International Journal of Basic and Applied Medical Sciences ISSN: 2277-2103 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jms.htm
2014 Vol. 4 (2) May-August, pp. 17-23/Rajajeyakumar et al.
Research Article

EFFECT OF YOGIC TYPE OF BREATHING (PRANAYAM) ON DIFFERENTGRADE OF HAND GRIPSTRENGTHAMONG YOUNG ADULTS

***Rajajeyakumar M[1], Janitha A[2], Balachander J[3], Madanmohan[4] and Bhattacharjee M[5]**
[1]*Department of Physiology, Chennai Medical College Hospital & Research Centre, Trichy-621105*
[2]*Bharat Heavy Electrical Limited, Main Hospital, Trichy-620014*
[3]*Department of Cardiolog[3], JIPMER, Pondicherry*
[4]*Department of Physiology, Mahatma Gandhi Medical College & Research Centre, Pondicherry*
[5]*Department of Physiology, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi*
**Author for Correspondence*

ABSTRACT
Hand grip strength (HGS) is an indicator of muscle function and nutritional status. Very few studies have been conducted on the effect of single fast yogic type of voluntary breathing exercise (Pranayam) on different grade of isometric hand grip strength of right arm population. Hence, we assessed the effect of single fast yogic type of voluntary breathing exercise on different strength of isometric handgrip exercise and physiological parameters of an individual. The present study was conducted on 60 volunteers 19-25yrs.The subjects were randomly assigned to pranayam and control groups. The Pranayam group was taught Kapalabhathi by trained yoga teacher and practices same under our direct supervision for 30 min per day, thrice per week for total duration of 12 weeks. Control group were not practice pranayam. All the Physiological parameters were recorded before and after 12 weeks of the study period. Statistical analysis was done by student's t test. The parameters recorded in the control group did not show any significant difference. Male subjects of kapalabhati group showed an increase in SBP and RPP during 30% and 60% IHG. Female subjects of kapalabhati group showed an increase in MAP during rest, a decrease in QTc during deep breathing and an increase in QTc during IHG 30% The RPP and SBP also increased during IHG 30% & IHG 60% in this group. Our study has revealed a number of important facts which can have important therapeutic implications. The gender difference was evident in all the parameters measured. Moreover, specific breathing techniques can be advised depending on whether an individual has high sympathetic or parasympathetic tone.

Keywords: *Kapalabhathi, Pranayam, Hand grip strength, Yoga*

INTRODUCTION
Yogic techniques include meditation, regulation of respiration with a variety of breathing exercises and a number of physical exercises and postures in which the focus is more on isometric exercise. They induce relaxation response which consists of a generalized reduction in both cognitive and somatic arousal as observed in the modified activity of the hypothalamic - pituitary axis and the autonomic nervous system. Pranayama helps to improve cardio respiratory and neurological functions, decreases the effect of stress and improves physical and mental health **(**Raghuraj *et al.,* 1997). Grip strength has been shown to be a predictor of general body strength, postoperative complications, mortality and functional decline (Bohannon *et al.,* 2009). Handgrip strength is commonly evaluated in different clinical settings as an indicator of general health status and upper limb strength (Schlüssel *et al.,* 2008). However, there is very few of literature on the gender differences in hemodynamic response to pranayam and isometric handgrip exercise. In view of this, the present study was planned to study the effect of gender on the autonomic and electrocardiographic response to yoga type breathing.

Aim of the Study
1. To study the effect of yogic type of voluntary breathing exercise (Pranayam) on different grade of isometric handgrip exercise and physiological parameters of an individual.

2. To detect gender difference, if any in the recorded variables at the beginning as well as at the end of the study period.

MATERIALS AND METHODS

The present study was conducted in department of physiology, JIPMER, Pondicherry. Sixty young healthy volunteers were recruited after obtaining ethical clearance from the institutional Human Ethics Committee. Their age ranged between 17-20 years (17.65 ± 0.15), body weight between 46-65 kg (53.72 ± 2.28) and height between 146-173 cm (168.5 ± 1.12). The subjects were randomly divided into control group and kapalabhathi group. Each group consisted of 30 volunteers and was further divided into two sub-groups based on gender. The participants were explained in detail about the study protocol and informed consent was obtained from them. They were advised to refrain from smoking, drinking alcohol and any other exercise other than those prescribed during the study period.

