Chapter - II

REVIEW OF RELATED LITERATURE

A review of research report related to the present study that the research scholar could gather, is presented in this chapter in order to provide the background material to evaluate the significance of this study as well as to interpret its finding.

Widely acclaimed yogic text on nasal cycle is Shivaswarodaya. (Rai, 1980)¹ It is a science of prediction about health, fortune and auspicious or inauspicious aspects of life activities in relation to breathing through a particular nostril. The breathing through (any) nostril is known as ‘Swar’ and a change of nostril from left to right and right to left is known as ‘Udaya’

Lying on one side has been advocated by Swarayoga to facilitate change of the nostril flow (Muktibodhananda, 1984)². According to this text, the breath flows freely through one nostril for two ghatikas (48 minutes) and then slowly switches over to the other nostril for two ghatikas. Other information available in this text has been summarized as follows:

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<table>
<thead>
<tr>
<th>Name Of Element</th>
<th>Place</th>
<th>Shape</th>
<th>Quality</th>
<th>Colour</th>
<th>Taste</th>
<th>Bija Swara</th>
<th>Sara's Place in the Nostril</th>
<th>Length of Swara</th>
<th>Period of Swara (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>Muladhara</td>
<td>Square</td>
<td>Small</td>
<td>Yellow</td>
<td>Sweet</td>
<td>Lam</td>
<td>Middle Part of nostril</td>
<td>12 Fingers</td>
<td>20</td>
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<tr>
<td>Water</td>
<td>Svadhishana</td>
<td>Half-moon</td>
<td>Taste</td>
<td>White</td>
<td>Astringent</td>
<td>Vam</td>
<td>Lower part of nostril</td>
<td>16 Fingers</td>
<td>16</td>
</tr>
<tr>
<td>Fire</td>
<td>Manipura</td>
<td>(Train-</td>
<td>From</td>
<td>Red</td>
<td>Bitter</td>
<td>Ram</td>
<td>Upper part of nostril</td>
<td>4 Fingers</td>
<td>12</td>
</tr>
<tr>
<td>Air</td>
<td>Anahata</td>
<td>Hexagonal</td>
<td>Touch</td>
<td>Green or cloudy</td>
<td>Sour</td>
<td>Yam</td>
<td>Side of nostril</td>
<td>8 Fingers</td>
<td>8</td>
</tr>
<tr>
<td>Ether</td>
<td>Vishuddha</td>
<td>Oval or Cotted</td>
<td>Sound</td>
<td>Multifarious</td>
<td>Pungent</td>
<td>Ham</td>
<td>Rotating</td>
<td>2 Fingers</td>
<td>4</td>
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Ganguly, Gharote and Jolly\(^3\) conducted their research on 14 make students of the residential Regional Police Training School. The subject mean age, height and weight were 23 years, 170.8 cm. And 56.8 Kg. respectively. The subjects were trained in the technique of Kapalabhati (a type of Yogic breathing exercise). Every day four subjects reported in the laboratory for the tests in the morning without any food, drink or exercise. Every day the following four following conditions were studied on the groups of four subjects: Condition-A: Harvard Step test, Condition-B: Harvard Step test followed by one minute of Kapalabhati, Condition-C: Harvard Step test followed by one minute of Hyperventilation and Condition-D: One minute of Kapalabhati followed by Harvard Step test. The study concludes that one minute of Kapalabhati as well as

hyperventilation help to improve cardiovascular endurance significantly. However, practice of Kapalabhati shows better and safer result.

Cordain et al., (1990)\(^4\) determined whether respiratory muscle strength is related to pulmonary volume differences in athletes and non-athletes. 11 intercollegiate female swimmers, 11 female cross-country runners, and two non-athletic control groups, matched to the athletes in height and age, were evaluated for pulmonary parameters including maximal inspiratory pressure (P\(_{1\text{max}}\)) and maximal expiratory pressure (P\(_{E\text{max}}\)). Swimmers exhibited larger (p<0.05) vital capacities (VC), residual lung volumes (RV), inspiratory capacities (IC), and functional residual capacities (FRC) than both the runners or the controls but no difference (p>0.05) in the either maximal inspiratory pressure or inspiratory flow. Timed expiratory volumes were significantly (p<0.05) lower in the swimmers than in the controls. These data suggest that an adaptational growth may be responsible, in part, for the augmented static lung volumes demonstrated in swimmers.

