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RESEARCH ARTICLE

The Behavioural Analysis of the *Dosha* Pattern Derived from Associated Current Diseases and Symptoms along with Parkinson's Disease

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Abstract

Parkinson's Disease (PD) in *Ayurveda* can be correlated with *Kampavata* or Tremor, which is one of the four cardinal symptoms of PD. Along with this tremor, various other symptoms or diseases can manifest along with PD. In this research, we considered 43 different diseases and symptoms for analysis of the current health status of PD. Initially, we marked each disease and symptom with its respective disturbed *Dosha*. Next, we calculated the cumulative *Dosha* score for each individual *Tridosha* based on the diseases and symptoms a person is currently suffering from along with PD. Finally, different *Dosha* patterns were identified through different statistical analyses. We observed the variation of *Tridosha* due to changes in Body Mass Index (BMI) and age. The results obtained successfully established the association of various current health-related *Doshas* with PD compared to controls. The positive significant differences in mean *Dosha* score were observed for *Vata* and *Kapha Dosha* for PD compared to control. Significant *Dosha* variations have been observed for PD in relation to different BMI categories and age categories. There is a possibility that *Dosha* will become distorted when a subject's weight varies from normal weight to underweight or obese. Likewise, the probability of *Dosha* vitiations increases with age. The *Vata Dosha* with Odds Ratio (OR) 1.036 (1.016-1.058), *Pitta Dosha* OR 0.814 (0.784-0.846) and *Kapha Dosha* OR 1.280 (1.229-1.332) shows the probability of all *Doshas* occurring in Parkinson's disease.

Keywords: *Ayurveda*, BMI, *Kampavata*, Parkinson's Disease, *Tridosha*

1. Introduction

The basic process of diagnosing a disease in *Ayurvedic* literature has been done through the *Dosha* determination of the subject[1]. This *Dosha* determination was made to identify the subjects Prakriti (Constitution) and *Vikriti* (Deviation)[1,2]. The comparison between *Prakriti* and *Vikriti* helps us to understand the cause of disease manifestation[1,2]. The determination of the *Dosha* was done through various methods such as physiological, psychological, and clinical observation through self-assessment questionnaires, analysis of medical history and also the analysis of associated diseases and symptoms that a subject currently has with the main disease for which the subject mostly feels uncomfortable[2,3]. In this research, we will discuss the *Dosha* variation due to other diseases or symptoms that a subject may develop alongside PD.

PD is a neurodegenerative disease that occurs mainly in older people due to the degeneration of the dopaminergic neuron in the substantia nigra pars compacta in the area of the basal ganglia, which mainly controls the movement of the body[4]. No such disease is found in contemporary *Ayurvedic* literature to be fully consistent with PD, although the tremor symptom of PD can be correlated with *Kampavata* in contemporary *Ayurvedic* literature[5,6].

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There are more than 75% of PD patients with resting tremor symptoms and almost 60% of PD patients with symptomatic action tremor[7], but the tremor is not only the symptom of PD, along with bradykinesia, stiffness and postural instability, which are the other three cardinal symptoms of PD besides tremor[8]. Therefore, diagnosing PD based on *Kampavata* is always not as truthful to the disease itself. These factors lead us to this research to find different possible *Dosha* factors based on the current health condition of PD.

By analyzing current health-related diseases and symptoms, we can generate a pattern of disease behaviour that can contribute to understanding the etiology of the disease. To achieve this goal, we considered 43 different diseases and symptoms that a patient with PD may have. Determining the *Doshas* based on these current health conditions can help us understand PD behaviour. Successfully establishing the association and pattern of *Dosha* behaviour due to the current health-related diseases and symptoms of PD will be our main focus in this research. Also, we will try to find the significant variance of *Dosha* behaviour in relation to the subjects' BMI and age.

2. Methods

2.1 Study Design and Participants

The study participants selected in this study and their respective data were obtained from the Fox Insight (FI) dataset sponsored by the Michael J. Fox Foundation. The FI data set consists of different types of data related to PD[9]. Here, we have taken the data labeled with 'your current health'. This data section contains information on the subject's current health status in relation to diseases and symptoms other than PD. We looked at a total of 43 different types of diseases and symptoms that a subject currently has along with or without PD. The list of selected diseases and symptoms is shown in Table 1. In addition to these data, we considered some other data related to sex, age, height in centimeters, weight in kilograms of the subjects, and the data identifying PD and control subjects.

