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Original Article

Physiological variations in the autonomic responses may be related to the constitutional types defined in Ayurveda

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ABSTRACT

According to Ayurveda, an individual can be classified into any one of the seven constitutional types *(Prakriti)* depending on the dominance of one, two, or three *Doshas*. A '*Dosha'* is representative of fundamental mechanisms that are responsible for homeostasis, and thus, to health. In the recent years, there have been several efforts to see whether certain physiological, haematological or biochemical parameters have any relationship with the constitutional types or not. The objective of the present study was to see if the results of autonomic function tests vary according to *Prakriti* of an individual. We conducted this study in clinically healthy volunteers of both the gender belonging to the age group of 17 to 35 years after obtaining their written consent. The *Prakriti* of these volunteers was assessed on the basis of a validated questionnaire and also by traditional method of interviewing. After confirming that the primary *Dosha* ascertained by both these methods matched, 106 volunteers were grouped into three on the basis of primary *Dosha* and were subjected to various autonomic function tests such as cold pressor test, standing-to-lying ratio, Valsalva ratio and pupillary responses such as pupil cycle time and pupil size measurement in light and dark. The results suggest that, the autonomic function tests in the healthy individuals may correlate linearly with the primary *Dosha* expressed in an individual. In particular, people with *Kapha* as the most dominant *Dosha* showed a tendency to have either a higher parasympathetic activity or a lower sympathetic activity with respect to their cardiovascular reactivity in comparison to the individuals with *Pitta* or *Vata* as the most dominant *Dosha*.

Keywords Ayurveda, Indian traditional medicine, *Prakriti*, constitution, autonomic responses, pupillary responses

INTRODUCTION

Prakriti, the constitution of an individual according to Ayurveda, is the sum total of physical, psychological and physiological traits expressed in that individual. According to the principles of Ayurveda, *Doshas* determine one's *Prakriti* (Tripathi and Singh, 1994). There are three *Doshas: Vata, Pitta* and *Kapha*. *Doshas* are defined as the fundamental, mutually antagonistic - yet reciprocal - mechanisms responsible for maintaining the homeostasis, and thus, health. When these mechanisms deviate from their state of equilibrium, the result is often ill-health and disease (Dubey et al., 2015; Patwardhan, 2013). Ayurveda constructs all its principles governing the physiological, nutritional, pathological, and pharmacological understandings around the axial framework of this theory (Jayasundar, 2010). Each of these *Doshas* has been ascribed with specific mutually opposite attributes (*Gunas*). Ayurveda proposes that a specific 'attribute' of a *Dosha* has a causal relationship with the specific trait expressed in an individual (Dubey et al., 2015). For instance, *Pitta* possesses the '*Ushna'* (heat) attribute which determines the enhanced digestive and metabolic abilities of an individual, whereas, *Kapha* possesses '*Shita'* (cold) attribute that causes sluggishness in digestive and metabolic abilities. In the same manner, *Vata* possesses *Cala* (mobility) attribute that makes the individual active, whereas, *Kapha* possesses *Stimita* (rigid) attribute that makes the individual less active (Dubey et al., 2015; Tripathi et al., 2011).

The *Prakriti* of an individual is determined by the dominance of one, two or three *Doshas* expressed in that individual. Though it is determined genetically, several environmental factors too contribute in its manifestation. Therefore, on the basis of one, two or three dominant *Doshas* expressed in an individual, one can have any one of the seven possible types of *Prakriti: Vata, Pitta, Kapha, Vata-Pitta, Pitta-Kapha, Vata-Kapha,* and *Sama Doshaja* (balanced state of all the three *Doshas).*

In the recent years, the individualized approach to therapeutics has received impetus with the growing understandings in the field of genetics. Several workers have investigated the possible association of constitutional types with the individual genetic make-up, metabolic abilities and chronic diseases. There have been several efforts to see whether

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certain physiological, haematological or biochemical tools can be used to establish a link between constitution types and other health-related parameters. (Aggarwal et al., 2010; Bhalerao and Deshpande, 2012; Dey and Pahwa, 2014; Ghodke et al., 2011; Patwardhan et al., 2005; Prasher et al., 2008).

