Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i2.4329

IMPACT OF THE NUTRITIONAL APPROACH IN PATIENTS WITH PARKINSON'S NEURODEGENERATIVE DISEASE; LITERATURE REVIEW

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Abstract:

Introduction: Malnutrition in the context of Parkinson's disease involves both excess and deficiency, with deficiency recognized as a prominent global cause of immunodeficiency. Various risk factors, including weight loss, levodopa treatment duration, anxiety, and symptoms related to dysautonomia, contribute to malnutrition in Parkinson's patients.

Objective: This study aims to delineate the impact of nutritional interventions on individuals with neurodegenerative Parkinson's disease.

Methodology: Conducted as a retrospective descriptive bibliographic review, the study involves a comprehensive search and analysis of original scientific articles in Spanish and English. Medical information databases such as PubMed, Web of Science, BVS, Scholar, Medline, SciELO, etc., were utilized for article selection.

Results: Out of 37 screened scientific articles, nine high-level evidence surveys were included, following predefined inclusion and exclusion criteria. The nutritional approach to Parkinson's involves guided diets tailored to the patient's nutritional status and disease progression. The Mediterranean diet emerges as a well-supported option for nutritional support in Parkinson's, along with recommendations for diet modification in the consistency of both liquids and solids.

Conclusion: This review underscores the importance of addressing malnutrition in Parkinson's disease through a targeted nutritional approach. Guided diets, especially those aligned with the principles of the Mediterranean diet, are recognized as valuable strategies. Modification of diet consistency, considering the progression of the disease, further adds to the nuanced nutritional management of Parkinson's patients.

Keywords: Parkinson's, Nutritional approach, Dysphagia, Food supplements.

INTRODUCTION:

When we talk about the nutritional approach, the World Health Organization (WHO), from a multidisciplinary point of view, defines it as a set of activities responsible for improving unwanted eating behaviors whose sole objective is to improve the patient's nutritional status. Nutrition education requires the intervention of multiple professionals to encourage the exchange of knowledge with the user and family to acquire responsibility in promoting health through the in-depth and individualized analysis of the nutritional problem, identifying the risk factors to be addressed and defining the objectives. Furthermore, it requires an adequate emotional relationship between the professional and the patient so that the latter, through the information provided and the nutritional behaviors in which they seek help, can achieve health and do everything possible to maintain it (Tosin, Goetz, & Stebbins, 2024).

Similarly, the term "malnutrition" encompasses two situations of nutritional imbalance: on the one hand, obesity is generated by an excess, and on the other, malnutrition is generated by a deficiency. It is recognized as the leading global cause of immunodeficiency; although the humoral response is preserved, an impairment of the response occurs (Hiu et al., 2024).

Local in the mucous membranes where depletion of IgA-producing plasma cells and lymphocytes occurs, which would explain the high prevalence of respiratory and enteric diseases acquired in these patients. Furthermore, an essential alteration of cellular immunity is observed since a decrease in T lymphocytes is observed without global lymphopenia and a cellular depletion in the lymph nodes and spleen, which translates into energy in delayed hypersensitivity reactions; the bactericidal capacity of neutrophils is also reduced. For this reason, we see the importance of correct nutritional orientation in patients with risk factors for malnutrition, and it becomes a fundamental objective of the professional to achieve the subjective well-being of the patient and his family environment or to guide him in improving his diet. Parameters for a better quality of life (Cheng, Quan, & Thompson, 2024).

On the other hand, neurodegenerative Parkinson's disease (PD) is a chronic multifactorial disease in which several risk factors determine its generation or progression, such as ageing, male sex and even the specific characteristics of each individual. Higher incidence is observed between 70 and 74 years of age and in women around 85. As regards mortality rates, differences are found: the levels are higher for males, for white people and at older ages (Ciocca & Pizzamiglio, 2024).

Parkinson's disease was described in 1817 by James Parkinson, who described it as characterized by changes at the extrapyramidal level, mainly tremors at rest, bradykinesia, rigidity, and postural instability. Other changes related to autonomic nervous system dysfunction include sweating, sialorrhea, and subsequent cognitive changes that can lead to dementia in the final stages of the disease (Mazzucca, Cappellano, & Chiocchetti, 2024).

Patients with Parkinson's disease are particularly nutritionally vulnerable, with an incidence of malnutrition as high as 24% in some series. Risk factors that have been primarily associated with malnutrition in Parkinson's disease are weight loss, anxiety, duration of levodopa treatment, weight at the start of treatment, the presence of symptoms related to dysautonomia (dysphagia, salivation, constipation), severity of the disease and dose in treatment with levodopa (Leonard et al., 2024).

During the disease, the majority of patients present a significant weight loss, with therapeutic and prognostic implications: lower weight, greater incidence of motor complications of dopaminergic treatment (dyskinesia) and greater risk of general worsening and consequent complications. Chronic diseases and weight loss are due to an imbalance between energy consumption and intake; however, some circumstances are critical in Parkinson's disease (Duvdevani et al., 2024).

The goal of nutritional support in PE is to cover the patient's nutritional and energy deficiencies safely, as well as treat and prevent them, malnutrition and its complications, taking into account personal and clinical circumstances to accommodate the patient's situation at every moment of its evolution. This is to optimize quality of life and reduce morbidity and mortality. The peculiarity of nutritional support depends on the patient's symptoms and the safety and effectiveness of the swallowing function. When carrying out the nutritional diagnosis, two fundamental aspects must be considered: the patient's degree of dysphagia and the nutritional status. We can opt for oral and integrative therapy in cases of even mild dysphagia and malnutrition (Shafiee et al., 2024).

