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The implications of the foot health status in Parkinson patients: A case–control study

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Abstract

Parkinson's disease (PD) is a neurodegenerative disorder that affects both health of the feet, as to gait patterns. This study aimed to find out about foot problems and their impact on self-perceived quality of life and related to foot health in Parkinson's patients compared to a group of healthy subjects and to measure it with Spanish Podiatry Health Questionnaire (PHQ-S). It is about a case–control study in a sample of Parkinson's patients n = 62, healthy controls n = 62. The PHQ-S was reported, it describes perception the subject has in each of podiatric 6 dimensions consulted, assessing appreciation of health status of interviewee's feet and a self-rated the foot health score on the visual analog scale (VAS). There were statistically significant differences ($P < 0.05$) in the dimensions that assessed problems with walking and moving, nail trimming, concern feet state, and affectation of quality of life related foot health. Regarding the self-perception of state of their feet, Parkinson's patients perceive a worse state of health of their feet than healthy subjects. The mean value was 4.8 (SD 2.2) for Parkinson's patients and 3.8 (SD 2.3) for healthy subjects. In conclusion, patients with PD have problems in walking or moving, foot pain, difficulties in foot hygiene and in cutting for their nails, as well as the concern they suffer from deterioration in state of their feet affect them and decrease their quality of life. Podiatric problems in Parkinson's patients have a great impact in reducing quality of life related to foot health.

KEYWORDS

foot health status, foot pain, Parkinson's disease, PHQ-S, quality of life, Spanish podiatry health questionnaire

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Key Messages

- We have evaluated the foot health status in parkinson population.
- Parkinson's patients with gait problems can be increase with to presence of foot conditions.
- Preventive care in Parkinson's disease are extremely important to improve the foot health.

1 | INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects both the health of the feet in general, as well as the gait patterns (length and timing), and the way of moving and walking, adding an increased risk of falls in those who suffer from it. The high prevalence and severity of main PD symptoms is related to gait alterations.[1] Clinicians and health policymakers are recognising cases of PD may increase by more than 50% by 2030, being an important public health threat because of its negative impact on the individual and society.[2,3]

It is of great importance to investigate the subject of the feet and their involvement in PD, among other reasons because it is known that foot problems affect posture by increasing postural instability and balance disorders, which Parkinson's patients already suffer, with repercussions on walking and falls. All this worsens if the presence of tremors in the lower limbs and frozen gait are added.[4]

Previous studies have analysed in Parkinson patients the quality of life in relation to the state of health of the foot,[5] the presence and levels of depression,[6] the fear of movement they experience,[7] all of these circumstances being affected by neurological disease with a negative impact. Novo-Trillo et al. analysed the feet of 53 patients with Parkinson's, resulting in 88.68% presenting some podiatric pathology, predominantly nail pathologies and presentation of the ankle joint in equine position.[8]

Another study carried out in the United Kingdom with questionnaires in Parkinson's patients confirmed that 53% of the 218 patients interviewed presented problems in their feet, the most frequent being loss of sensitivity, weakness, limited movements in the feet/ankles and pain of feet.[9] In the study by Navarro-Flores et al., foot pain was the reason that most influenced the quality of life of patients with PD.[5]

Certain motor abnormalities, in their mild form, such as alterations in gait patterns, reduced arm swing when walking, rigidity, tremor and bradykinesia may precede the clinical phase of PD.[10] For podiatrists, it is essential to know these prodromal stages of PD, with the presence of initial signs of involvement in the feet and in walking, to establish an early diagnosis, as well as to be able to design preventive interventions for PD. Evolution of the disease at the level of the foot and its associated deterioration.[11]

In the same way, once the clinical phase has been established, it is important not to forget that Parkinson's patients are the ones who first warn about the state of health of their feet, providing information about problems walking, pain in their feet and the impact on their quality of life.[5] This self-perception of the health of their feet and changes in walking must be collected and assessed, since it also allows the incipient recognition of foot involvement for the early start of treatments that can stop or alleviate it.

Little is known about foot problems in Parkinson's patients, and foot assessments are not usually included in routine examinations or treatments. Although it is known that Parkinson's patients suffer from a deterioration and low level in the state of health of the feet in all its dimensions,[5,9] to date, little research has been done on it. The parkinsonian patient has a self-perception of their own podiatric health that has not been previously studied either.