A few workers in the past have hypothesised that certain autonomic responses might vary in accordance with the constitutional types as defined in Ayurveda (Thompson, 2005). One of the early studies in this regard has reported that the healthy individuals with *Vata*, *Pitta* and *Kapha Prakriti* exhibited a relative preponderance of blood Cholinesterase, Monoamine oxidase and Histaminase activity, respectively (Udupa et al., 1975). We, in one of our previous studies have reported that individuals having *Pitta* as a contributing component to their *Prakriti*, tend to show a significant rise in diastolic blood pressure immediately after isotonic exercise in comparison to others indicating a possible higher sympathetic activity (Tripathi et al., 2011). Considering the fact that certain autonomic responses might vary in accordance to age and gender of an individual, it was logical for us to hypothesise that these responses might also vary according to *Prakriti* (Manor et al., 1981; Moodithaya and Avadhany, 2009; Moodithaya and Avadhany, 2012). However, there are no studies in this area reporting a possible link between *Prakriti* and autonomic responses. If this kind of a relationship is confirmed, it would, apart from being helpful in predicting the susceptibility of an individual to certain health conditions, also prove beneficial in determining one's constitution by providing some objective and easy-to-conduct laboratory tests. This may be of value given the fact that the process of determining one's *Prkariti* by itself is a challenging task (Kurande et al., 2013; Kurande et al., 2013; Tripathi et al., 2011).

With this background, we planned the present study to investigate a possible relationship between certain autonomic responses and *Prakriti*. We hypothesized that people belonging to *Kapha*-dominant *Prakriti* might have a higher parasympathetic activity because of the specific attributes of *Kapha* such as *Manda* (slow), *Guru* (heavy), *Snigdha* (fatty/oily), *Sandra* (dense) and *Stimita* (rigid). Similarly, we hypothesized that individuals with *Vata* dominant *Prakriti* may have a higher sympathetic activity because of the attributes such as *Laghu* (light), *Sukshma* (minuscule), *Cala* (mobile), and *Shighra* (swift) (Dubey et al., 2015).

MATERIALS AND METHODS

The approval from the institutional ethics committee was obtained before starting the study.

Study Population

The population for the present study was defined in terms of students who were aged between 17 - 35 years and registered under various courses of study at our institution.

Sampling and inclusion criteria

The students were informed about the study in their classrooms through verbal announcements. The details of the study were explained to them and their voluntary participation in the work was solicited. After obtaining the written consent from those who responded to our request, a thorough clinical examination was carried out to confirm that they were clinically healthy. A detailed pro-forma was used to record the findings of the interview that included history taking and physical examination. Those who gave no history of any acute /chronic illnesses, or did not complain of any physical / psychological symptoms, and those who were found to be 'within the normal limits' on all parameters of systemic physical examination, were defined as 'clinically healthy' and were included in the study. Blood biochemistry or hematology parameters were not assessed. Students with obesity were excluded (one volunteer).

Table 1. Percentage-wise distribution of Doshik contribution in volunteers belonging to different groups

Groups	VATA (in %) (Mean ± SD)	PITTA (in %) (Mean ± SD)	KAPHA (in %) (Mean ± SD)
Vata (n = 29) (16 male, 13 female)	55.07 ± 12.077	27.28 ± 12.895	33.03 ± 15.907
Pitta (n = 24) (14 male, 10 female)	24.04 ± 13.678	52.92 ± 12.786	35.38 ± 13.723
Kapha (n = 53) (39 male, 14 female)	29.51 ± 13.269	30.36 ± 14.468	56.49 ± 12.788
Inter group comparison One-Way ANOVA	F = 47.421 $p < 0.001$	F = 28.181 $p < 0.001$	F = 34.551 $p < 0.001$