Damokosh\(^5\) (1987) conducted a study on 34 volunteer students who were randomly selected from the campus of Springfield College, Springfield, M.A. Subjects were dichotomized into synchrony and asynchrony of gait and breathing patterns. Subject defined as


\(^{5}\) A. Damokosh (1987), A Comparison of Aerobic Efficiencies Between the Synchrony and Asynchrony of Respiration and Stride Frequency, Completed Research in Health Physical Education and Recreation, 29, 116.
synchronous had a standard deviation between each locomotor respiratory control (LRC), taken over a measured minute sample, of 250 or less. Asynchronous Ss had a SD of 300 or greater and those Ss whose standard deviation was between 250 and 300 were omitted from statistical analysis. Aerobic efficiency was used as the criterion measurement and was determined by designating the S with the lowest oxygen consumed, for an equivalent workload, as the most aerobically efficient. Gait had breathing patterns were recorded on to a two channel stereo recorder. A microphone positioned in front of the mouth, recorded pneumo nomograms in to the left channel while the right channel was connected to a modified commercial device. Run alert that the recorded gait frequency. Analysis of expired gases was accomplished through the use of the Douglas bag technique atration was use to analyze the data. The dependent variable as the M value of $O_2$ consumed while the independent variable at 2 levels of synchrony of asynchrony of LRC patterning . No significance difference ($p>0.05$) were found between the M values of oxygen consumed between the group that exhibited synchrony of gait and breathing pattern and the group that exhibited asynchrony.

14 females and 6 males, and 22-32 (M=26), were studied by Attenborough (1984)\(^6\) while walking and or running on a treadmill. Each 8 participated in 2 exercise protocols. During protocol-A exercise the

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intensity was increased by increasing treadmill speed while elevation remained constant. During protocol-B, exercise intensity was increased by increasing treadmill elevation while speed remained constant. Synchronization between the respiratory and step cycles was examined using a cross correlation of expiration with the step cycle was examine only 30% of exercise. However, difference between the inspiratory and expiratory data were not found to be statistically significant. This study demonstrates that inspiratory and expiratory events are entrained to a similar degree by the stepping frequency. A simple model is presented to explain a possible path way by which different input from working muscle may influence the timing of the respiratory cycle.

Caast et al., 9 April, (1988)\textsuperscript{7} revealed that inspiratory threshold resistance led to statistically increase in the work of breathing. The increase in cardiac output resulting from 4 minutes of loaded breathing at 12 kg/min. was 1.8 liter/min. The increase in oxygen consumption was 108 ml./min, whereas oxygen extraction by the respiratory muscles was 60 ml. The increase in cardiac output was the result of increased in both heart rate and stroke volume. Inspiratory loaded re-breathing alone led to no significant changes in either cardiac output or in oxygen consumption. Average resting O\textsubscript{2} consumption was higher during the second set of studies, which was separated from the first set of experiment. In fact

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resting cardiac output was not significantly different between the two studies.

In the study of Mathesor and Mchenzie (May, 1998)\textsuperscript{8} seven healthy endurance trained female volunteers served as subjects in an experiment measuring arterial blood gases, acid-base status and inhale changes while breath holding during intense intermittent exercise. By the use of a counter balance design, each subject repeated five intervals of a 15s on and 30s off treadmill run at 125% VO\textsubscript{2} max, while breath holding and O\textsubscript{2} saturation (HCO\textsubscript{3} and lactate were sampled from a radial arterial catheter at the end of the each work and rest interval. It was concluded that breath holding during intermittent intense exercise 1) included a measurable rapidly reversible respiratory acidosis superimposed on the metabolic acidosis of maximal exercise; 2) included hypoxemia during exercise that did not continue into recovery; and 3) associated with greater rates of lactate appearance in the arterial blood during recovery.

