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Malnutrition in Patients with Parkinson's Disease: Associated Clinical Factors

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Abstract

Objective: Parkinson's disease (PD) is a chronic, progressive disease commonly affecting the elderly. Among patients with PD (pwPD), the ones above 60 years old are considered to be high risky in terms of malnutrition. Weight loss is a common complaint in pwPD. Thus, we aimed to define the risk factors of malnutrition in geriatric pw PD.

Materials and Methods: We enrolled 66 pwPD above the age of 60 years old. Socio-demographic features were recorded, comprehensive geriatric assessments were evaluated. Malnutrition was assessed with mini-nutritional assessment questionnaire. Anthropometric measurements including body mass index, mid- upper arm circumference, calf circumference (CC) was recorded.

Results: Seven (10.6%) pwPD had malnutrition, 22 (33.3%) pwPD were under the risk of malnutrition. Univariate logistic regression analysis results revealed that low CC, presence of dyskinesia, advanced Hoehn&Yahr stage, levodopa doses of ≥400 mg/day, difficulty in swallowing (p=0.035, p=0.041, p=0.048, p=0.027 and p=0.007, respectively) were strongly related to malnutrition among the pwPD. Difficulty in swallowing was independently related to malnutrition in pwPD [odds ratio: 7.81 (confidence interval: 2.17-28.10), p=0.002].

Conclusion: PD is the second common neurodegenerative disease in geriatric population that is likely to cause malnutrition as a result of several disabling symptoms in the progressive course of the disease such as dysphagia. To avoid or delay the poorer outcomes, clinicians should be careful to identify malnutrition with appropriate screening tools during follow-up of pwPD.

Keywords: Parkinson disease, geriatric population, malnutrition, risk factors, mini-nutritional assessment

Introduction

Parkinson's disease (PD), the second most common neurodegenerative disease among the population above 65 worldwide, is characterized by cardinal motor including bradykinesia, rigidity, rest tremor, postural instability and non-motor symptoms (1). Due to its progressive course, not only the disabling symptoms and complications, which are more likely to be seen as the disease advances, but bradykinesia itself affecting the gastrointestinal tract as well as other motor systems, autonomic involvement also acts an important role in the occurrence of malnutrition (2). In patients with PD (pwPD) there are many factors affecting malnutrition. It is stated that non-motor and motor symptoms, diagnosis in older age, higher levodopa equivalent daily dose/body weight, depression, dementia and hallucinations are related with malnutrition among pwPD (3). Moreover, dysphagia, delayed gastric emptying, constipation, malabsorption like disturbances in gastrointestinal system and weak hand-mouth coordination may affect the dietary status (4).

Malnutrition can be described as an imbalance between nutritional intake and requirements that eventually causes changes in body weight, body composition, and physical function

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(3). As a well-known entity, the prevalence of malnutrition in the geriatric population increases with aging, and comorbid diseases, as well as the level of care (4). In accordance with aging, the reported risk of malnutrition is 3-60%, and the prevalence of malnutrition was found to be 0-24% in pwPD who are mostly geriatric (2,5). Detecting possible malnutrition early and related lifestyle characteristics is crucial. Being prone to infection, decubital ulcer and behavioural and autonomic disorders, pwPD that do not feed well, have deficits in their quality of life (6). An improved nutritional status will also improve quality of life in pwPD.

Regarding these aspects, we aimed to investigate the possible factors affecting the risk of malnutrition in older pwPD patients who are an important part of the geriatric population.

Materials and Methods

This study was cross-sectionally designed. Sixty-six pwPD above the age of 60 were enrolled in the present study. Written approvals were taken from all the patients and the relatives of the patients with dementia before enrolment. The ethical approval was taken from the Local Ethical Committee of Erciyes University (decision no: 2016/595). The exclusion criteria were active malignancy, active infectious disease, history of cerebrovascular disease, hepatic failure, and renal failure. The socio-demographic features of the participants were recorded.