Assessment of *Prakriti*

There are quite a few difficulties that have been reportedly encountered in determining one's Ayurveda constitution (*Prakriti*). The age, physical and psychological status of the individual along with the season prevailing while assessing one's constitution are the major factors that tend to distort the outcome of this exercise (Tripathi et al., 2011). For instance, elderly people are likely to exhibit dominant features indicative of *Vata* such as dry and wrinkled skin. These features of *Vata* are likely to be exhibited dominantly during extreme winters as well. Differences in the subjective perceptions of the physicians also can make the assessment ambiguous resulting in high inter-rater variability (Kurande et al., 2013). The absence of definite criteria for designating one's constitution to be either due to a single *Dosha* (*Eka-doshaja*) or due to two *Doshas* (*Dvandvaja*) is another problem (Tripathi et al., 2011). Scarcity of standardised and validated tools for assessing *Prakriti* makes the situation even worse. Most of the tools available today are either based on too many textbooks or require physician-participant interaction in the form of a personalized interview and a detailed physical examination. This situation has led to the problems such as: lengthy and time-consuming questionnaires, inclusion of contradictory statements, and unnecessary divulgence of personal details by the participants (Tripathi et al., 2011).

To avoid these problems, the latest version of the 'Self assessment questionnaire for determining *Prakriti'* designed by our team was used to assess *Prakriti* of the volunteers (Tripathi et al., 2010). This tool has been already validated and is available in the public domain. This was the tool that originally provided us with some insights related to cardiovascular reactivity in relation to *Prakriti* (Tripathi et al., 2011).

This tool uses simple questions or statements that reflect each trait / feature as described in *Charaka Samhita* alongside the specific attribute of a given *Dosha*. The respondents were asked to record their agreement or disagreement with the statement/question in the form of "yes" or "no." After having completed the questionnaire, the volunteers were asked to calculate the percentage of each *Dosha* and report it. They were not asked to submit the filled-in questionnaire for reasons that have been discussed in our earlier paper (Tripathi et al., 2011).

We determined the *Prakriti* of each individual based on traditional approach of interview too. The first author of this

Table 2. Distribution of the whole sample (n = 106) according to the score-range for *Vata*, *Pitta* and *Kapha*

Score range (in %)	Distribution of volunteers according to *Vata* scores	Percent	Distribution of volunteers according to *Pitta* scores	Percent	Distribution of volunteers according to *Kapha* scores	Percent
0 - 25	35	33.0	32	30.2	17	16.0
26 - 50	54	50.9	60	56.6	42	39.6
51 - 75	14	13.2	14	13.2	44	41.5
76 - 100	3	2.8	0	0	3	2.8
Total	n = 106	100.0	n = 106	100.0	n = 106	100.0

report did this exercise. He is an institutionally trained graduate and certified physician in Ayurveda and was undergoing his postgraduate training during this study. He did not have access to the scores reported by the volunteers in response to the tool that was administered. Only the corresponding author had access to this information. We did not consider the question of inter-rater variability as the two methods were of different nature and hence, were not comparable. Only when the most dominant *Dosha* contributing to one's *Prakriti* assessed through both these methods matched, the volunteer was included in the study. 17 volunteers (11 males and 6 females) were excluded because of this criterion. One hundred and six volunteers (69 male and 37 female) fulfilled these requirements and were registered for the study.

Performing the autonomic function tests

All the registered volunteers (n = 106) underwent the following tests to record cardiovascular and pupillary responses. The tests related to pupillary reactions were carried out in the noon hours (11 am to 1 pm) whereas those related to cardiovascular responses were carried out in the evening hours (4 pm to 7 pm). However, due to some practical difficulties, we could not record the pupil cycle time in 5 enrolled volunteers, rendering the total sample size in this case to 101.