In these cases, the literature recommends taking into account that the drugs must be administered in the ON phase, i.e. 60 minutes before the meal and that nutritional therapy in these cases depends on the person's condition and his basic needs, as already mentioned; however, when initiating treatment with L-DOPA (0.8/kg protein weight) a protein redistribution diet is recommended (Bartolomeu Pires, Kunkel, Kipps, Goodwin, & Portillo, 2024).

When the person is evaluated and found at level 4.0 according to the Hoehn and Yarhr scale, it can be determined that he has severe dysphagia, which means that he has a high risk of complications arising from the ingestion of this food and a subsequent deterioration in quality of life. At this time, the option of an enteral artificial feeding method should be considered, which in the short term involves the placement of a nasogastric tube (NGT) or, in the long term, a gastric tube (PEG percutaneous endoscopic stoma), which would determine more care and modification of the consistency of the diet in the patient suffering from PD. The importance of the affective and symbolic meaning that the patient gives to his family and his food environment is also fundamental since these psychological aspects allow greater adherence to nutritional treatment (Karande & Kulkarni, 2024).

They mentioned some essential aspects to be considered during the professional interview with the family and the patient in a state of vulnerability. For example, the comprehensive approach and multidisciplinary nutrition training comment on the psychological impact on the patient's nutrition at different stages of disease progression and formulate a situational diagnosis (Mohamed, 2024).

The great need to address nutritional aspects in Parkinson's patients is evident, as several studies mention that between 50 and 70% of patients in the advanced stages of the disease suffer from malnutrition; furthermore, they report that one of the most reliable indicators of survival is the nutritional status of the patient and therefore constitutes a challenge for the nutrition professional who constantly evaluates the clinical evolution of the pathology (comorbidities, side effects of drugs, family environment, economy, etc.) for better adaptability of nutritional treatment; as well as formulate fixed goals for family behavior in the face of daily changes in the patient's diet (Cabanillas et al.).

Considering the above, the nutrition professional must develop skills and competencies for family accompaniment and support to avoid claudication crises due to emotional overload in the home environment. Therefore, their assessments should be multidimensional, with a symptom-based nutritional approach and advanced decision-making (Banou, Vrahatis, Krokidis, & Vlamos, 2024).
As mentioned previously, people with Parkinson's, as the disease progresses, may have a reduction in intestinal function; therefore, constipation and slowing of gastric emptying, resulting in Porstariazón, serious need for the study of this disease, which has a higher incidence of nutritional problems than others. Having said this, it is of fundamental importance that the study of dietary tactics is enriched according to the progression of Parkinson's patients; in this way, professionals will have various tools at their disposal with which they can intervene with their patients and their family environment in an individualized and specialized way (Delafontaine et al., 2024).

OBJECTIVES:

General Objective:

To describe the influence of nutritional management in patients with neurogenerative Parkinson's disease.

Specific Objectives:

- Conduct a literature search on neurogenerative Parkinson's disease and its impact on nutrition.
- Identify nutritional problems in patients with Parkinson's disease.
- Discuss the latest research with high-level evidence with content to investigate the literature regarding the impact of nutrition on Parkinson's disease.

MATERIALS AND METHODS:

The following article is a retrospective descriptive literature review study. The study is carried out through a detailed search and analysis of original scientific articles, review articles, case reports, literature reviews, meta-analyses, systematic studies, cohort studies, randomized controlled studies in languages such as Spanish and English and with Boolean operators present or not indexed in medical information databases such as Pub-med, Web of Science, Bvs, Scholar, Medline, SciELO, Springer and Redalyc. This study will allow us to detail, in an orderly and reproducible way, the results of the last 5 years and the tremendous scientific evidence on the nutritional approach in patients with neurodegenerative Parkinson's disease, using keywords such as nutrition, nutritional approach, Parkinson, dysphagia and swallowing problems (Arunachalam, Saranya, & Karuppannan, 2024; Wang, Liu, Ren, Guo, & Wang, 2024).

Inclusion Criteria:

Articles with a high level of scientific evidence using keywords from the thesaurus for their search, research with conclusive results and a sufficient sample, both in animal testing and systematic reviews.

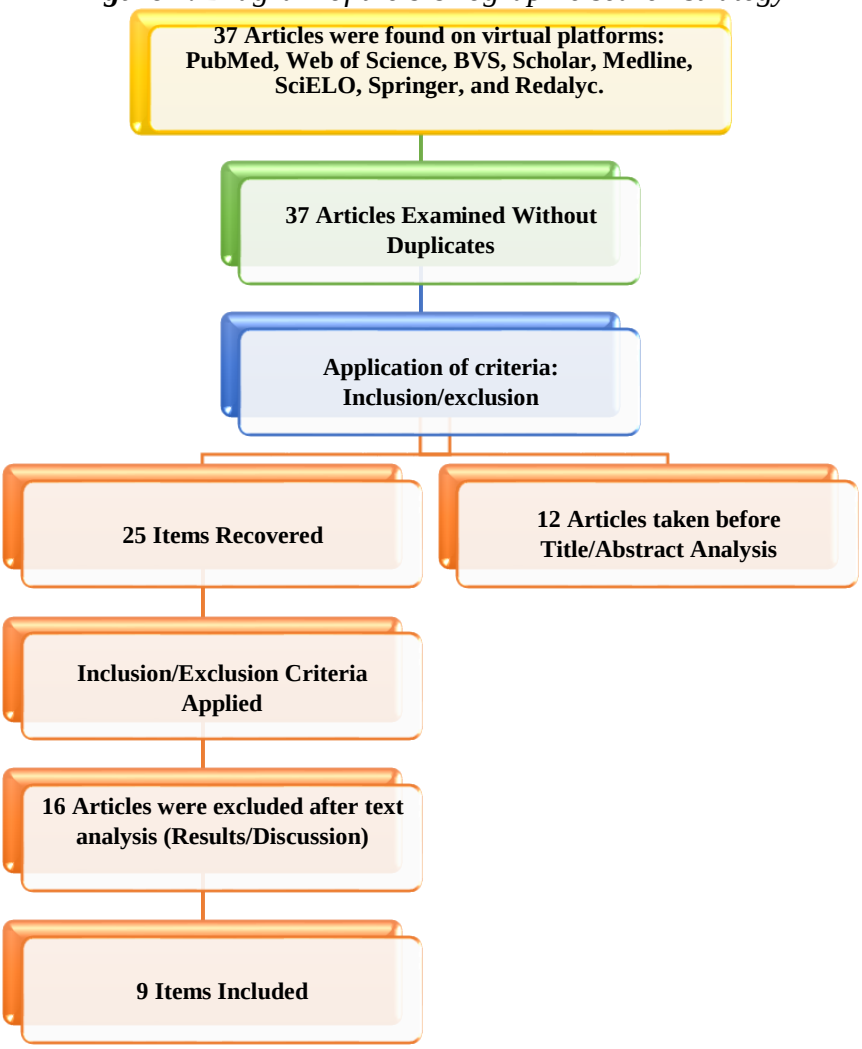
Exclusion Criteria:

Articles published more than 5 years ago, articles with low scientific evidence, a high level of bias in the research or results, and articles without clearly defined objectives or an adequately established research methodology.

Statistical Analysis:

For the analysis of the results obtained, a screening of the bibliographic studies was carried out using a scheme highlighting the main scientific results of the research and comparing them with studies of different levels of evidence present on virtual platforms, discussing these results according to the author's appreciation (Golpour-Hamedani et al., 2024).

Figure 1. *Diagram of the bibliographic search strategy*



RESULTS:

Below, Table 1 shows the articles of most significant scientific relevance collected for the development of our study (Chen & Small, 2024).

Table 1. *Scientific evidence articles on the approach*

Qualification	Year	Author	Country	Study Sample	Methods	Results	Conclusions	Recommendation Level
Diet quality and risk of Parkinson's disease: a prospective study and meta-analysis	2020	Liu YH, Jensen GL, Na M, Mitchell DC, Wood GC, Still CD and Gao X (16).	United States	3653 participants	Diet quality was assessed using a validated dietary screening tool, Dietary Screening Tool (DST), containing 25 specific food and behavior questions in 2009. Potential Parkinson's cases were identified using ICD9-based electronic health records	After a mean of 6.94 years of follow-up, 47 incident cases of Parkinson's were documented. Participants with better diet quality were likelier to be female, never smoke, have a higher educational level, and live with relatives. A high-quality diet was associated with a lower	In conclusion, it is suggested that having a high-quality diet or following a healthy dietary pattern is associated with a lower risk of PD. More observational studies with a larger sample size and longer follow-ups are needed to understand better the temporal relationship between dietary	IA

					(332), ICD10 (G20) and Parkinson's related treatments. After adjusting for potential confounders, the 95% confidence interval (CI) and hazard ratios (HR) at diet quality percentiles were calculated using Cox proportional hazards models. Furthermore, we performed a meta-analysis by combining our study with four published articles on this topic.	risk of incident PE over a mean of 6.94 years of follow-up (adjusted HR = 0.39 comparing two extreme tertiles; 95% CI: 0.17, 0.89; trend p = 0.02). Sensitivity analyzes excluded patients who had self-reported oral health problems generating similar results (adjusted HR = 0.39; 95% CI: 0.17, 0.90; p trend = 0.02). Similar trends between diet quality and PD risk were also observed in sensitivity analyses that excluded participants diagnosed within two years of follow-up plus with self-reported oral health problems (p = 0.05). A higher frequency of intake of fruits, whole grain cereals, pastries or pies, hot or cold breakfast cereals, and juices at breakfast was associated with a lower risk of Parkinson's disease (p < 0.05 for all).	patterns and Parkinson's development.	
Dietary Antioxidants and Parkinson's Disease Risk: A Systematic Review and Dose-Response Meta-Analysis of Observational Studies	2022	Talebi S., Ghoreishy SM, Jayedi A, Travica N, and Mohammadi H.	Iran	448 737 participants (4654 cases with PD)	A systematized search was conducted in electronic databases (PubMed, Scopus, Web of Science and Google Scholar) until March 2021. No filters or	A total of 7 prospective cohort studies (total n = 318,784) and 5 case-control studies were included for analysis of dietary vitamin C. The PE risk estimate was	In conclusion, the present dose-response meta-analysis revealed that a higher dietary intake of antioxidants, specifically vitamin E, vitamin C, and polyphenols such as	IA

