ORIGINAL ARTICLE

Oral health-related quality of life in patients with Parkinson's disease

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Abstract

Background: Parkinson's disease (PD) is a neurodegenerative condition affecting the quality of life. Due to a worsening of oral health in PD patients with the progression of the disease, oral health-related quality of life (OHRQoL) could be impaired as well.

Objectives: To assess whether PD patients in The Netherlands experience worse OHRQoL than historical controls, and to investigate which factors are associated with OHRQoL in PD patients.

Materials & Methods: In total, 341 PD patients (65.5 ± 8.4 years) and 411 historical controls (62.6 ± 5.3 years) participated. Both groups completed a questionnaire. The PD patients were asked questions regarding demographics, PD, oral health, and OHRQoL. The historical controls filled in demographic information and questions regarding OHRQoL. The latter construct was assessed using the Dutch 14-item version of the Oral Health Impact Profile (OHIP-14). Data were analysed using independent samples t-tests and univariate and multivariate linear regression analysis.

Results: The mean OHIP-14 score was higher in PD patients (19.1 ± 6.7) than in historical controls (16.5 ± 4.4) ($t(239) = 6.5$; $p < .001$). OHRQoL in PD patients was statistically significant associated with motor aspects of experiences of daily living ($B = 0.31$; $t(315) = 7.03$; $p < .001$), worsening of the oral environment during disease course ($B = 3.39$; $t(315) = 4.21$; $p < .001$), being dentate ($B = -5.60$; $t(315) = -4.5$; $p < .001$), tooth wear ($B = 2.25$; $t(315) = 3.29$; $p = .001$), and possible burning mouth syndrome ($B = 5.87$; $t(315) = 2.87$; $p = .004$).

Conclusion: PD patients had a lower OHRQoL than historical controls. Besides, PD-related variables and oral health-related variables were associated with OHRQoL.

KEYWORDS
dental care for aged, oral health, Parkinson's disease, quality of life, self-assessment, tooth wear

1 | INTRODUCTION

Parkinson's disease (PD) is a degenerative neurological condition in which dopamine levels in specific parts of the brain (e.g., striatum) are reduced.[1] Due to factors like the ageing of the population,[2] its estimated prevalence (currently 2 per 1,000 persons in The Netherlands) is expected to increase in the near future.[3] Although PD is well-known for its motor symptoms (e.g., tremor, rigidity, bradykinesia),[1] non-motor

symptoms like depression and cognitive decline are also common, with large differences between individuals.[1,4] These different phenotypes make PD complex and difficult to manage. Although no curative treatment for PD exists so far, the symptoms can be suppressed by dopaminergic medication. Nevertheless, patients' quality of life can be reduced by the impairment and inconvenience caused by the disease.[5,6] For example, autonomic dysfunction, sleep problems, and cognitive decline are factors that can contribute to a deteriorated health-related quality of life.

Literature showed that also the oral health-related quality of life could be affected by PD. This so-called Oral Health-Related Quality of Life (OHRQoL) is defined as "a multidimensional construct that reflects factors such as people's comfort when eating, sleeping, and engaging in social interaction; their self-esteem; and their satisfaction with respect to their oral health".[7,8] OHRQoL can be measured with several instruments (e.g., the Oral Health Impact Profile).[9-12]

A German study on OHRQoL showed that PD patients with oral symptoms like xerostomia, drooling, and dysphagia had a lower OHRQoL than PD patients without oral symptoms.[13] In addition, a weak but significant correlation was found between the OHRQoL and the duration of PD.[13] Further, a pilot study conducted in The Netherlands suggested that PD patients had a higher prevalence of temporomandibular disorder (TMD) (viz., disorders of the temporomandibular joint, masticatory muscles, and/or adjacent anatomical tissues) pain than older adults without PD.[14,15] In the literature, Da Costa Silva et al. (2015) reported that in Brazil, the OHRQoL in patients with PD with TMD[16] was worse than in PD patients without TMD.[16] However, it is still indecisive whether the OHRQoL is influenced by having PD or by TMD. Taking this evidence together, it could be speculated that PD patients have a worse OHRQoL than healthy older adults without PD. Although clinically relevant, the OHRQoL in patients with PD living in The Netherlands was not examined before. In addition, insight into the factors that are associated with the OHRQoL in PD patients is lacking.

