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RESEARCH ARTICLE

“Effect of Yoga training on Bio-energy dynamics with reference to Bioelectrical Impedance and Tridosha in Dominant Nostril Breathing Types – A pilot study”

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Abstract:

Yoga and Ayurveda are the traditional sciences, aims to balance body-mind functions. The study objective was to evaluate the effect of yoga practice in modulating tridosha assessed by Nadipariksha (NP) and bioelectrical impedance (Z) towards balanced bio-energy dynamics among three Nostril Dominance (ND) breathing types. The Z measure at cellular level could be an alternate to the limitation of NP outcome reliability. This was a self as control study conducted on residential yoga college students (N=23) of both genders aged 18-45 years (26.2 ±6.1), grouped as; Right Nostril Dominance (RND) (n₁=7), Left Nostril Dominance (LND) (n₂=9) and Equal Nostril Dominance (END) (n₃=7). The Z was measured by Body Composition Analyzer (Maltron Bioscan-907 UK) instrument and the dominant pulse of tridosha was assessed by physician through NP as per Ayurvedic texts, before and after 12 weeks of yoga training. The between group data analysis was done using statistical software Graph Pad InStat 3.06 version. The results of study revealed: a) RND subjects: - Significant decrease in Z (P <0.004) and moderate decrease of Pitta (P), infers reduction in higher baseline energy expenditure (EE). b) END subjects: - Significant decrease in Z (P <0.003), but dosha combinations remain unchanged reflects balanced EE and energy storage (ES). c) LND subjects:-Non-significant change in Z (P >0.08) with a mild enhancement in P reflects slight enhanced EE and higher ES, which suggests need of prolonged duration of yoga practice. Study concludes that yoga practice modulates tridosha and Z in three ND breathing types towards balanced bio-energy dynamics and homeostasis.

Key Words: Yoga training, Bioelectrical Impedance, Tridosha, Nostril Dominance, Bio-energy dynamics and Homeostasis.

Introduction

The bio-energy dynamics deals with the energy aspects of health. The dominance of nostril breathing types as per yogic literature (Bhole and Karambelkar, 1968) has a significant contribution towards overall health as reflected through metabolic profile. For example, high metabolic rate in Right Nostril Dominance (RND), low metabolic rate in Left Nostril Dominance (LND) (Shannahoff-Khalsa and Kennedy, 1993) and balanced metabolic activity in END with an equal magnitude of Energy expenditure (EE) and Energy storage (ES) is evident from a study involving both nostrils during high frequency yogic breathing (Telles *et al*, 2015). Ayurvedic science also link varied metabolic profile with *tridosha* such as *pitta* for higher metabolic rate, *kapha* for slow metabolism etc. (Purva and Meena, 2011). The whole body metabolic activity could be co-related with Nostril Dominance (ND) and *tridosha* through cerebral hemispheres function (Werntz *et al*, 1987; Kurup and Kurup, 2012). The assessment of *tridosha* through *Nadipariksha* (NP) by skilled physicians has several limitations with ambiguity in its outcome due to poor inter-rater reliability (Kurande *et al*, 2013). The scientific understanding of *tridosha* examined by NP represents whole body energy dynamics at cellular level (Kulkarni *et al*, 2014)

in contrast to proposed parameters by various researchers (Joshi, 2005; Sareen *et al*, 2008; Joshi *et al*, 2007). Accordingly, possible quantification of *tridosha* through the measure of bioelectrical impedance (Z) based on bioelectrical principle has been reported (Kulkarni *et al*, 2014; Ursula *et al*, 2004). Hence, the limitations to standardize NP outcome may be substituted by the measure of Z in terms of magnitude and direction. (Kulkarni *et al*, 2014). The bioelectrical model of energy dynamics of *tridosha* (Kulkarni *et al*, 2014) may operate on both Parallel and Series Resistance-Capacitance (R-C) circuit cell models that represents ES and EE respectively (Sunbocho, 2011; Elliot *et al*, 2014). The Z is an opposing cellular response to incoming Alternating Current (AC) stimulus that passes through both extra and intra cellular fluid path reflects extent of EE and ES (Ursula *et al*, 2004). So far, the present research scenario has not addressed the co-relation between bioelectrical basis of *tridosha* assessed by NP in different types of ND and its modulation through *yoga* training. This approach may lead to understand the possible theoretical basis for diagnostics of NP outcome and its contribution towards *yoga* practice effect on balanced bio-energy dynamics aspect of health in different ND types.