					restrictions regarding publication time or language were applied. Keywords related to dietary intake of various antioxidants, PD, and study design were used. Articles that met the following criteria were individually selected: 1) observational studies with a prospective cohort, nested case-control, or case-control design; 2) performed in adults (≥18 years); 3) reported the consumption of the dietary antioxidants vitamin C, vitamin E, vitamin A, selenium, zinc, α-carotene, β-carotene, Lycopene, β-cryptoxanthin, lutein, flavonoids, and antioxidant capacity; 4) reported PD risk estimation as an outcome variable; and 5) OR, RR, or HR reported along with 95% CIs. They were omitted.	similar for the lowest compared to the highest category of vitamin C intake (RR: 0.95; 95% CI: 0.77, 1.18; I2 = 75.9 %; 95% CI: 49, 89; p < 0.001. On the other hand, two prospective cohort studies, consisting of 805 PD cases among 129,617 participants, were included in the pooled analysis of dietary intake of total flavonoids and their subclasses. The PD summary RR for the highest flavonoid intake was lower than the lowest (RR: 0.77, 95% CI: 0.46, 1.29; I2 = 77.1%, p= 0.03). Similarly, two case-control studies analyzed the association between dietary zinc intake and the risk of PD. The relative risk of PD was lower for the highest group than the lowest dietary zinc intake group (OR: 0.64, 95% CI: 0.31, 1.31; I2 = 68.8%, p= 0.07). A 1 mg/d increase in dietary zinc intake was associated with a significantly lower risk of PD (OR: 0.65; 95% CI: 0.49, 0.86; n = 1).	anthocyanins, is associated with a lower risk of Parkinson's. The meta-evidence quality rating indicated little confidence in the effect size estimates generated across various dietary antioxidants examined. Future well-designed prospective cohort studies may be needed to determine reliably whether dietary consumption of antioxidants is a plausible option for PD prevention.	
Prevalence of malnutrition in patients with Parkinson's disease: a	2022	Kacprzyk KW, Milewska M, Zarnowsk	Poland	5613 study subjects	A systematic search was conducted: Cochrane, PubMed,	Mini Nutritional Assessment is used to evaluate the	In conclusion, this study demonstrated a limited number of articles	IA

systematic review		a A, Panczyk M, Rokicka G andSzostak-Wegierek D (18).			Embase and Web of Science. Articles published between 2000 and 2020, from October 2021 to June 2022, were included. The included studies had to use a method of assessing nutritional status: a specific questionnaire or measurement of BMI. The inclusion criteria were: patients over 18 years of age diagnosed with PD and with nutritional evaluation; Research with animals; incorrect publication of the study, studies on in vitro cells; patients diagnosed with other Parkinsonian syndromes; and unavailability of the abstract and full text were excluded.	nutritional status of patients. Twenty-two studies in which MNA assessments were performed were included. There were 2,713 participants, of which 39.2% were women and 60.8% were men. The youngest patient was 20 years old, while the oldest was 92. The highest reported number of malnourished patients was 39.2%; the risk of malnutrition was 59% [32], and the lowest were 0% and 14%, respectively. A significant number of studies (6 of 22) did not report the prevalence or risk of malnutrition.	dedicated to evaluating nutritional status in patients with Parkinson's disease. The studies varied widely due to the use of several different questionnaires to assess the nutritional status of patients. It was not Parkinson's. These factors could provide more information and help differentiate more aspects determining a patient's risk level. Additionally, it is essential to note that many patients tend to be overweight or obese, which should not be ignored when assessing nutritional status. Increased body weight can be seen as a marker of good nutritional status. However, the opposite can be accurate and is quite common in patients with Parkinson's disease. According to available data, the prevalence of malnutrition in patients with Parkinson's disease is significant, even though many patients have excessive body mass.	
Nutritional ketosis for mild cognitive impairment in Parkinson's disease: a controlled pilot trial	2019	Robert Krikorian, Marcelle D. Shidler, Suzanne S. Summer, Patrick G. Sullivan, Andrew P. Duker,	USA	18 patients	It was conducted by recruiting patients from the Gardner Center for Parkinson's Disease and Movement Disorders at the Academic Health Center.	Compared to the high-carbohydrate group, the low-carbohydrate group exhibited better performances on the lexical access	In conclusion, it has been shown that short-term nutritional ketosis is capable of improving cognitive performance in patients with PD-MCI. The	IA

		Richard S. Isaacson, Alberto J. Espay.			Participants diagnosed with PD according to UK Brain Bank criteria and with cognitive signs and symptoms corresponding to MCI according to the Movement Disorder Society Working Group guidelines for Level I PD-MCI were included. Inclusion criteria were a total score between 20 and 25 on the Montreal Cognitive Assessment (MoCA). Additionally, patients had to have been treated with a stable regimen of antiparkinsonian medications for at least six weeks.	compound ($F(1,11) = 6.55$, $p = 0.02$, Cohen's f effect size = 0.76) and the composite memory ($F(1,11)=8.42$, $p=0.01$, $f=0.87$). The low carbohydrate group also tended to reduce memory interference ($F(1,11)=4.03$, $p=0.06$, $f=0.60$). Change in body weight was strongly associated with memory performance (standardized beta (βstd) = − 0.59, $p < 0.001$) and marginally predicted lexical access (βstd = − 0.34, $p = 0.06$). However, for the low carbohydrate group, daily energy intake decreased significantly (2205 (624) kcal to 1667 (404) kcal, $p=0.004$), as did carbohydrate intake (from 44.9% to 8%). of total kcal, $p=0.001$). Protein (14% to 29%, $p=0.009$) and fat (38% to 61%, $p=0.04$) intake increased relative to pre-intervention levels, and there was a reduction in fibre intake (20.2 (7.1) g to 6.8 (4.1) g, $p=0.007$).	findings expand previous observations of neurocognitive benefits in individuals at risk and those with early neurodegeneration. However, more research with larger samples is needed to demonstrate the reproducibility of the findings. In addition, it will be necessary to investigate whether a more extended duration intervention could provide similar or greater benefit and whether the benefit is maintained after treatment termination. Future studies of nutritional ketosis will also be of interest to evaluate the effects of genetic and epigenetic factors and PD endophenotypes.	
Clinical and nutritional correlates in Parkinson's disease: preliminary report.	2019	Sławomir Budrewicz, Anna Zmarzły, Dominik Rączka, Aleksandr	Poland	40 patients	40 patients diagnosed with PD were analyzed according to clinical criteria; all	In 10 (25%) PD patients, the NRS 2002 result was ≥3 points. NRS 2002 results were	The duration of Parkinson's, motor and non-motor symptoms, and frequency of l-DOPA intake	2B