Equipment Used

1. Blood pressure and heart rate were recorded with the subject seated comfortably, using the noninvasive automated BP monitor (NIBP).
2. Handgrip dynamometer (INCO India Ltd Ambala) was used to measure the muscle strength and endurance of the upper limbs according to the technique described and validated by Madanmohan *et al.*, (2005).

IHG at 10% of MVC

This test assesses the sympathetic reactivity of an individual. Using a handgrip dynamometer, the volunteer was asked to do maximum voluntary contraction (MVC) for a few seconds. After five minutes rest, they were requested to maintain 10% of MVC for up to one minute while blood pressure was monitored in the non-exercising arm. The difference between the diastolic blood pressure just before release of handgrip was taken as the measure of the response.

IHG at 30% of MVC

The procedure was same as that of IHG 10% of MVC; however, instead of 10% the volunteer was asked to maintain 30% of his MVC for a period of one minute.

IHG at 60% of MVC

Here, the volunteer was asked to maintain 60% of his MVC for a period of one minute

Following these recordings, the volunteers were trained in kapalabhati Pranayam and instructed to refrain from any yogic practice or exercise depending on whether they belonged to group II (Kapalabhati group), or group I (Control group) Each group consisted of 30 volunteers and was further divided into two sub-groups based on gender.

After explaining the procedure to the study subject and giving a demonstration, they were asked to hold the handgrip dynamometer in the dominant hand in sitting position. The forearm was extended over a table and elbow flexed at 90°. Subjects were asked to hold the dynamometer in such a way that the second phalanx was against the inner stirrup, and were then asked to grip the dynamometer handle with as much force as they possibly could apply. The handgrip muscle strength was recorded in kilograms as indicated by the pointer on the dynamometer. Three recordings were taken with a gap of two minutes between each effort and the maximum value was recorded for the analysis.

Parameters Recorded

The following parameters were recorded in all volunteers at the beginning and end of three months study period. Body mass index (BMI), Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) &QTc interval.

Procedure

Subjects were asked to report to the recording laboratory between 4-6 pm. Basal parameters like HR & BP were recorded by using NIBP after 15 min rest in sitting posture.

Procedure for Kapalabhathi Pranayam

Kapalabhathi Pranayam done with subject in sitting posture (with erect spine) in a well ventilated room. Sharp contraction of abdominal muscles produces active and quick expiration while inspiration is

spontaneous and relatively passive (Stancak *et al.,* 1991). The subject performs 30 cycles in 1 minute. Kapalabhathi consists of in fast shallow abdominal respiratory movements at about 2 Hz frequencies. The above mentioned parameters were recorded in all volunteers of both control and Kapalabhathi groups at the end of three months study period.

Calculation of R- R interval

ECG was acquired at a rate of 1000 samples per second using the BIOPAC MP 100 system and the BIOPAC Acknowledge software 3.7.1 (BIOPAC Inc., USA) for at least 330 seconds. ECG was examined for artifacts and ectopics and if present they were edited out and the preceding and successive noise-free segments were joined by linear interpolation with NN intervals (i.e. normal-to-normal RR intervals). When atrial or ventricular premature complexes were encountered, the preceding and the succeeding intervals were excluded. The edited ECG was processed using an R-wave detector to obtain an RR interval tachogram. A detailed account of techniques of R- R interval analysis is mentioned in the Task Force Report of the European Society of Cardiology, 1996.

Calculation of QTc

QT & QTc intervals were analyzed by lab chart pro 6 software (AD Instruments, Australia). The files were recorded from the BIOPAC Acknowledge software 3.7.1 imported into lab chart pro 6 software. The ECG Beat Classifier enables the selection and removal of unsatisfactory beats or groups of beats. Once the appropriate setting has been chosen, the ECG Analysis Module automatically detects the ECG beats according to the ECG settings. The MLS360/6 ECG Analysis Module for Windows automatically detects and reports QT and QTc intervals, either online or offline. The QTc interval was calculated by applying Bazzet formula: $QTc = QT/\sqrt{RR}$. The ECG Analysis Module averages any chosen ECG beats within an ECG recording. The number of ECG beats averaged and analyzed together the mean QTc interval was obtained from the same software. The ECG Table View logs and displays selected ECG parameters. Available parameters are chosen in the ECG Table View dialog. Values for each ECG average are automatically logged to the ECG Table View and can be added to the Data Pad (Lab Chart's internal spreadsheet) or the parameters can also be exported to graphing or statistical programs for further analysis.