Therefore, this study aimed to find out about foot problems and their impact on the self-perceived quality of life and related to foot health in Parkinson's patients compared to a group of healthy subjects and measure it with the Podiatry Health Questionnaire (PHQ). We hypothesized that parkinson's patients may present a negative impact on all domains linked foot health-related quality of life.

2 | METHODS

2.1 | Design and sample

The study consisted of a descriptive and observational case–control study was conducted in a Parkinson Association's of Malaga (Spain) between October and December 2020 and was conducted according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[12] A non-randomised and consecutive sampling

method was used to select the 124 subjects enrolled the study and they were divided into persons with PD (for case group, n = 62) and a matched-paired of non-PD subjects (for the control group, n = 62). The criteria for inclusion were patients and healthy subjects between 50 and 84 years old, as PD is more prevalent in this age range.[13]

Disregarded cases include: immune-depressed patients with antecedents of foot and ankle fractures or surgery, cognitive disorders, or lack of or partial autonomy in daily activities, as well as those who refused to sign the consent form or were incapable of understanding the instructions necessary to carry out the present study.

2.2 | Procedure

Baseline measurements included general questions associated to[1] demographic variables (eg, age, weight, height, years of chronicity) and[2] characteristics about comorbid conditions (eg, diabetes, obesity, musculoskeletal difficulties, vascular disorders).

Next, participants completed the Spanish Podiatry Health Questionnaire (PHQ-S).[14]

The PHQ-S is a self-administered health questionnaire to assess foot problems and their impact on foot health-related quality of life. It consists of 6 dimensions to be evaluated, which are: (a) Problems walking or moving, (b) Foot hygiene problems, (c) Problems cutting toenails, (d) Foot pain, (e) Concern about the foot status and (f) Quality of Life in relation to the presence of foot problems. Each of these dimensions analysed are rated with three levels of severity (no problems, some problems and severe problems). In addition, a Visual Analog Scale (PHQ-S VAS) should be added for the self-perception of the current state of foot health with points from 0 to 10, with the minimum value (0) being the best possible state and the maximum value[10] of the scale being the worst state of health of the feet. The PHQ assesses respondents' foot health in two ways: as a descriptive profile of their responses on all 6 dimensions and as a self-reported foot health score on the visual analog scale. All questions refer to how they are in the present time, in relation to the day the questionnaire is answered.

Then, this podiatric health questionnaire describes the perception that the subject has in each of the podiatric dimensions consulted, assessing the appreciation of the health status of the interviewee's feet on the same day that the questionnaire is completed of their responses across 6 dimensions and as a self-rated foot health score on the visual analog scale (VAS).

The PHQ was initially developed in the United Kingdon with appropriate concurrent validity.

The PHQ was created based on the Euroquol 5 Dimensions questionnaire (EQ-5D),[15] taking the EQ-5D format as a model for the new measure.[16] This instrument was translated into Spanish and has been evidenced to be a validated instrument. Excellent test–retest reliability (ICC = 0.99 [95% CI = 0.96–0.98]) was shown for the total score and High internal consistency was shown for the six domains.[14]

The PHQ-S is a useful instrument, with quick and easy administration, being one of its strong points. In addition, there is a variety of possibilities of use in populations and interpretation of the results, from the description of the general health status of the feet by dimensions to the evaluation of how podiatric health affects the quality of life.

The PHQ can be easier and simpler to administer and measure than other questionnaires, since it provides new specific elements, such as: walking, hygiene, nail trimming, worries or the self-perception of how their feet feel measured by a VAS,[16,17] compared with previous clinimetric analyzes of tools to assess foot health-related quality of life, such as the Foot Health Status Questionnaire, Foot Function Index, and Manchester Foot Pain and Disability Index.[18-20]

2.3 | Ethical considerations

This research was approved by the Bioethics and Biosafety Committee at the University of Valencia (Spain, 2020), with file number 1450610. All voluntary informants gave their consent in written form before their inclusion in the study. Ethical standards for research on human beings based on the Declaration of Helsinki (World Medical Association) and the Convention of the Council of Europe on human rights and biomedicine, as well as those based on the Universal Declaration of the UNESCO on the Human Genome and Human Rights and other appropriate national or institutional organisations were preserved.