		a Szczepańs, Ewa Koziorow ska-Gawron, Krzysztof Słotwińsk i Magdalen a Koszewic z.			were analyzed in an outpatient clinic. An ordered anamnesis was taken in all patients: age, sex, duration of the disease, pharmacologic al treatment of PD, alterations of smell, taste and gastrointestina l tract, other alterations and their treatment, and addiction to stimulants. The risk of malnutrition was established based on the Nutrition Risk Screening (NRS 2002) and body mass index (BMI). In NRS 2002, scores ≥3 indicate the threat of malnutrition and the need for nutritional intervention. The thickness of 3 skin folds was measured: deltoid, abdominal and subscapular.	positively correlated with PD duration, while taste disturbances were negatively correlated with BMI. A positive correlation was also observed between the NRS 2002 result and the frequency of l-DOPA intake, while there was no such correlation between BMI and l-DOPA intake. A negative correlation was revealed between the thickness of the subscapular fold and the duration of PD and between the thickness of the abdominal and subscapular folds and the results of H-YSS. SEADLS scores were positively correlated only with abdominal fold thickness.	are closely correlated with nutritional status. Understanding multifactorial interdependenc e could help estimate an algorithm to monitor the nutritional status of PD patients and early nutritional intervention.	
Nutritional support aimed at muscles for rehabilitation in patients with Parkinson's syndrome.	2019	Michela Barichella , Emanuele Cereda, Giovanna Pinelli, Laura Iorio, Diana Caroli, Irene Masiero, Valentina Ferri, Erica Cassani.	Italy	327 patients	We conducted a pragmatic, two-center, randomized (1:1), blinded estimator controlled trial (Protein, Leucine and Vitamin D Enhancing Rehabilitation [PRO-LEADER]; April 2017 to January 2018) in cognitively intact patients with PD or parkinsonism and subjected to MIRT of 30 days. Patients (n = 150) received a standard hospital diet	Nutritional support resulted in a more significant increase in distance walked during the 6MWT (mean 69.6 meters [95% confidence interval (CI): 60.7-78.6]) than no support (51.8 meters [95% CI 37.0-66.7]): center-adjusted mean difference, 18.1 meters (95% CI 0.9-35.3) (p = 0.039). Further adjustment for	Consumption of a nutritional formula based on whey protein enriched with leucine and vitamin D with MIRT improved lower extremity function. It preserved muscle mass in patients with PD or parkinsonism.	IA

					with or without a nutritional supplement based on whey protein enriched with leucine and vitamin D twice daily. The primary efficacy endpoint was increased distance walking during a 6-minute walk test (6MWT).	changes in dopaminergic therapy and SMM yielded consistent results: mean difference, 18.0 meters (95% CI, 0.7 to 35.2) (p = 0.043). A significant effect was also found for the following secondary endpoints: 4-meter walking speed (p = 0.032), TUG (p = 0.046), SMM, and SMM index (p = 0.029). Six patients discontinued nutritional therapy due to mild side effects.		
The effect of the Mediterranean diet on cognitive function in patients with Parkinson's disease: a randomized controlled clinical trial Dietary lycopene supplementation improves cognitive performance in tau transgenic mice expressing the P301L mutation by inhibiting oxidative stress and hyperphosphorylation of tau.	2017	Lixia Yu, Weiguang Wang, Wei Pang, Zhonghai Xiao, Yugang Jiang, Yan Hong.	China	46 P301L transgenic mice.	P301L transgenic mice were assigned to three groups: P301L group (P301L), P301L+lycopene (Lyc), and P301L+lycopene/vitamin E group (Lyc+VE). The present study used age-matched C57BL/6J mice as wild-type (Con) controls. Spatial memory was assessed using the radial arm, while passive memory was assessed using step-down and step-by-step tests. Tau phosphorylation levels were detected by Western blotting. Biomarkers of oxidative stress were measured in serum using biochemical assay kits.	Compared with the control group, P301L mice showed significant spatial and passive memory impairments, elevated malondialdehyde (MDA) levels, and decreased glutathione peroxidase (GSH-Px) activity in serum. Increased tau phosphorylation on Thr231/Ser235, Ser262 and Ser396 in the brain Lycopene or lycopene/vitamin E supplements could significantly improve memory deficits, observably decrease MDA concentrations and increase GSH-Px activities, and markedly attenuate hyperphospho	The present study was carried out to examine whether Lycopene or lycopene/vitamin E could exert protective effects on memory deficit and oxidative stress in tau transgenic mice expressing the P301L mutation. It was concluded that the antioxidant combination of Lycopene and vitamin E synergistically generated significant effects against oxidative stress in tauopathies.	IA

