

Comparative Study of Immediate and Long-Term Effect of Kumbhaka Practice on Lung Capacities, Cognition and Anxiety in Healthy Volunteers

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ABSTRACT

Background

Kumbhaka is one of phase on pranayama practice in hath yoga tradition. It is the ability of breath retention by practitioner to remain without breathing as long as possible, without any kind effort. Many studies are carried to see the changes on the various physiological and psychological parameters due to practice of kumbhaka in health volunteer.

Aim

The aim of the present study is to evaluate the immediate and long-term effect of Kumbhaka practice on lung capacities, cognition and anxiety in healthy volunteers.

Methodology

Sixty healthy male volunteers age range between 20-30 years (mean±SD; 26.03±2.54 years) underwent half an hour practice of kumbhaka (inhalation followed by retention of breath as long as possible then slow exhalation), five days in a week for 30 days. Selective attention, concentration, memory, maximum breath holding time (BHT) & peak expiratory flow rate (P.E.F.R), state and trait anxiety were assessed using appropriate assessment tools, before and after thirty days. Data were analyzed using SPSS version 16.

Results

There was a significant improvement in digit letter substitution scores, six letter cancellation test scores and digit forward and backward score and state and trait anxiety score after one month of kumbhaka practice. Kumbhaka has shown the significant effect on BHT (p=0.001), P.E.F.R (p=0.050), State anxiety (p=0.001), Trait anxiety (p=0.001), DLST (p=0.013), SLCT (p=0.045) & DMT (p=0.001) also has immediate effects on BHT (p=0.254), P.E.F.R. (p=0.224), State

anxiety ($p=0.001$), Trait anxiety ($p=0.008$), DLST ($p=0.554$) SLCT ($p=0.226$) & DMT ($p=0.066$).

Conclusion

One-month practice of kumbhaka exhibited significant improvement on lung capacities, cognition and anxiety in healthy volunteers. However, further randomized controlled trial need to be performed to confirm findings on a bigger sample size to generalize the effect of practice for general population.

Keywords: Kumbhaka, Healthy volunteers, Lung Capacity, Cognition and Anxiety.

INTRODUCTION

Pranayama means control of the vital force by concentration and regulated breathing. It is a physical, mental, spiritual and cosmic energy. Prana is usually translated as breath; which moves in the thoracic region absorbing vital energy at the manifestation level in human body. The movements of the thoracic organs include vertical ascension, horizontal expansion and a circumferential movement. Pranayama is recognized as a technique not on the basis of nature of kumbhaka but on the basis of its nature of inhalation and exhalation. There are several techniques practices as per classical texts such as Suryabhedana, Ujjayi, Sitkari, Sitali, Bhastrika, Bhramari, Murchha & Plavini. (M.Gore., 1991)

Physiology of Pranayama

Pranayama decreases oxygen consumption, decreases heart rate, and brings blood pressure to the normal state. It also increases theta wave amplitude in EEG recordings and the parasympathetic activities. Due to increase in parasympathetic activity, there is a decline in heart rate and blood pressure which leads to prevent diseases like Hypertension, Coronary Artery Disease, Arrhythmias & other cardiovascular diseases (Sachit Goel, Varun Malhotra, Neera Goel, 2016) It has been reported that practice of pranayama modulates cardiac autonomic status and improves cardio-respiratory functions (Udapa K, Madanmohan, Bhavanani AB, Vijayalakshmi P, 2003). Pranayama is also beneficial for developing cognitive functions, central neural processing and sensory-motor performance (Subramanian, 2014)

Kumbhaka

Kumbhaka is the pause between an inhale and exhale and it is simultaneously the retention or holding of breath. In another words, it a state where there is no inhalation or exhalation taking place. There are three types of kumbhaka prescribed. The first is Antar kumbhaka (inner retention) where ceasing of breath when the inhalation (Poorak) is complete and the lungs are filled up with air. In this kumbhaka, inhalation is recommended to be slightly forceful to take more air than normal and ceasing it as per one's ability. The second is Bahya Kumbhaka (outer retention) where ceasing of breath when the exhalation (rechak) is complete. It is also recommended to exhale more than normal and then cease it as per one's ability. The third is Kevali Kumbhaka (stoppage of breath without effort): Inhalation or exhalation is not required or not focused in exercising Kevali Kumbhaka. It is the extreme stage of Kumbhaka which is attained only by continuous long term practice of pranayama and kumbhaka .(B.K.S. Iyengar, 1993)