2.4 | Sample size calculation

The sample size was calculated for this case–control study aplying specific levels confidence, power, and groups of equal size using the Epidat 4.2 software. One hundred twenty-two people (61 cases and 61 controls) was determined assuming a confidence level of 70%, a power of 0.80, an odds ratio to detect of 2.0 and an expected proportion of exposed of 50% in the controls of the 66.67%.

TABLE 1 Descriptive data of the parkinson patients and healthy matched-paired controls

Descriptive data		Total group, Mean ± SD range (n = 124)	Cases, Mean ± SD range (n = 62)	Controls, Mean ± SD range (n = 62)	*P*-Value
Age (years)		69.18 ± 9.12 (50–84)	69.23 ± 9.15 (50–84)	69.13 ± 9.15 (50–84)	.097[a]
Weight (kg)		74.10 ± 14.84 (43–135)	73.36 ± 17.63 (43–135)	74.83 ± 11.49 (54–100)	.582[a]
Height (m)		1.67 ± 0.09 (1.47–1.91)	1.66.37 ± 9.64 (1.47–1.91)	1.67 ± 7.80 (1.47–1.85)	.690[a]
BMI (kg/m^2)		26.61 ± 4.61 (16.16–40.31)	26.37 ± 5.24 (16.16–40.31)	26.85 ± 3.90 (19.83–35.43)	.0563[a]
Chronicity (years)		5.92 ± 7.59 (0–32)	11.83 ± 6.71 (0–32)	0	**<.001**[a]
Sex (%)	Male	75 (60.5%)	38 (61.3%)	37 (59.7%)	.854[b]
	Female	49 (39.5)	24 (38.7%)	25 (40.3)	

Note: In all the analyses, $P < .05$ (with a 95% confidence interval) was considered statistically significant. Median ± interquartile range, range (min–max).
Abbreviation: BMI, body mass index.
[a]Student's *t*-test for independent samples were applied.
[b]χ^2 test were used.

2.5 | Statistical analysis

A descriptive analysis of the variables included in the study was performed. The mean, SD, and maximum and minimum values were calculated and compared between groups: persons with or not PD. Categorical data were described by frequency and percentage and comparisons for these data were performed by the χ^2 test. All variables were examined for normality of distribution using the Kolmogorov–Smirnov test, and data were considered normally distributed if $P > .05$. Independent Student *t*-tests were performed to find if differences are statistically significant when showing a normal distribution. Measurements which were not normally distributed were tested using non-parametric Mann–Whitney *U* test. In all of the analyses, statistical significance was established with a *P*-value < .05. All the analyses were performed with commercially available software (SPSS 25.0, Chicago, IL, USA).

3 | RESULTS

3.1 | Descriptive data

A total of 124 people between 50 and 84 years of age completed the research. The sample analysed included 62 (50%) persons with Parkinson and 62 (50%) non- persons with Parkinson. Table 1 shows the sociodemographic characteristics of the participants showing a significant difference by chronicity (years) ($P < .05$), but there were no differences at age, sex, height, weight and BMI ($P > .05$).

Generally speaking, the 100% (n = 124) of participants stated the characteristics that showed in Table 1. Furthermore, 57.3% of the patients who participated in the research presented predisposing factors, such as: 21.8% (n = 27) vascular disease, 21.8% (n = 27) osteoarticular pathology, 9.7% (n = 12) diabetes and 4% (n = 5) obesity.

3.2 | Outcome measurements

Regarding the results, the subjects suffering from PD presented worse results of the PHQ-S compared to the healthy subjects (Table 2). It should be noted these results in each dimension, as well as in the Walk or Move dimension, 53.2% of the subjects with PD presented some problems compared to 35.5% of the healthy subjects. There was a statistically significant difference between both groups ($P = .001$).

Respondents were less likely to report symptoms in the hygiene dimension, not reporting having problems cleaning and drying their feet in 48.4% in PD and 64.5% in healthy subjects. Showing moderate and severe problems in 25.8% of PD compared to 24.2% and 11.3% respectively for the control group. There was no statistically significant difference between these results for both groups. Regarding the Nail Care or Cutting dimension, 50% of Parkinson's patients presented Severe Problems compared to 8.1% in the group of healthy subjects. There was a significant difference between both groups ($P = .000$).