Material and Methods

Subjects:

In this self as control study design, 67 residential students of both genders aged 18-45 years (26.21 ± 6.17) from Goverdhandas Sexaria College of Kaivalyadhama *Yoga* Institute, Lonavla were enrolled. Among them, 8 students were drop outs as they left the course and 59 students were randomized to categorize for either of three Nostril Dominance (ND) breathing types. They were screened for medical examination by the physician appointed by the institute. The selected participants had no background of *yoga* practice prior to admission of the course. After approval of Institutional Ethical Committee (IEC), the study was initiated and written consent of the subjects was obtained. They were pre-tested on selected parameters and imparted *yoga* training for 12 weeks of duration as per the course syllabus by a competent *yoga* instructor of the institute. In post- test, 23 subjects who did not show change in ND were recruited for the study. While, remaining 36 subjects with change in ND were excluded. The procedure of subjects' enrollment is described in flow chart diagram [Figure 1].

Inclusion criteria: Subjects having sound physical and mental health.

Exclusion criteria: Subjects suffering from any physical and mental illness.

Design: The subjects (N=23) were categorized according to dominant nostril breathing types such as 1) Right Nostril Dominance (RND) ($n_1=7$) 2), Left Nostril Dominance (LND) ($n_2=9$) and 3) Equal Nostril Dominance (END) ($n_3=7$) determined by the vapor deposition method. They were tested for pre-post *yoga* training effect on *tridosha* assessment by *Nadipariksha* (NP) and Z using Body Composition Analyzer (Maltron Bioscan-907 UK) instrument.

a. **Measurement of Nostril Dominance (ND):** The ND was detected based on the surface area and duration of vapor deposited during the simultaneous forced exhalation of both nostrils on a clean polished mirror surface (Raghuraj and Telles, 2004).

b. **Measurement of Z:** The Z variable is the resistance to flow of Alternating Current (AC) stimulation elicited through non-invasive method by using Body Composition Analyzer (BCA), Maltron Bio-scan Model 907, UK with an operating frequency of 50 KHz. It is expressed in units as ohms (Ω). The Z data were collected on the subjects by tetra polar electrode recording method using two paired adhesive gel paper electrodes (Zarowitz and Pilla, 1989). The subjects in supine position were made to stretch their arms and legs apart. One pair of active gel paper electrodes are placed one below the other of third knuckle of middle finger and centrally opposite of palm surface on right hand. Similarly, the other pair of electrodes was placed on the

right foot at the union of second and third toe and on central portion of the same side (Chien *et al*, 2010). All electrodes are placed on right side of the body with cables as per manual (Zarowitz and Pilla, 1989; Chien *et al*, 2010).

c. **Assessment of *tridosha* by NP:** The dominant pulse of *tridosha* was assessed by NP, a method of pulse pattern examination, conducted by an Ayurvedic physician. Since, the NP examination conducted by group of experienced doctors revealed poor inter-rater reliability (Kurande et al, 2013). Hence, repetition of NP test by second physician was not opted for the study. The method of NP examination involves placing of three fingers in series on the vicinity of radial fossa to sense one or more dominant throbbing pulse such as index finger for *vata*, middle one for *pitta* and ring finger for *kapha* respectively (Kulkarni *et al*, 2014; Lad, 2005; Gupta and Singh, 2012) as illustrated in the [Figure 2] (Roopini N *et al*, 2015). The dominant pulse of *dosha* by NP was given in terms of percentage.

Statistics:

The bioelectrical variable or Z data between groups was statistically analyzed using paired T-test through Graph Pad InStat 3.06 version statistical software. The scores of subjects with dominant pulse of *dosha* by NP were calculated in percentage.

Yoga Intervention:

The *yoga* training was imparted as per institutional tradition by a *yoga* expert, daily an hour twice a day, for 12 weeks of duration excluding holidays. The *yoga* module is illustrated in [Table 1]:

Observations and Results:

The trend of results on Z and Percentage of subjects with specific dominant pulse of *dosha* in three dominant nostril groups are presented in [Table 2] and [Figures 3-4]:

The post-*yoga* intervention results in the RND group [Table 2]and [Figures 1-2], showed significant decrease in Z ($P < 0.004$). The percent of subjects with dominant pulse of *tridosha* namely *Vata* (V), *Pitta* (P), *Kapha* (K) in NP test at baseline were P: 26.08% (n=6), V-P: 4.34% (n=1) and in post-*yoga*, P-K:13.04% (n=3), P:8.69% (n=2) and V-P:8.69%(n=2) each. Among six subjects of P, two subjects remain unchanged.