The nutritional status of the pwPD was evaluated by mini-nutritional assessment (MNA) questionnaire, which had 18 questions with a total score of 30 (7). The normal nutrition scores were 23.5 to 30 points. Scores 17 to 23 points were considered as "risk of malnutrition", and scores below 17 points were considered "malnutrition". The study population was categorized into two groups according to MNA scores for analysis. Patients with a MNA score ≤23.5 points defined as group with malnutrition (including both patients with malnutrition and at risk of malnutrition), and the second group with a MNA score ≥24 points defined as normal nutritional status.

Anthropometric assessments of the groups were performed by height in centimeter (cm), weight measurements in kilogram (kg), body mass index (BMI kg/m^2), mid-upper arm circumference (MUAC) in cm, calf circumference (CC) in cm and triceps skinfold thickness (TSF) in cm. Since all the participants were pwPD, the severity of PD was assessed with the Hoehn&Yahr score (8). Disease characteristic features, therapy regimens and daily levodopa equivalent doses were recorded. Associated complaints of the pwPD including dyspepsia, constipation, and weight loss in one year were also investigated by self-reported questions regarding the related symptomatology. Swallowing function was evaluated subjectively by the question "Do you have difficulty in swallowing with solid food?"

The cognitive status of pwPD was assessed with a mini-mental status exam (MMSE). This assessment included eleven questions with a total score of 30/30 points. Since the cut-off score for cognitive impairment is 24 points, patients with the MMSE score of 24 to 30 points were considered to be normal, while mild scores between 18-23 points were considered "mild dementia", and those ≤17 points "severe dementia" (9).

Mood assessments for depression were performed through the geriatric depression scale which has 30 items. The scores ≥14 points were considered as depression (10).

Statistics

The Shapiro-Wilks test, histogram, and q-q plots were examined to evaluate data normality. Independent samples t-test and Mann-Whitney U test was applied for continuous variables. Pearson chi-square test or Fisher's Exact test was applied for categorical variables. Univariate and multivariate binary logistic regression models were applied to examine the risk effect of variables on malnutrition. The odds ratios (OR) were estimated with 95% confidence intervals (CI). Significant variables with potential risk factors of malnutrition on univariate analysis with $p<0.1$ were taken into multivariate analysis including marital status, H&Y scale, levodopa dose, DBS, difficulty in swallowing and depression. Backward stepwise selection was applied using likelihood ratio statistic at $p<0.10$ stringency level. Goodness of fit was assessed by the Hosmer-Lemeshow test ($p=0.840$). SPSS Version 22.0 (Statistical Package for Social Sciences for Windows) database was used to organize data. P-values <0.05 were accepted to remark statistical significance.

Results

Sixty-six pwPD (37 men, 29 women) above the age of 60 participated in the study. The mean age of the pwPD was 67.50 years (minimum-maximum =60-86 years). The mean BMI of the pwPD was 30.13±5.04 kg/m^2 (minimum-maximum =22.9-42.0 kg/m^2). In the study group, 37 (56.1%) pwPD had normal nutrition status, while 22 (33.3%) had malnutrition risk, and 7 (10.6%) had malnutrition. Although malnutrition was more common among widowed patients, there were no statistically significant differences in terms of socio-demographic features between the patients regarding nutrition status ($p>0.05$). The comparison of the socio-demographic and clinical characteristics of the pwPD according to their nutrition status is given in Table 1.