Haseltion and Sperandio (1988)\textsuperscript{9} are in opinion that there is little rebreathing of gas exhaled through the nose. A detailed physical model system has been used to quantify and identify the mechanisms responsible for this phenomenon. By the use of cast of the upper respiratory tract and oscillating flows with a Reynolds number of 500 and


non dimensional frequency' of 1.6 corresponding to quite tidal breathing through the nose. The dye dilution measurement indicated an efficiency of tidal exchange of 0.95. The findings confirmed that connecting gas exchange between the nose and the atmosphere is highly efficient. However, the underlying mechanism responsible for this exchange also maximizes the exposure of the respiratory system to aerosols contained in the ambient atmosphere.

Tanaka and Honda (1989)\textsuperscript{10} experimented on six normally healthy male volunteers (21-40 years). The experiment was designed to compare the respiratory data obtained from a sleep study with nose open with that with nose-obstructed breathing. Sleep studies for each subject were conducted over two consecutive nights between 10 p.m. and 7 a.m. Nasal obstruction is due to disordered breathing during sleep. The study demonstrated diminished ean-tidal PCO\textsubscript{2} with nose obstruction while subjects were awake. If this is also a cause during sleep, decreased CO\textsubscript{2} stimulus may easily induce apnea, hypopnea and disordered breathing. Endi-tidal PCO\textsubscript{2} during nose-obstructed sleep was lower than that during nose-open sleep in all of the subjects. The result also revealed that apnea during nasal obstruction occurred most frequently shortly after transition to a deeper sleep stage. These results suggest that diminished PCO\textsubscript{2} stimulus combined with depressed behavioural activity play an important role for disordered breathing in nose obstructed sleep.

Conningham (1990)\textsuperscript{11} conducted a research with a view to relate three determinants of distance running success a) maximal oxygen consumption, b) ventilatory threshold and running economy with actual running time in 5 km. Race. Twenty four female runners (mean age: 15.9 years) from four high school teams that completed at the Massachusetts. The mean VO\textsubscript{2} max of these runners was 61.7 m/kg.1, HR max 201 b-min.\textsuperscript{11} and ventilatory threshold 10 L/min.\textsuperscript{11} This study concludes that either of the derived variables i.e., ventilatory threshold and VO\textsubscript{2} max appear to explain significant variation in distance running performance among adolescent female cross country runners.

Stevener (1979)\textsuperscript{12} compared 2 methods of weight training in the developments of cardiovascular fitness and upper body strength method I, the experimental group, utilized a special bar and a specialized method of breathing designed to "blow off" excessive CO\textsubscript{2} built up during exercise. Method 2 used the traditional bar, 6 standard weight training exercises and the traditional breathing method of 1 breath per repetition. The Ss were randomly divided into 2 equal groups. A pre-test was given to the respective groups which then trained for a period of 6 weeks using their assigned method. At the end of the training the groups participated in a post-test. The results were compared to determine if a significant

\textsuperscript{11} L.N. Cunningham (1990), Relationship of Running Economy, Ventilatory Threshold and Maximal Oxygen Consumption to Running Performance in High School Females, Research Quarterly for Exercise and Sport 61, 4, pp. 369-374.

\textsuperscript{12} M.E. Stevener (1979), A Study to Determine the Effects of a Weight Training Program Using the Robert Meyer's Wrestling Weight-Bar and Utilizing the Four-Cycle Breathing Method on Cardiovascular Fitness and Dynamic Strength, Completed Research in Health, Physical Education and Recreation, 26, 150.
difference existed. The experimental group utilizing the specialized weight training program did not differ significantly from the traditional program in the physical variables of grip strength and cardiovascular fitness.

Haight (1983)\(^{13}\) thought that a feedback loop relaying information about the patency of one nasal cavity might be processed by the central nervous system to modify the vascular engorgement of the other, thereby minimizing total airflow resistance alternation during nasal cycle. He used histamine and xylometazoline to alter the degree of mucosal swelling and a cotton plug to alter airflow in one nostril (which is open) and measured the resistance from its fellow nostril. No changes the latter were observed. It was concluded that this feedback does not exist.