						rylation of tau at multiple AD-related sites (p < 0.001).		
Efficacy of vitamin B supplementation on cognition in elderly patients with cognition-related diseases.	2017	Dong-Mei Zhang, Jian-Xin Ye, Jun-Shan Mu, Xiao-Ping Cui.	China	77 items	The current meta-analysis evaluated the efficacy of folic acid and vitamins B12 and B6 in reducing homocysteine, thereby attenuating cognitive decline in elderly subjects with neurodegenerative disease or dementia. Randomized controlled trials (RCTs) comparing the effectiveness of folate and vitamin B supplements in patients with cognitive impairment secondary to neurodegenerative disease or dementia were identified using the keywords “homocysteine, hyperhomocysteinemia, vitamin B, vitamin B6, B12, acid folic, cognitive, disease and dementia". The outcome measures analyzed were the Mini-Mental State Examination (MMSE) score and serum homocysteine.	Results reveal that the intervention group achieved a statistically significant greater reduction in homocysteine levels than the control (pooled mean difference = -3.625, 95% confidence interval [CI] = -5.642 to -1.608, P < 0.001). However, no statistically significant difference was found in the MMSE (pooled mean difference = 0.027, 95% CI = -0.518 to 0.573, P = 0.921) between the groups.	In summary, the current analysis indicates that for patients with cognitive impairment secondary to Alzheimer's and dementia, adjunctive therapy with vitamin B and folic acid supplements reduced plasma homocysteine levels. However, it did not provide significant advantages over placebo in preventing further cognitive decline. The current results suggest that the evidence on reducing cognitive impairment induced by vitamin B supplementation by decreasing homocysteine ranges is discordant. Further validation of the current findings with trials of larger sample sizes and longer durations is recommended.	IA

As mentioned previously, patients suffering from Parkinson's disease, from a nutritional point of view, are more vulnerable to suffering from malnutrition; therefore, the quality of life of these patients is significantly reduced. A meta-analysis conducted in China involved 2,707 patients with PD and 150,661 healthy controls, aiming to observe the impact of the disease on their quality of life (QoL). The professionals involved in this study used several questionnaires that observed a statistically significantly worse quality of life in Parkinson's patients, which varied depending on their association with the disease, the most significant of which is the Parkinson's Disease Questionnaire-39 (PDQ-39).) which had the largest effect size (standard mean difference, SMD=−1.384, 95% CI: −1.607, −1.162,

Z=12.189, P<0.001) followed by questions. European Quality of Life Questionnaire-Visual Analogue Scale (EQ-VAS)(DME= −1.081, 95% CI: −1.578, −0.584, Z=−4.265, P<0.001) (Helgudóttir et al., 2024).
Similarly, in another systematic review in which QOL was observed to be influenced by motor and non-motor symptoms of Parkinson's disease, 1149 patients with this pathology were included, who used for qualitative evaluation a Rainbow model of integrated care integration to determine the integration of professional with the patient and a better quality of life. Meta-analysis of randomized controlled trials revealed significant heterogeneity (I2=90 %, P < 0.0001). Subgroup analysis including only ambulatory care models indicated homogeneity of effects and improved health-related quality of life in favor of integrated care (standardized mean difference [SMD], -0.17; 95% CI, from -0.31 to -0.03; P = 0.02) (Chiang, Cheong, Cordato, & Smerdely, 2024).

In the same way that we observe that Parkinson's has a directly proportional relationship with the quality of life, malnutrition has a clear relationship with the sick person's QoL, depending on the disease's stage. In 2020, in Germany, Gruber MT et al. conducted a study to determine the relationship between quality of life, clinical parameters and malnutrition in Parkinson's disease. It involved 92 people without dementia who used the Mini Nutritional Assessment (MNA) to assess nutritional status; for motor disability and level of non-motor symptoms, they used the Unified Disease Rating Scale.
For Parkinson's [MDSUPDRS], Nonmotor Symptoms and Staging Questionnaire, for depression (Becks Depression Scale-II) and for QoL (PDQ-39). It was found that one in two patients were malnourished or at risk of malnutrition; furthermore, there is a significant relationship between neuropsychological symptoms, duration of the disease and decreased food intake, which led to malnutrition. Since malnutrition affects quality of life, we analyzed the relationship between nutritional status and domains of the PDQ-39. The MANOVA revealed a significant multivariate main effect for the total MNA score across all eight PDQ-39 subdomains (p = 0.016; Wilk's Λ = 0.799, partial $\eta 2$ = 0.20). However, significant univariate main effects for MNA were only found for emotional well-being (p<0.001, η2partial=0.15).), mobility (p = 0.004, partial $\eta 2$ = 0.09), stigmatization (p = 0.003, partial $\eta 2$ = 0.1) and social support (p=0.043, η2partial=0.05). As indicated by η2partial, the strongest association was found between malnutrition and emotional well-being (Kluger et al., 2024).

That is, the QoL of the patient suffering from Parkinson's has a proportional relationship with his nutritional status. Going into the topic of our study, several studies indicate that diet quality also has a direct relationship with the onset of Parkinson's of their diet via the Dietary Screening Tool (DST) in 2009 and their potential risk of Parkinson's. After 6.94 years of follow-up, 47 non-accidental cases of Parkinson's disease were reported. High diet quality was related to not being a smoker, having a higher level of education, and living with relatives. A direct association was found between a high-quality diet and a lower risk of suffering from Parkinson's disease (p=0.02), just as high consumption of fruit, whole grains, cakes and juices at breakfast was associated with a lower risk of Parkinson's disease (p=0.02), p<0.05) (Katiyar et al., 2024).

Similarly, TalebiS et al. so relate the intake of antioxidants and the risk of suffering from Parkinson's in their study, which involved 448,737 participants (4,654 cases of PD) in which they relate this risk to various antioxidants and determined that there is a relationship between high consumption of flavonoids and their derivatives with a lower risk of suffering from PD (RR: 0.77; CIdel95%:0.46,1.29; I2=77.1%,p=0.03). Furthermore, they observed that a 1 mg/day increase in dietary zinc intake was associated with a significantly lower risk of PD (OR: 0.65, 95% CI: 0.49, 0.86, n = 1). No significant differences were found in the intake of vitamin C (Caminiti et al., 2024; Pandit, Kulkarni, & Singhvi, 2024).