Calculation of RPP

RPP was calculated (RPP = SP × HR / 100) as the product of systolic pressure and heart rate It has been shown to correlate with myocardial oxygen consumption during exercise in patients with angina pectoris (Gobel *et al.,* 1978).

Data Analysis

Data was analyzed using SPSS statistical program (version 13 for Windows. SPSS Inc Chicago IL, USA). An unpaired t test was done to compare parameters between male and female subjects and a paired t test to compare values at the beginning and end of the study period. P value less than 0.05 was considered significant.

RESULTS

Control Group: The control group was not subjected to any Pranayam training. In control male subjects, all the parameters measured during the experimental conditions were similar at the beginning and end of the three months study period (Table 1). In control female subjects also the parameters similar at the two study period (Table 2).

Kapalabhati Group

The volunteers of this group received three month training in kapalabhati pranayam. Tables 3&4 \shown the various parameters measured in the male and female subjects of kapalabhati groups at the beginning and end of the study period.. At the end of the study period a significant increase in SBP from a value of 130.66 ± 1.29 to 137.20 ± 1.71 during IHG 30% and from 136.93 ± 1.85 to 142.50 ± 1.36 during IHG 60% was observed, the differences being statistically significant ($p \leq 0.01$). RPP also showed a significant increase at the end of the study period from a value of 118.41 ± 2.52 to 129.86 ± 3.73 during IHG 30%

and from 128.88 ± 3.15 to 141.45 ± 3.57 during IHG 60%, these differences being statistically significant ($p \leq 0.05$).

Basal MAP decreased from a value of 82.29 ± 2.35 at the beginning to 74.27 ± 2.84 at the end of the study period, the decrease being statistically significant ($p \leq 0.05$). In contrast, during IHG 10%increased significantly from a value of 0.347 ± 0.011 to 0.387 ± 0.008 ($p \leq 0.01$). RPP increased at the end of the study during IHG 30% & 60% from an initial value of 115.80 ± 3.72 to 128.13 ± 3.35 and 126.68 ± 3.67 to 140.25 ± 4.26 respectively, the increase being statistically significant ($p \leq 0.05$ and $p \leq 0.01$) respectively..At the end of the study period an increase in SBP during IHG 60% from a value of 127.46 ± 1.80 at the beginning to 135.40 ± 1.53, at the end was observed, the increase being statistically significant ($p \leq 0.01$).

To summarize, the parameters recorded in the control group did not show any significant difference. Male subjects of kapalabhati group showed an increase in SBP and RPP during 30% and 60% IHG. Female subjects of kapalabhati group showed an increase in MAP during rest, a decrease in QTc during deep breathing and an increase in QTc during IHG 30% The RPP and SBP also increased during IHG 30% & IHG 60% in this group. Briefly, a gender difference in various parameters such as MAP, QTc existed in the control group at the beginning of the study and the differences persisted at the end of three months in the group. In the kapalabhati group, HR, RPP& QTc during rest even after three moths practice in kapalabhati pranayam, the differences persisted.

Table 1: Parameters of group I (control male) subjects at the beginning and end of the three months study period:

	Rest		**IHG 10%**		**IHG 30%**		**IHG 60%**	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End
HR	73.80±2.11	72.73±1.58	78.86±2.08	78.66 ± 1.94	83.20 ± 2.28	83.66 ± 2.28	87.60 ± 2.26	88.26 ± 2.15
SBP	121.80±2.13	121.60±1.94	127.20±2.04	127.87±1.71	133.87± 2.11	133.27 ± 1.43	137.40 ± 0.83	137.47 ± 0.90
DBP	74.26±1.71	74.20±1.39	76.66±1.71	76.20 ± 1.63	81.46 ± 1.41	80.93 ± 1.22	84.60 ± 1.22	84.33 ± 1.05
MAP	90.11±1.20	90.00±1.03	93.51±1.31	93.42 ± 1.26	98.93 ± 1.07	98.37 ± 0.88	102.20 ± 0.88	102.04 ± 0.75
RPP	89.74±2.72	88.39±2.26	100.31±3.06	100.58±2.81	111.32 ±3.18	111.69 ± 3.70	120.29 ± 3.18	121.32 ± 3.70
QTc	0.342±0.006	0.334±0.003	0.339±0.005	0.342±0.005	0.336± 0.006	0.337 ± 0.007	0.354 ± 0.01	0.356 ± 0.01