The effects of breathing through 1. sided resistance on the cardiorespiratory response were studied by Turner (1984)\(^{14}\) in 5 healthy men between 20 and 30 year of age. Their Vo\(_2\) max values ranged from 2.79 to 3.89 L/min. following preliminary medical examination, pulmonary function, and graded exercise tests, each subject completed 11/1-hour exercise test, 1 control and 10, 1-sided resistance breathing tests. The resistance ranged from 12 to 8 cm H\(_2\) O/2 L/Sec and were either on the expiratory side or inspiratory side. The S worked at 60% Vo\(_2\) max or less if 60% Vo\(_2\) max. could not be maintained for the hour. Although no

\(^{13}\) J.S. Haight and P. Cole, (1983), Nasal Responses to Local Unilateral Stimuli in Man, Rhinology, 21, 1, pp. 67-72.

significant increase in resistance resulted in increases of peak expiratory pressure, peak inspiratory pressure, work of expiration, work of inspiration, time of expiration, time of the inspiration, and tidal partial pressure of CO₂ increased resistance caused decreases in O₂ consumption, pulmonary ventilation, respiratory frequency, tidal volume and HR. These were not significant decreases. It was concluded that work rate had not been significant Affected; there was no difference between tolerance to inspiratory resistance and expiratory resistance; and 1-sided resistance is no more easily tolerated than equal resistance when the resistance level is 83 cm H₂O/2L/Sec or less.

In a study Lowdermilk (1984)¹⁵ examined time of breathing frequency to stepping frequency, while running and walking on a treadmill at selected speed and elevations. Ss were 6 males and 14 females, aged 22-32 (m age 26). Each sunderwent two testing procedures with a rest period between each test protocol. Test protocol a consisted of a constant treadmill elevation of 10 grade with speed ranging from 2-6 mph and test protocol B a constant treadmill speed of 4 mph, with the elevation ranging from 0-20% across occurring between breathing and stepping frequency. Based on the cross correlogram, K, values were used to determine strength of the r and define the s groups (synchronizers and non - synchronizers) 45 % of the subjects

demonstrated strong synchronization or no neat all. The study suggests that a significant relationship exists between timing of breathing frequency to stepping frequency. However, the 45% of subjects classified as synchronizers may suggest that the inspiratory phase of respiration may not be the only factor determining synchronixation of breathing and stepping frequencies.

Eccles et al. (1983)\textsuperscript{16} reported that menthol inhalation had no effect on nasal resistance but the majority of subjects reported a sensation of increased nasal airflow and a cooling sensation. This indicates that menthol stimulates cold receptors in the nasal mucosa and creates a sensation of increased airflow. Now evidence was found in support of any decongestant action of menthol.

Bell (1980)\textsuperscript{17} examined 10 male adolescent and young adults. A comparison of VO\textsubscript{2}, blood lactic acid (LA), ventilation (VE) and the respiratory exchange ratio (RQ) response to a timed swim were made under two experimental breathing conditions: in condition-1, the subjects swam breathing once every arm cycle and in condition-2 the subjects swam breathing every alternate arm cycle. Expired air and ventilation were collected and measured using gas analysis, procedures Blood

\textsuperscript{17} Jr, G.H. Bell, (1980), The Effects of Two Breathing Patterns on Selected Physiology Parameters During a Simulated 200 Yard Freestyle in Male Swimmers, Completed Research in Health, Physical Education and Recreation 22, 252.
samples were collected and LA concentration was determined using blood lactic acid procedures. The data analysis revealed the following:

- There was significant difference in the physiological variables as a result of the breathing patterns;

- Under condition-2, VE was found to be more related than any other dependent variable;

- Between conditions it was found that the breathing pattern associated with each condition was not related to changes in VO$_2$ Max.

The findings suggested that breathing on alternate strokes was associated with lower energy requirements than breathing every stroke.

Vasistha Samhita (Digambarji, Jha & Sahay, 1984)$^{18}$ also refers breathing with particular nostril and its relation with life activities such as eating, erotic love, war, amassing wealth, pilgrimage, marriage etc. in the Vth chapter, while in the VIIth chapter there is a mention about the inference of one's time of death on the basis of nostril dominance.