Cold pressor response

The test is conducted in following steps:
1) The test is explained to the subject and he/she is made to sit on a chair comfortably. The baseline blood pressure is recorded.
2) The subject is asked to immerse one hand up to the level of wrist in cold water maintained at 4 to 5℃ for 2 min. The Blood Pressure (BP) is recorded from the other arm at 30 sec intervals.
3) The maximum increases in systolic and diastolic pressures are noted and compared with the baseline readings.

The Systolic Blood Pressure (SBP) normally increases by 16 - 20 mmHg, while the Diastolic Blood Pressure (DBP) normally increases by 12 - 15 mmHg on an average. Reduced Sympathetic activity is indicated by a lesser than 16 mm Hg rise in SBP and lesser than 12 mm Hg rise in DBP (Ghai, 2007; Noronha et al., 1981).

Standing-to-lying ratio (S/L ratio)

When a normal person lies down from a standing position, there is at first a rise in Heart Rate (HR) which then is slowed down. This rise and fall of HR is due to changes in the vagal tone. The test is performed in following steps:
1) The procedure is explained to the subject. ECG leads are connected for recording lead II. The subject is asked to stand in the upright position quietly for two minutes and without taking any support is then asked to lie down supine.
2) ECG is recorded for 20 beats before and for 60 beats after lying down. The point of change of position on the ECG paper is noted.
3) Calculation of S/L ratio: The average of R-R interval during 5 beats before lying down is noted and the shortest R-R interval during 10 beats after lying down is also noted down. Any abnormally low ratio indicates parasympathetic insufficiency, the normal ratio being > 1 (Ghai, 2007).

Valsalva ratio

Valsalva manoeuvre is defined as the forced expiration against a closed glottis. This straining, associated with changes in HR, is a simple test for baroreceptor activity.
1) The subject is seated on a stool and procedure is explained to him / her. ECG leads and BP cuff are connected to him / her, and the nostrils are closed with a nose clip.
2) The cuff is disconnected from another BP apparatus and the subject is asked to take a deep breath, blow into the manometer and maintain the pressure at 40 mm Hg for 15 s.
3) ECG (lead II) is recorded for 1 minute before the straining, and for 45 s after the release of strain.
4) Calculation of Valsalva Raio: The Valsalva ratio is calculated as the ratio of the longest RR interval after manoeuvre to shortest R-R interval during manoeuvre. A value > 1.21 is taken as normal and a value less than that is indicative of parasympathetic insufficiency (Neumann and Schmid, 1997).

During the straining there is decrease in venous return, fall in cardiac output, and vasoconstriction. The HR increases throughout straining due to vagal inhibition initially and sympathetic activation later. After this, the HR slowly decreases. A failure of HR to increase during straining suggests sympathetic insufficiency, while failure of HR to slow down after the effort suggests a parasympathetic insufficiency (Ghai, 2007).

Pupillary responses

Besides the cardiovascular autonomic activity evaluation tests, the pupil has been recognized to be a useful parameter for the study of the physiology of autonomic nervous system. It has exclusively autonomic innervations, and is accessible in vivo to direct influences of physical and chemical agents (Cahill et al., 2001)

Stimulation of the parasympathetic division leads to the contraction of the constrictor muscles of the pupil resulting in miosis. On the other hand, stimulation of sympathetic nerves causes contraction of dilator pupillae resulting in mydriasis (Patel, 1999). Various methods have been used to measure pupillary functions, however, the pupil cycle time and the pupil diameter measurement in light and dark are the useful ones.

Pupil size

We captured the photographs of right and left eyes of the subjects from a uniform distance of 1.5 feet with the Nikon coolpix 6500 camera mounted on a tripod. We also managed to set each subject's image with uniform 4× optical zoom. For the measurement of light-adapted pupil size, we captured the eye image in the 40 watt tube-light illumination from a fixed direction. For the measurement of dark-adapted pupil size, we captured the image in darkroom by switching the lights off. We waited for 30 sec after switching off the lights and thereafter, we captured the image of the eye using an inbuilt flash light with camera set at shutter speed of 1/125. After capturing the image we transferred this image on to the computer and measured the photographic corneal size and photographic pupil size with the Vernier scale. We then calculated the pupil size using the following algebraic formula:

$$\text{Pupil size} = \frac{\text{Actual Corneal Size x Photographic Pupil Size}}{\text{Photographic Corneal Size}}$$

Where, actual corneal size was directly measured by placing the Vernier scale in front of the subject's eye.