As shown in Table 1, pwPD with malnutrion had lower CC ($p=0.041$) and MUAC ($p=0.080$) than pwPD with normal nutrition. In addition in the group of pwPD with malnutrition the stage of PD was more advanced ($p=0.048$) and levodopa daily doses were higher ($p=0.027$) than the group with normal nutritional status. Dyskinesia was also more frequent in patients with malnutrition ($p=0.048$). Moreover, most of the pwPD in

Table 1. The comparison of the socio-demographic and clinical characteristics of the people with Parkinson's disease according to their nutrition status

Variables	All n=66 (100)	Nutritional status Malnutrition (MNA score ≤23.5) n=29 (43.9)	Normal (MNA score ≥24) n=37 (56.1)	p
Age	67.5 (63.0-72.0)	66.0 (63.0-73.0)	68.0 (63.0-71.0)	0.990
Gender				
Men	29 (43.9)	16 (55.2)	13 (35.1)	0.136
Women	37 (56.1)	13 (44.8)	24 (64.9)	
BMI kg/m²	30.1±5.1	29.3±4.8	30.9±5.2	0.231
Education				
Illiterate	17 (25.8)	9 (31.0)	8 (21.9)	0.609
5 years	29 (43.9)	11 (37.9)	18 (48.6)	
Over 5 years	20 (30.3)	9 (31.0)	11 (29.7)	
Marital status				
Married	51 (77.3)	19 (65.5)	32 (86.5)	0.074
Widow	15 (22.7)	10 (34.5)	5 (13.5)	
Income				
Low	49 (74.2)	20 (69.0)	29 (78.4)	0.410
Middle/high	17(25.8)	9 (31.0)	8 (21.6)	
MUAC, cm	29.4±3.6	28.5±4.1	30.2±3.0	0.075
CC, cm	36.1±4.4	35.6±4.4	37.9±4.1	0.035
TSF, mm	17.2±7.3	15.8±7.1	18.4±7.4	0.158
Dyskinesia				
Yes	17 (26.2)	11 (39.3)	6 (16.2)	0.048
No	48 (73.8)	17 (60.7)	31 (83.8)	
H&Y scale				
Early stages	30 (45.5)	9 (31.0)	21 (56.8)	0.048
Advanced stages	36 (54.5)	10 (69.0)	16 (43.2)	
Levodopa dose				
≥400 mg	35 (53.0)	20 (69.0)	15 (40.5)	0.027
<400 mg	31 (47.0)	9 (31.0)	22 (59.5)	
DBS				
Yes	8 (12.1)	7 (24.1)	1 (2.7)	0.018
No	58 (87.9)	22 (75.9)	36 (97.3)	
Dyspepsia				
Yes	18 (29.0)	10 (35.7)	8 (23.5)	0.400
No	44 (71.0)	18 (64.3)	26 (76.5)	
Constipation				
Yes	41 (62.1)	19 (65.5)	22 (59.5)	0.799
No	25 (37.9)	10 (34.5)	15 (40.5)	
Difficulty in swallowing				
Yes	22 (33.3)	15(51.7)	7(18.9)	0.008
No	44 (66.7)	14(48.3)	30(81.1)	
Weight loss				
Yes	25 (37.9)	16 (55.2)	9 (24.3)	0.020
No	41 (62.1)	13 (44.8)	28 (75.7)	
Depression (GDS score ≥14)				
Yes	28 (42.4)	16 (55.2)	12 (32.4)	0.082
No	38 (57.6)	13 (44.8)	25 (67.6)	
Cognitive impairment (MMSE score <24)				
Yes	10 (15.2)	6 (20.7)	4 (10.8)	0.315
No	56 (84.8)	23 (79.3)	33 (89.2)	

Values are stated as n (%), mean ± SD or median (1st-3rd quartiles). BMI: Body mass index, CC: Calf circumference, DBS: Deep brain stimulation, H&Y:Hoehn and Yahr, MUAC: Mid-upper arm circumference, TSF: Triceps skin fold thick ness, GDS: Geriatric depression scale, SD: Standard deviation, MMSE: Mini-mental status exam

malnutrion group were under the treatment of deep brain stimulation (DBS) (p=0.018), had difficulty in swallowing (p=0.008) and had weight loss (p=0.020) (Table 1).