Similar results were also found in another meta-analysis carried out in Sweden, where the aim was to analyze a relationship between plasma levels of thiamine (P-THIAM), thiamine monophosphate (P-TMP) and phosphate (PePHOS) and PD. Seventy-five patients with mild and average cognitive impairment participated and showed bivariate correlations between PePHOS and P-TMP for the total PD population and controls, as well as for men with mild cognitive impairment ($r=0.533$; $n=22$; $p=0.011$) but not for men with normal cognition ($r=0.314$; $n=19$; $p=0.204$)(X. Liu et al., 2024).

Considering the poor quality of life of Parkinson's patients and its relationship with diet, a systematic review was carried out in Poland on the prevalence of malnutrition in Parkinson's disease involving 5,613 subjects over the age of 18 between 2000 and 2020. The assessment method was MNA, with 60.8% of men in 22 studies, where the youngest was 20 years old and the oldest was 92 years old. They determined that 39.2% of patients were malnourished and 59% were at risk of malnutrition. These results correlate with those. The prevalence of malnutrition in this group was 39.2%, and 30.3% were at risk of malnutrition, with no significant differences by sex or age ($p<0.05$). Similarly, these two groups had a longer course of the disease, severe motor and non-motor symptoms, lower cognitive scores, and higher levels of depression and anxiety ($p < 0.05$) (Farombi et al., 2024).

The literature supports that the risk of malnutrition is more significant in people who have advanced stages of the disease, and its symptoms are a possible predisposing factor; furthermore, it produces a lower cognitive level, therefore, a greater risk of mental problems and a worsening of the quality of life.
Another study, published in 2019, conducted a study on malnutrition in 75 patients with Parkinson's disease and its gastrointestinal clinical correlation using MNA as a nutritional assessment method, where 12% presented malnutrition and 41.3% were at risk of malnutrition. Similarly, a clinical correlation was found between gastrointestinal manifestations and abnormal nutrition, sialorrhea ($p=0.041$), dysphagia ($p=0.00081$) and constipation ($p=0.0042$) with malnutrition. No statistically significant differences were found between groups for age, sex and disease duration. These results correlate with those in Budrewicz's research (Dagar et al., 2024).

A study was also carried out in 2019, where it was demonstrated that in 40 patients suffering from PD, 25% had a high risk of malnutrition positively associated with the duration of the disease through the use of Nutrition Risk Screening (NRS 2002). The difference between these two studies was marked in the positive relationship that the 2002 NRS result had with the intake of L-DOPA, which results in a directly proportional relationship between these two variables. (Federico et al., 2024)

Taking into account that dysphagia has a crucial clinical correlation with the patient's nutrition, Parkinson Umemoto G. and Furuya H. mention that symptoms such as bradykinesia and muscle rigidity are recognized causes of swallowing disorders related to abnormal movements that include hesitant chewing, loss of the labial bolus, tongue tremor, prolonged tongue elevation, pumping, limited and slower mandibular excursion in the oral phase; Therefore, a modification of the consistency of solids and liquids is recommended to avoid aspiration pneumonia (Liang et al., 2024). Furthermore, there is an Italian consensus on the treatment of dysphagia in Parkinson's disease published in 2021, which cites compensatory swallowing therapies in patients suffering from this pathology. Standard swallowing therapy addresses the pathophysiological and mechanical mechanisms of the disease in which the patient is guided in swallowing manoeuvres, muscle strengthening exercises and tactile thermal stimulation, as well as neurostimulation therapies to treat this gastrointestinal manifestation; however, there is insufficient long-term evidence to prevent complications such as bronchial aspiration, other than the use of this drug (Tasleem, Kaushik, Kaushik, Tabassum, & Parvez, 2024).

For cynics, it is necessary for a patient with sufficient cognitive abilities to follow the doctor's instructions. For this reason, the idea of suggesting postural therapies and using food thickeners considers the person's hydration, which slows down the flow of liquids, allowing more time for the respiratory tract to close (Pigott et al., 2024).

Krikorian R. et al. carried out a controlled study in 2019 with 18 patients with Parkinson's disease and mild cognitive impairment to observe whether nutritional ketosis helps stop cognitive deterioration. They observed that the low-carbohydrate group improved short-term performance in lexical access ($F(1,11) = 6.55$, $p = 0.02$, effect size Cohen's $f = 0.76$) and in composite memory ($F(1,11)= 8.42$, $p=0.01$, $f=0.87$), therefore, demonstrated a strong relationship between the ketogenic diet and cognitive impairment; However, a larger sample is needed to be fully used in the nutritional treatment of Parkinson's, but it is an option in this type of patients (J. Liu et al., 2024).

Likewise, it supports the theory of nutritional ketosis to avoid neuroinflammation and oxidative stress typical of Parkinson's disease, in this case, with the administration of polyunsaturated acids, especially Omega 3 (PUFAn-3). They defend that n-3 PUFAs are essential components that preserve cell membrane structure, inhibit the production of proinflammatory cytokines, and protect astrocyte function by promoting the production of neurotrophins, normalizing neurotra Barichella M.etal. Also, encouraging results were obtained by studying a nutritional formula based on whey proteins enriched with leucine and vitamin D in 327 patients with Parkinson's disease without cognitive impairment, subjected to a test of walking 6 minutes for 30 days. They observed a significant increase in mean center-corrected distance difference, 18.1 meters (95% CI 0.9-35.3) ($p=0.039$). Therefore, we could say that nutritional support for muscle rehabilitation could also be effective in avoiding dysphagia and the consequent risk of malnutrition, knowing that this is caused by bradykinesia and muscle rigidity (Hanff et al., 2040).
On the other hand, dietary supplements have also been studied to improve cognitive performance, as in the study where the combination of Lycopene and vitamin E antioxidants in transgenic mice had synergistic reactions against oxidative stress, thus arresting cognitive impairment ($p < 0.001$), and Zang DM's research. et al. observed that folic acid and vitamin B supplements reduced plasma homocysteine levels ($p<0.001$); however, no significant differences in improvement of cognitive impairment were found (Rafe, 2024).