Initially, the data were preprocessed using IBM SPSS version 28 to remove missing values, calculate new variables by other variables and recode new variables based on different conditions. We have defined some more variables as the BMI contains the information about the subject BMI which is calculated based on the information from the subject's height and weight using the formula[10],

$$\text{BMI} = \frac{\text{Weight in Kgs}}{\left(\frac{\text{Height in Cm}}{100}\right)^2}.$$

Next, we defined another categorical variable called BMI Category derived from the values obtained from the variable BMI by conditions such as underweight with BMI < 18.5; normal weight with BMI ≥ 18.5 and < 25; pre-obese with BMI ≥ 25 and < 30; and obese with BMI ≥ 30[10]. Depending on the age of the subject, we defined another categorical variable called the 'age category' where the age of subjects < 50 have been labeled as early-onset; age ≥ 50 and < 70 as mid-onset; and age ≥ 70 as late-onset[11], but this variable was only flagged for PD subjects, not controls, to identify PD age onset[11].

2.2 Determination of *Dosha* Score

First, all selected 43 diseases and symptoms with their caused implicated disturbed *Doshas* were marked positive 1 depending on the available *Ayurvedic* literature as shown in Table 1. Next, the cumulative *Dosha* score for each individual *Dosha* type was calculated depending on the diseases involved or symptoms and their respective *Dosha* score appeared for each subject in our dataset. We have used these cumulative *Dosha* scores of *Vata*, *Pitta,* and *Kapha Doshas* with different subject categories as defined here to find the pattern of the *Dosha* that appears through the statistical analysis.

2.3 Statistical Analysis

We performed various statistical analyzes to find the *Dosha* pattern using IBM SPSS version 28. First, the mean with standard deviation and the median with range were calculated for each individual cumulative *Dosha* score for both uncategorized and gender-categorized. Mean comparisons were performed between control and PD subjects, between different BMI categories, and between different age categories. We also calculated Pearson's correlation coefficient to obtain the correlation between different subject categories[51]. The association of *Doshas* between PD and control as well as PD male and PD female was

Table 1. List of diseases and symptoms and their respective involved *Doshas* considered for the analysis of the current health status of the subjects besides PD

Disease and Symptom Name		*Vata*	*Pitta*	*Kapha*
Heart Disease	Congestive heart failure[12]	1	0	1
	Valvular heart disease[13]	1	1	1
	Arrhythmia[14]	1	0	0
	Coronary heart disease[15]	1	0	1
	Atrial fibrillation[16]	1	0	1
High Blood Pressure[17]		1	0	0
Lung Disease	Asthma[18]	1	0	1
	Emphysema[19]	1	1	1
	Chronic obstructive pulmonary disease (COPD)[20]	1	0	1
	Pneumonia[21]	1	0	1
	Tuberculosis[22,23]	1	1	1
Diabetes[24,25]		0	1	1
Gastric Disturbance	Acid reflux (GERD)[26]	0	1	0
	Gastritis[27]	1	1	0
	Hiatal hernia[28]	1	0	1
	Ulcer[29]	0	1	0
Kidney Disease (not cancer)	Renal failure[30]	1	1	0
	Cysts in Kidney[31]	1	0	1
	Kidney stones[32]	1	0	1
Liver Disease (not cancer)	Cirrhosis of Liver[33,34]	1	1	1
	Chronic viral hepatitis (Hepatitis C or hep C)[35,36]	0	1	1
	Hepatitis A[37]	0	1	0
	Hepatitis B[38,39]	0	1	0
Blood Disease (not cancer)	Anemia[40]	0	1	0
	Thalassemia[41]	1	1	0
	Sickle cell disease[42]	1	1	0
Cancer	Bladder Cancer[43,44]	1	1	1
	Breast Cancer[43,44]	1	1	1
	Colon Cancer[43,44]	1	1	1
	Leukemia Cancer[43,44]	1	1	1
	Liver Cancer (Hepatic cancer)[43,44]	1	1	1
	Lung Cancer[43,44]	1	1	1
	Lymphoma Cancer[43,44]	1	1	1
	Melanoma Cancer[43,44]	1	1	1
	Prostate Cancer[43,44]	1	1	1
	Thyroid Cancer[43,44]	1	1	1
	Skin Cancer (non-melanoma)[43,44]	1	1	1
	Uterine Cancer[43,44]	1	1	1
Depression[45]		1	0	0
Arthritis	Osteoarthritis/ degenerative arthritis[46,47]	1	0	0
	Rheumatoid arthritis[47,48]	1	0	0
Back Pain[49]		1	0	1
Anxiety[50]		1	0	0