The univariate logistic regression analysis of the data revealed a strong relation between the marital status, CC, dyskinesia, stage of PD, levodopa doses, DBS procedure, difficulty in swallowing, weight loss and malnutrition. Multiple regression analysis demonstrated an independent relationship between difficulty in swallowing and malnutrition (OR: 7.81, CI: 2.17-28.10, p=0.002). The results of the univariate and multivariate logistic regression analysis determining the risk factors of malnutrition are shown in Table 2.

Discussion

PD is an important disabling neurodegenerative disease which interferes with patients' quality of life and more prone to affect the geriatric population (11,12). Not only the motor problems including rigidity, tremor, postural instability, and bradykinesia leading to dysphagia, constipation and other problems in daily activities, but also health-related problems such as mood changes, cognitive decline, and fatigue may lead to malnutrition in pwPD (4). In this study we observed that presence of dyskinesia, advanced stages of PD, higher levodopa doses, DBS procedure, difficulty in swallowing and depression were strongly related with malnutrition in pwPD. Among these variables difficulty in swallowing was independently related with malnutrition in pwPD.

Malnutrition is common in pwPD but often under-reported both by the patients and clinicians. The main reasons why pwPD are at high risk of malnutrition are, firstly, disease characteristic features, defined as the motor findings of the disease, secondly, the negative effects of the disease on nutrition in older individuals such as depression, cognitive damage, which are highly prevalent in pwPD as non-motor symptos, and thirdly, the drugs used for the treatment of PD (3). In addition studies have shown that PD patients have a lower BMI than age matched healthy controls (13). Since there is an increased risk of malnutrition reported in the literature for pwPD, it is crucial to screen nutrition in pwPD (14,15). Similar to our study, the common methods used to assess the nutritional status are anthropometric measurements including the weight and BMI, and the MNA questionnaire which is the most frequently utilized tool for nutritional status (14).

In the literature, the prevalence of malnutrition and malnutrition risk has been stated up to 24% for malnutrition, and 60% for malnutrition risk in PD (3,11). Similar to the literature, our results revealed a malnutrition rate of 43.9 % which approximately corresponds to half of our study population. Tomic et al. (3) examined 96 patients, and from among 96 patients, 55.2% were at risk of malnutrition, while 8.3% has already been malnourished. There are several determinants of malnutrition has been implicated in PD patients. It is announced that age, severity of motor symptoms, duration of the disease and intensity of stage, especially "off" states, rigidity dominant type with "off" periods, mostly affect the nutritional status (3,16). Moreover, Fávaro-Moreira et al. (17) analysed the risk factors of malnutrition among older adults above 65 years old and reported that age and PD were independent risk factors for malnutrition. In the above-mentioned study, the presence of PD in older individuals was found to be independently associated with malnutrition, reflecting that PD poses a very high risk for malnutrition.

Interestingly, pwPD are shown to be overweight in the beginning stages of the disease, but as the disease progresses and the patients end up in the advanced conversely, lower BMI and weight loss are reported to be extremely common and the latter was shown to be associated with nigrostriatal depletion, cognitive impairment, deteriorated motor functions and a poorer quality of life (18). In this study, BMI, which is one of the anthropometric determinants of malnutrition, which is frequently used in clinics, was not observed to be associated with malnutrition in PD, whereas decreased MUAC and CC were closely associated with malnutrition. In this case, although it has been stated that BMI in PD patients is lower than normal healthy controls, especially in advanced stages, we observed that BMI alone may not be sufficient in PD patients in the evaluation of malnutrition. It may be more effective to use a valid and safe screening tool such as MNA in the evaluation of malnutrition in these patients. Since one of the main manifestations of malnutrition is weight loss, the possible risk factors of weight loss in pwPD may include dysphagia which may lead to low dietary uptake, slowed gastric motility and emptying as a result of bradykinesia, and increased energy consumption as a consequence of levodopa-induced dyskinesia in some patients (19). Similar to the literature, our results disclosed that the risk of malnutrition was significantly higher in patients experiencing the advanced stage, in need of increased daily doses of levodopa, have difficulty in swallowing, levodopa-induced dyskinesia, and weight loss. However, the possible reasons for malnutrition in pwPD, apart from weight loss, and considered "not related" to weight loss actually, are hyposmia, reduced appetite, changed reward mechanism due to degeneration in the mesocorticolimbic network, and decreased levels of orexin (20,21).