Breathing Disorders

There are various breathing disorders where complications are occurring in different ways. Some of the breathing problem are shortness of breath, breathlessness, difficulty breathing. These are the obstructions described in classical Yoga sutra of Patanjali. It is a state, which involves uncomfotability breathing and also feeling difficulty in breathing enough air. Breathing problem can be caused by many things including lung disease, heart disease, anaemia, and at low fitness level (Sitalakshmi, R, 2013)

Respiratory disease is a medical term that encompasses pathological conditions affecting the organs and tissues that make gas exchange possible. The leading causes of respiratory disease are tobacco, smoking, passive smoke exposures, air pollution and workplace exposure to unsafe air. Contact with smoke from fires used in heating and cooking causes acute and chronic respiratory illness (World Health Organization, 2006)

Shortness of breath is a state where one will feel like not getting enough air or chest may feel tight such as a cough, chest pains or a fever. Shortness of breath can be caused by many things, including Asthma, lung diseases, Heart failure, Panic attacks (Karnani N, Reisfield G, 2005).

Impact of Yoga Practices

The specialty of Yoga is that physical, mental, intellectual and emotional faculties are sharpened in tune with spiritual progress. Yoga offers a conscious process to solve the menacing problems like unhappiness, restlessness, emotional upset, hyper-reactivity in a systematic and scientific way There are various techniques in Yoga used to control the fluctuations taking place at the different level in human personality.

Yoga is a way to achieve total health, peace, bliss and wisdom. Physical, mental and spiritual aspects of yoga help to make one's life purposeful, useful and noble. Thus, Yoga is an art, science and philosophy, which influence the life of man at each level. Yogic practices designed in a way by ancient seers that they improve one's thought process and enable one to face life's difficult situations happily and with equanimity (Gopaalananda, 2007) These techniques are making practitioners to feel that yoga develops the personality of an individual mentally, morally, spiritually and intellectually (Sharma, 1989).

Scientific Aspect of Kumbhaka and Pranayama Practice

May studies are attempted to explore the impact of kumbhaka and pranayama in specific and in general ways. One study reported that two weeks of slow breathing with kumbhaka on 18 healthy volunteers between age range 30 to 45 years showed significant increase in forced expiratory volume (Singh et al., 1990). Twenty-one months of Chandranuloma Pranayama, Suryanuloma Pranayama with Kumbhaka practice on 71 healthy volunteers between age range 21-71years showed significant increase in hand grip strength in both right and left hands.(Raghuraj & Telles, 2008). Ninety days of Rechaka Puraka with Kumbhaka, Chandrabedhan with kumbhaka on 35 healthy volunteers between age range 25 to 35years showed significant decrease in Body weight and Fat Fold Thickness. (K.V.V. Prasad, Madhavi Sunita, P. Sitarama Raju, M. Venkata Reddy, 2006) Sixty days of Kapalabhati, Chandrabedha and Suryabedha Pranayama with Kumbhaka on 64 healthy volunteers between age range 18 to 30years showed significant decrease in Cholestrol, Triglycerides, Free Fatty Acids, LDL (low density lipoprotein),VLDL (very low density lipoprotein) but found increase in HDL(high density lipoprotein).Thirty days of practice of Jalandhara Bandha along with Kumbhaka on 20 healthy volunteers between age range 20 to 25 years showed significant difference in resting

heart rate and blood pressure (Anup kumar Dadarao Dhanvijay , Nitin Dhokne , Arbind Kumar Choudhary, 2015)

Bahir-Kumbhaka (BK) showed significant increase in EDV (end diastolic velocity) and MFV (mean flow Velocity) with significant reduction in PI (pulsatility index) (Nivethitha et al., 2018). This practice brings cerebrovascular hemodynamic changes in healthy volunteers. *Bahir-Kumbhaka* showed a significant increase in systolic blood pressure (SBP) and rate pressure product (RPP) during the practice of BK which was revert back to normal after the practice. It also showed a significant increase in diastolic blood pressure (DBP), mean arterial pressure (MAP) and double product (Do-P) during the practice of BK which did not revert back to normal even after the practice (Nivethitha et al., 2017) A significant increase in Systolic blood pressure (SBP), Diastolic blood pressure (DBP), mean arterial pressure (MAP), and total peripheral resistant (TPR), with a reduction in stroke volume (SV) and cardiac output (CO) during *Kumbhaka* practice (Nivethitha et al., 2021)