Table 2: Parameters of group II (control female) subjects at the beginning and end of the three months study period

	Rest		**IHG 10%**		**IHG 30%**		**IHG 60%**	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End
HR	75.93 ± 1.82	76.53 ± 1.81	81.40 ± 1.75	81.86 ± 1.78	84.60 ± 1.72	85.26 ± 1.69	87.86 ± 1.61	88.8 ± 1.55
SBP	122.33±1.47	123.47±1.25	127.50±1.38	128.70±1.23	132.70 ±1.47	133.90 ± 1.32	136.40±1.51	138.10 ± 1.32
DBP	69.26 ±1.37	69.66 ± 1.02	74.07± 1.63	75.20 ± 1.47	78.73 ±1.61	80.20 ± 1.41	81.47 ± 1.76	82.07 ± 1.62
MAP	86.95 ± 1.00	87.60 ± 0.97	91.86 ± 1.09	93.04 ± 0.94	96.73 ± 1.26	98.11 ±1.13	99.77 ± 1.46	100.8 ± 1.33
RPP	92.86 ± 1.00	94.43 ± 0.97	103.67±2.24	105.33±2.31	112.22 ± 2.38	114.20 ± 2.52	119.84±2.54	122.64 ± 2.35
QTc	0.368±0.009	0.366±0.008	0.351±0.006	0.354±0.005	0.367 ± 0.006	0.361 ± 0.007	0.356±0.008	0.365 ± 0.009

Values are expressed as mean ± SEM. Paired t test was applied to compare the parameters at the beginning and end of the study did not show any significant difference. HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, MAP – mean arterial pressure, RPP – rate pressure product, QTc – corrected QT interval, IHG – isometric handgrip.

**P ≤ 0.05 **P ≤ 0.01 ***P ≤ 0.001*

Table 3: Parameters of group III (kapalabhati male) subjects at the beginning and end of the three months study period

	Rest		IHG 10%		IHG 30%		IHG 60%	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End
HR	76.33 ± 1.41	80.86 ± 2.42	90.80 ± 1.66	93.73 ± 2.24	90.53 ± 1.30	94.60 ± 2.37	94.06 ± 1.66	99.26 ± 2.26
SBP	116.93±1.81	119.60±1.81	140.00±3.24	136.90±1.42	130.66 ± 1.29	137.2 ± 1.71**	136.93±1.85	142.50±1.36*
DBP	64.46 ± 1.59	63.80 ± 1.63	83.66 ± 2.03	79.46± 2.50	80.73 ± 1.87	82.33 ± 2.85	82.53 ± 2.30	87.73 ± 2.29
MAP	81.96 ± 1.42	82.40± 1.23	103.90±2.19	98.60 ± 1.95	97.38 ± 1.41	100.62 ± 1.89	100.70±1.65	105.98 ± 1.39
RPP	89.35± 2.34	96.87 ± 3.70	127.43±2.34	128.36±3.70	118.41 ± 2.52	129.86±3.73**	128.88±3.15	141.45±3.57*
QTc	0.338±0.004	0.347±0.007	0.326±0.007	0.346±0.008	0.343 ± 0.006	0.366 ± 0.012	0.349±0.005	0.361 ± 0.004

Table 4: Parameters of group IV (kapalabhati female) subjects at the beginning and end of the three months study period