The dimensions: Pain in the foot and Concern about their condition gave similar results in both dimensions, that is, 51.6% of patients with Parkinson's presented some problem in both dimensions. Being in the Concern dimension, the difference between the groups was statistically significant. And regarding the dimension that assesses whether foot problems affect the quality of life, patients with Parkinson's reported that their feet had

TABLE 2 Comparisons of results PHQ-S dimensions between the parkinson patients and healthy matched-paired controls

Outcomes measurements		Group				
		Healthy n = 62	Healthy percentage	Parkinson patient n = 62	Parkinson patient percentage	*P*-Value (Healthy vs Parkinson patient)
Walking	No problems	39	62.9%	21	33.9%	**<.001***
	Some problems	22	35.5%	33	53.2%	
	Severe problems	1	1.6%	8	12.9%	
Hygiene	No problems	40	64.5%	30	48.4%	.083
	Some problems	15	24.2%	16	25.8%	
	Severe problems	7	11.3%	16	25.8%	
Nail care	No problems	32	51.6%	16	25.8%	**< .001***
	Some problems	25	40.3%	15	24.2%	
	Severe problems	5	8.1%	31	50.0%	
Foot pain	No problems	31	50.0%	27	43.5%	.344
	Some problems	25	40.3%	32	51.6%	
	Severe problems	6	9.7%	3	4.8%	
Worry	No problems	45	72.6%	30	48.4%	**.002***
	Some problems	13	21.0%	32	51.6%	
	Severe problems	3	4.8%	0	0.0%	
Quality of life	No problems	48	77.4%	34	54.8%	**.012***
	Some problems	13	21.0%	28	45.2%	
	Severe problems	1	1.6%	0	0.0%	

Note: Frequency, Percentage (%) and Chi-squared test (χ^2) were utilised. PHQ-S domains were divided as: (1) No Problems, (2) Some Problems, (3) Severe Problems. In all the analyses, $P < .05$ (with a 95% confidence interval) was considered statistically significant (**bold**).
Abbreviation: PHQ-S, Podiatry Health Questionnaire.

some effect on quality of life in a frequency of 45.2% compared to 21% of patients healthy subjects, with a significant difference between both groups. The mean value of self-assessed foot health status on the PHQ-S in VAS was 4.8 (SD 2.2) for patients with Parkinson's and 3.8 (SD 2.3) for healthy subjects. Values close to 0 that indicate the best possible state of health (Figure 1). The mean value of this dimension in the entire sample and for both groups was 4.3 (SD 2.3).

4 | DISCUSSION

Our study aimed to analyse foot problems and their impact on perceived quality of life related to foot health in Parkinson's patients compared to a group of healthy subjects, using the Spanish Podiatric Health Questionnaire (PHQ-S). It is the first study to describe the self-perception of the state of their feet and its impact on the quality of life of Parkinson's patients. Although the cross-cultural adaptation of the PHQ to the PHQ-S was carried out in 2018, no previous podiatric study has been found in which it has been applied.

Although previous research assessed foot health-related quality of life in Parkinson's patients, self-perceived foot health was not addressed. A different tool was used, the Foot Health Status Questionnaire (FHSQ), with other dimensions of different measurement, it has a different approach or perspective, very appreciable and complementary results with those of our study.[5]

At a general level, our study confirms the existence of problems in the feet of Parkinson's patients to a greater extent than in the group of healthy subjects, as well as, the patients perceive the state of health of their feet. Analysing the results of the PHQ-S in its 6 dimensions, it is stated that Parkinson's patients have some moderate or severe problem in all dimensions. Specifically these dimensions, based on and elaborated from the EQ-5D questionnaire,[15] question whether the feet influence gait or movement and offer problems for it, if they admit having problems washing and drying their feet, if there are difficulties cutting their nails, pain or discomfort in the feet, concern about the condition of their feet and if the quality of life of the feet is affected.