Pupil cycle time

The pupil cycle time was measured in both the eyes using a slit lamp and a connected computer with video recording facility. This is a modification of the method described by Miller and Thompson (Miller and Thomson, 1978). Intensity of illumination was kept fixed for the entire study. The volunteer was comfortably seated at the slit lamp in a dimly lit room. He/she removed his/her spectacles if he/she wore one. A 0.5 mm thick slit beam of light was focussed on to the pupillary margin. The beam was then adjusted in a manner so that half of the slit fell on iris and half entered into the pupil. Pupil contracted due to retinal stimulation and prevented further entry of light in the eye. With the retina now in darkness, the pupil dilates to allow the entry of light into the eye, thus setting up persistent oscillations. 30 s of time was fixed for capturing the pupillary oscillation video in the computer. We then counted the number of oscillations of pupil per 30 s and calculated the average time taken for each cycle. The average time taken was then expressed in terms of milliseconds.

For comparing the various mean readings of different tests among different *Prakriti* groups, One-way ANOVA was applied, followed by the post hoc test, namely, the Least Significant Difference (LSD) test, for pair-wise group comparison. Wherever the data did not follow the normal distribution, (as a general rule of thumb, whenever the standard deviation exceeded half of the mean) Kruskal Wallis test was applied. The Mann-Whitney test was applied to test the significance of difference between two groups whenever Kruskal Wallis test gave significant results. We had to go for these non –parametric tests in the case of maximum increase in systolic and diastolic BP during cold pressor test. $p < 0.05$ was considered as statistically significant. As the sample was a homogenous group of healthy volunteers, we did not go for descriptive statistics.

RESULTS

After administering the self-assessment tool to determine *Prakriti* among the volunteers, we observed that no volunteer had scored zero for any *Dosha*. In other words, each volunteer had scored at least some points for each *Dosha*. Therefore, we could not name any class of volunteers to be strictly *'Ekadoshaja'* (*Prakriti* with single *Dosha*) or *'Dvandvaja'* (*Prakriti* with two *Doshas*). Similarly, we found no volunteer who scored equal scores for all the three *Doshas* and, hence, there was no *'Samadoshaja'* individual in our sample either. Therefore, we decided to classify the sample into three groups based on the primary *Dosha* (most dominant *Dosha*) that contributed to one's *Prakriti*. Table 1 shows that out of 106 volunteers, the maximum number (50%) of volunteers had *Kapha* as the primary *Dosha* while minimum number (22%) of volunteers had *Pitta* as the primary *Dosha*. Table 1 also shows that the mean percentage scores for primary *Dosha* in one group were significantly greater ($p < 0.001$) than the mean percentage scores for the same *Dosha* in other two groups. Table 2 gives the details of distribution of the whole sample (n = 106) according to the score range for *Vata, Pitta* and *Kapha* separately.