Need for the Study

In previous studies, Kumbhaka practice has bring the changes on several physiological assessments like end diastolic velocity(EDV), mean flow Velocity (MFV), pulsatility index (PI), rate pressure product (RPP), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), double product (Do-P), total peripheral resistant (TPR), reduction stroke volume (SV), & (CO) cardiac output) has been done. There was no research carried out which focused on cognitive aspect along with lung capacity and anxiety assessment on kumbhaka and practice. Thus, the current study is devised to explore the effect of kumbhaka practice on psychological and cognitive parameters

MATERIALS AND METHOD

In the present study sixty (60) male healthy volunteers were recruited from Vijayanagar residential area, Bangalore with age range between 20 to 30 years. The inclusion criteria applied here to include subjects were: individuals who had the willingness to participate in the study, only healthy volunteers, only male candidates, age Range between 20years to 30years, individuals should be able to understand English language, only Right-handed participants are allowed in the study and all the subjects with same socio-economic conditions.

The exclusion criteria were: individuals with alcoholism, smoking and drugs, having mental health problems, having major physiological health issue like heart, kidney, Diabetics & hypertension etc., women subjects, age below 20 years & above 30 years, had been to major surgery, under any specific medication which can alter result, and left-handed people.

The individuals who participated in the study expressed their willingness to readily participate in the study. The information of the individuals who participated in the study had been kept highly confidential. Inform consent form was given to participants to fill up and details of study had been explained to them before starting of the study.

The research design was self as control where pre-post assessment was done to compare the result of the collected data. A self as a control experimental single pre-post study was carried out at (Vijayanagar), a residential area of Bangalore. 60 male healthy volunteers participants age range between (20 to 30) years, with no health issues, who is willing to participate & who were not exposed to yoga were included in the study. Subjects were having medical illness, psychiatric disorder; recent surgery were excluded from the study. Informed signed consent was

taken from all the participants. The module of the study is of 30 minutes, which includes breath awareness, Antarkumbhaka and QRT were given for 30 days. Duration of the intervention was thirty minutes/ five days in weeks of kumbhaka practice for thirty days. Breath awareness has been observed for same observation. The whole group assessed Pulse Rate, Blood Pressure (BP), Peak Expiratory Flow Rate (PEFR), Vital Capacity (VC), six-letter cancellation task (SLCT), The State-Trait Anxiety Inventory (STAI), Digital Memory Test, D L S T (Digit Letters Screening Test) at the base line and after one months of practices.

Intervention:

The intervention has given for 30 days. Duration of the intervention was thirty minutes/ five days in weeks of kumbhaka practice for thirty days. Breath awareness has been observed for same observation. The module of the study is of 30min which includes breath awareness, Antarkumbhaka and QRT. Module details has been given below:

Sr.No.	Name	Duration
1.	Breath Awareness	05 min
2.	30sec kumbhaka (10 times)	10 min
3.	1min relaxation between each kumbhaka (10times)	10 min
4.	QRT	05 min

Procedure to the practice of Kumbhaka

Subjects are instructed to sit in any comfortable meditation posture by keeping back erect. They are made to inhale deeply and hold the breath for 30sec and then they have asked exhale slowly. They have asked to relax for 1min by doing normal breathing. This process was repeated for 10 times. Session completed with 5 min of QRT. Breath awareness has been done by observing the normal breath.

Measurements (Variables)

Day 1: Assessment 1

(28 days of Antar Kumbhaka practice as per the Intervention Module)

Day 29: Assessments of Immediate effects.

Day 30: Assessments of Long-term effects.

The participants were contacted personally and explained about the study and took their permission. On first day the details of the demographic information, voluntary consent form of the participants was taken and filled. Day 1 intervention is carried out and respective readings were noted and explained the next intervention practice which has to be performed for next 30 days. The interventions were given over a period of 30 days. On Day 30 once again the respective readings were noted as per the design.

