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Correlation of Nutritional Status with the Severity of Idiopathic Parkinson's Disease

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Abstract: ***Background: Nutrition plays a vital role in both the progression and potential neuroprotection of Parkinson's disease. Objective: To evaluate the nutritional status of patients with idiopathic Parkinson's disease and to investigate its correlation with the severity of the condition. Methods: This study was a cross - sectional observational study conducted over a period from November 2018 to March 2020 in the Department of General Medicine and the Department of Neurology among patients presenting with idiopathic Parkinson's disease. Results: The study involved 50 participants with an average age of 63.9 years. The sample was fairly balanced between those under and over 65 years, with 64% male participants. A significant difference in BMI distribution was observed across Parkinson's disease severity. Anemia was common, affecting over 50% in the early illness group, 73.3% in the moderate group, and all those with severe illness, though this was not statistically significant. Nutrient deficiencies were noted: 10.5% of early illness participants had calcium deficiency, and vitamin D deficiency affected 42.1% in early illness. Folate and vitamin B12 deficiencies were seen in a substantial portion of the sample. Correlations between nutritional factors and Parkinson's severity showed that BMI and hemoglobin were significantly negatively correlated with the Webster score, suggesting that lower BMI and hemoglobin levels are associated with higher disease severity. Age showed a weak, non - significant positive correlation with severity. Other nutrients like calcium, magnesium, albumin, vitamin D, folate, and vitamin B12 showed weak or insignificant correlations with disease severity. Anemia, calcium, magnesium, and vitamin D deficiencies were more prevalent in those with moderate Parkinson's severity, while vitamin B12 deficiency was equally common across severity levels. Conclusion: The study reaffirms the importance of regular nutritional assessments in PD patients, particularly for parameters such as hemoglobin, vitamin D, folate, and B12 levels. Early identification and management of nutritional deficiencies can potentially mitigate symptom severity, improve overall health, and enhance the quality of life.***

Keywords: Nutrition, Parkinson's disease, Brain Bank Criteria, Webster scale, India

1. Introduction

Parkinson's disease (PD) is a chronic, progressive neurodegenerative disorder and the most common form of parkinsonism. It is characterized by clinical features such as bradykinesia, rest tremor, rigidity, and postural instability. [1] The disease primarily arises from the degeneration of dopaminergic neurons in the substantia nigra, resulting in reduced facilitation of voluntary movements, asymmetric rest tremors, motor impairments, and a marked response to dopaminergic therapy. [2] The pathological hallmark of PD includes the presence of α - synuclein - containing Lewy bodies and a progressive spread of Lewy body pathology to neocortical and cortical regions. [3] The prevalence of Parkinson's disease increases with age, affecting approximately 1–2 per 1000 individuals in the general population and about 1% of individuals over 60 years of age. [4]

Malnutrition, a persistent public health challenge in many low - income countries, has been linked to various health complications, including Parkinson's disease. [5, 6] Inadequate food diversity, micronutrient deficiencies (e. g., vitamins, minerals, trace elements), and protein - energy malnutrition are significant contributors to this burden. While malnutrition often affects economically disadvantaged populations, Parkinson's disease related to micronutrient deficiencies is not exclusive to these groups and can also occur in individuals with better economic resources. [7] Importantly, many malnutrition - related neurological disorders, including PD, are preventable with timely intervention. [8]

Emerging evidence suggests that nutrition plays a vital role in both the progression and potential neuroprotection of Parkinson's disease. Epidemiological and biochemical studies have identified specific food components, such as vitamins and minerals, that may influence disease outcomes. [9] Nutritional deficiencies, including deficiencies in serum vitamin D, vitamin B12, folate, calcium, and magnesium, as well as conditions such as anemia and hypoalbuminemia, can impair the structure and functionality of the nervous system. [10] The brain and nervous system require a full complement of essential nutrients and energy to develop and maintain their neuronal and supporting cellular architecture. A deficiency in any of these essential nutrients could exacerbate the neurological decline observed in PD. [11]

Despite the growing recognition of the importance of nutrition in PD, there is a paucity of studies in Indian literature that assess the correlation between nutritional status and disease severity in idiopathic Parkinson's disease. Addressing this gap, our study aims to evaluate the nutritional status of patients with idiopathic Parkinson's disease and to investigate its correlation with the severity of the condition.