Starting to review the results by the dimension that deals with whether they have problems in their feet to

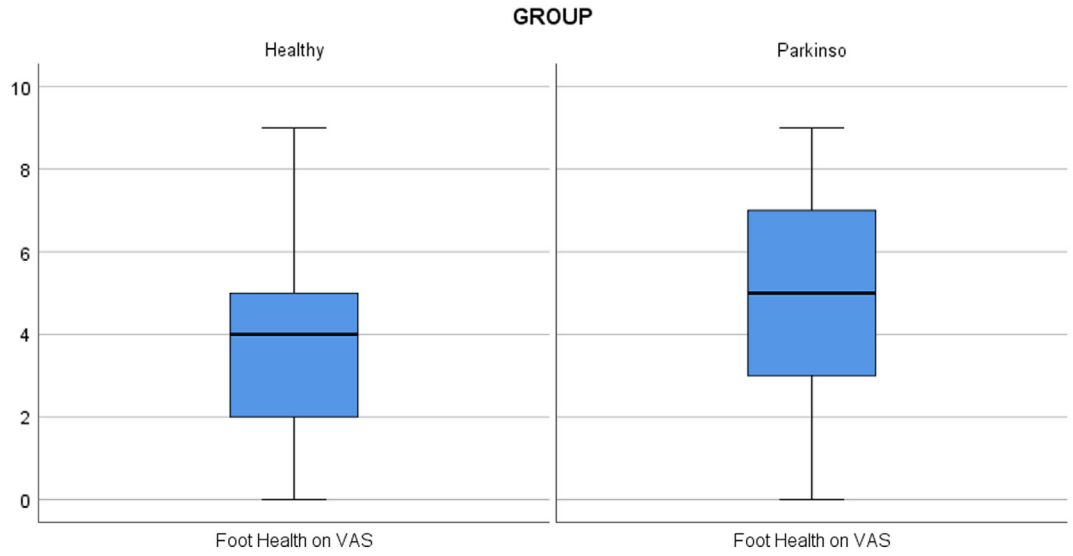

FIGURE 1 Box-plot to illustrate the differences of the Foot Health on PHQ-S on VAS scores between the Parkinson patients and healthy matched-paired controls. Value 0: best possible state of foot health. Value 10: worst possible state of foot health. Abbreviations: PHQ-S (Spanish Podiatry Health Questionnaire), VAS (Visual Analogue Scale)

walk or move, statistically significant differences were found between both groups, resulting in our study that 53.2% of patients with Parkinson's have some problem in the feet, which influences walking or movement compared to 35.5% of the control group. Of this same sample, 12.9% of Parkinson's patients claim to have serious problems walking compared to 1.6% of controls. This result was expected since PD is a neurological disease that, among its main effects, presents gait disturbance and, to a lesser degree, frozen gait. Parkinson's patients approach the ground to walk with short steps, slower walking speed, absence and short heel strike and little elevation of the foot in the swing phase, situations that increase the risk of falls, due to balance disorder.[21-24] Also, it is known that Parkinson's patients suffer from Kinesiophobia or fear of movement due to gait disturbances and fear of falling.[7] All these factors reduce the independence, the ability to socialise and the mobility of Parkinson's patients, significantly reducing their quality of life.[25]

In this sense, another study shows lower scores for quality of life related to foot health in the domains of physical activity, social capacity and vigour in patients with PD.[5] However, research related to PD has only shown alterations in relation to gait parameters without referring to quality of life.[13]

On the other hand, in the analysis of the hygiene results, results of moderate and severe problems are reported in a higher percentage in Parkinson's patients, the opposite being the result in the refusal to have foot problems, where healthy individuals in a greater proportion than those with Parkinson's, they showed no problems with grooming their feet (64.5% in control vs 48.4% in PD). Parkinson's patients suffer from rheumatological-type deformities in their hands and feet.[26,27] In the hands they are conditioned to difficulties for fine movement such as drying between the toes. This factor can, among others, motivate difficulties for daily foot hygiene, as well as carrying out activities of daily living. No other study related to foot health has been found that assesses how the study population approaches foot hygiene.