1. DLST : Digit Letters Substitution Test

The DLST test sheet consisted of a worksheet, which has 8 rows and 12 columns and randomly arranged digits in rows and columns. The students are asked to substitute as many target digits as possible in the specified time of 90 seconds. The letter substitution may be undertaken in a horizontal, vertical, or randomized manner by selecting a particular digit. The total number of substitutions and wrong substitutions are scored. The net score was obtained by deducting wrong substitutions from the total substitutions attempted. Five trained assistants at the neuropsychological test laboratory administered tests. (Natu MV, 1997)

2. DMT: Digital Memory Test

The Wechsler Memory Scale (WMS) is a neuropsychological test designed to measure different memory functions in a person. Anyone ages 16 to 90 is eligible to take this test. The current version is the fourth edition (WMS-IV) which was published in 2009 and which was designed to be used with the WAIS-IV. WMS-IV is made up of seven subtests: Spatial Addition, Symbol Span, Design Memory, General Cognitive Screener, Logical Memory (I & II), Verbal Paired Associates (I & II), and Visual Reproduction(I & II). A person's performance is reported as five Index Scores: Auditory Memory, Visual Memory, Visual Working Memory, Immediate Memory, and Delayed Memory.

There is clear evidence that the WMS differentiates clinical groups (such as those with dementias or neurological disorders) from those with normal memory functioning and that the primary index scores can distinguish among the memory-impaired clinical groups (John Hunsley, 2010).

3. STAI: State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (STAI) is a commonly used measure of trait and state anxiety (Marteau & Bekker, 1992). It can be used in clinical settings to diagnose anxiety and to distinguish it from depressive syndromes. It also is often used in research as an indicator of caregiver distress

Form Y, its most popular version, has 20 items for assessing trait anxiety and 20 for state anxiety. State anxiety items include: "I am tense; I am worried" and "I feel calm; I feel secure." Trait anxiety items include: "I worry too much over something that really doesn't matter" and "I am content; I am a steady person." All items are rated on a 4-point scale (e.g., from "Almost Never" to "Almost Always"). Higher scores indicate greater anxiety. The STAI is appropriate for those who have at least a sixth-grade reading level.

4. SLCT: Six-letter cancellation task

The six-letter cancellation task (SLCT) consists of a sheet of 22 rows × 14 columns of randomly arranged letters of the alphabet. The top of each sheet names six target letters. Subjects are given the choice of two possible strategies to cancel target letters (i) all six letters at once or (ii) selecting a single target letter at a time. It is also suggested that, according to their own choice, they follow horizontal, vertical, or random paths on the test sheet. They are told to cancel as many target letters as possible in the test time of 90 seconds.

5. Peak Expiratory Flow Rate (PEFR)

It is found more convenient and informative to measure the rate at which one liter of air is expelled over the fastest part of the expiratory curve and express this as maximum forced expiratory flow rate or peak flow rate (Shah & Mehta, 1961)

6. Blood Pressure (BP) and Pulse Rate

The pressure measured in the vascular system that is associated with cardiac contraction (systolic) and relaxation (diastolic) (Laurence Englemohr Morehouse, 1976)

7. Systolic Blood Pressure (SP)

"The highest level to which the arterial blood pressure rises during the systolic ejection of blood from the Ventricle". "Systolic Blood Pressure is the highest blood pressure of the Cardiac cycle occurring immediately after systolic of the Ventricles of the heart (Guyton, 1969)

8. Diastolic Blood Pressure (DP)

Diastolic Pressure is the lowest arterial blood pressure of the cardiac cycle occurring during diastolic of the heart (Guyton, 1969)

9. Pulse Rate

28 The number of beats of a pulse per minute or the number of the beats of the heart and entries per minute⁵⁴ The number of beats felt in exactly in one minute is known as pulse rate. (Webster, 1959)

Data Extraction and Data Analysis

Statistical analysis was done using SPSS, version 10.0 (SPSS, Chicago, IL, USA). The values were checked for normal distribution by the Shapiro-Wilk test. As the data were not normally distributed, analyses of the data were done using Mann-Whitney and Wilcoxon Signed Ranked test within and between groups comparison.