	Rest		IHG 10%		IHG 30%		IHG 60%	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End
HR	82.57 ± 2.21	88.93 ± 3.26	99.13 ± 2.73	101.47±2.86	93.86 ± 2.13	99.33 ± 2.60	99.40 ± 2.51	103.67 ± 3.17
SBP	114.21±3.02	116.80±2.81	124.86±3.45	128.73±2.37	123.26±2.52	129.20±2.11	127.46±1.80	135.40±1.53**
DBP	64.71 ± 2.63	67.86 ± 1.62	73.93 ± 2.45	77.6 ± 4.84	74.53±2.37	77.06 ±3.50	81.13 ± 2.00	86.06 ± 2.83
MAP	82.29 ± 2.35	74.27±2.84*	92.53 ± 3.28	94.64 ± 3.68	90.78 ± 2.10	94.44 ±2.79	96.58 ± 1.67	102.50 ± 2.24
RPP	106.68±2.34	94.07 ± 3.70	124.45±6.00	130.42±3.86	115.80±3.72	128.13±3.35*	126.68±3.67	140.25±4.26**
QTc	0.376±0.009	0.359±0.007	0.347±0.011	0.387±0.008**	0.362±0.006	0.375±0.006	0.370±0.007	0.391 ± 0.014

Values are expressed as mean ± SEM. Paired t test was applied to compare the parameters at the beginning and end of the study. HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, MAP – mean arterial pressure, RPP – rate pressure product, QTc – corrected QT interval, IHG – isometric handgrip.

**P ≤ 0.05 **P ≤ 0.01 ***P ≤ 0.001*

DISCUSSION

Effect of three months Pranayam training on autonomic and ECG parameters

Control group of male as well as female volunteers the recorded cardiovascular parameters were similar in the beginning and the end of the three months study period.

Pranayam Group (Male): In male volunteers of kapalabhati groups the SBP and RPP were significantly higher than the initial value during IHG exercise at 30% and 60% of MVC. IHG provides pressure stimulation to cardiovascular system through efferent sympathetic pathways with a resultant increase in blood pressure (Bannister, 2003). Kapalabhati Pranayam is known to enhance sympathetic tone and hence the observed changes are easily explained. In the female volunteers of this group, the SBP during at 60% of MVC and the RPP during IHG 30% and 60% of MVC were higher at the end of the study period. This change can be attributed to an increase in pressure response due to kapalabhati pranayam. However, the MAP during rest was significantly reduced in the females but there was such observation in the males. Probably, the males responded more to the kapalabhati pranayam owing to their already high sympathetic tone as reported in the literature (Sana *et al.,* 2003; Stancak *et al.,* 1991). The pressure response in the females was evident during higher grades of IHG (60% of MVC).

Pranayam Group (Female): At the beginning of the study, during rest, the HR RPP and QTc were significantly higher in females as compared to males. In this connection, it is interesting to note that Badiale *et al.,* (1997) have reported that resting sympathetic vasomotor tone is lower and resting heart rate is higher in women. During IHG exercise, SBP and DBP were higher in males as compared to females. Ewing *et al.,* (1985) have reported that sustained handgrip produces smaller response in women. The blood pressure response to IHG depends on the strength of contraction of muscle group and the duration of the contraction (Martin *et al.,* 1974). Higher BP response in men is due to stronger muscles than females. At the end of the study during rest, HR and QTc were higher in females as compared to male. It is reported that kapalabhati; a type of rapid breathing enhances the sympathetic drive to myocardium

with a shift of balance shifted towards sympathetic side. The blood pressure response to IHG was significantly lower in females both in comparison in males and their own initial values. Therefore, a gender difference definitely exited in the various parameters measured. In this regard, Matsukawa *et al.*, (1998) have reported that younger women have lower sympathetic nerve activity than men. They attributed this to the presence of the basis of estrogen and progesterone in females. Kapalabhati pranayam which is known to enhance sympathetic system had a more profound effect in males as compared to female volunteers (Rajajeyakumar *et al.*, 2013).

Conclusion

Our study has revealed a number of important facts which can have important therapeutic implications. The gender difference was evident in all the parameters measured. Our findings are in accordance with that of other authors. Therefore, our study demonstrates that fast pranayam was beneficial on the handgrip dynamometer parameters (HGS & HGE) and the beneficial effect of the two groups can be considered comparable (Thangavel *et al.*, 2014). Therefore yogic breathing practices can be prescribed to both healthy people and those with cardiovascular autonomic dysfunction. Moreover, specific breathing techniques can be advised depending on whether an individual has high sympathetic or parasympathetic tone (Sharma *et al.*, 2013).