Tracy (1981)$^{19}$ conducted an experiment on 10 females (max. VO$_2$ max=46 ml.Kg. min. $^{-1}$) exercised 4 times on an electronic bicycle ergo

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meter at 65% VO₂ max. for 6 minutes followed by 10-min recovery periods. The subjects breathed at a frequency of 15 breaths per minute. Significantly lower (p<0.05) exercise HR (133.70 Vs 138.07 beats per min), VO₂ max (1.67 Vs1.74 litre.min⁻¹), VCO₂ (1.47 Vs 1.58 litre.min⁻¹), VE (38.92 Vs 45.65 litre.min⁻¹) and O₂ ventilation (23.36 Vs 26.48) were observed during the experimental breathing treatment. Recovery HR (73.39 Vs 75.11 beats per min.) and O₂ ventilation (31.62 vs 33.10) were also significantly lower following experimental breathing frequency, were significantly affected.

Kennedy et al., (1986)²⁰ found that there is an alteration in high levels of catecholamines in the blood samples drawn simultaneously from both the arms every 7.5 min. for the period of 3-6 hours. This alternating internalization of nurotransmitted correlated with the sympathetic activity in the nasal cycle, since norepinephrine is considered to be the parameter of sympathetic activity, this correlation with the nasal cycle would not be surprising.

Bhole and Karambelkar (1968)²¹ Studies 95 persons and found that 85% of them showed uninostril breathing which was either right nostril dominated (47.8%) or the left nostril dominated (37.7%). Only studies in respect of force of breathing. They also showed that a 'Yoga

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²¹ M.V. Bhole, & P.V. Karambelkar, (1968), Significance of nostrils breathing, Yoga Mimansa 10, 4, pp. 1-12.
Danda' (crutch) when placed under the arm pith, pressing the axilla, helped to open the nostril on the opposite side.

Karambelkar, Deshpande and Bhole\textsuperscript{22} have made sixteen observation on three adult male who were well established in different types of Pranayamas over a period of one year. They have conducted this study with two experiments. In Experiment No.1, normal breathing was recorded, expired air was collected in the Douglas bag for 10 min. Same experiment was repeated with Bhaastrika Pranayama with internal retention ( Antar Kumbhaka) instead of normal breathing. In Experiment No.2, normal breathing was compared with Bhastrika Pranayama with external retention of breath (Bahya Kumbhaka). The study concludes that Bhastrika Pranayama With Bahya Kumbhaka (Patanajali type) and with Antar Kumbhaka (Gheranda type) increase oxygen, consumption and carbondioxide tolerance.

Pratap (1972)\textsuperscript{23} reported that although the ideal pattern indicated by the ancient rishis could not be verified significantly, yet there was some kind of a pattern of nostril breathing which differed from day to day and person to person.

\textsuperscript{22} P.V. Karambelkar, R.R. Deshpande, & M.V. Bhole, (Oct.1982). Some respiratory studies on Bhastrika Pranayama with internal and external retention of breath. \textit{Yoga Mimamsa} 21, 3 & 4, 14-20.

Rao and Potdar (1970)\textsuperscript{24} postulated that this was due to: 1) the stimulation of the brachial plexus which brings about reflex parasympathetic vasodilation on the same side, and 2) pressing of the shoulder which stimulates the medullary vasomotor centre and brings about vasoconstriction on the opposite side.

Karambelkar, Deshpande and Bhole\textsuperscript{25} also examined the composition of expired air in pranayamic breathing. The study was carried out on eleven healthy males in the age group of 22 to 35 who were well established in various yoga technique. Expired air was collected by open circuit method yoga technique. Expired air was collected by open circuit method in completely evacuated rubber bags. Composition of expired air was studied in different conditions in five experimental designs. The study helps to concludes that oxygen and carbondioxide percentage of expired air varies to great at the end of six round of Ujjayi and Bhastrka Pranayama having 1:2:2 ratio for Puraka: Rechaka: Kumbhakar, but different time units for one round viz., 30, 40 and 70 seconds.