RESULTS

Demographic Details: Sixty (N=60) healthy male volunteers of age group 20-30years participated in the study.

IMMEDIATE EFFECTS (day 29th pre/post)

1. Changes in Physiological parameters after intervention

Variable	Group	Before Intervention	After Intervention	ES	% changes	Within Gps (Wilcoxon-sign rank) Sig- P value	Sig- P values Between two intervention (Mann-whiney)	
		Mean/SD	Mean/S.D			Pre/Post	Pre /pre	Post /post
B.P (SYS)	K (N= 60)	121.52±7.25	124.65±9.73	0.35	3%	0.019	0.971	0.053
	B (N=60)	121.75±5.50	120.92±5.62	0.18	1%	0.219		
B.P (DIA)	K (N= 60)	80.85±6.92	82.35±7.03	0.20	2%	0.181	0.864	0.549
	B (N=60)	81.17±6.64	81.33±6.56	0.02	0.21%	0.763		
PR	K(N= 60)	80.92±9.63	82.13±12.28	0.11	2%	0.217	0.365	0.077
	B (N=60)	79.30±9.42	79.12±8.96	0.04	0.23%	0.475		
BHT	K (N= 60)	17.42±9.51	19.35±10.47	0.13	11%	0.000	0.340	0.254
	B (N=60)	17.13±3.61	17.48±3.34	0.17	2%	0.176		
PFR	K (N= 60)	505.5±87.14	523.67±92.35	0.52	4%	0.001	0.846	0.224
	B (N=60)	502.17±87.47	504.17±86.55	0.13	0.40%	0.263		

Abbreviations: LB: lower bound, UB: Upper bound, ES-effect size, BP (SYS): Blood pressure Systolic, BP (DYS): Blood Pressure Diastolic, PR: Pulse rate, BHT: Breath holding time, PFR: peak flow rate. K: Kumbhaka, B: Breath awareness.

Legend: There is significant changes in physiological parameters after intervention.

Table -1 is showing physiological changes immediately after the practice. It is observed that there were no significant changes in the physiological parameters but BP, PR and BHT increased after kumbhaka practice in Kumbhaka group whereas breath awareness group showed very less changes after practice.

2. Changes in cognitive parameters after intervention

Variable	Group	Before Intervention	After Intervention	ES	% change	WithinGps (Wilcoxon-sign rank) Sig- P value	Sig- P values	
		Mean/S.D.	Mean/S.D.			Pre/Post	Between two intervention (Mann-whiney)	
							Pre /pre	Post /post
STAI S	K (N= 60)	47.8±6.42	49.62±6.28	0.63	8%	0.000	0.881	0.000
	B (N=60)	42.63±6.90	49.9±5.78	0.17	3%	0.207		
STAI T	K (N= 60)	44.18±5.97	47.23±6.05	0.38	5%	0.002	0.746	0.008
	B (N=60)	49.05±5.21	50.02±5.47	0.01	0.24%	0.830		
DLST	K(N= 60)	46.68±16.45	49.85±17.80	0.13	7%	0.628	0.931	0.554
	B (N=60)	46.48±15.75	47.12±15.12	0.04	1.36%	0.486		
SLCT	K (N= 60)	21.42±10.42	28.83±10.25	0.40	11%	0.002	0.910	0.226
	B (N=60)	26.77±11.98	27.63±13.46	0.13	3%	0.189		
DMT	K (N= 60)	12.52±2.65	14.18±2.93	0.45	13%	0.004	0.345	0.066
	B (N=60)	12.28±2.70	13.25±2.31	0.40	8%	0.003		

Abbreviations: LB: lower bound, UB: Upper bound, ES-effect size, STAI-S: State trait anxiety inventory, STAI-T: state train anxiety, DLST: Digit letter substitution test. SLCT: Six letter cancellation test, DMT: Digit memory test. K: Kumbhaka, B: Breath awareness.

Legend: There is significant changes in cognitive parameters after intervention.

Tables-2 showing the cognitive changes after pre and post practice of kumbhaka and breath awareness. It is found out that in Kumbhaka group state and train anxiety increased significantly as compared to breath awareness group on SLCT measures. DMT scores also showing significant changes in Kumbhaka group as compared to breath awareness group as assessed in immediately after practice.