In LND group [Table 2]and [Figures 3-4], there was non-significant decrease in Z ($P > 0.08$). The NP test at baseline was K-P: 21.73% (n=5), K: 13.04% (n=3), K-V: 4.34% (n=1) and in post-*yoga*, K-P: 13.04% (n=3), K-V: 13.04% (n=3), K: 8.69% (n=1), P-V: 4.34% (n=2). Among Five subjects of K-P, three subjects remain unchanged.

While, the END group [Table 2] and [Figures 3-4] showed significant decrease in Z ($P < 0.003$). The NP test at baseline was V: 21.73% (n=5), V-K: 4.34% (n=1), V-P: 4.34% (n=1) and in post *yoga*, V-P 13.04% (n=3), V-K: 8.69% (n=2), V: 8.69% (n=2). Among five subjects of V, two subjects remained unchanged.

Figure 1: Flow chart diagram of subject’s enrolment procedure

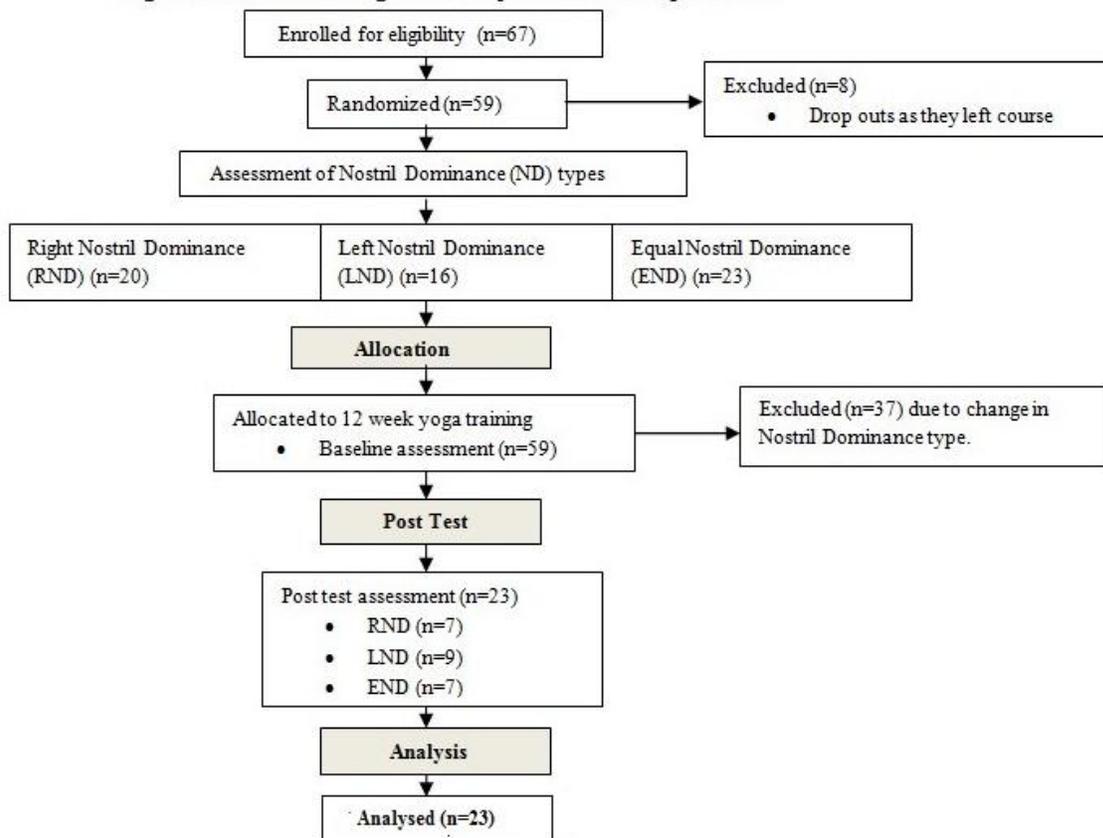
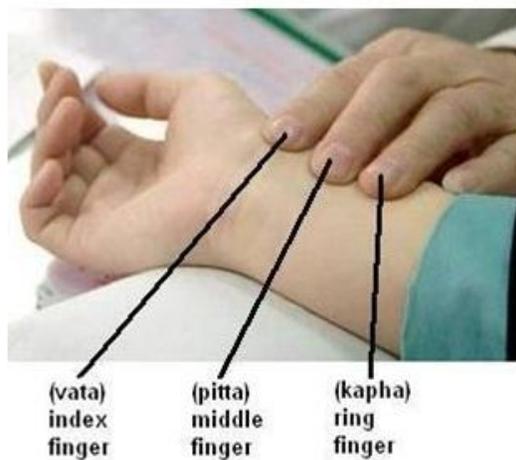
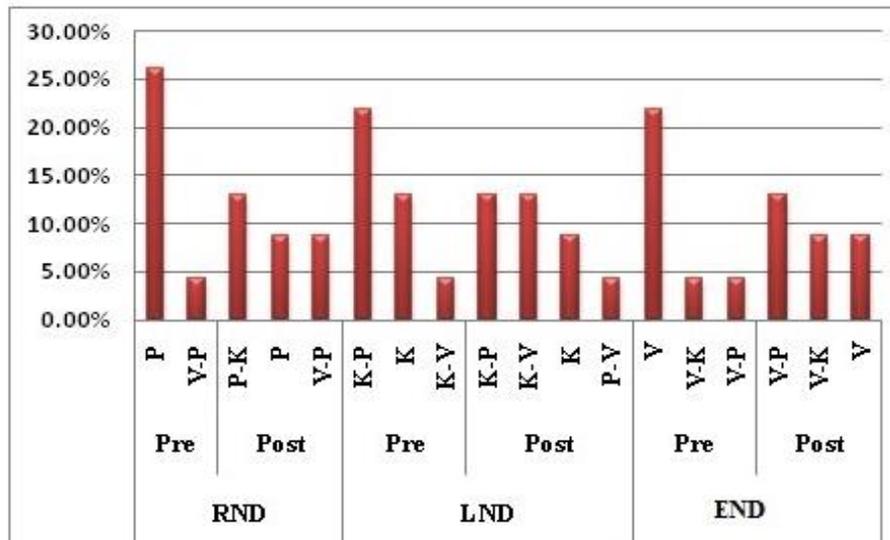