Regarding nail cutting, Parkinson's patients showed severe and serious difficulties and inability to cut their nails in a much higher proportion than the control group (50.0% in the PD group vs 8.1% in the control group). Note that there was a statistically significant difference between both groups. Among the most reported foot problems in Bowen's study were nail problems, not specifically in relation to nail trimming, but in the frequency of ingrown toenails and nail infections. We deduce that the problem of clipping the nails of Parkinson's patients may be related to their thickening, motivated, among other factors, by walking on tiptoe with advancement of the center of gravity and anteriorization of the trunk that causes continuous microtrauma to the nails and hypertrophy. of the nail plate. In addition, the aforementioned rheumatological deformity of the fingers and hands favours said difficulty in using devices for cutting nails, as well as the tremor present in the extremities.[9,26-29]

Regarding the results obtained in our study in the pain dimension, the patients with Parkinson's reported having discomfort and moderate pain to a greater extent than the healthy participants, although this result did not

show statistically significant differences between the two groups. Previous studies highlight the issue of suffering from pain in Parkinson's patients. PD patients may experience a variety of painful sensations, often localised to the joints. Joint pain commonly occurs in PD, most frequently in the shoulders, hips, knees, and ankles.[30] Such pain is often accentuated by aspects of PD itself, such as prolonged abnormal postures. At the level of the foot they suffer more frequently from the painful Plantar Fasciitis.[9,31] On the other hand, the results related to foot pain and quality of life obtained in the study by Navarro-Flores et al, have shown results similar to those of our research.[5]

Regarding the concern shown about the state of their feet, a certain concern is also present in a greater proportion in patients with Parkinson's, with a statistically significant difference between both groups. We did not find previous studies related to the feet in which this variable had been studied. We consider that it is normal behaviour for these patients to see how their feet and the ability to move and walk deteriorate with the course and evolution of the disease. This feeling of worry can lead the Parkinson's patient to suffer from depression or another psychological illness of the state of mind or phobia.[6,7]

In relation to the dimension of whether foot problems affect quality of life in some way, the response obtained by the group of Parkinson's patients is that the feet have some effect on the quality of life of these patients in a greater proportion than in the group of healthy subjects, with a statistically significant difference between both groups. In the study by Navarro-Flores et al,[5] results similar to those of our research are shown. The quality of life is related to the state of health, in this case with the health of the feet and risk of falls, in addition to the psycho-social components.[32,33]

Similarly, regarding the analysis of the last section of the PHQ-S, we highlight that the self-perception of the health status of the feet of the study participants, evaluated with VAS, the finding obtained is that Parkinson's patients perceive a worse foot health than healthy subjects, the difference between the two being one point. We did not find other research that has assessed the self-perception of the health status of the feet in any population, although there are two studies in which a worse health status of the feet of Parkinson's patients was found after the evaluation.[5,9]

On the other hand, it must be taken into account that in the study by Bowen et al.,[9] 47% of patients with Parkinson's had foot problems and reported that they had not received any support or advice on foot care. The feet. People with PD need more education about the health of their feet and general gait improvement, as well as guidelines to promote their podiatric health, especially as multifaceted and multidisciplinary podiatric interventions can improve prevention strategies for such frequent falls in these patients. Furthermore, it should also be considered that Bowen et al,[9] in its study in 2016, highlights that there are few studies that analyse the specific problems of the feet in patients with PD. In the analysis and review of the studies carried out subsequently, there is still a lack of research focused on the involvement of the feet of these patients. Podiatrists need to understand this disease and its limitations to properly participate in the foot care of PD patients, helping them achieve a better quality of life.

Finally and regarding the PHQ-S, we found a limitation in not treating or evaluating the footwear, whether there are problems in using it and to what extent. Previous studies[5,8,24,34] in Parkinson's patients analyse footwear since the foot walks with shoes and it is an element that influences the health of the feet and its relationship with quality of life.

In addition, this research had some limitations. For future research, a larger sample size including a larger number of participants would be appropriate to strengthen the results of the study. A longitudinal follow-up evaluation of the results could also be included, helping to determine more definitive conclusions. Similarly, a simple random sampling process would be better to ensure sample homogeneity. And despite using a sample size calculation, it would have been useful to have carried out an earlier pilot study to obtain better quality research. Finally, although the proper validity of the PHQ is know, the reliability for patients with PD has not been recognised and should be considered for future research.