LONG TERM EFFECTS (Day 1 & day 30th)

3. Changes in Physiological parameters after intervention

Variable	Group	After Intervention Day 1	After Intervention Day 30	ES	% changes	Within Gps (Wilcoxon-sign rank) Sig- P value	Sig- P values	
		Mean /S.D.	Mean /S.D.			Pre/Post	Between two intervention (Mann-whiney)	
							Pre /pre	Post /post
B.P (SYS)	K(N= 60)	120.55±5.60	120.72±5.78	0.02	0.14%	0.470	0.811	0.777
	B (N=60)	120.87±5.28	120.47±5.33	0.06	0.33%	0.292		
B.P (DIA)	K(N= 60)	80.40±6.11	82.08±6.61	0.20	2%	0.293	0.856	0.642
	B (N=60)	80.58±6.04	81.43±6.49	0.10	1%	0.485		
PR	K(N= 60)	78.73±8.79	81.62±12.62	0.23	3.66%	0.074	0.990	0.141
	B (N=60)	78.82±9.05	78.95±8.92	0.02	0.17%	0.938		
BHT	K(N= 60)	14.63±4.13	20.38±3.64	1.94	39%	0.000	0.823	0.000
	B(N=60)	14.77±4.01	17.40±3.42	0.75	18%	0.000		
PFR	K(N= 60)	486.33±85.03	535.67±84.56	1.18	10%	0.000	0.956	0.050
	B(N=60)	485.83±84.85	503.00±87.66	0.46	4%	0.002		

Abbreviations: LB: lower bound, UB: Upper bound, ES-effect size, BP (SYS): Blood pressure Systolic, BP (DYS): Blood Pressure Diastolic, PR: Pulse rate, BHT: Breath holding time, PFR: peak flow rate. K: Kumbhaka, B: Breath awareness.

Legend: There is significant changes in physiological parameters after intervention.

Table-3 showing data-the long-term effect of Kumbhaka and breath awareness comparatively. The data shows that there were significant changes in both groups on breath holding time and peak flow rate parameters after 30 days’ practices of kumbhaka and breath awareness. There was no significant change in other physiological parameters.

4. Changes in cognitive parameters after intervention

Variable	Group	After Intervention Day 1	After Intervention Day 30	ES	% changes	WithinGps (Wilcoxon-sign rank) Sig- P value	Sig- P values	
		Mean /S.D.	Mean /S.D.			Pre/Post	Between two intervention (Mann-whiney)	
							Pre /pre	Post /post

STAI S	K(N= 60)	47.72±7.50	45.22±6.43	0.33	5%	0.014	0.950	0.000
	B(N=60)	47.85±7.44	49.90±5.78	0.22	4%	0.078		
STAI T	K(N= 60)	50.88±5.40	45.03±4.41	1.42	12%	0.000	0.943	0.000
	B(N=60)	50.82±5.37	50.32±5.33	0.06	1%	0.574		
DLST	K(N= 60)	46.17±11.04	51.67±11.86	0.41	12%	0.013	0.881	0.464
	B(N=60)	46.43±11.37	48.62±16.69	0.14	5%	0.209		
SLCT	K(N= 60)	26.23±10.10	30.62±11.45	0.52	17%	0.000	0.842	0.045
	B(N=60)	26.67±13.60	27.42±13.67	0.05	3%	0.245		
DMT	K(N= 60)	12.18±2.73	15.23±3.22	0.94	25%	0.000	0.911	0.000
	B (N=60)	12.12±2.73	13.17±2.15	0.33	9%	0.010		

Abbreviations: LB: lower bound, UB: Upper bound, ES-effect size, STAI-S: State trait anxiety inventory, STAI-T: state train anxiety, DLST: Digit letter substitution test. SLCT: Six letter cancellation test, DMT: Digit Memory test. K: Kumbhaka, B: Breath awareness.

Legend: There is significant changes in cognitive parameters after intervention.

Table-4 showing comparative data related to the cognitive changes after long term practice of Kumbhaka and breath awareness in two groups. In kumbhaka group state anxiety was significantly reduced after one-month practice whereas in breath awareness group increased. Data shows that in train anxiety score also reduced after practice in kumbhaka group after practice. There were also significant changes in DLST, SLCT and DMT score in Kumbhaka group after thirty days' practices as compared to breath awareness group.