'1' is represented as an involved *Dosha* and '0' is represented as an uninvolved *Dosha*

obtained by logistic regression and the respective odds ratios were given[52]. Finally, all the resulting reports were presented in various tables and figures. The level of significance for each statistical analysis was set at $p<0.05$. All methods used in this study were performed using standard methods.

3. Results

After completing the pre-processing, we have a total of n = 37,457 subjects, where, we have n = 27,372 PD subjects and n = 10,085 control subjects. After gender

categorization as male and female, we have a total of n = 15,448 male PD subjects, n = 11,924 female PD subjects, n=2,525 male controls, and n = 7,560 female controls, who became our main study cohort for further analysis. We found 80.19% of PD persons with disturbed *Vata Dosha*, 31.16% of PD persons with disturbed *Pitta*

Table 2. Mean with standard deviation and median with a range of cumulative *Dosha* score

			Vata	***Pitta***	***Kapha***
Control	Male	Mean (Std. Deviation)	1.62 (1.71)	0.39 (0.72)	0.62 (0.97)
		Median (Range)	1 (12)	0 (7)	0 (8)
	Female	Mean (Std. Deviation)	1.87 (1.77)	0.43 (0.77)	0.59 (0.93)
		Median (Range)	2 (14)	0 (7)	0 (9)
	Total	Mean (Std. Deviation)	1.81 (1.76)	0.42 (0.76)	0.6 (0.94)
		Median (Range)	1 (14)	0 (7)	0 (9)
PD	Male	Mean (Std. Deviation)	1.96 (1.71)	0.41 (0.73)	0.8 (1)
		Median (Range)	2 (14)	0 (9)	1 (13)
	Female	Mean (Std. Deviation)	2.2 (1.79)	0.44 (0.78)	0.74 (0.96)
		Median (Range)	2 (13)	0 (8)	1 (10)
	Total	Mean (Std. Deviation)	2.07 (1.75)	0.43 (0.75)	0.77 (0.98)
		Median (Range)	2 (14)	0 (9)	1 (13)

*Due to the high variance of Mean in all *Dosha* score we have calculated the mediate

Table 3. Independent sample t-test of cumulative means of *Vata*, *Pitta*, *Kapha Dosha* between PD and control

		Levene's Test for Equality of Variances		**t-test for Equality of Means**							
		F	**Significance**	**t**	**Degree of freedom**	**Significance**		**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
						One-Sided p	**Two-Sided p**			**Lower**	**Upper**
All Participants											
Vata	Equal variances not assumed	7.006	0.008	12.658	17855.394	0.000	0.000	0.259	0.020	0.219	0.299
Pitta	Equal variances assumed	0.004	0.948	1.026	37455	0.153	0.305	0.009	0.009	-0.008	0.026
Kapha	Equal variances not assumed	7.651	0.006	15.561	18741.083	0.000	0.000	0.173	0.011	0.151	0.194
Male Participants											
Vata	Equal variances assumed	3.315	0.069	9.389	17971	0.000	0.000	0.344	0.037	0.272	0.416
Pitta	Equal variances assumed	2.114	0.146	1.604	17971	0.054	0.109	0.025	0.016	-0.006	0.056
Kapha	Equal variances assumed	0.225	0.636	8.276	17971	0.000	0.000	0.177	0.021	0.135	0.219
Female Participants											
Vata	Equal variances assumed	2.337	0.126	12.633	19482	0.000	0.000	0.331	0.026	0.280	0.383
Pitta	Equal variances assumed	1.834	0.176	1.408	19482	0.080	0.159	0.016	0.011	-0.006	0.038
Kapha	Equal variances assumed	3.571	0.059	10.512	19482	0.000	0.000	0.147	0.014	0.119	0.174

Dosha, and 51.9% of PD persons with disturbed *Kapha Dosha* based on *Dosha* Score, obtained from the diseases and symptoms a person currently suffers from besides PD. The mean with standard deviation and median with range for all *Tridosha* are given in Table 2 and the mean to t-test comparisons are given in Table 3.