In this study difficulty in swallowing was only clinical determinant that was independently related with malnutrition in PD and 33 percent of the patients had difficulty in swallowing. It has been reported that about 80% of patients with PD evolve dysphagia in the progress of the disease. Swallowing disorder complicates drug intake in pwPD, leads to malnutrition and aspiration pneumonia, and in this way, it reduces quality of life and increases mortality in pwPD. Although the fundamental

Table 2 The univariate and multivariate logistic regression analysis results, determining the risk factors of malnutrition

	Univariate		Multivariate	
Variables	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Age	0.99 (0.91-1.08)	0.807	Not selected	
Gender Men Women	 1 2.27 (0.84-6.15)	 0.106	Not selected	
BMI (kg/m²)	0.940 (0.85-1.04)	0.230	Not selected	
Education Illiterate 5 years Over 5years	 1 0.543 (0.16-1.83) 0.727 (0.19-2.67)	 0.324 0.630	Not selected	
Marital status Married Widow	 1 3.37 (1.001-11.345)	 0.050		
Income Low Middle/high	 1 0.61 (0.20-1.86)	 0.387	Not selected	
MUAC (cm)	0.88 (0.77-1.16)	0.080	Not selected	
CC (cm)	0.88 (0.78-0.99)	0.041	Not selected	
TSF (mm)	0.95(0.89-1.02)	0.159	Not selected	
Dyskinesia No Yes	 1 3.34 (1.05-10.64)	 0.041	Not selected	
H&Y scale Early stages Advanced stages	 1 2.92 (1.05-8.09)	 0.040		
Levodopa dose <400 mg >400 mg	 1 3.26 (1.17-9.08)	 0.024		
DBS No Yes	 1 11.46 (1.32-99.46)	 0.027		
Dyspepsia Yes No	 1 1.81 (0.60-5.46)	 0.296	Not selected	
Constipation No Yes	 1 1.30 (0.47-3.55)	 0.615	Not selected	
Difficulty in swallowing No Yes	 1 4.59 (1.53-13.78)	 0.007	 1 7.81 (2.17-28.10)	 0.002
Weight loss No Yes	 1 3.83 (1.34-10.93)	 0.012	Not selected	
Depression No Yes	 1 2.56 (0.94-7.00)	 0.066		
Cognitive impairment No Yes	 1 2.15 (0.55-8.49)	 0.274	Not selected	

OR: Odds ratio, CI: Confidence interval, p<0.005, BMI: Body mass index, CC: Calf circumference, DBS: Deep brain stimulation, H&Y: Hoehn and Yahr, MUAC: Mid-upper arm circumference, TSF: Triceps skin fold thick ness

pathophysiology is not fully realized, dopaminergic and non-dopaminergic mechanisms have been shown to play a role in the development of dysphagia in PD. Clinical assessment of dysphagia in PD patients is difficult and often yields discordant results (22). However, in this study, it was observed that PD patients who were evaluated only with a single question and described difficulty in swallowing were highly associated with risk of malnutrition.