The consolidated Table 3 shows the results of all the tests, except for pupil cycle time which are shown in Table 4. From the Table 3 it can be seen that the maximum increase in systolic and diastolic blood pressure during the cold exposure varied significantly as per primary *Dosha,* the increase being significantly higher in *Vata* group in comparison to *Kapha* group in both the cases ($p = 0.000$ and $p = 0.021$ respectively). However, the maximum increase in diastolic BP was significantly greater in *Vata* group in comparison to *Pitta* group too ($p = 0.046$). The S/L ratio significantly varied as per primary *Dosha*, the ratio being significantly greater in *Kapha* group in comparison to *Vata* ($p = 0.024$) group. The Valsalva ratio significantly varied as per primary *Dosha*, the ratio being significantly lower in *Pitta* group in comparison to *Vata* and *Kapha* groups ($p = 0.035$ and $p = 0.000$ respectively). The right pupil diameter in light varied significantly as per primary *Dosha*, the diameter being lower in *Kapha* group in comparison to *Pitta* and *Vata* groups ($p = 0.002$ and $p = 0.036$ respectively). Similarly, the left pupil diameter in light too varied significantly as per primary *Dosha*, the diameter being lower in *Kapha* group in comparison to *Pitta* and *Vata* groups ($p = 0.007$ and $p = 0.035$ respectively).

Table 4 suggests that the pupil cycle time varied significantly in right eye as per primary *Dosha* group, the mean cycle time being greater in *Kapha* group in comparison to *Pitta* group ($p = 0.026$). Similarly, the pupil cycle time varied significantly in the left eye too as per primary *Dosha* group. In this case too, the mean cycle time was greater in *Kapha* group in comparison to *Pitta* group ($p = 0.036$).

DISCUSSION

The tool that we have used in the present study assumes that each *Dosha* can express itself in a person to its fullest extent (100%) and calculates the percentage expression of that *Dosha* on 'absolute' basis unlike some other popular tools available for assessing *Prakriti* such as AyuSoft, which calculate the percentage contribution of each *Dosha* on a 'relative' basis (AyuSoft, a decision support software developed by C-DAC, 2005).

In this kind of relative calculation, if the score-wise contributions of *Vata*, *Pitta* and *Kapha* in an individual are, say, 5, 10 and 5 respectively, the final result displayed will be: *Vata*-25%, *Pitta*-50% and *Kapha*-25%. Therefore, when this kind of a tool expresses the contribution of a *Dosha* to be 50%, it need not necessarily mean that the concerned *Dosha* expresses 50% of the total traits ascribed to it in the classical Ayurveda textbooks. This is because, the denominator used in such a calculation is not the maximum 'attainable' scores for that *Dosha*, rather, it is the sum of the total scores 'attained' for all the three *Doshas* by that individual. This calculation ignores the total number of traits (i.e., the maximum attainable scores) 'ascribed' to a *Dosha*, but only considers the total number of scores 'attained' by an individual for each *Dosha* for final analysis of the results.

In the present tool that we have used in our study, however,

Table 3. Variables of Autonomic functions in relation to Primary *Dosha* of the participants