Therefore, the aims of this study were: 1. to evaluate the OHRQoL of patients with PD as compared to that of older adults without PD; and 2. to identify factors that are associated with the OHRQoL of patients with PD. We hypothesised that, due to the expected decline of oral health and difficulties in self-care with the progression of PD, the OHRQoL of patients with PD is worse than that of older adults without PD. In addition, we hypothesised that the OHRQoL in PD patients is negatively associated with disease-related factors like the motor aspects of experiences of daily living, the duration of PD diagnosis, and a person's ability to perform oral self-care.

2 | MATERIALS AND METHODS

2.1 | Study design

For the first aim (viz., to compare the OHRQoL of participants with PD to that of older adults without PD), a case-control study was conducted. Data collection amongst the cases (i.e., the PD patients) was performed between June 2020 and June 2021, using an electronic questionnaire produced with Qualtrics[XM] (SAP America Inc. Company,

US) and consisting of three questionnaires, viz. 1. Self-constructed questionnaire; 2. Oral Health Impact Profile (OHIP-14)[10,11]; and 3. Movement Disorder Unified Parkinson's Disease Rating Scale-II (MDS-UPDRS II)[17,18] (see Supplementary material – Questionnaire). The recruitment of the cases took place through an advertisement for the electronic questionnaire on social media (e.g., Facebook, LinkedIn), and the homepage of the Dutch association of Parkinson's Disease (https://www.parkinson-vereniging.nl). Older adults without PD were added to the study as historical controls. These participants were recruited in 2013 to participate in a large epidemiological study conducted in's-Hertogenbosch, The Netherlands (viz., a city representative of the general Dutch population regarding sociodemographic factors). In order to enable recruitment, health insurance companies were asked to provide names and addresses of their clients between 25 and 75 years of age under the authority of the National Health Care Institute (viz., Zorginstituut Nederland).[19] The historical controls were divided by 10-year age groups to include a sufficient amount of persons per group. For the second aim (viz., to identify factors associated with the OHRQoL of patients with PD), a cross-sectional study design was used wherein only the cases of the first aim were included. The current study was approved by the Ethics Committee of the Academic Centre for Dentistry Amsterdam (ACTA), Amsterdam, The Netherlands (file no. 2020139; approval date May 26th, 2020). The large epidemiological study (i.e., regarding the historical controls) was approved by the Central Committee on Research Involving Human Subjects (CCMO) as not falling under the Medical Research Involving Human Subjects Act. Furthermore, all requirements of the Personal Data Protection Act were met (approval No. m1501261). All participants gave their informed consent.

2.2 | Participants with PD

For the PD patients, the following inclusion criteria were used: being older than 18 years of age, having PD, and having completed the electronic questionnaire. Participants who were treated with chemotherapy or radiotherapy in the head or neck region or were diagnosed with parkinsonism were excluded. For the first aim only, PD patients of 75 years and older were excluded, because the historical control group also did not contain adults of 75 years and older.

2.3 | Historical controls

The historical control group (25–74 years old) was only used for the case-control part of this study (i.e., for the study's first aim). To match the PD patients as much as possible, individuals aged 55–74 were included in the present study.

2.4 | Dependent variable

For both the cases and the controls, and thus the primary and secondary aim of this study, OHRQoL was measured by means of the

Dutch 14-item version of the Oral Health Impact Profile (OHIP-14), (Supplementary material – Questionnaire part 2).[10,11] This validated questionnaire consists of 14 questions with five response options, scored as follows: "Never" (score 1), "Hardly ever" (score 2), "Occasionally" (score 3), "Fairly often" (score 4), and "Very often "(score 5). A total score of 14–70 can be reached, a higher score indicating a worse OHRQoL.[9-12]

2.5 | Independent variables

The independent variables that were analysed for the secondary aim of this study (viz., to determine if they have an association with the OHRQoL of PD patients) are presented in Table 1. Besides, the original questionnaire used in this study is included in the supplementary materials (Supplementary material – Questionnaire).

2.6 | Miscellaneous variables

In addition, to better understand the used oral hygiene methods, participants were asked which tools they use (e.g., electric toothbrushes, toothpicks, dental floss) and how often they apply these methods.