Edwin (1980)\textsuperscript{26} established relationship between right nostril dominance and intake of meals (particularly first two meals of the day) as described in yogic texts. He also confirmed the presence of a regular

\textsuperscript{25} P.V. Kambelkar, R.R. Deshpande, & M.V. Bhole, (Jan., 1983) Composition of expired air in pranayamic breathing- An exploratory study, Yoga-Mimamsa 21, 3 &4, 1-6.
cycle of nostril dominance with a periodicity of 3 to 4 hours. The cycle was never exactly balanced but it showed dominance of left or right nostril. Furthermore, the right nostril dominance was observed to be associated with outward directed, more vigorous activity while left nostril dominance was related to more quiet, receptive moods. Balanced flow was felt to be conductive to a sensitivity to inner meditative awareness.

Dick (1982)\textsuperscript{27} found Shifting of the air-flow to the upper nostril when lying on one side with a rolled - towel in the axilla. There was no shift in nasal dominance when lying on one's back. He also set the method to calculate nasal dominance ratio from the time taken for evaporation of the condensed vapour on the mirror during exhalation from both the nostrils.

Telles, Nagarathna and Nagendra (1994)\textsuperscript{28} conducted a study on two groups with 24 male subjects, age 24 to 48 years. The first group was randomly sub-divided in to two groups. Both groups were given the customary training in yoga. One group was asked to practice 27 respiratory cycles through the right nostril, repeated 4 times during the day (Surya Anuloma Viloma Pranayama Group). The other practiced 27 respiratory cycles through alternate nostril (the Nadisuddhi Pranayama group) repeated 4 times during the day. Duration of training was for one month. The result revealed that breathing selectively through either nostril


\textsuperscript{28} S. Telles, R. Nagarathna, & H.R. Nagendra (April, 1994). Breathing through a particular nostril can alter metabolism and autonomic activities. \textit{Indian J. of Physiol. & Pharmacol.}, 38,2,pp.133-137.
could have a marked activating effect or a relaxing effect on the sympathetic nervous system. The therapeutic implication could be able to alter metabolism by changing the breathing pattern have been mentioned.

Eccles (1978)\(^{29}\) inferred that, under the resting conditions, the air flow through the nasal passage is asymmetrical due to difference in the state of congestion of the venous erectile tissue in the nasal mucosa. It is evidenced that the filling of this tissue is regulated by the sympathetic innervation of the nose from the hypothalamus.

Widdicombe (1986)\(^{30}\) revealed that the resistance in the two nostrils alternates and the cycle duration is 1 to 4 hours. In fact 80% of humans show this cycle and it has also been demonstrated in rats, pigs and rabbits. Evolutionary advantage of having nasal cycle is not known.

Bhole\(^{31}\) experiment on breath-holding time. Twenty males in the age group of 30 to 50 years volunteered in this study. Experimental design and training programme were almost the same as in the previous work on breath holding after inhalation except that the students were asked to hold the breath after complete exhalation. Accordingly other instruction were suitably modified. Three conditions of the abdominal muscles employed and the result revealed that any particular condition of

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the abdominal muscles as well as any sequence of the three conditions studied had insignificant effect on the period of breath holding after complete expirations which was between 22 to 28 seconds. It was also noticed that any of the three conditions of abdominal muscles as studied here are not recognised as yoga technique while Uddiyana is supposed to be a powerful yogic practice, even for spiritual purpose.

Eccles (1983)\textsuperscript{32} also indicates that the nasal mucosa normally warms and humidifies the inspired air and the cyclic fluctuations in nasal resistance associated with the nasal cycle may be related to this air conditioning function.

Eccles (1978)\textsuperscript{33} suggested that the oscillations in sympathetic tone observed in the erectile tissue of nasal mucosa may be due to 1) oscillation in tone, in phase with respiration, and 2) reciprocal changes in sympathetic tone in two nostrils every 1 to 4 hours. The control is however a ‘central control’ The report also found the sympathetic tone increases in one nostril and simultaneously decreases in the nostril on the other side.