5 | CONCLUSIONS

The results of our study have shown that people with PD suffer from foot problems to a greater degree than healthy subjects. The problems they have in walking or moving, foot pain, difficulties in foot hygiene and in cutting and caring for their nails, as well as the concern they suffer from deterioration in the state of their feet affect them and decrease their quality of life. Regarding the self-perception of the state of their feet, Parkinson's patients perceive a worse state of health of their feet than healthy subjects. Podiatric problems in Parkinson's patients have a great impact in reducing quality of life related to foot health.

AUTHOR CONTRIBUTIONS

Conceptualization, Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel

López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores; Data curation, Ana María Jiménez-Cebrián and Alonso Montiel-Luque; Formal analysis,Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores; Investigation, Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores; Methodology, Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores; Writing – original draft, Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores; Writing – review & editing, Ana María Jiménez-Cebrián; Luis López-López; Marta Elena Losa-Iglesias, Ricardo Becerro-de-Bengoa-Vallejo; Carlos Romero-Morales; Daniel López-López; Carmen de Labra; Alonso Montiel-Luque; Emmanuel Navarro-Flores. Finally, all the authors meet the criteria for authorship as per the ICMJE criteria.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data used in this research are not publicly available due to concerns about confidentiality; however, we summarise descriptive information about our participants in the manuscript text. The data that support the findings of this study are available from Dr. Ana María Jimenez Cebrián upon reasonable request.

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REFERENCES

1. Kalia LV, Lang AE. Parkinson's disease. *Lancet*. 2015;386(9996):896-912.
2. LeWitt PA, Kymes S, Hauser RA. Parkinson disease and orthostatic hypotension in the elderly: recognition and management of risk factors for falls. *Aging Dis*. 2020;11(3):679-691.
3. Dickson DW. Neuropathology of Parkinson disease. *Park Relat Disord*. 2018;46:S30-S33.
4. Dallaire M, Gagnon G, Fortin É, et al. The impact of parkinson's disease on postural control in older people and how sex can mediate these results: a systematic review. *Geriatrics*. 2021;6(4):105.
5. Navarro-Flores E, Jiménez-Cebrián AM, Becerro-de-Bengoa-Vallejo R, et al. Effect of foot health and quality of life in patients with Parkinson disease: a prospective case-control investigation. *J Tissue Viability*. 2022;31(1):69-72.
6. Jiménez-Cebrián AM, Becerro-De-bengoa-vallejo R, Losa-Iglesias ME, et al. The impact of depression symptoms in patients with parkinson's disease: a novel case-control investigation. *Int J Environ Res Public Health*. 2021;18(5):1-7.
7. Jiménez-Cebrian AM, Becerro-de-Bengoa-Vallejo R, Losa-Iglesias ME, et al. Kinesiophobia levels in patients with Parkinson's disease: a case-control investigation. *Int J Enviromnmental Res Public Heal*. 2021;18:4791-4798.
8. Novo-Trillo E, López-López D, de Labra C, et al. Impact of footwear and foot deformities in patients with Parkinson's disease: a case-series study. *Int J Med Sci*. 2020;18(2):372-377.
9. Bowen C, Ashburn A, Cole M, et al. A survey exploring self-reported indoor and outdoor footwear habits, foot problems and fall status in people with stroke and Parkinson's. *J Foot Ankle Res*. 2016;9(1):1-10.
10. Mahlknecht P, Seppi K, Poewe W. The concept of prodromal Parkinson's disease. *J Parkinsons Dis*. 2015;5(4):681-697.
11. Warden MN, Nielsen SS, Camacho-Soto A, Garnett R, Racette BA. A comparison of prediction approaches for identifying prodromal Parkinson disease. *PLoS One*. 2021;16(8):1-13.
12. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. *Int J Surg*. 2014;12:1500-1524.
13. Brognara L, Navarro-flores E, Iachemet L, Serra-catalá N, Cauli O. Beneficial effect of foot plantar stimulation in gait parameters in individuals with Parkinson's disease. *Brain Sci*. 2020;10(2):69.
14. Navarro-Flores E, Losa-Iglesias ME, Becerro-De-Bengoa-Vallejo R, et al. Translation and test–retest of the Spanish