Lacunae & Recommendations

It is important to standardize the procedure and increase the reliability, as otherwise the measurement error may be too large to detect actual changes in strength. It must be borne in mind that different kinds of dynamometers and postures might change the results. We recommend side adjustment of measured values for intra individual comparison and inclusion of information regarding anthropometric characteristics, as well as using gender- and age-adjusted reference values, whereas hand dominance can be neglected. In addition the influence of grip span, and posture on cognitive function should be considered.

ACKNOWLEDGMENT

Our sincere thanks to Dr. Navasakthi, Yoga expert, JIPMER and all subjects for their willingness and full cooperation during the study period.

REFERENCES

Badiale MS, Locati EH, Martinelli A, Courville J and Schwarrtz PJ (1997). Gender and the relationship between ventricular repolarization and cardiac cycle length during 24 h holder recordings. *European Heart Journal* **18** 1000- 1006.

Bannister R and Mathias CJ (2003). *Autonomic Failure: A Textbook of Clinical Disorders of the Autonomic Nervous System* (London, Oxford University Press) 169-192.

Bohannon RW (2009). Dynamometer measurements of grip and knee extensionstrength: are they indicative of overall limb and trunk muscle strength? *Perceptual & Motor Skills* **108** 339–342.

Schlüssel MM, Anjos LA and Vasconcellos MT *et al.*, (2008).Reference values of handgrip dynamometry of healthy adults: a population-based study. *Clinical Nutrition* **27** 601-607.

Davey PP (1999). Influence of posture and handgrip on the QT interval in left ventricular hypertrophy and in chronic heart failure. *Clinical Science* **96** 403 – 407.

Dinesh Thangavel, Girwar Singh Gaur, Vivek Kumar Sharma, Ananda Balayogi Bhavanani, Rajajeyakumar M and Syam Sunder A (2014). Effect of Slow and Fast Pranayama Training on Handgrip Strength and Endurance in Healthy Volunteers. *Journal of Clinical and Diagnostic Research* **8**(5) BC01-BC03.

Ewing DJ, Martyn CN, Young RJ and Clarke BF (1985).The value of cardiovascular autonomic function tests: 10 years experience in diabetes. *Diabetes Care* **8** 491.

Madanmohan, Prakash ES and Bhavanani AB (2005). Correlation between short – term heart rate variability indices and heart rate, blood pressure indices, pressure reactivity to isometric handgrip in healthy male subjects. *Indian Journal of Physiology and Pharmacology* **49** 132 – 138.

Martin CE, Shaver JA, Leoon DF, Thompson ME, Ready PS and Leonard JJ (1974). Autonomic mechanisms in hemodynamic responses to isometric exercise. *Journal of Clinical Investigation* **54** 104-15.

Matsukawa T, Sugiyama Y, Watanabe T, Kobayashi F and Mano T (1998). Gender difference in age-relatedchangesin muscle sympathetic nerve activity in healthy subjects. *American Journal of Physiology* **275** R1600–R1604.

Raghuraj P, Nagaratna R, Nagenra HR and Telles S (1997). Pranayama increases grip strength without lateralized effects. *Indian Journal of Physiology and Pharmacology* **41**129-133.

Rajajeyakumar M, Bhattacharjee M and Madanmohan Balachander J (2013). Effect of slow and fast pranayams on gender specific difference in QTc interval of healthy young adults. *International Research Journal of Pharmaceutical and Applied Sciences* **3**(5) 266-270.

Sana M, Nancy M, Lapointe A and Karmer JM (2003). What clinicians should know about the QT interval? *JAMA* **289** 2120- 2127.

Sharma VK, Trakroo M, Subramaniam V and Rajajeyakumar M (2013). Effect of fast and slow pranayam on perceived stress and cardiovascular parameters in young health-care students. *International Journal of Yoga* **6** 104-110.

Stancak A, Kuna M, Srinivasan and Visnudevananda S (1991). Kapalabhati- yogic cleansing exercise on cardiovascular and respiratory changes. *Homeostasis in Health & Disease* **33** 126 – 134.

VarshneyV, Mona VP, Bharti B and Jyotsna B (2006). Effect of handgrip exercise on QTc interval during different phases of menstrual cycle. *Vascular Disease Prevention* **3** 83- 86.