Babatola\textsuperscript{34} in 1986, studied vasomotor responses in conscious human subjects by means of intranasal water balloons. He found that the hyperventilation caused an increase in intranasal balloon pressure

\textsuperscript{33} Eccles, Op Cit, pp. 46-78.
\textsuperscript{34} R.D. Babatola, and R. Eccles, (Dec., 1986), Nasal Vasomotor Responses in Man to Breath Holding and Hyperventilation Recorded by Means of Intranasal Balloons, Rhinology, 24, 4, pp. 271-276.
associated with vasodilation whereas breath-holding caused a decrease in the intranasal balloon pressure associated with vasoconstriction. This suggests that an elevated arterial level of CO₂ stimulates carotid and aortic chemoreceptors and causes a pronounced reflex vasoconstriction of nasal blood vessels during breath holding manoeuvre. This could be useful in some conditions of mild epistaxis as the induced vasoconstriction would promote homeostasis and control the bleeding. Increased nasal resistance to airflow due to hyperventilation is again decreased by breathing normally.

Forsyth et al., (1983)³⁵ in his study on 20 subjects concluded that the nasal air-flow resistance decreased with intensity but not due to the duration of exercises. 5 to 10 minutes after the exercise, the resistance recovered up to 75%. This indicated that during the exercise, when the body needs oxygen, the nostrils are decongested or cleared automatically.

The nasal Cycle has been correlated with alternating changes in mental states as indicated by the dynamic lateralization of activity in the cerebral hemispheres (Werntz, 1983)³⁶. Werntz demonstrated this correlation with the changes in relative nostril dominance with the help of EEG studies. Relatively greater integrated EEG amplitude in one

hemisphere was correlated with the dominant (less congested) contralateral nostril, defining a new inter-relationship between cerebral dominance and peripheral autonomic nervous function.

Klein et al. (1986)\textsuperscript{37} also found a significant relationship between the pattern of nasal air-flow during normal breathing and relative spatial vs verbal performance. The subjects having right nostril dominance, performed verbal task better (relative to spatial performance) than subjects exhibiting left nostril dominance. It may be noted that spatial task is controlled by right hemisphere while verbal task is performed by the left cerebral hemisphere. However, forced uninostril breathing by plugging or blocking the nostril by the ipsilateral thumb showed no effect on verbal or spatial performance. Since the rhythms of cortical activity are tightly coupled with the nasal rhythms and nasal cycle appears to be coupled with nor-epinephrine secretion, the hemispheric activity is also expected to correlate with the patterns of nor-epinephrine secretion.

A study conducted by Bhole (1991)\textsuperscript{38} consists of more than 800 adults. A preparatory session in the first phase of the experiment consists of –1) Mostly in a group situation while sitting in a comfortable position on the group of chair, the subjects were asked as to whether they could experience their breathing without any external and aid or guidance.

\textsuperscript{37} R. Klein, D. Pilon, S. Prosser and D.S. Shannehoff-Khalsa, (Oct., 1986), Nasal Airflow Asymmetries and Human Performance, Biological Psychology 23, 2, pp. 127-137.
2) Inquiries about the mode and nature of experiencing breathing were made from those answering in the positive. 3) Then all the subjects were helped to become aware of the fact that certain movements related to breathing are taking place at the level of the body as primary movements and they are responsible for air movement which is secondary in nature. 4) The subjects were then asked to find out the every exhibiting these movements related to breathing which was to keep at natural as possible. However almost all the subjects resorted to deep breathing in the order to experience the movement. 5) The subjects were than made to realize from their own related to breathing were not uniform in different areas of the body and different subjects have reported differently. 6) The helped to around curiosity in the using of the subjects about the experimental and ensure co-operation from them as they were motivated to develop further understanding about these moments.

The actual experiment started by sitting in comfortable position. The subjects were asked to put their hands on two areas at a time and experience the movements related to breathing which was supposed to be kept as natural. Fifteen areas were examined in nine pairs as mentioned below;

1st pair – Chest-front and epigastrium.

2nd pair – Abdomen right and left side.

3rd pair – Thorax right and left side.
4th pair – Supra clavicular areas right and left.

5th pair – Iliac fossa right and left.