2. Materials and Methods

This study was a cross - sectional observational study conducted over a period from November 2018 to March 2020. It was carried out in the Department of General Medicine and the Department of Neurology at Lady Hardinge Medical College (LHMC) and Associated Hospitals, New Delhi, in collaboration with the Department of Biochemistry, LHMC, and PGIMER, Dr. Ram Manohar Lohia Hospital, New Delhi. The study population included patients presenting to the medical and neurology outpatient departments as well as inpatients admitted to the medical wards. A total of 50 diagnosed cases of idiopathic Parkinson's disease were

recruited for the study. Patients eligible for inclusion were adults above 18 years of age with a confirmed diagnosis of idiopathic Parkinson's disease. Exclusion criteria were applied to patients with coexisting illnesses that could influence nutritional status, including bronchial asthma, interstitial lung disease, congestive cardiac failure due to cardiovascular illness, malignancies, thyrotoxicosis, neuromuscular disorders, gastrointestinal diseases, and connective tissue disorders. Additionally, patients with a recent history of intake of vitamin D, B12, folate, calcium, or magnesium supplements were excluded from the study.

After obtaining approval from the Institutional Ethics Committee (IEC), the study was conducted with patients who provided written informed consent after being informed about the study objectives and methodology. The diagnosis of idiopathic Parkinson's disease was confirmed using the Brain Bank Criteria. [12] Each participant underwent a thorough evaluation, including a detailed medical history and clinical examination. The clinical assessment involved general physical and systemic examinations, along with evaluations using the Mini - Mental State Examination (MMSE) and the Webster Scale to determine the severity of Parkinson's disease. [13, 14] Anthropometric measurements, including weight, height, body mass index (BMI), waist - to - hip ratio, and skinfold thickness, were recorded. Body weight was measured to the nearest half kilogram using a digital weighing machine, while height was measured to the nearest half centimeter using a stadiometer, both in light clothing and without shoes. Waist circumference was measured in the standing position and divided by the measurement of the widest part of the hip to calculate the waist - to - hip ratio. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2), and obesity classification was determined based on Asia - Pacific guidelines: underweight (<18.5), normal (18.5–22.9), overweight (23–24.9), and obese (≥25). The severity of Parkinson's disease was categorized using the Webster Scale, with scores ranging from 1–10 indicating early illness, 11–20 indicating moderate disability, and 21–30 indicating severe disability.

Venous blood samples were collected from all participants for biochemical analysis. Parameters measured included complete hemogram, analyzed using the Coulter counter method, and serum levels of vitamin B12, folate, vitamin D, calcium, magnesium, and albumin. Biochemical investigations were conducted as follows: calcium was measured using the colorimetric method based on Arsenazo III, which binds to calcium to form a colored complex with absorption at 660 nm. Albumin levels were determined using the bromocresol green method, which measures the albumin - BCG complex with maximal absorption at 578 nm. Magnesium was quantified using a direct method involving xylidyl blue and glycoletherdiamine - N, N, N, N - tetraacetic acid (GEDTA), with bichromatic readings at 520/800 nm. Serum folic acid and vitamin B12 levels were measured using chemiluminescent immunoassay kits from Beckman Coulter, while vitamin D was analyzed using the chemiluminescent method on a Beckman Coulter DXI analyzer with commercial kits. The following reference ranges were applied: anemia was defined as hemoglobin levels of less than 12 g/dL for females and less than 14 g/dL for males. Hypoalbuminemia was defined as serum albumin levels of less than 3.5 g/dL in individuals younger than 60 years and less than 3.2 g/dL in individuals aged 60 years or older. Hypocalcemia was defined as serum calcium levels of less than 8.6 mg/dL, while hypercalcemia was defined as levels exceeding 10.2 mg/dL. Hypomagnesemia was defined as serum magnesium levels of less than 1.6 mg/dL. Folic acid deficiency was considered when levels were below 6.0 nmol/L. Vitamin B12 deficiency was defined as levels below 180 pg/mL, and vitamin D deficiency was identified as levels below 20 ng/mL, with insufficiency classified as levels between 20 and 29.9 ng/mL.

Statistical analysis: Categorical variables were summarized as counts and percentages, while continuous variables were reported as mean ± standard deviation (SD) or median, depending on the data distribution. The Kolmogorov - Smirnov test was used to assess data normality. For non - normally distributed data, non - parametric tests were applied. Comparisons between three groups were performed using ANOVA or the Kruskal - Wallis test for quantitative variables, and the Chi - square test was used for qualitative variables. Correlations with the Webster score were analyzed using Pearson's or Spearman's correlation coefficients, as appropriate. A p - value of less than 0.05 was considered statistically significant. Data were recorded in MS Excel and analyzed using SPSS version 21.0.