	Primary Dosha of participants			Between group comparison	Significant pairs
	Vata (n = 29)	Pitta (n = 24)	Kapha (n = 53)	F: One Way ANOVA χ2: Kruskal Wallis test	Post hoc test (LSD) / Z: Mann-Whitney test
Cold Pressor Test - Blood pressure (mmHg)					
Pre-test Systolic BP (mean ± SD)	117.66± 10.171	119.58 ± 12.594	120.30 ± 12.306	F = 0.472, *p* = 0.625	-
Maximum increase in Systolic BP during Cold Exposure (mean ± SD)	18.34 ± 11.881	14.17 ± 11.999	10.04 ± 7.227	χ2 = 12.212, *p* = 0.002	Vata Vs Kapha Z = 3.567, (*p* = 0.000)
Pre-test Diastolic BP (mean ± SD)	75.10 ± 8.922	78.58 ± 9.297	79.55 ± 9.246	F = 2.241, *p* = 0.111	-
Maximum increase in Diastolic BP during Cold Exposure (mean ± SD)	14.83 ± 8.220	10.83 ± 7.817	10.36 ± 6.892	χ2 = 6.144, *p* = 0.046	Vata Vs Pitta Z = 2.000, (*p* =0.046)
					Vata Vs Kapha Z = 2.307, (*p* =0.021)
S/L Ratio					
Average R-R during 5 beats before lying down (mm) (mean ± SD)	16.43 ± 1.836	16.28 ± 1.719	17.20 ± 2.309	F = 2.215, *p* = 0.114	-
Shortest R-R during 10 beats after lying down (mm) (mean ± SD)	15.76 ± 1.455	15.58 ± 1.792	15.85 ± 1.586	F = 0.228, *p* =0.797	-
S/L ratio (mean ± SD)	1.04 ± 0.059	1.05 ± 0.076	1.08 ± 0.087	F = 3.288, *p* = 0.041	Vata Vs Kapha (*p* = 0.024)
Valsalva Ratio					
Longest R-R after the strain (mm) (mean ± SD)	19.86 ± 3.533	19.29 ± 3.617	21.33 ± 4.257	F = 2.698, *p* = 0.072	-
Shortest R-R during the strain (mm) (mean ± SD)	15.38 ± 3.005	16.67 ± 2.944	15.45 ± 2.770	F = 1.733, *p* = 0.182	-
Valsalva Ratio (mean ± SD)	1.3079 ± 0.210	1.1642 ± 0.188	1.3928 ± 0.279	F = 7.331, *p* = 0.001	Vata Vs Pitta (*p* = 0.035) and Pitta Vs Kapha (*p* = 0.000)
Pupil Diameter (mm)					
Right Eye in light (mean ± SD)	4.8714 ± 0.891	5.0746 ± 0.445	4.5243 ± 0.693	F = 5.621 , *p* = 0.005	Vata Vs Kapha (*p* = 0.036) and Pitta Vs Kapha (*p* = 0.002)
Right Eye in dark (mean ± SD)	5.7786 ± 0.758	5.9375 ± 0.645	5.6549 ± 0.619	F = 1.520, *p* = 0.224	-
Left Eye in light (mean ± SD)	4.9459 ± 0.922	5.0900 ± 0.609	4.5700 ± 0.731	F = 4.656, *p* = 0.012	Vata Vs Kapha (*p* = 0.035) and Pitta Vs Kapha (*p* = 0.007)
Left Eye in dark (mean ± SD)	5.8417 ± 0.706	5.9083 ± 0.615	5.6851 ± 0.604	F = 1.217, *p* = 0.300	-

the results are derived in terms of absolute percentage values, where, the calculation of contribution of one *Dosha* does not depend on the contribution of other *Doshas*. Therefore, if this tool expresses the contribution of a *Dosha* to be 50%, it definitely means that the concerned *Dosha* expresses 50% of the total traits ascribed to it.

Though, 'which kind of a tool is ideal and suitable for research' is a matter of debate, the absolute expression has certain edge over the relative expression because it gives a precise idea about the extent of expression of a particular *Dosha*. Further, the results obtained by this method can always be converted into 'relative' expression, if a researcher desires so.

From a point of scientific curiosity, we also tried classifying the sample on the basis of 'two most dominant *Doshas'*. However, while doing so, we encountered a question as to how should we group the individuals with same *Dosha* composition but with varying dominance? For instance, if we group people with '*Vata-Kapha'* and '*Kapha-Vata'* into a single group, the significance of dominance would be lost, compromised and even may get nullified. Similarly, if we classify '*Vata-Kapha'* and '*Kapha-Vata'* into two different groups, there would be a total of ten groups, which is again, against the recommendation of the classical textbooks of Ayurveda. Therefore, we concluded that the classification of the sample by most dominant *Dosha* (primary *Dosha*) was the most rational one.

The autonomic nervous system has two components: a. Sympathetic, and, b. Parasympathetic. The sympathetic activity is dominant during emergency "fight-or-flight" situations and during exercise. The effect of sympathetic stimulation under such circumstances is to prepare the body for vigorous physical activity by increasing the blood flow to the skeletal muscles. The parasympathetic system, on the other hand, is dominant during quiet, resting conditions. The effect of the parasympathetic system in such situations is to conserve energy and to regulate basic body functions such as digestion, and, an optimal, moderate heart rate (McCorry, 2007).