podiatry health questionnaire (PHQ-S). *Int J Environ Res Public Health*. 2018;15(10):2205.
15. Brooks R, de Charro F. EuroQol: the current state of play. *Health Policy*. 1996;37(1):53-72.
16. Macran S, Kind P, Collingwood J, Hull R, McDonald I, Parkinson L. Evaluating podiatry services: testing a treatment specific measure of health status. *Qual Life Res*. 2003;12(2): 177-188.
17. Riskowski JL, Hagedorn TJ, Hannan MT. Measures of foot function, foot health, and foot pain: American Academy of Orthopedic Surgeons Lower Limb outcomes assessment: foot and ankle module (AAOS-FAM), Bristol foot score (BFS), revised foot function index (FFI-R), foot health status Questionnair. *Arthritis Care Res*. 2011;63(S11):S229-S239.
18. Bennett PJ, Patterson C, Wearing S, Baglioni T. Development and validation of a questionnaire designed to measure foot-health status. *J Am Podiatr Med Assoc*. 1998;88(9):419-428.
19. Gijon-Nogueron G, Ndosi M, Luque-Suarez A, et al. Cross-cultural adaptation and validation of the manchester foot pain and disability index into Spanish. *Qual Life Res*. 2014;23(2):571-579.
20. Paez-Moguer J, Budiman-Mak E, Cuesta-Vargas AI. Cross-cultural adaptation and validation of the foot function index to Spanish. *Foot Ankle Surg*. 2014;20(1):34-39.
21. Creaby MW, Cole MH. Gait characteristics and falls in Parkinson's disease: a systematic review and meta-analysis. *Park Relat Disord*. 2018;57(June):1-8.
22. Kimmeskamp S, Hennig EM. Heel to toe motion characteristics in Parkinson patients during free walking. *Clin Biomech*. 2001; 16(9):806-812.
23. Sofuwa O, Nieuwboer A, Desloovere K, Willems AM, Chavret F, Jonkers I. Quantitative gait analysis in Parkinson's disease: comparison with a healthy control group. *Arch Phys Med Rehabil*. 2005;86(5):1007-1013.
24. Reina-Bueno M, Calvo-Lobo C, López-López D, et al. Effect of foot orthoses and shoes in parkinson's disease patients: a prisma systematic review. *J Pers Med*. 2021;11(11):1136-1145.
25. Gao C, Liu J, Tan Y, Chen S. Freezing of gait in Parkinson's disease: pathophysiology, risk factors and treatments. *Transl Neurodegener*. 2020;9(1):1-22.
26. Pandey S, Garg H. Postural & striatal deformities in Parkinson's disease: are these rare? *Ind J Med Resh Ind Counc Med Res*. 2016;143:11-17.
27. Wijemanne S, Jankovic J. *Hand, Foot, and Spine Deformities in Parkinsonian Disorders*. Vol 126. Springer-Verlag Wien: Journal of Neural Transmission; 2019.
28. Smith MD, Brazier DE, Henderson EJ. Current perspectives on the assessment and management of gait disorders in parkinson's disease. *Neuropsychiatr Dis Treat*. 2021;17:2965-2985.
29. Guadagnolo D, Piane M, Torrisi MR, Pizzuti A, Petrucci S. Genotype-phenotype correlations in monogenic Parkinson disease: review on clinical and molecular findings. *Front Neurol*. 2021;12(September):648588.
30. Mylius V, Perez Lloret S, Cury RG, et al. The Parkinson disease pain classification system: results from an international mechanism-based classification approach. *Pain*. 2021;162(4):1201-1210.
31. Rabin ML, Earnhardt MC, Patel A, Ganihong I, Kurlan R. Postural, bone, and joint disorders in Parkinson's disease. *Mov Disord Clin Pract*. 2016;3(6):538-547.
32. Schrag A, Quinn N. What contributes to quality of life in Parkinson's disease: a re-evaluation. *J Neurol Neurosurg Psychiatry*. 2000;69:308-312.
33. Grimbergen YAM, Schrag A, Mazibrada G, Borm GF, Bloem BR. Impact of falls and fear of falling on health-related quality of life in patients with Parkinson's disease. *J Parkinsons Dis*. 2013;3(3):409-413.
34. Pereira MP, Orcioli-Silva D, de Sousa PN, Beretta VS, Gobbi LTB. The effects of habitual footwear in gait outcomes in people with Parkinson's disease. *Gait Posture*. 2019;68: 111-114.

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