3. Results

The study included 50 participants with a mean age of 63.9 years (SD = 8.9). Among the participants, 48% (n = 24) were younger than 65 years, while 52% (n = 26) were aged 65 years or older. The gender distribution showed that 64% (n = 32) of the participants were male, and 36% (n = 18) were female. Regarding dietary habits, 58% (n = 29) followed a vegetarian diet, while 42% (n = 21) were non - vegetarian. The mean body mass index (BMI) was 22.8 kg/m^2 (SD = 3.9). Based on BMI categories, 8% (n = 4) of the participants were underweight (BMI < 18.5), 52% (n = 26) had normal weight (BMI 18.5–22.9), and 40% (n = 20) were overweight or obese (BMI ≥ 23). The mean Webster score, which reflects Parkinson's disease severity, was 11.4 (SD = 3.8). According to the Webster scale, 38% (n = 19) of the participants were categorized as having early illness, 60% (n = 30) had moderate disability, and 2% (n = 1) had severe disability.

The study participants had a mean hemoglobin level of 12.3 g/dL (SD = 1.9), with anemia present in 66% (n = 33) of the cases and absent in 34% (n = 17). The mean serum calcium level was 9.2 mg/dL (SD = 1.5). Among the participants, 22% (n = 11) had calcium deficiency, 66% (n = 33) had normal calcium levels, and 12% (n = 6) had elevated calcium levels. The mean serum magnesium level was 2.4 mg/dL (SD = 0.6), with only 2% (n = 1) showing deficiency, while 98% (n = 49) had normal levels. Serum albumin levels had a mean of 3.9 g/dL (SD = 0.5), with 8% (n = 4) of participants showing deficiency and 92% (n = 46) having normal levels. The mean serum vitamin D level was 27.9 ng/mL (SD = 17.2), with 44% (n = 22) classified as deficient, 20% (n = 10) as insufficient, and 36% (n = 18) as sufficient. The mean serum folate level was 12.5 nmol/L (SD = 9.9); 32% (n = 16) of participants had folate deficiency, while 68% (n = 34) had normal levels. The mean serum vitamin B12 level was 494.3 pg/mL (SD =

526.9), with 38% (n = 19) of participants showing deficiency and 62% (n = 31) having normal levels.

Association between study variables and severity of Parkinson's disease: The distribution of BMI categories across Parkinson's disease severity levels showed a statistically significant difference (p = 0.037). Among participants with early illness, 63.2% (n = 12) had a BMI ≥ 23, while 36.8% (n = 7) had a BMI of 18.5–22.9, and none were underweight (BMI < 18.5). In the moderate disability group, 60% (n = 18) had a BMI of 18.5–22.9, 26.7% (n = 8) had a BMI ≥ 23, and 13.3% (n = 4) were underweight. The single participant with severe illness had a BMI of 18.5–22.9.

Anemia was present in 52.6% (n = 10) of participants with early illness, 73.3% (n = 22) of those with moderate disability, and 100% (n = 1) of those with severe illness, although this difference was not statistically significant (p = 0.253). Calcium deficiency was observed in 10.5% (n = 2) of participants with early illness, 30% (n = 9) of those with moderate disability, and none in the severe category (p = 0.481). Normal calcium levels were more common in the early illness (78.9%, n = 15) and severe illness groups (100%, n = 1) compared to moderate disability (56.7%, n = 17). Magnesium deficiency was rare, with only one participant in the moderate disability group (3.3%) affected, while all others had normal levels (p = 0.712). Serum albumin deficiency was observed in 13.3% (n = 4) of those with moderate disability, but none in the early or severe illness groups (p = 0.235). Vitamin D deficiency affected 42.1% (n = 8) of those with early illness, 43.3% (n = 13) of the moderate group, and 100% (n = 1) of the severe group (p = 0.757). Folate deficiency was noted in 26.3% (n = 5) of participants with early illness, 33.3% (n = 10) with moderate disability, and 100% (n = 1) in the severe group (p = 0.296). Vitamin B12 deficiency was present in 36.8% (n = 7) of participants with early illness and 40% (n = 12) with moderate disability, with none in the severe group (p = 0.714).

While BMI differences were statistically significant (p < 0.05), no significant differences were observed for other biochemical parameters across the severity categories.