Through bivariate analysis of Pearson's correlation, we found that the *Doshas Vata* (p<0.001) and *Kapha* (p<0.001) are significantly and positively correlated with PD, while, the *Doshas Pitta* (p = 0.305) show no significant differences between PD and have control. The mutual correlation between each *Dosha* has been found with positively significant results for each other, such as: between *Vata* and *Pitta*, *Vata* and *Kapha* and *Pitta* and *Kapha*, the significant values remain p = 0.000. This factor implies that when one of the three *Doshas* increases, it also increases other *Doshas*. In addition, we also found that the mean value of *Vata* (p<0.001) and *Pitta Dosha* (p = 0.001) remains high for female PD compared to male PD. *Kapha Dosha* (p<0.001) remains high in male PD compared to female PD. Similarly, all three *Doshas* for *Vata* (p<0.000), *Pitta* (p<0.001), and *Kapha* (p<0.001) *Dosha* are positively significant with BMI, implying that as the BMI rate increases, so does the *Dosha* score. We also found that all three *Doshas* are positively significant with the age of the subjects, as for *Vata* (p<0.001), *Pitta* (p<0.001), and *Kapha* (p<0.001), stating that all three *Doshas* increase with increasing age. Through this analysis, we also found that

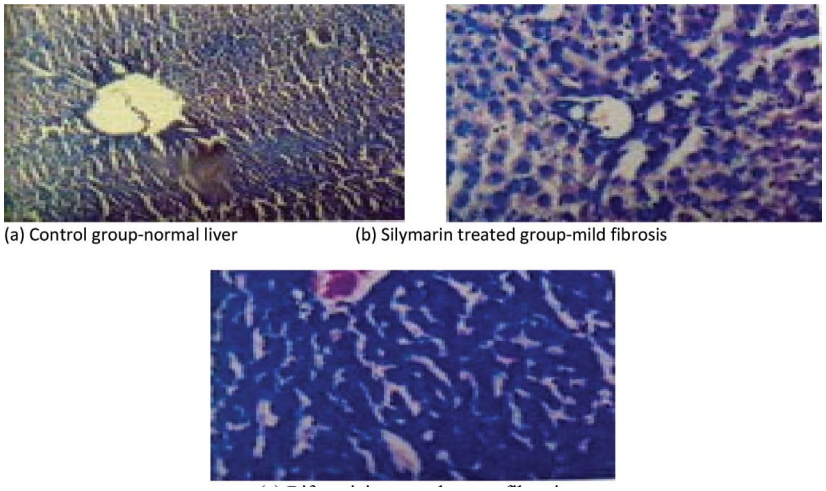

Figure 1. Cluster bar chart with 95% confidence interval of mean *Dosha* values for different BMI categories of PD.

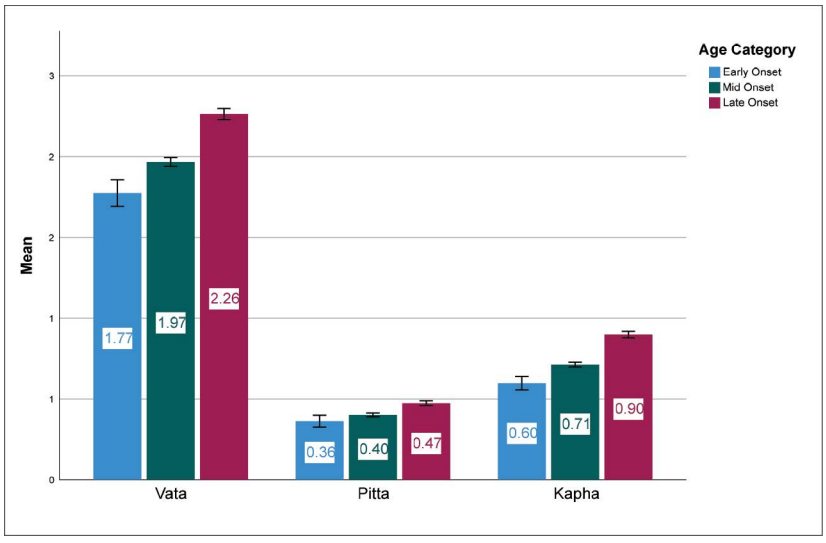

Figure 2. Cluster bar chart with 95% confidence interval of mean *Dosha* values for different age categories of PD.