Figure 2: Illustration of Nadipariksha



(Roopini N et al, 2015)

Figure 3: Yoga practice effect on percent of subjects with dominant pulse (*dosha*) in three Nostril Dominance groups



a. V=Vata, P=Pitta, K=Kapha, x-y = Combined Dominance of any two pulse (*Dosha*)
 b. RND=Right Nostril Dominance, LND=Left Nostril Dominance, END=Equal Nostril Dominance

Figure 4: Effect of yoga practice on Bioelectrical Impedance (Z) in ohms (Ω) among three Nostril Dominance groups

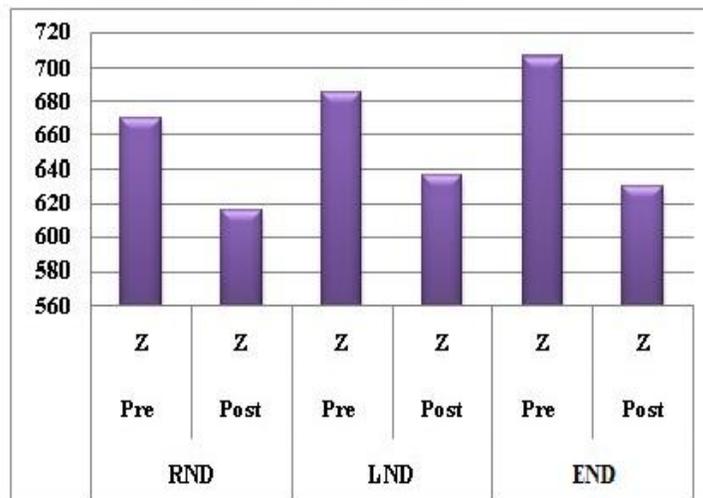


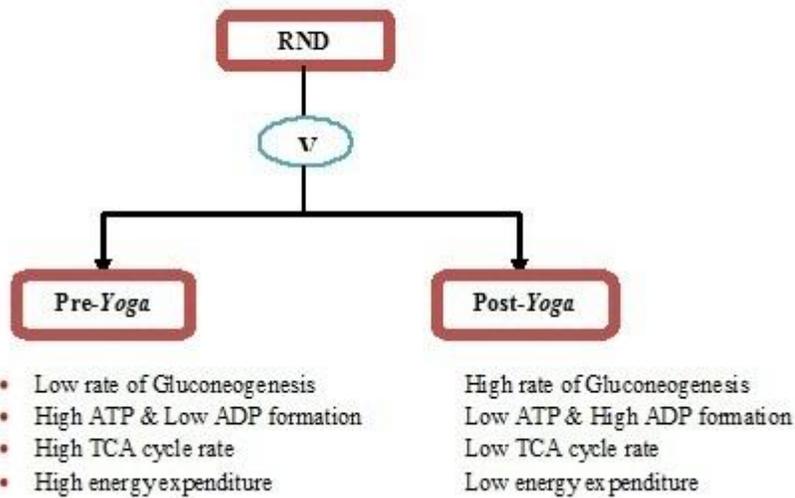
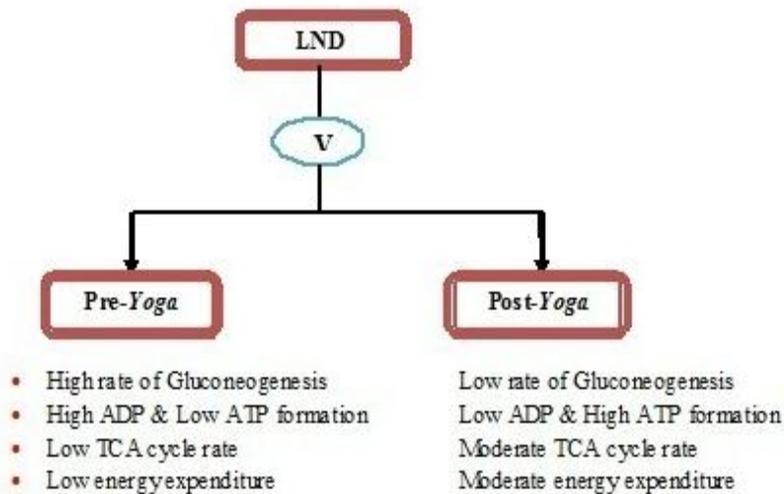
Figure 5: Effect of *Yoga* training on Bio-energy dynamics in RND subjectsFigure 6: Effect of *Yoga* training on Bio-energy dynamics in LND subjects