Correlation between study variables and severity of Parkinson's disease: The correlation of age, BMI, hemoglobin, albumin, calcium, magnesium, serum folate, serum vitamin D, and vitamin B12 with the Webster score was analyzed in a sample of 50 participants. Age showed a positive correlation with the Webster score (r = 0.209), but the result was not statistically significant (p = 0.1461). Body mass index (BMI) exhibited a significant negative correlation with the Webster score (r = - 0.432, p = 0.0017). Hemoglobin levels also showed a significant negative correlation (r = - 0.315, p = 0.0257). Albumin demonstrated a weak negative correlation (r = - 0.222), but the association was not significant (p = 0.1214). Calcium levels had a negligible negative correlation (r = - 0.111, p = 0.4447), and magnesium showed a very weak negative correlation (r = - 0.063, p = 0.6647), both of which were statistically insignificant. Similarly, serum folate (r = - 0.114, p = 0.4324), serum vitamin D (r = - 0.011, p = 0.9391), and vitamin B12 (r = - 0.087, p = 0.5467) all showed weak and insignificant negative correlations with the Webster score.

Deficiency of nutrients with respect to severity of Parkinson's disease: The overall prevalence of nutrient deficiencies among participants revealed that anemia was the most common, affecting 66% of the total study population. When stratified by the severity of Parkinson's disease, anemia was observed in 52.6% of those with early illness and 73.3% of those with moderate disability. Calcium deficiency was present in 22% of all participants, with 10.5% in the early illness group and 30% in the moderate group. Magnesium deficiency was rare, affecting 2% of participants overall and limited to 3.3% in the moderate disability group, with no cases in the early illness group. Albumin deficiency was seen in 8% of participants, occurring in 13.3% of the moderate group and none in the early illness group. Vitamin D deficiency was highly prevalent, affecting 64% of participants, with 57.9% in the early illness group and 66.7% in the moderate group. Folate deficiency was noted in 32% of participants overall, including 26.3% of those with early illness and 33.3% with moderate disability. Vitamin B12 deficiency affected 38% of participants, with 36.8% in the early illness group and 40% in the moderate group.

4. Discussion

The findings of the present study provide a comprehensive understanding of the demographic and clinical characteristics of Parkinson's disease patients, particularly in relation to the correlation between various nutritional parameters and the severity of the disease. The mean age of participants in this study was 63.94 ± 8.9 years, which aligns closely with other studies, such as those by Pagano et al. [15] (61.6 ± 9.7 years) and Van den Eeden et al. [16] (70.5 years), highlighting that Parkinson's disease predominantly affects older adults. Furthermore, the positive association between age and disease severity observed in this study reinforces the notion that aging is a significant risk factor for the progression of Parkinson's disease.

The male - to - female ratio of approximately 2: 1 in the study population underscores the well - documented gender disparity in Parkinson's disease prevalence, with men being at higher risk of developing the condition. [17] This finding is consistent with global epidemiological data, suggesting that biological, genetic, and hormonal factors may contribute to the observed differences in susceptibility. [18] The mean body mass index in this study was 22.8 ± 3.91 kg/m², with an inverse correlation between BMI and disease severity (correlation coefficient - 0.432, p = 0.0017). This finding aligns with studies by Ma et al. [19] and Logroscino et al., [20] which also reported an inverse relationship between BMI and Parkinson's disease severity. This inverse association may reflect weight loss and muscle wasting in advanced disease stages due to factors such as reduced appetite, increased energy expenditure, and dysphagia. However, the conflicting findings in studies by Chen et al. [21] and Hu et al. [22] highlight the complexity of the relationship between BMI and Parkinson's disease, suggesting that additional factors, including regional dietary habits, genetic predispositions, and methodological differences, may play a role.

The mean Webster score of 11.42 ± 3.82 in the present study reflects the degree of motor impairment among participants.