Study Limitations

There are some limitations in this study. The most important limitation of the study is that swallowing function was not evaluated with an objective method such as functional swallowing tests, an instrumental method such as videofluoroscopic evaluation, or a PD-specific swallowing questionnaire. However, studies in the literature have shown that single screening question for dysphagia as difficulty in swallowing in is closely related to the results of evaluations made by dysphagia diagnostic tools, both in cancer patients and older people living in the community (23,24). In addition, the relationship between a one-question dysphagia screening test and difficulty in swallowing pills was investigated in Parkinson's patients, and the sensitivity of the single question in estimating dysphagia was found to be moderate, while the specificity was found to be high (25). In addition, it is a cross-sectional study with a relatively small sample size. It is important to emphasize that further investigation through large-scaled longitudinal studies is mandatory to detect early malnutrition risk in the geriatric pwPD. Since aging and neurodegenerative diseases such as PD have a strong impact on patients' nutritional status, leading to weight loss, and malnutrition via direct, and indirect mechanisms, it is important to be aware of the risk of malnutrition especially in the geriatric pwPD. To prevent the damaging effects of weight loss on motor function in pwPD, especially in the geriatric population, clinicians should be aware of the malnutrition risks such as advanced stages of the disease, increased doses of daily levodopa, dysphagia, dyskinesia. When swallowing dysfunction is detected, treatment approaches should be applied with pharmacological interventions and therapy by speech and language therapists. Regular screening of malnutrition in pwPD with a validated tool like MNA alongside anthropometric measures such as body weight and BMI in the follow-ups is another clue for early recognition of malnutrition and applying essential interventions for malnutrition to maintain a better quality of life in pwPD.

Conclusion

pwPD are at risk for malnutrition. pwPD should be regularly followed up for malnutrition by the clinicians, particularly those with high risk factors associated with disease characteristics like dysphagia. In addition, the common treatment plan of PD should include a nutritional consultation with a dietary regime.

Information: This study presented in International Congress of Parkinson's Disease and Movement Disorders in 2018, in Hong Kong, as a poster.

Ethics

Ethics Committee Approval: The ethical approval was taken from the Local Ethical Committee of Erciyes University (decision no: 2016/595).

Informed Consent: Informed consent was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.G., F.F.Ö., S.A., A.Ö., Y.D., Concept: M.G., F.F.Ö., S.A., A.Ö., Y.D., Design: M.G., F.F.Ö., S.A., A.Ö., Y.D., Data Collection or Processing: M.G., F.F.Ö., S.A., Analysis or Interpretation: M.G., F.F.Ö., S.A., A.Ö., Y.D., Literature Search: M.G., F.F.Ö., Writing: M.G., F.F.Ö.

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References

1. Thenganatt MA, Jankovic J. Parkinson disease subtypes. JAMA Neurol 2014;71:499-504.
2. Paul BS, Singh T, Paul G, Jain D, Singh G, Kaushal S, Chinna RS. Prevalence of Malnutrition in Parkinson's Disease and Correlation with Gastrointestinal Symptoms. Ann Indian Acad Neurol 2019;22:447-452.
3. Tomic S, Pekic V, Popijac Z, Pucic T, Petek M, Kuric TG, Misevic S, Kramaric RP. What increases the risk of malnutrition in Parkinson's disease? J Neurol Sci 2017;375:235-238.
4. Barichella M, Cereda E, Pezzoli G. Major nutritional issues in the management of Parkinson's disease. Mov Disord 2009;24:1881-1892.
5. White JV, Guenter P, Jensen G, Malone A, Schofield M. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). JPEN J Parenter Enteral Nutr 2012;36:275-283.
6. Guyonnet S, Rolland Y. Screening for Malnutrition in Older People. Clin Geriatr Med 2015;31:429-437.
7. Sarikaya D, Halil M, Kuyumcu ME, Kilic MK, Yesil Y, Kara O, Ozturk S, Gungor E, Karabulut E, Balam Yavuz B, Cankurtaran M, Ariogul S. Mini nutritional assessment test long and short form are valid screening tools in Turkish older adults. Arch Gerontol Geriatr 2015;61:56-60.
8. Hoehn M, Yahr M. Parkinsonism: Onset, progression and mortality. Neurology 1967;17:427-442.
9. Güngen C, Ertan T, Eker E, Yaşar R, Engin F. [Reliability and validity of the standardized Mini Mental State Examination in the diagnosis of mild dementia in Turkish population]. Turk Psikiyatri Derg 2002;13:273-281.