6th pair – Chest front and upper dorsal region.

7th pair- Epigastrium and dorso-lumber region

8th pair – Hypogastrium and lumbo-sacral region.

9th pair – Hypogastrium and perineum.

In psycho physiological investigations, generally, breathing movements is recorded from the chest or abdominal area for the response of calculating rate of breathing. Usually gaseous exchange and ventilation is given importance in various pulmonary function tests. As Yoga is essentially subjective in nature, in present study emphasis was laid on experiencing breathing movements by the subjects them selves rather than by the investigator or with the help of instruments.

The preset work could therefore be called a study in the sensory experiential aspects of the breathing movements which is generally neglected in clinical medicine as well as in psycho physiological investigations.

❖ The present study could also be looked upon as an experiment in bio-feedback where hands have been used experience breathing movements.
 It could also be concluded that breathing movements are not present all over the abdominal-nonthoracic region and they are not uniform wherever they are present.

 It is postulated that various yogic terms and concepts relating to breathing could be explained to the beginners in Pranayama techniques on the basis of these observation.

 The research report of Bart, Chaureau, Labble and Lockhart\textsuperscript{39} (2000) revealed that a common mechanism, triggered by drying and cooling of the airways could lead to either bronchial obstruction or only to bronchial hyperactivity.

 Karmabelkar, Deshpande and Bhole\textsuperscript{40} conducted experiment on three adult males well established in the practice of pranayamic breathing over a period of one year. Experiments were conducted on the same day for one subject in morning on empty stomach with rest for 30 minutes before and in between. Minute ventilation and composition of expired air during the practice of Ujjayi and Bhasrika Pranayamas were measured by using standard methods. The result indicates that minute ventilation significantly decreased by 1.68 litre in Ujjayi while it significantly increased by 3.51 litre in Bhasrika Pranayama with bahya kumbhaka. The result on


\textsuperscript{40} Karambelkar, P.V., Deshpande, R.R. & Bhole M.V. (Ocy., 1982). Some respiratory studies on Bhasrika Pranayama with internal and external retention of breath. \textit{Yoga Mimamsa} 21, 3&4, 14-20.
composition of expired air revealed that $O_2$ content of the expired air was lower (15.2% in Ujjayi and higher (18.4%) in Bhashrika Pranayama that in normal breathing (17.2%), whereas CO$_2$ content of expired air increased to 4.75% in Ujjayi and decreased to 2.2% in Bhashrika in comparison to 3.0% in normal breathing.

It is obvious form the review that in resting conditions, the body alters the sympathetic and parasympathetic activities in relation to nostril dominance and also the right and left hemispheric activities but the question that still remains unsolved is, what makes the body shift dynamically over these rhythms? Why?, and How?

The literature reviewed so far, in this study, revealed that nasal cycle refers to the alternate congestion and decongestion of nasal mucosa of right or left nostril with a periodically from 25 to 200 minutes. Normally, we are not aware of this changing of nostril dominance. Yogic literature claims that health fortune, auspicious or inauspicious aspects of our life depend on a dominance of a particular nostril. Hatha yoga emphasises alternate nostril breathing as a purificatory process prior to Pranayama. The nasal cycle exists in 85.5% population. And can be changed by applying Yoga Danda or lying on the lateral sides. The studies also revealed that breath holding reduces the nasal resistance while hyperventilation causes an increase in the congestion. It is obvious that in resting conditions, the body alters the sympathetic and
Parasympathetic activities in relation to nostril dominance and also the right and left hemispheric activities.

A relationship has also been reported between the nostril dominance and grip strength. In fact, the ability of grip strength of an athlete is essential in holding racket in Badminton and Tennis, bat and ball in Cricket, Javelin and Shot put in events of athletics etc. and is one of the important skills to score better sports performance.

The various directly and indirectly related literature was thoroughly reviewed & analytically reviewer by the scholar. This was also discussed with the guide and other experts in the field of yoga finally. The present reviews of supporting studies are revealed sufficient evidence to formulate the hypothesis, that the nostril dominance may play an important role in achieving different effect on selected physical and physiological variables for better performance in games & sports.