The inverse correlation between hemoglobin levels and disease severity (mean hemoglobin: 12.27 ± 1.87 g/dL, correlation coefficient - 0.315, p = 0.0257) is consistent with studies by Deng Q et al. [23] and Savica R et al., [24] which also reported a positive association between anemia and Parkinson's disease severity. Anemia in Parkinson's disease may be attributed to chronic inflammation, iron metabolism dysregulation, and reduced dietary intake, highlighting the need for regular monitoring and management of hemoglobin levels in this population. [24]

Serum magnesium levels in this study were 2.37 ± 0.58 mg/dL, and an inverse correlation with disease severity was observed (correlation coefficient - 0.063, p = 0.6647). This finding is in agreement with studies by Bocca et al., [25] Oyanagi et al., [26] and Uitti et al., [27] which reported a negative correlation between magnesium levels and the progression of Parkinson's disease. Magnesium deficiency may exacerbate oxidative stress and neurodegeneration, emphasizing the potential neuroprotective role of magnesium in Parkinson's disease management. Serum albumin levels, with a mean of 3.9 ± 0.52 g/dL, were also inversely associated with disease severity (correlation coefficient - 0.222, p = 0.1214). This finding aligns with the study by Wang L et al., [28] which identified hypoalbuminemia as an independent risk factor for Parkinson's disease. Hypoalbuminemia in this population may reflect poor nutritional status, systemic inflammation, or chronic disease burden, necessitating targeted nutritional interventions to prevent further deterioration.

The mean serum calcium level of 9.19 ± 1.48 mg/dL in this study was inversely correlated with disease severity (correlation coefficient - 0.111, p = 0.4447). While the findings contrast with those of Lautenschläger J et al., [29] who reported a positive correlation between calcium levels and Parkinson's disease, the limited research on this topic suggests the need for further studies to elucidate the role of calcium in disease progression and management. Vitamin D levels in this study were 27.85 ± 17.21 ng/mL, with a negative correlation with disease severity (correlation coefficient - 0.011, p = 0.9391). This is consistent with studies by Knekt P et al., [30] Rimmelzwaan LM et al., [31] and Ding H et al., [32] which highlighted the protective effect of vitamin D against the development and progression of Parkinson's disease. The high prevalence of vitamin D deficiency in Parkinson's disease patients underscores the need for routine screening and supplementation to mitigate associated complications such as falls and fractures.

Folic acid levels, with a mean of 12.52 ± 9.98 nmol/L, were negatively correlated with disease severity (correlation coefficient - 0.114, p = 0.4324). This finding is in line with studies by Dos Santos E et al. [33] and the National Institute on Aging (NIA), which also reported a negative correlation between folate levels and Parkinson's disease severity. The role of folic acid in regulating homocysteine levels and its potential neuroprotective effects warrant further investigation. Serum vitamin B12 levels, with a mean of 494.29 ± 526.96 pg/mL, also showed a negative correlation with disease severity (correlation coefficient - 0.087, p = 0.5467). This aligns with findings by Chen H. et al. [34] and Christine C. et al., [35] highlighting the importance of maintaining adequate vitamin B12 levels to prevent exacerbation of motor and cognitive symptoms in Parkinson's disease.

This study reinforces the complex relationship between nutritional parameters and Parkinson's disease severity. The findings highlight the significant burden of nutrient deficiencies in this population and their potential role in disease progression. Regular monitoring and targeted nutritional interventions should be integral components of comprehensive Parkinson's disease management to improve patient outcomes and quality of life. Further research is needed to explore the underlying mechanisms and causal relationships between nutritional status and Parkinson's disease progression.

The study's limitations include its cross - sectional design, which limits the ability to infer causal relationships between nutritional deficiencies and Parkinson's disease severity. The sample size was relatively small, which may affect the generalizability of the findings. Additionally, the study relied on clinical measures without accounting for potential confounding factors such as genetic predispositions or environmental influences. The use of self - reported dietary habits may introduce recall bias. Finally, the absence of longitudinal data prevents assessment of changes in nutritional status over time and its impact on disease progression.

5. Conclusion

The key findings include a high prevalence of anemia, vitamin D deficiency, and suboptimal levels of folic acid, vitamin B12, and albumin among participants, all of which were inversely associated with the severity of the disease. Additionally, BMI, magnesium, and calcium levels were also negatively correlated with disease progression. These findings underscore the multifactorial nature of Parkinson's disease and the critical role of nutritional status in influencing disease severity and progression. The study reaffirms the importance of regular nutritional assessments in PD patients, particularly for parameters such as hemoglobin, vitamin D, folate, and B12 levels. Early identification and management of nutritional deficiencies can potentially mitigate symptom severity, improve overall health, and enhance the quality of life for individuals with Parkinson's disease. Furthermore, the variability in correlations observed across studies emphasizes the need for more extensive research to establish definitive causal relationships and to identify effective interventions.