However, the study published in 2020 measured motor capacity and cytokine levels in serum and brain tissues in laboratory models by administering lactic acid (LAB) and vitamin B-producing bacteria. They demonstrated that animals administered the 3 strains had higher brain cell counts by tyrosine hydrolysis, decreased inflammatory cytokines and TNF-α in serum, and increased anti-inflammatory delacytokine interleukin 10 in serum and brain tissues compared to animals that did not receive supplementation. For this reason, Boulos C.etal claims in his systematic review that high consumption of vitamin B can be considered neuroprotective against Parkinson's disease since there are lower levels of homocysteine, which is neurotoxic (Wei, Zhao, Cheng, Huang, & Zhang, 2024).

One of the most exciting tests was presented by PaknahadZ.etal, in which the effect of the Mediterranean diet on the cognitive function of 80 patients in Iran was demonstrated for 10 weeks. This longitudinal study was conducted with a Persian version of the Montreal Cognitive Assessment (MoCA). They determined that, compared to the control group, there was a statistically significant difference of a higher mean score for executive function, language, attention, active memory and concentration ($p < 0.05$, for all); however, visual-spatial ability learning memory, and time-place navigation did not differ significantly. This leads us to think about the high impact of using this type of diet against the cognitive deterioration of people with Parkinson's and the improvement of quality of life. Similar results were also observed in the study conducted by Bianchi et al., where significant effects and high drug adherence (Suryawanshi, Gujarathi, Mulla, & Bagban, 2024)

Mediterranean diet as prevention of cognitive deterioration linked to the quality and quantity of food and the consequent reduction of insulin. The characteristics of this diet are the abundance of fruit and vegetables, unrefined carbohydrates, olive oil and red wine. However, they observed better clinical outcomes in studies with controlled calorie intake in this diet; for example, they found symptomatic improvement following a low-energy, low-carbohydrate, high-fat regimen of this diet, with a caloric intake of approximately 1700 to 1800 Kcal (CHO 39%, protein 14% and fat 47%) (Kezele & Ćurko-Cofek, 2024).

Finally, it is worth mentioning what was studied by Lange KW et al., where they observed the protective effects of the Mediterranean diet in neurodegenerative diseases since it associates high adherence to this dietary regime with an older age of onset of the disease with a lower risk of developing Parkinson's disease. Furthermore, it is mentioned that adopting a Mediterranean diet was associated with a reduced likelihood of prodromal PE in older adults in Greece; this is very interesting since preventive approaches are more effective at this stage. However, it is important to remember that in Mediterranean culture, exercise and muscle strengthening are an essential part of lifestyle, which was not taken as a variable in this study (Levi, Ripamonti, Moro, & Cozzi, 2024; Parihar, Gaur, & Khan, 2024).

Furthermore, as already mentioned, vitamin and antioxidant supplements have a significant effect in preventing or delaying the onset of Parkinson's disease since they intervene in the pathophysiological mechanisms involved in the disease, such as oxidative stress, the formation of free radicals and neuroinflammation. For this reason, it becomes a challenge for the nutritionist to find an adequate and individualized diet for the Parkinson's patient depending on the stage he is in, following the established guidelines regarding the dietary treatment of Parkinson's disease examined in this study (Al-Hakeem, Zhang, DeMarco, Bitter, & Hinyard, 2024; Shukla et al., 2024).

CONCLUSION:

Parkinson's disease is one of the neurodegenerative pathologies with the highest incidence in men aged between 70 and 74 years, characterized by extrapyramidal alterations such as tremor at rest, postural instability, bradykinesia and rigidity, the latter two considered the leading causes of symptoms gastrointestinal disorders such as dysphagia, which impacts a high risk of malnutrition in Parkinson's disease depending on the severity of the disease stage and pharmacological doses. Furthermore, malnutrition and the symptoms that accompany it predispose the patient to have a deteriorated lifestyle on both a personal and interpersonal level.

Malnutrition and low quality of life are two of the leading nutritional problems observed in these patients; in extreme cases where the level of dysphagia is severe, pneumonia due to aspiration of the product is observed of an inadequate diet. It has been observed that there is a proportional relationship between malnutrition and lifestyle since adequate nutritional therapy predisposes the person to emotional well-being at both a personal and family level. Furthermore, the quality and quantity of the diet predisposes to the rapid progression of Parkinson's; furthermore, a high consumption of fruit, whole grains, polyunsaturated fatty acids, vitamins and antioxidants predisposes to a slow progression of the disease and less cognitive deterioration.

The research mentions the use of guided diets depending on the nutritional status of the person suffering from Parkinson's and the progress of the disease. There is evidence of muscle-strengthening diets based on whey protein supplements enriched with leucine and vitamin D, but also with Lycopene and vitamins E and B, which can inhibit oxidative stress and the consequent decrease in homocysteine, which would delay the neurodegenerative process, therefore, reducing symptoms. The Mediterranean diet is considered a feasible option for nutritional support for Parkinson's since it features a guided calorie intake with a low CHO content and is rich in fat. Furthermore, guidelines for the treatment of dysphagia recommend a diet that can be modified in the consistency of liquids and solids throughout the disease.

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