2.7 | Sample size calculation

To calculate the sample size for the study's second aim (i.e., with the OHIP-14 scores as an outcome variable), the software Gpower (Heinrich-Heine-Universität, Düsseldorf, Germany) was used.[20] An error of 5%, a z-score of 1.96, and a medium effect size of 0.13 for R^2 were utilised.[21] Thus, the sample size was estimated as 185 participants.

2.8 | Missing data

When checking the data of PD, a technical complication was detected that had hampered the registration of gender. Therefore, after the complication was corrected, the term during which the questionnaire could be accessed was extended. Consequently, the final sample size of the PD group was more extensive than calculated ($n = 341$). Gender was not registered in 64% of the PD patients ($n = 217$). Therefore, getting as accurate as possible, gender was imputed based on a multiple imputation technique (viz., with in total 64 imputed datasets with ten iterations).[22]

2.9 | Statistics

Descriptives were calculated for all variables. To compare the OHRQoL of PD patients with that of the historical controls, the independent samples t-test was used.[19] In addition, because the included PD patients older than 75 years of age could not be compared to the historical controls (viz., because of the age difference), an independent sample t-test was performed to see whether there is a difference in OHRQoL between the younger PD patients (74 and younger) and the older PD patients (75 and older).

To analyse which factors were associated with the OHRQoL in the PD-patient sample, a regression analysis was performed. The Variance Inflation Factor (VIF) was analysed to test for multicollinearity between the variables inserted in the regression analysis. A VIF value of 1 indicates no relation, while a VIF value above 10 shows a strong relation.[23] When a VIF value of a predictor was higher than 5, collinearity was considered present, and the predictor was excluded for the subsequent linear regression analysis.[24] We used both univariate and multiple linear regression analysis to evaluate the associations between the above-mentioned independent variables and OHRQoL. The independent variables associated with the OHRQoL ($p < .10$) in the univariate linear regression analyses were included in the final multiple linear regression analysis. With the backward selection procedure, all independent variables with the largest p-value were step-by-step excluded until all independent variables showed a p-value equal to or lower than 0.05. The regression analysis was performed with both the original and the imputed dataset. No differences in the results were found between both datasets. Therefore, the original dataset was used. Data analysis was performed with IBM SPSS statistics (version 27.0).

3 | RESULTS

In total, 808 people participated in this study. There were 411 historical controls, with a mean age of 62.6 ± 5.3 years and with 50.9% having the male gender. In the PD group, 397 people filled in the questionnaire, of whom 56 participants had to be excluded because they had no PD diagnosis ($n = 18$), and/or were treated with chemo- or radiotherapy ($n = 4$), and/or did not complete the entire electronic questionnaire ($n = 38$). Therefore, 341 PD patients (65.5 ± 8.4 years) were finally included in the PD group. In only 36% of the cases, gender was described (viz., 48.8% males and 51.2% females). All the descriptives of the PD patients are presented in Tables 2 and 3.

The mean OHIP-14 score of PD patients (19.1 ± 6.7) was significantly higher (t(239) = 6.5; $p < .001$) than that of the controls (16.5 ± 4.4). Furthermore, an analysis was performed to see whether there was a difference between the younger group of PD patients (viz., <75 years of age, included in the analysis of the primary aim), and the older group of PD patients (viz., ≥75 years of age, excluded in this analysis) in their OHRQoL. Although the mean OHIP-14 scores were 3 points lower in PD patients ≥75 years of age (21.9 ± 9.5), compared to PD patients <75 years of age (19.1 ± 6.7), no statistically significant difference was found (t(339) = −2.0, $p = .06$).