Figure 7: Effect of *Yoga* training on Bio-energy dynamics in END subjects

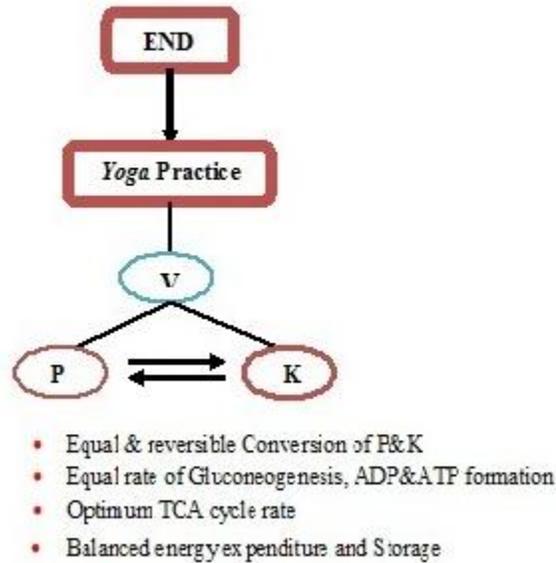


Table 1: *Yoga* module

ASANAS	<i>Shavasana, Shrishasana, Pavanmuktasana, Naukasana, Viparitakarani, Sarvangasana, Matsyasana, Halasana, Karnapidasana, Bhujangasana, Shalabhasana, Sarpasana, Dhanurasana, Vakrasana, Ardha-Matsyendrasana, Paschimatanasana, Supta Vajrasana, Yoga Mudra, Simhasana, Gomukhasana, Matsyendrasana, Mayurasana, Ushtrasana, Gorakshasana, Padma – Bakasana, Baddha –padmasana, Parvatasana, Janushriasana, Siddhasana, Padmasana, Tolangulasana, Muktasana, Virasana, Guptasana, Sankatasana, Uttanamandukasana, Vrishabhasana</i>
PRANAYAMA	<i>Anuloma-viloma ,Ujjayi, Shitali, Sitkari, Bhastrika, Bhramari, Suryabhedana, Chandrabhedana</i>
BANDHAS	<i>Jalandhara Bandha, Uddiyana Bandha, Jicha Bandha, Mula Bandha</i>
KRIYAS	<i>Jala Neti, Sutra Neti, Dhauti (Vamana, Danda, Vastra)</i>

Table 2: Yoga training effect on Bioelectrical Impedance (Z) & Percentage of subjects with dominant pulse (*dosha*) in three Nostril Dominance groups.

Nostril Dominance	Yoga training	% of subjects with Dominant <i>Dosha</i> in NP	Z in ohms (Ω)	SEM	SED	“t” value
			Mean \pm SD			
RND (n=7)	Pre	P:26.08% V-P:4.34%	669.33 \pm 75.27	28.45	12.26	4.4(P<0.004)*
	Post	P-K:13.04%, P:8.69%, V-P:8.69%	615.28 \pm 90.90	34.35		
LND (n=9)	Pre	K-P:21.73%, K:13.04%, K-V: 4.34%.	684.99 \pm 88.25	29.41	23.99	1.9(P >0.08)
	Post	K-P: 13.04%, K-V:13.04%, K: 8.69%. P-V:4.34%	637.25 \pm 83.76	27.92		
ENP (n=7)	Pre	V:21.73%, V-K:4.34%, V-P:4.34%	705.71 \pm 80.58	30.45	16.5	4.5(P<0.003)*
	Post	V-P:13.04, V-K:8.69%, V: 8.69%.	630.52 \pm 82.89	31.30		

Discussion

The alternate cycle of dominant exhalation force in particular nostril varies for every two to eight hours, is referred as nasal cycle or ND that could be RND, LND and END depending upon psycho-physiological activity of subject like rest, physical activity, lethargy etc (Keuning, 1968; Shannahoff-Khalsa *et al*, 1991; Bhole and Karambelkar, 1968). The Ayurvedic concept of *tridosha* namely *Vata* (V), *Pitta* (P) and *Kapha* (K) present in entire body with varied proportions (Shukla and Tripathi, 2003). Both *tridosha* and ND influence various psycho-physiological features such as; cerebral hemisphere activity, diet, diurnal and circadian rhythms, season etc (Werntz *et al*, 1987; Kurup and Kurup, 2012; Singh and Chauhan, 2012; Pratap, 1972; Mallika, 2002).

Within the framework of Resistance-Capacitance (R-C) series circuit Cell model (Sunbocho, 2011; Elliot *et al*, 2014), the measure

of Z refers to opposing flow of AC stimulus. The bioelectrical response of tissues to AC stimulation varies in healthy, damaged or cell death according to electrical resistance (Hermann, 1871; Thomasset, 1963). It is indicated from the Z measure and depends on water content, body fat, BMI, RMR etc. of tissue (Ursula *et al*, 2004). In context to *tridosha*, according to R-C series circuit Cell model, the AC stimulus flow within extracellular path implies V (circulatory energy) that regulates P (energy expenditure) or K (energy storage) functions (Kulkarni *et al*, 2014) in terms of magnitude of Z. Similarly, from the Biochemical view point, V-P combination is related to process of ADP to ATP formation and V-K combination with ATP to ADP formation

(Kulkarni *et al*, 2014). With reference to the above reviews, the logical basis of energy dynamics in relation to *tridosha* may be co-related with Z response measure.