10. Ertan T, Eker E. Reliability, validity, and factor structure of the Geriatric Depression Scale in Turkish elderly: are there different factor structures for different cultures? Int Psychogeriatr 200;12:163-172.
11. Kim SR, Chung SJ, Yoo SH. Factors contributing to malnutrition in patients with Parkinson's disease. Int J Nurs Pract 2016;22:129-137.
12. Bianchi VE, Herrera PF, Laura R. Effect of nutrition on neurodegenerative diseases. A systematic review. Nutr Neurosci 2021;24:81-834.
13. van der Marck MA, Dicke HC, Uc EY, Kentin ZHA, Borm GF, Bloem BR, Overeem S, Munneke M. Body mass index in Parkinson's disease: a meta-analysis. Parkinsonism Relat Disord 2012;18:263-267.
14. Sheard JM, Ash S, Silburn PA, Kerr GK. Prevalence of malnutrition in Parkinson's disease: a systematic review. Nutr Rev 2011;69:520-532.
15. Sheard JM, Ash S, Mellick GD, Silburn PA, Kerr GK. Improved nutritional status is related to improved quality of life in Parkinson's disease. BMC Neurol 2014;14:212.
16. Chen H, Zhang SM, Hernán MA, Willett WC, Ascherio A. Weight loss in Parkinson's disease. Ann Neurol 2003;53:676-679.
17. Fávaro-Moreira NC, Krausch-Hofmann S, Matthys C, Vereckeen C, Vanhauwaert E, Declercq A, Bekkering GE, Duyck J. Risk Factors for Malnutrition in Older Adults: A Systematic Review of the Literature Based on Longitudinal Data. Adv Nutr 2016;7:507-522.
18. Lee JJ, Oh JS, Ham JH, Lee DH, Lee I, Sohn YH, Kim JS, Lee PH. Association of body mass index and the depletion of nigrostriatal dopamine in Parkinson's disease. Neurobiol Aging 2016;38:197-204.
19. Pisciotta MS, Fusco D, Grande G, Brandi V, Lo Monaco MR, Laudisio A, Onder G, Bentivoglio AR, Ricciardi D, Bernabei R, Zuccalà G, Vetrano DL. Untangling the relationship between fat distribution, nutritional status and Parkinson's disease severity. Aging Clin Exp Res 2020;32:77-84.
20. Pfeiffer RF, Quigley EM. Gastrointestinal mobility problems in patients with Parkinson's disease-epidemiology, pathophysiology and guidelines for management. Cent Nerv Syst Drugs 1999;11:435-448.
21. Pålhagen S, Lorefält B, Carlsson M, Ganowiak W, Toss G, Unosson M, Granérus AK. Does L-dopa treatment contribute to reduction in body weight in elderly patients with Parkinson's disease? Acta Neurol Scand 2005;111:12-20.
22. Suttrup I, Warnecke T. Dysphagia in Parkinson's Disease. Dysphagia 2016;31:24-32.
23. Borean M, Shani K, Brown MC, Chen J, Liang M, Karkada J, Kooner S, Doherty MK, O'Kane GM, Jang R, Elimova E, Wong RK, Darling GE, Xu W, Howell D, Liu G. Development and evaluation of screening dysphagia tools for observational studies and routine care in cancer patients. Health Sci Rep 2018;1:e48.
24. Heijnen BJ, Speyer R, Bülow M, Kuijpers LM. What About Swallowing?' Diagnostic Performance of Daily Clinical Practice Compared with the Eating Assessment Tool-10. Dysphagia 2016;31:214-222.
25. Buhmann C, Bihler M, Emich K, Hidding U, Pötter-Nerger M, Gerloff C, Niessen A, Flügel T, Koseki JC, Nienstedt JC, Pflug C. Pill swallowing in Parkinson's disease: A prospective study based on flexible endoscopic evaluation of swallowing. Parkinsonism Relat Disord 2019;62:51-56.