TABLE 1 Independent variables analysed for the second aim of the study (viz., to determine if the independent variables have an association with the OHRQoL of PD patients)

Variable	Question (if applicable)	Response option
Gender	What is your gender?	Male/female
Age	What is your age in years?	Years
Duration of PD diagnosis	Since how many years do you have this diagnosis?	Years
Motor aspects of experiences of daily living	Movement Disorder Unified Parkinson's Disease Rating Scale-II (MDS-UPDRS II)[17,18]	13 questions with five response options: "Normal" (score 0), "Slight" (score 1), "Mild" (score 2), "Moderate" (score 3), and "Severe "(score 4). A total score of 0–52 can be reached, a higher score indicating worse motor aspects of experiences of daily living
Living situation	What is your living situation?	Alone/with support
Frequency of dental visits	See supplementary materials*	≤6 months / >6 months
Frequency of brushing	See supplementary materials*	<2 times a day / ≥2 times a day
Self-reported worsening of oral environment during disease course	Did you notice deterioration of your oral health during your disease?	Yes/no
Dentate	See supplementary materials*	Yes/no
Tooth wear	"Do you experience tooth wear?"	Five response options: "No" (score 0), "Somewhat" (score 1), "Quite" (score 2), "A lot" (score 3), "Very much" (score 4), and "I don't know" (score 5). A score ≥1 and ≤4 indicates the presence of self-reported tooth wear
Possible TMD pain	"Did you ever had pain in your jaw, temple, in the ear, or in front of the ear on either side?"[35]	Yes/no
Possible burning mouth syndrome (BMS)	"Have you ever had persistent pain and/or burning sensation in your mouth the last 12 months?"	Yes/no
Drooling	MDS UPDRS II question 2 "Over the past week, have you usually had too much saliva during when you are awake or when you sleep"[17,18]	Score ≥2 indicated the presence of drooling
Dry mouth	"Do you experience dryness of your mouth?"	Yes/no

*See supplementary materials (SM2) for the detailed questionnaire and combined questions.

Following the second aim, the VIF of all included variables in the multiple linear regression analysis was lower than 2. Thus, no variable was excluded from the linear regression analysis based on collinearity.[23,24] The following variables showed a p-value <.10 in the univariate linear regression analyses: age ($p < .07$) duration of PD diagnosis ($p < .001$), motor aspects of experiences of daily living ($p < .001$), frequency of dental visits ($p = .03$), worsening of oral environment during disease course ($p < .001$), being dentate ($p < .001$), tooth wear ($p < .001$), possible TMD pain ($p = .01$), possible BMS ($p < .001$), and drooling ($p = .003$) (Table 4). Neither in the original dataset nor in the imputed dataset, gender was found to be associated with OHRQoL. When using the multiple linear regression analysis, only the following independent variables remained statistically significant: motor aspects of experiences of daily living ($p < .001$), worsening of oral environment during disease course ($p < .001$), tooth wear ($p = .001$), being dentate ($p < .001$), and possible BMS ($p = .004$). This model explained 31% of the total variance in OHRQoL.

4 | DISCUSSION

The aim of the present paper was twofold: first, to evaluate the OHRQoL of patients with PD compared to that of older adults without PD; and second, to identify factors associated with the OHRQoL of patients with PD. Our results showed that PD patients had a lower OHRQoL than the historical controls. In addition, PD-related variables and oral health-related variables were positively (i.e., being dentate) and negatively (i.e., motor aspects of experiences of daily living, worsening of oral environment during disease course, having tooth wear, and having possible burning mouth syndrome) associated with OHRQoL.

Barbe et al. (2017) showed that German PD patients with oral symptoms (viz., xerostomia, drooling, and dysphagia) reported reduced OHRQoL as compared to PD patients without such symptoms.[13] Compared to the study of Barbe et al. (2017), PD patients in the present study had an even lower OHRQoL. Besides, in the

Participants (n = 341)		
Male gender [n (%)]		60 (17.6)
	Missings	217 (63.6)
Age [M, SD (range)]		65.5 ± 8.4 (33–84)
Duration of PD diagnosis [M,SD (range)]		7.0 ± 5.5 (0–30)
Motor aspects of experiences of daily living [M, SD (range)]		11.5 ± 7.5 (0–45)
Living situation [n (%)]	Home (alone)	55 (16.1)
	Home/other (with support)	284 (83.3)
Frequency of dental visits [n (%)]	≥2 times a year	249 (73.0)
Frequency of brushing [n (%)]	≥2 times a day	248 (72.7)
Self-reported worsening of oral environment during disease course [n (%)]		81 (23.8)
Dentate [n (%)]		314 (92.1)
Tooth Wear [n (%)]		198 (58.1)
Possible TMD pain [n (%)]		49 (14.4)
Possible BMS [n (%)]		10 (2.9)
Drooling [n (%)]		154 (45,2)
Dry mouth [n (%)]		87 (25.5)
Oral Health-Related Quality of Life [M, SD (range)]	<75 years of age	19.1 ± 6.7 (14–53)
	≥75 years of age	21.9 ± 9.5 (14–53)

Abbreviations: n = number of participants, M = mean, SD = standard deviation.