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Table 1: Characteristics of the study population

		Number (N = 50) (n)	Percentage (%)
Age (in years), Mean (SD)		63.9 (8.9)	
Age (in years)	Less than 65	24	48.0
	>=65	26	52.0
Gender	Female	18	36.0
	Male	32	64.0
Type of diet	Non - veg	21	42.0
	Veg	29	58.0
Body mass index (in kg/m2), Mean (SD)		22.8 (3.9)	
Body mass index (in kg/m2)	<18.5	4	8.0
	18.5 - 22.9	26	52.0
	>=23	20	40.0
Webster score, Mean (SD)		11.4 (3.8)	
Webster score	Early illness	19	38.0
	Moderate disability	30	60.0
	Severe disability	1	2.0
SD, Standard deviation			

Table 2: Descriptive analysis of laboratory investigations

		Number (N = 50) (n)	Percentage (%)
Hemoglobin (in g/dl), Mean (SD)		12.3 (1.9)	
Anemia	Present	33	66.0
	Absent	17	34.0
Calcium (in mg/dL), Mean (SD)		9.2 (1.5)	
Calcium (in mg/dL)	Deficient	11	22.0
	Normal	33	66.0
	Increased	6	12.0
Magnesium (in mg/dL), Mean (SD)		2.4 (0.6)	
Magnesium (in mg/dL)	Deficient	1	2.0
	Normal	49	98.0
Albumin (in g/dL), Mean (SD)		3.9 (0.5)	
Albumin (in g/dL)	Deficient	4	8.0
	Normal	46	92.0
Serum Vitamin D (in ng/mL), Mean (SD)		27.9 (17.2)	
Serum Vitamin D (in ng/mL)	Deficient	22	44.0
	Insufficient	10	20.0
	Sufficient	18	36.0
Serum folate (in nmol/L), Mean (SD)		12.5 (9.9)	
Serum folate (in nmol/L)	Deficient	16	32.0
	Normal	34	68.0
Vitamin B12 (in pg/mL), Mean (SD)		494.3 (526.9)	
Vitamin B12 (in pg/mL)	Deficient	19	38.0
	Normal	31	62.0
SD, Standard deviation			

Table 3: Association between study variables and severity of Parkinson's disease

		Early illness (N = 19)	Moderate (N = 30)	Severe (N = 1)	P value
		n (%)	n (%)	n (%)	
Body mass index (in kg/m2)	<18.5	0 (0.0)	4 (13.3)	0 (0.0)	0.037
	18.5 - 22.9	7 (36.8)	18 (60.0)	1 (100)	
	>=23	12 (63.2)	8 (26.7)	0 (0.0)	
Anemia	Present	10 (52.6)	22 (73.3)	1 (100)	0.253
	Absent	9 (47.4)	8 (26.7)	0 (0.0)	
Calcium (in mg/dL)	Deficient	2 (10.5)	9 (30.0)	0 (0.0)	0.481
	Normal	15 (78.9)	17 (56.7)	1 (100)	
	Increased	2 (10.5)	4 (13.3)	0 (0.0)	
Magnesium (in mg/dL)	Deficient	0 (0.0)	1 (3.3)	0 (0.0)	0.712

	Normal	19 (100)	29 (96.7)	1 (100)	
Albumin (in g/dL)	Deficient	0 (0.0)	4 (13.3)	0 (0.0)	0.235
	Normal	19 (100)	26 (86.7)	1 (100)	
Serum Vitamin D (in ng/mL)	Deficient	8 (42.1)	13 (43.3)	1 (100)	0.757
	Insufficient	3 (15.8)	7 (23.3)	0 (0.0)	
	Sufficient	8 (42.1)	10 (33.3)	0 (0)	
Serum folate (in nmol/L)	Deficient	5 (26.3)	10 (33.3)	1 (100)	0.296
	Normal	14 (73.7)	20 (66.7)	0 (0.0)	
Vitamin B12 (in pg/mL)	Deficient	7 (36.8)	12 (40.0)	0 (0.0)	0.714
	Normal	12 (63.2)	18 (60.0)	1 (100)	
*Statistically significant at p<0.05					

Table 4: Deficiency of nutrients with respect to severity of Parkinson's disease

	Total deficiency (%)	Early illness (%)	Moderate (%)
Hemoglobin	66.0	52.6	73.3
Calcium	22.0	10.5	30.0
Magnesium	2.0	0.0	3.3
Albumin	8.0	0.0	13.3
Vitamin D	64.0	57.9	66.7
Folic acid	32.0	26.3	33.3
Vitamin B12	38.0	36.8	40.0