age was negatively and significantly correlated with BMI ($p<0.001$). Subjects' sex was also negatively and significantly correlated with age ($p<0.001$) and BMI ($p<0.001$). These state that the BMI decreases with increasing age. In female PD, mean BMI and mean age remain lower compared to male PD. The following Figure 1 and Figure 2 show the cluster bar chart with a 95% confidence interval of the mean *Dosha* values between different BMI categories and different age categories of PD respectively.

The bivariate relationship between different *Doshas* for both male and female gender for all BMI categories and age categories was represented by a scatterplot matrix in Figures 3 and 4 respectively.

Binary logistic regression was performed between PD and control for both uncategorized and sex-categorized males and females, and also between male PD and female PD subjects for *Vata*, *Pitta*, and *Kapha Dosha*. The calculated odds ratio with a 95% confidence interval is presented in Table 4.

We performed multinomial logistic regression for different BMI categories and age categories for PD participants. Multinomial logistic regression for BMI categories was performed with respect to normal-weight subjects, while logistic regression for age categories was performed with respect to the early onset of PD. The result of the logistic regression is presented in Table 5.

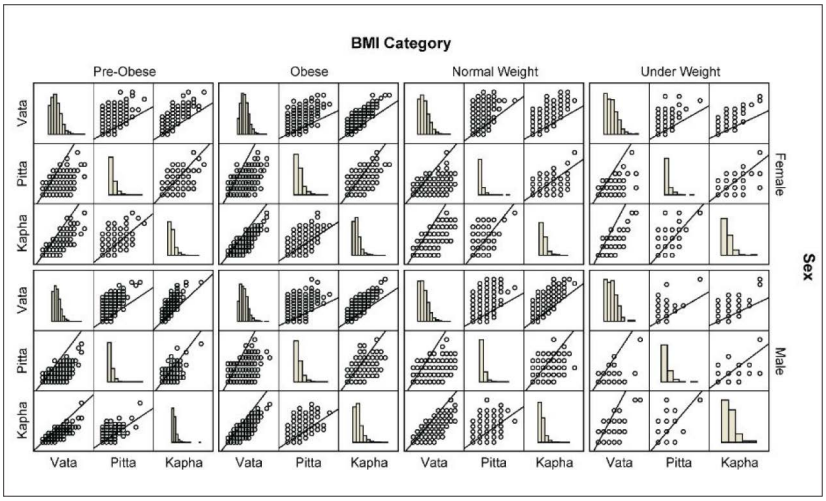

Figure 3. Bivariate relationship between *Doshas* for all BMI categories.

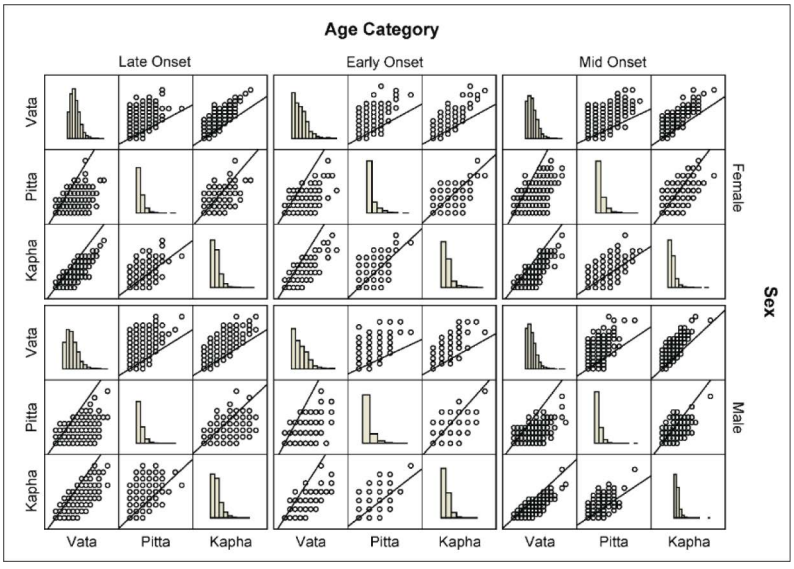

Figure 4. Bivariate relationship between *Doshas* for all age categories.