TABLE 3 Descriptives of the miscellaneous variables from the participants with PD

Participants (n = 341)		
Autonomous self-care [n (%)]		333 (97.7)
Brushing tools [n (%)]	Manual	75 (22.0)
	Electric toothbrush or both	266 (78.0)
Interdental cleaning [n (%)]		264 (77.4)
Frequency of interdental cleaning [n (%)]	≥1 time a day	166 (39)
Interdental tools [n (%)]	Floss	89 (33.7)
	Toothpicks (wood)	132 (50)
	Interdental brushes (rubber)	92 (34.8)
	Interdental brushes (metal)	114 (43.2)

Abbreviations: n = number of participants.

current study, PD patients were also younger, had a shorter duration of their PD diagnosis, and had lower scores for motor aspects of experiences of daily living. Because of that, we expected a better OHRQoL than that reported in the study of Barbe et al., while the contrary was found. This implies that Dutch PD patients in the current study, despite a relatively mild disease rate, are experiencing a worse OHRQoL than German PD patients. In contrast to the Dutch oral health care system, German citizens are compensated for basic oral health care, which could, at least in part, explain these outcomes. This could implicate that PD patients living in The Netherlands may be deterred by the financial consequence of maintaining their oral health. When their oral health is becoming worse, their quality of life can be reduced.

4.1 | Worsening of oral environment during disease course

In the present study, worsening of oral environment during disease course was associated with a reduced OHRQoL in PD patients. Van Stiphout et al. (2018) described that PD patients might experience difficulties with oral hygiene.[25] This can increase the incidence of dental pathology, resulting in, for example, dental pain and, therefore, reduced quality of life. Besides, O'Neill et al. (2021) reported a prevalence of orofacial pain in PD patients of 7.3%, associated with oral motor dysfunction.[26] Orofacial pain can greatly influence vital human needs like eating and chewing, which can have a negative impact on the quality of life of those who suffer from orofacial pain.[27] It would be logical to suggest that when people experience and report a deteriorated oral health, they would also report a worsened

TABLE 4 Univariate and multivariate regression analyses (backward selection, with >0.05 for removal) of all independent variables with Oral Health-Related Quality of life (OHRQoL) in PD patients (n = 341)

	Univariate regression analysis				Multiple linear regression analysis		
	Unstandardised coefficient	95% C.I.	p-value	p-to-the-exit value	Unstandardised coefficient	95% C.I.	p-value
Gender	1.84	1.65–2.03	.18				
Age	0.09	−0.01–0.18	**.07**	0.98			
Duration of PD	0.27	0.13–0.40	**<.001**	0.82			
Motor aspects of experiences of daily living	0.38	0.29–0.48	**<.001**		0.31	0.23–0.40	<.001
Living situation	−0.01	−2.08–2.06	.99				
Frequency of dental visits	−1.91	−3.63–−0.19	**.03**	0.76			
Frequency of brushing	−0.97	−2.70–0.76	.27				
Self-reported worsening of oral environment during disease course	4.43	2.69–6.18	**<.001**		3.39	1.80–4.97	<.001
Dentate	−7.05	−9.80–−4.30	**<.001**		−5.60	−8.06–−3.14	<.001
Tooth wear	3.29	1.77–4.81	**<.001**		2.25	0.91–3.60	.001
Possible TMD pain	2.88	0.71–5.05	**.010**	0.74			
Possible BMS	11.50	7.11–15.89	**<.001**		5.87	1.84–9.90	.004
Drooling	1.06	0.43–1.70	**.001**	0.68			
Dry mouth	0.31	−1.45–2.08	.73				

Abbreviations: R = 0.56, R^2 = 0.31, C.I. = confidence interval, bold = p < .10 and included in multivariable regression model.

