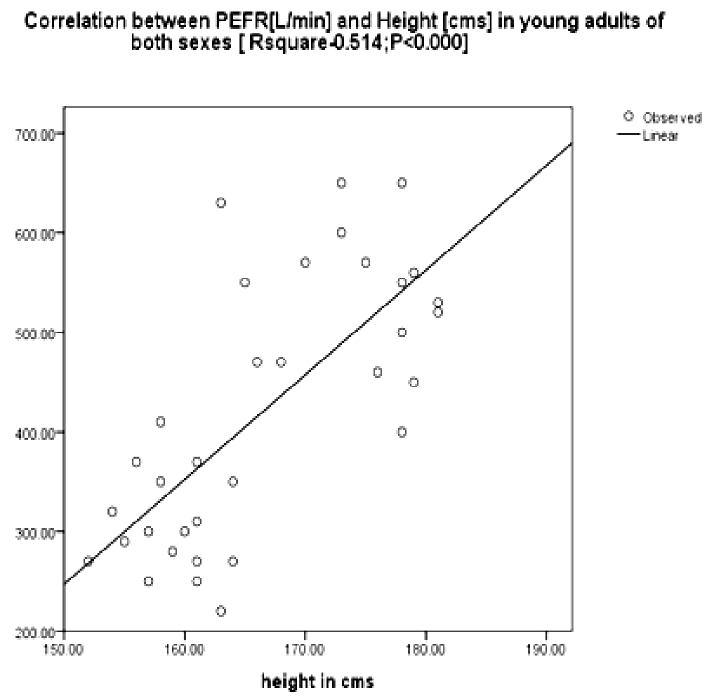

Table-3: represents Comparison of breath holding time [in seconds] before & after deep breathing in both genders [n =99].

Variable	Before deep breathing [mean ± SD]	After deep breathing [mean ± SD]	P value by paired 't' test
Breath holding time [in seconds]	56.91±21.84	81.47±25.49	0.000†

†P<0.001, statistically significant
×p>0.05, statistically not significant

Discussion

Comparison of various physiological parameters before & after deep breathing

Respiratory Rate before and after deep breathing and breath holding was not significant in the present study, which is supporting another research work done by Orfanos et al [8]. In the present study we got PEFR was significant. Our results corroborates with other studies [9]. A number of research works proved that deep slow breathing exercise helps to improve heart rate variability, without changing their cardiac autonomic balance. In our study, we found there was no statistical relationship between heart rate and above mentioned factors [10]. Study done by Arzu Genç et al showed that there was no statistically significant difference in HR or MAP was observed after DBE. In our study, we got the same result [11]. The regulation of Respiration is under both automatic & voluntary control. Voluntary deep breathing will wash out excess CO_2 & cause depression of central respiratory centers. Voluntary breath holding up to breaking point retains excess CO_2 & cause strong excitation of central respiratory centers. A significant increase of 45% in breath holding time after the deep breathing proves the fact that there is depression of the central ventilatory response by wash out of excess CO_2, due to the increase in minute ventilation. At the end of breath holding, there is retention of CO_2 due to zero ventilation, which has reversed the central ventilatory response. This explains the insignificant decrease of respiratory rate, heart rate & mean arterial pressure observed in the present study as compared to several other studies showing significant decrease in RR, HR & BP after deep breathing. This can be explained by the effect of deep breathing & the effect of breath holding nullifying each other, when both are coupled. Study done by Pramanik et al in both the genders slowed that Bhramari pranayamic breathing (respiratory rate 3/min) for 5 minutes caused a slight fall in heart rate & significant decrease by 4mm of Hg in MAP, mentioning slow pace pranayama influence the heart rate and blood pressure through the parasympathetic dominance [12]. The significant 5% increase in PEFR in both genders after deep breathing coupled with breath holding, can be contributed to peripheral factors influencing the small airway resistance.

Comparison of breath holding time [in seconds] before & after deep breathing

Breath holding time is used as an indicator and measuring tool of distress tolerance and self-regulation. However, research works in this field is comparatively less and determinants of breath holding in healthy individual are unknown [13]. In the present research work we observed that breath holding time increased after deep breathing exercise which was statistically significant. In normal healthy individuals, breath holding time was interpreted as a measuring tool of distress tolerance helping in self-regulatory strength [14-17]. The present study focused on relationship between breath holding time and Before and after deep breathing in normal healthy subjects.

Conclusion

In summary, the immediate effects of deep breathing exercises on RR, HR & BP may be reverted very quickly by just breath holding up to breaking point is probably mediated by central regulatory mechanisms. But the effect of significant 5% increase in PEFR which is long lasting may be induced by peripheral factors reducing the small airway resistance. It suggests that the claimed parasympathetic dominance caused by deep breathing is very quickly opposed by sympathetic dominance caused by breath holding up to breaking point. So these two breathing exercises practiced together may cause better autonomic balance which can be further studied in detail by Autonomic function tests.

Limitations & future scope of the study

Sample size of the present study was less. Future research with more number of samples may want to investigate whether there is any other interrelationship between the variables used in this study.

Abbreviations

Respiratory rate [RR], Heart rate [HR], Mean arterial blood pressure [MAP] & Peak Expiratory flow rate [PEFR], MMEF(maximum mid-expiratory flow).

Competing interests

Authors do not have any competing interests.

Authors' contribution

Bindu. C.B[1], Dharwadkar AA[2], Dharwadkar AR[3] designed the study, performed the experiment, interpreted the data, drafted the manuscript, and revised it. All authors contributed in data analysis, interpreted the data, and revised the manuscript. Final manuscript was approved by all authors.

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