DISCUSSION

The current study was focused to find out the changes immediately after practice of kumbhaka and after 30 days of practice the same techniques comparatively in two group viz practicing group of kumbhaka and breath awareness group as control group on physiological and cognitive parameters. The purpose of this study was to assess the effect of kumbhaka on breath holding capacity, peak flow rate, attention, concentration, memory & state trait anxiety. Finding suggested that the practice of kumbhaka has an immediate and also has long term effect compared to breath awareness. The effect of 30min Kumbhaka practice for 30days found to be significantly improving in respiratory parameters by 39% improvement in breath holding Time, 10% improvement in PFR, 3.66% change in pulse Rate, 5% change in STAI S, 12% change in STAI T, 12% in DLST, 17% in SLCT and 25% change in DMT.

Two weeks of slow breathing with kumbhaka on 18 healthy volunteers between age range 30 to 45 years showed 20% increase in forced expiratory volume done by Singh et al., in 1990. (Singh et al., 1990) Twenty-one months of Chandranuloma Pranayama, Suryanuloma Pranayama with Kumbhaka practice on 71 healthy volunteers between age range 21-71years showed significant lowering 19% of oxygen consumption. done by Tellas et al., in 2000 (Telles et al., 2000)

Ninety days of Rechaka Puraka with Kumbhaka, Chandrabedhan with kumbhaka on 35 healthy volunteers between age range 25 to 35 years showed significant decrease in $P < 0.05$ Body weight and Fat Fold Thickness done by Venkata Reddy et al, in 2003 (Raju et al., 1997)

Sixty days of Kapalabhati, Chandrabedha and Suryabedha Pranayama with Kumbhaka on 64 healthy volunteers between age range 18 to 30 years showed significant decrease in Cholesterol (0.82%), Triglycerides (24.59), Free Fatty Acids (20.44%), LDL(6.62%), VLDL(23.77) but found increase in HDL(5.56) done by K.V.V Prasad et al. in 2006 (K.V.V. Prasad, Madhavi Sunita, P. Sitarama Raju, M. Venkata Reddy, 2006)

Thirty days of on Jalandhara Bandha along with Kumbhaka 20 healthy volunteers between age range 20 to 25 years showed significant difference in resting heart rate (9.48%) and Systolic blood pressure (8.16%) Diastolic Blood Pressure (9.86%) done by Binod Chowdhary et al. in 2015 (Anupkumar Dadarao Dhanvijay , Nitin Dhokne , Arbind Kumar Choudhary, 2015)

Bahir-Kumbhaka showed significant increase in EDV (53.36%) and MFV (33.43%) with significant reduction in PI (33.01%) during kumbhaka practice (Nivethitha et al., 2018) A pilot study suggests that the practice of BK increases the SBP (11.46%), , DBP (12.99%), MAP (12.76%), RPP (15.72%) and Do-P (17%) during the practice (Nivethitha et al., 2017) A significant reduction in TPR (13.74%), SV (22.86%) and CO (20.19%) during *Kumbhaka* practice (Nivethitha et al., 2021) (Earlier studies on kumbhaka practice support our present finding.

Strength of the study

This is one of the unique studies which is aimed to see immediate effect on such mind centric practices on regular basis. It has also compared the effect both- immediate & long-term effect and has been measured. The study has also focused on only kumbhaka practices, no additional intervention was given. Psychological & cognitive assessments have been done for the first time.

Limitations of the Study

There was short term intervention which may not be effective to exhibit the effect often in yoga-based practices. Other limitations are small sample size, no control group & no female participants.

Suggestions for the Future Research

Suggestions for the future work is kumbhaka practices can be used for therapeutic application. Objective measurements to be taken to understand the mechanism. Study should have control group. Large sample size can be studied. Longer duration of kumbhaka effect to be seen.

CONCLUSION

One-month practice of kumbhaka exhibited significant improvement on lung capacities, cognition and anxiety in healthy volunteers. It is also observed in the study that thirty days' practice of kumbhaka is more beneficial in improving cognition & psychological states as compared to breath awareness in healthy volunteers. However, further randomized controlled trial need to be performed to confirm findings on a bigger sample size to generalize the effect of practice for general population.

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