The earlier study indicated low EE due to *yoga* practice (Chaya and Nagendra, 2008). In RND group, the same is inferred from the decrease of P from 26.08% to 8.69% as well as significant decrease in Z value ($P < 0.004^*$) [Table 2] and [Figures 3-4] with an indication of reduction in higher baseline EE. The possible biochemical changes could be due to low TCA cycle rate facilitating enhanced gluconeogenesis, low ATP and high ADP formation after *yoga* practice [Figure 5], suggests low metabolic rate and the same is inferred from earlier study (Chaya and Nagendra, 2008). It reflects that overall effect of *yoga* practice seem to modulate *tridosha* and EE to reach the equilibrium state as similar to bio-dynamics of END. Further, based on bioelectrical model viewpoint (Kulkarni *et al*, 2014), the majority of cells might undergo a change in current - voltage relationship through gradient switching from Series R-C cellular circuit (indicating EE) to Parallel R-C cellular circuit (indicating ES) (Sunbocho, 2011; Elliot *et al*, 2014). This leads to phase difference wherein, current leads the voltage due to more reactance and less resistance.

The LND is characterized by low basal metabolic rate (Shannahoff-Khalsa, 1993) infers more energy storage. Ideally, *yoga* practice should shift LND to END by enhanced EE. The results show a similar trend from the appearance of P-V; 4.34%, in post test indicating slight rise in EE. However, non-significant decrease in Z value ($P > 0.08$) as well as decrease in K-P dominance from 21.73% to 13.34%, K; 13.4% to 8.69%, K-V; 4.34% to 13.04% infers higher ES [Table 2] and [Figures 3-4]. Therefore, it suggests the need of prolonged *yoga* training for LND group in order to enhance EE, mostly through increased P that leads to energy homeostasis (Prasher *et al*, 2008) to attain equal magnitude of EE and ES, similar to END. This could be possible through biochemical changes such as moderate TCA cycle rate leading to reduced gluconeogenesis, low ADP and high ATP formation due to increased EE after *yoga* practice as shown in Figure- 6. As per the bioelectrical model viewpoint (Kulkarni *et al*, 2014), majority of cells could undergo gradient switching from Parallel R-C cellular circuit (indicating ES) to Series R-C cellular circuit (indicating EE) (Sunbocho, 2011). This leads to phase difference wherein, voltage leads the current due to more resistance and less reactance.

In END, there exists equal nostril breathing force (Bhole and Karambelkar, 1968). Hence, there would be equal magnitude of EE and ES to sustain homeostasis of energy dynamics. The pre-post test percent change of V from 21.73% to 8.69% suggest decreased circulatory function (V), mostly due to reduced magnitude of EE and ES after *yoga* practice. However, in post test, observed higher magnitude of V-P (13.04%) as compared to V-K (8.69%) suggests slight increased EE, probably due to the presence of P to restore energy homeostasis (Prasher *et al*, 2008) [Table 2] and [Figures 3-4]. The same is reflected from significant decrease in Z value ($P < 0.003^*$). It is also evident from the past studies that revealed 30 to 40 percent of energy recovery during exhalation through nose (Cole, 1982; Cole, 1988) which infers ES to some extent in END. According to bio-dynamic viewpoint of *tridosha*, an equal and reversible conversion of P & K regulation by V through *yoga* practice is inferred. The plausible biochemical changes could be optimum TCA cycle rate that leads to equal rate of gluconeogenesis, ADP, ATP formations, balanced EE and storage after *yoga* practice as illustrated in Figure-7. As per the bioelectrical model viewpoint (Kulkarni *et al*, 2014), majority of cells could undergo gradient switching towards equal magnitude of both Parallel R-C cellular circuit (indicating ES) and Series R-C cellular circuit (indicating EE) functions (Sunbocho, 2011), that leads to voltage and current to remain in-phase due to equal resistance and reactance.

The above findings reflect, at initial stage, an enhancement in EE seems necessary to bring a balance between whole body EE and ES (Telles *et al.*, 2015). Within the limitations of the study, it is speculated that ‘Z’ variable seem to be an objective tool to assess the effect of *yoga* practice on bio-energy dynamics through modulation of *tridosha*. Further, it is recommended that, the present study may be conducted on large sample to substantiate the above findings and its implication towards theoretical basis for diagnostics.

Conclusion:

The study concludes that, the decreased EE in RND subjects due to *yoga* practice leads to attain the state of END with a balanced EE and ES. While, in LND subjects, more of ES and slight enhanced EE suggests a need of prolonged *yoga* practice. Study concludes that *yoga* practice modulates *tridosha* and Z in three ND breathing types towards balanced bio-energy dynamics and homeostasis.

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