OHRQoL. However, in practice, when people have objectively established poor oral health, it is our experience that they do not always report having problems regarding their quality of life. Nevertheless, patients with PD in the present study did report a reduced OHRQoL. Hence, we could assume that because in PD patients quality of life is already reduced, a further reduction due to worsening of the oral environment may affect their daily life more, compared to healthy controls without a reduced quality of life.

4.2 | Self-reported tooth wear

In the literature, a poorer OHRQoL has been associated with the presence of tooth wear in the general population.[28,29] The findings of the current study confirm this negative association also in a population of PD patients. It is noteworthy to mention that, according to our clinical experience, people are not always complaining about tooth wear when the severity of the wear (i.e., the extent and amount of loss of the dental hard tissues) is mild. Therefore, it could be speculated that the severity of tooth wear is at least mild in our population, because the patients were noticing it themselves. However, no conclusion can be drawn regarding the severity of the actual, objectively established tooth wear in the studied population. In the future, it would be interesting to test whether this finding will remain significant if the tooth wear is objectively assessed during a clinical examination.

4.3 | Wearing a denture

In the present study, a positive association between OHRQoL and being dentate was found. This implies that dentate persons with PD reported a significantly better OHRQoL than persons with PD who are edentulous and/or wearing a full removable prosthesis. In a study that examined both PD patients and healthy controls with partial or complete removable dentures, Ribeiro et al. (2017) found that the OHRQoL was lower in PD patients than in healthy controls.[30] However, when both groups were given new prostheses, this effect disappeared after a 2-month adaptation period, suggesting that a functional prosthesis does not negatively affect the OHRQoL. Also, in a recently published systematic review, the authors described that people who wore a denture had a 1.4 times higher chance of having a poor OHRQoL as compared to persons not wearing a denture.[31] It seems that due to all the motor effects of PD, wearing a denture can be a challenge. This can motivate people with PD to take good care of their dentition to prevent becoming edentulous. Likewise, it is also important for dental professionals to focus on preventive strategies in PD patients.

4.4 | Possible burning mouth syndrome (BMS)

In the current study, a prevalence of possible BMS of 2.9% was found in older adults with PD. The literature shows a wide range (4–24%)

of the prevalence of BMS in PD patients.[32,33] However, it is not certain whether there is an actual causal association between BMS and having PD. Besides, the pathophysiology underlying such an association remains unclear. In the current study, the OHRQoL was negatively associated with possible BMS in PD patients. Another questionnaire-based cross-sectional study in a healthy Swedish population supported our finding that that the presence of BMS is associated with a lower OHRQoL.[34] Since the nature of the association between BMS and PD is not evident, research should elaborate on this gap in our knowledge.

4.5 | Motor aspects of experiences of daily living

The study of van Stiphout et al. (2018) showed that the disease stage of PD was negatively associated with chewing and biting problems as well as with some oral health factors (e.g., number of teeth with carious lesions, number of root remnants).[25] Because of the design of the present study, the disease stage was not included in the collected data. However, the disease stage is most of the time established by means of the symptomatology of PD, including motor complaints. Motor aspects of experiences of daily living were one of the variables that was negatively associated with the OHRQoL in the present study. Consequently, it could be hypothesised that a negative association is present between the severity of PD and OHRQoL. PD patients in the current study were diagnosed relatively recently and were therefore relatively healthy if one considers that this disease yields no shorter lifespan for PD patients than for people without PD and that the disease course of PD has a progressive nature. This may imply that PD patients with a longer duration of their disease could experience an even worse OHRQoL. Further longitudinal studies are needed to address this aspect in the future.

4.6 | Temporomandibular disorders

In the current study, no association was found between possible TMD and the OHRQoL. In earlier studies, TMD pain was found to be negatively associated with OHRQoL.[28,34] Furthermore, Da Costa Silva et al. (2015) showed that PD patients with TMD have a lower OHRQoL than PD patients without TMD.[16] Because an earlier pilot study suggested a higher prevalence of TMD pain in PD patients,[14] and TMD pain was considered to be negatively associated with the OHRQoL,[16,28,34] we assumed that in the current study the OHRQoL would be lower in PD patients. However, in contrast to the studies of Papagianni et al. (2013) and Costa da Silva et al. (2015), the methodology of the current study was based on self-report.[16,28] This could be the reason that there is a discrepancy between our results and the results described in the literature.[16,28] Therefore, a clinical assessment of TMD by means of a valid international tool like the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)[35] is recommended for future studies.