Table 4. Variables of pupil cycle time in relation to Primary *Dosha* of the participants

	Primary Dosha of participants (Mean ± SD)			Between group comparison	Significant pairs
	Vata (n = 29)	Pitta (n = 24)	Kapha (n = 48)	F: One Way ANOVA	
Pupil Cycle Time (milliseconds)					
Pupil cycle time in right eye (mean ± SD)	921.14 ± 101.209	890.33 ± 106.875	991.52 ± 111.110	F = 8.310, *p* = 0.000	Kapha Vs Pitta (*p* = 0.026)
Pupil cycle time in left eye (mean ± SD)	924.72 ± 94.284	891.96 ± 97.767	982.92 ± 116.992	F = 6.541, *p* = 0.002	Kapha Vs Pitta (*p* = 0.036)

According to the concept of constitution in Ayurveda,*Kapha* people are usually less dynamic, more stable, more relaxed and are more lethargic; whereas, the *Vata* and *Pitta* people are more excitable, anxious, aggressive, and are often volatile. These traits prompted us to propose a hypothesis that, *Vata* and *Pitta* individuals may be sympathetically dominant while the *Kapha* individuals may be parasympathetically dominant (Low et al., 2013).

As the results of Cold Pressor Test indicate, the sympathetic activity in *Vata* group is higher than that in *Kapha* group as far as Cold Pressor Test is concerned. Similarly, the results of S/L ratio indicate that the corresponding sympathetic activity in *Vata* group is higher than that in *Kapha* group. The results of Valsalva ratio suggest that the corresponding parasympathetic activity in *Pitta* group is lower than that in *Vata* and *Kapha* groups. Further, the Pupil Diameter in light was relatively smaller in *Kapha* group in comparison to *Pitta* and *Vata* groups suggesting that the corresponding sympathetic activity may be relatively higher in *Vata* and *Pitta* groups in comparison to *Kapha* group. However, since the differences in the mean pupil diameter were too small to have any clinical significance, a similar study in a large sample is recommended. The results of Pupil Cycle Time suggest that the corresponding ocular parasympathetic activity is relatively lower in *Kapha* group in comparison to *Pitta* group. This is in accordance with the observation recorded in an earlier study that cardiac parasympathetic activity may be negatively correlated with pupillary parasympathetic activity (Moodithaya and Avadhany, 2009). It is to be noted however, that all the results mentioned above were within the physiological limits in all the volunteers.

The overall impression that we could gather from this study is that *Vata* and *Pitta* individuals may have a relatively dominant sympathetic activity whereas *Kapha* individuals may have a relatively dominant parasympathetic activity (within the physiological limits) when it comes to cardiovascular responses. However, when the pupil cycle time is considered, the opposite seems to hold true, i.e., *Kapha* individuals may have a relative dominance of sympathetic activity than *Pitta* individuals.

A relatively small sample size of the study limits the generalizability of the results to a larger population. Volunteers belonging to both the genders were included in the study; hence, it ignores any possible gender differences with respect to autonomic responses.

CONCLUSION

The study suggests that people with *Kapha* as the most dominant *Dosha* tend to have either a higher parasympathetic activity or a lower sympathetic activity in comparison to other groups in the context of cardiovascular reactivity. The study also suggests a possibility that autonomic function tests, especially the ones related with cardiovascular reactivity and pupillary responses may serve as indicators to identify the primary *Dosha* contributing to the *Prakriti* in an individual. Further, the present model of grouping people depending on their 'primary *Dosha'* seems to be a useful and practical approach that researchers may like to explore, while investigating various aspects of *Prakriti*.

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CONFLICT OF INTEREST

The present institutional affiliation of the first author, Sunil Buchiramulu Rapolu, has no relationship whatsoever with the present study. This study was performed when he was working as a post-graduate scholar at Banaras Hindu University, Varanasi.

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