Table 4. The result of binomial logistics regression between PD and control

	Odds Ratio	95% Confidence Interval		Degree of Freedom	Significance
		Lower	Upper		
PD vs. Control for All Participants					
Vata	1.036	1.016	1.058	1	0.001
Pitta	0.814	0.784	0.846	1	0.000
Kapha	1.280	1.229	1.332	1	0.000
PD vs. Control for Male Participants					
Vata	1.111	1.068	1.155	1	0.000
Pitta	0.836	0.776	0.900	1	0.000
Kapha	1.157	1.074	1.247	1	0.000
PD vs. Control for Female Participants					
Vata	1.114	1.086	1.142	1	0.000
Pitta	0.836	0.797	0.877	1	0.000
Kapha	1.110	1.055	1.168	1	0.000
Female PD vs. Male PD					
Vata	1.257	1.231	1.284	1	0.000
Pitta	1.097	1.054	1.142	1	0.000
Kapha	0.665	0.639	0.692	1	0.000

Table 5. The result of Multinomial logistics regression of different BMI categories and different age categories

		Odds Ratio	95% Confidence Interval		Degree of freedom	Significance
			Lower Bound	Upper Bound		
Multinomial logistics regression of BMI categories in reference with Normal Weight						
Under Weight	***Vata***	1.103	1.023	1.189	1	0.011
	Pitta	1.145	0.980	1.338	1	0.088
	Kapha	0.834	0.716	0.971	1	0.019
Pre-Obese	***Vata***	1.086	1.060	1.113	1	0.000
	Pitta	1.184	1.126	1.245	1	0.000
	Kapha	1.077	1.027	1.130	1	0.002
Obese	***Vata***	1.328	1.292	1.366	1	0.000
	Pitta	1.357	1.286	1.432	1	0.000
	Kapha	1.043	0.990	1.099	1	0.111
Multinomial logistics regression of age categories in reference with early onset						
Mid Onset	***Vata***	1.034	0.990	1.081	1	0.135
	Pitta	0.957	0.877	1.044	1	0.323
	Kapha	1.136	1.040	1.241	1	0.005
Late Onset	***Vata***	1.077	1.029	1.126	1	0.001
	Pitta	0.920	0.842	1.006	1	0.066
	Kapha	1.322	1.208	1.445	1	0.000

4. Discussion

Through this analysis, we found that 80.05% of our study participants, including PD and controls, currently have at least one of our 43 diseases or symptoms. In Parkinson's patients, we found a total of 82.23% of the participants currently have at least one of these 43 diseases and symptoms. In other words, 82.23% of Parkinson's patients have at least one disturbed *Dosha* in addition to Parkinson's disease due to their current health-related diseases or symptoms. After comparing this statistic to our individual *Dosha*, we found that 97.52% of PD patients have at least one *Vata Dosha*, while, 37.89% of PD patients have at least one *Pitta* and 63.12% of PD Individuals exhibit at least one *Kapha Dosha* due to current illnesses or symptoms alongside PD.

The obtained cumulative *Dosha* score of each *Tridosha* for each subject and their respective mean shows that each *Dosha* has a higher mean for PD compared to the control for both uncategorized and categorized by sex male and female. Through the t-test, we concluded that *Vata* and *Kapha Dosha* have significant differences in their mean, but *Pitta Dosha* had no significant differences in mean for both uncategorized and gender categorized. These findings imply that the other diseases and symptoms that have emerged alongside Parkinson's also invoke *Vata* and *Kapha Doshas*.

In the bivariate correlation analysis, we found significant correlations between the individual *Doshas*. The change in *Dosha* behaviour is also observed for the change in BMI and age. Through the cluster bar chat, we can easily observe that *Dosha* variation increases with deviation from the norm weight range to either underweight or obese. But for obese people, the *Dosha* score becomes maximum for all *Tridosha*. This implies that with age, the likely risk of *Dosha* disorders also increases.