4.7 | Clinical consequences

When the OHRQoL is reduced, a person's oral health perception and the actual oral health status may be worsened. Furthermore, when the oral health status is reduced, other consequences may appear, such as difficulties in chewing, which may, in turn, be associated with factors like cognitive decline[36] and weight loss. The latter is a common problem in people affected by PD,[37] and chewing difficulties may worsen that condition. Furthermore, cognitive decline is one of the non-motor symptoms that PD patients could experience. In a population that is already in need of help provided by different health care providers, the consequences of worsening of oral health could thus further increase the pressure on our health care system. To prevent that, we recommend that health care providers actively advise PD patients to seek regular oral health care and explain the urgency thereof. Besides, dental health care providers do have the task to create awareness about this topic in other domains health care. When medical doctors and dentists work together closely,[38] the OHRQoL of PD patients could be preserved.

5 | LIMITATIONS

First, this study was based on self-report, and the questionnaires were only distributed online. Due to the latter, selection bias is a possible risk because relatively healthy persons are more likely to respond to online questionnaires than more severely affected individuals. Therefore, our results could give an underestimation. Second, due to the difficulty, we experienced in earlier questionnaire-based studies with correctly interpreting medication intake (e.g., the respondents' inconsistent reporting of medication types and dosages), medication usage was not asked. Hence, this factor could not be considered in our analyses. Third, due to a technical complication, most PD patients were not asked the question about gender (64%). However, the technical complication was repaired, and in the remaining 36% of the questionnaires, a 50–50 distribution was found between females and males. When imputing the missing variable (gender), no differences were found between the results of the regression analysis with the imputed datasets versus the original dataset. This is in accordance with the assumption that the missing value was at random, because the origin of the missing was a technical complication. Fourth, the study that was used to compare the OHIP-14 scores with our patient group did not contain adults of 75 years of age and older.[19] It is possible that the older adults in that category experience a worsened OHRQoL. Although in the current study no significant difference was found in that direction, the mean OHIP-14 scores were 3 points lower in PD patients <75 years of age. Because PD has no shorter life expectancy than older adults without PD, this may indicate that the OHRQoL can become even worse in this group of people. Fifth, the historical controls were not asked if they had PD.[19] Therefore, it is possible that there is a PD patient included in the historical control group and therefore

an underestimation of the results is a possibility. However, because the diagnosis is often made after several years, the chance of having a PD patient in the control group is probably the same as in studies that were asking this question directly. Besides, because of the current prevalence (viz., 2 per 1,000 persons in The Netherlands), one or two persons in the control group may have had PD. This small number is unlikely to have influenced the results of our study. Sixth, the historical controls were included during a time in which COVID19 did not exist. This contrasts with the PD patients, who were included during the first lockdown of the global pandemic. It is possible that this could have influenced our results. However, PD patients already have some distance towards society and social and professional life. Hence, the consequences of this are expected to have had a minimal influence on our results, if at all. For future studies, we recommend a longitudinal study that investigates the oral health objectively in patients with PD, along with their OHRQoL, with respect to possible associated factors (viz., medication usage, disease severity, disease stage).

6 | CONCLUSION

In our study PD patients showed a lower OHRQoL than the historical controls. Besides, PD-related variables and oral health-related variables were positively (i.e., being dentate) and negatively (i.e., motor aspects of experiences of daily living, worsening of oral environment during disease course, having tooth wear, and having possible burning mouth syndrome) associated with OHRQoL. Although problems concerning oral health are probably subordinate to other problems present in PD patients, this article suggests that the OHRQoL may be impaired in patients with PD. By being aware of this, dentists may be more alert and thus improve PD patients' oral health to prevent further deterioration of their OHRQoL.

AUTHOR CONTRIBUTION
All co-authors took part in the conceptualisation and preparation of this manuscript. MV and AvL performed the analysis of data and drafted a first version. AS provided the data for the historical controls. MV, FL, AvL, AS and MK revised the manuscript.

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