Through the scatterplot matrix of both the BMI category and age category, we can see the pattern of *Dosha* score incidence under different conditions for both male and female gender. We have not found such a *Dosha*-*Dosha* relationship with a negative slope. This implies that in all possible states if there is a possibility of vitiation in one *Dosha*, it can affect other *Doshas* as well. The individual slopes of these scatter matrix diagrams show the individual increase pattern of one *Dosha* in relation to another *Dosha*. The diagonal histograms also show the distribution of study participants for each *Dosha*. We can observe that for all *Doshas*, the frequency distribution of the subjects for a low *Dosha* score becomes higher. This means that patients with multiple diseases or symptoms in PD are very rare.

The binary logistic regression between PD and control shows that PD patients show significantly more *Vata* and *Kapha Doshas*. Wherein an increase in *Pitta Dosha* is significantly associated with a reduction in the likelihood of developing PD for both uncategorized and sex-categorized males and females. Comparing female PD and male PD, we found that female PD subjects are significantly more likely to exhibit *Vata* and *Pitta Dosha* than male PD, where *Kapha Dosha* is significantly associated with a reduction in the likelihood of PD in female subjects.

Through multinomial logistic regression for BMI categories, we found that *Vata Dosha* vitiation is positively and significantly more likely to occur in underweight, pre-obese, and obese compared to normal-weight subjects It also states that the likelihood of having a person with underweight PD increases by 10.3%, pre-obese PD by 8.6%, and obese PD by 32.8% compared to normal-weight people with increasing *Vata Dosha*. Similarly, *Pitta Dosha* imbalance is positive and significantly more likely in pre-obese and obese groups compared to normal weight groups. This shows that the likelihood of having a person with pre-obese PD increases by 18.4% and obese PD by 35.7% compared to a normal weighted PD group with increasing *Pitta Dosha*. We found that vitiated *Kapha Dosha* is negatively and significantly likely to be in the underweight category and positively and significantly likely to be pre-obese compared to normal-weighted subjects. This implies that having a subject with underweight PD is 16.6% less likely and having a subject with pre-obese PD is 7.7% more likely than normal-weight subjects with increasing *Kapha Dosha*.

The results of multinomial logistic regression between age categories state that vitiated *Vata Dosha* is positively and significantly likely in late-onset PD compared to early-onset PD. Vitiated *Kapha Dosha* is also positive and significantly likely in mid and late-onset PD compared to early-onset PD. This means that the risk of developing *Vata*-related diseases and symptoms increases in late-onset PD compared to early-onset PD. The likelihood of developing *Kapha Dosha*-related diseases and symptoms increases with both mid and late-onset PD compared to early-onset PD.

In this research, we attempted to ascertain the *Dosha* pattern generated by the current health-related diseases and symptoms along with PD. The derived results were shown with accurate precession of two decimal places generated from large FI data samples. Through the results, we have successfully established the relationships between the current health-related *Dosha* pattern with PD. Although there are several limitations in this research, it can be overcome in future research. This research is mainly based on the quantitative approach, the root cause of this derived pattern has not been discussed. Apart from that, the *Dosha* pattern based on race, ethnicity, and geographic location has not been analyzed. The possible treatments or preventive approaches were not discussed either. This analysis was performed based on the cumulative *Dosha* score obtained from a person's current diseases or symptoms, but the individual impact of each disease or symptom on PD was not discussed.

5. Conclusion

In summary, we have successfully identified the relationship between *Dosha* deviation due to other diseases and symptoms that a patient may develop or suffer from alongside PD. We also recorded the different patterns of *Dosha* deviation due to the changes in subjects' gender, BMI, and age. The images from this research infer that the tendency to develop diseases and symptoms in Parkinson's tries to mainly increase the *Vata* and *Kapha Dosha*. All *Doshas* increase with increasing BMI and age of the subject. This means that if any subjects gain weight alongside Parkinson's disease, there is a higher likelihood of developing other diseases and symptoms. Similarly, aging develops other diseases besides PD that can increase *Dosha* vitiation. There remains a higher likelihood of *Dosha* imbalance for other *Doshas* when any of the three *Doshas* become vitiated. The derived results and their patterns for different conditions lead *Ayurvedic* practitioners to understand the etiology of PD in terms of *Dosha* behaviour, which could help understand PD through the *Ayurvedic* literature.

6. Acknowledgement

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