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REVIEW ARTICLE

Geriatrics, Gerontology and Aging

Five-factor model of personality and Parkinson's Disease: a systematic review

Modelo dos cinco fatores da personalidade e Doença de Parkinson: uma revisão sistemática

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Abstract

Some studies have associated Parkinson's disease with specific personality traits. We aimed to analyze personality profiles in Parkinson's disease based on the Five- Factor Model, using the following 3 instruments as parameters: NEO Personality Inventory, revised NEO Personality Inventory, and NEO Five-Factor Inventory. A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The PsycINFO, PubMed, Scopus, and Web of Science databases were searched. The initial search resulted in 232 studies, and 11 studies were selected for full-text review. The personality traits most commonly associated with Parkinson's disease were high neuroticism and low extraversion and conscientiousness. These results cannot be attributed only to Parkinson's disease because other associated diseases were present in the included studies. Evidence from these studies is insufficient to state that there is a typical personality profile associated with Parkinson's disease, given that this profile is nonspecific and found in many psychopathological disorders that differ considerably from each other. This study was registered with PROSPERO (registration number CRD42021271526).

Keywords: Parkinson disease, personality, neuroticism, extraversion, systematic review.

Resumo

Alguns estudos têm associado a doença de Parkinson a traços de personalidade específicos. Esta pesquisa teve como objetivo analisar o perfil de personalidade na doença de Parkinson com base no Modelo dos Cinco Fatores, utilizando como parâmetro três instrumentos baseados nessa teoria: *NEO Personality Inventory*, *NEO Personality Inventory* revisado e *NEO Five-Factor Inventory*. Foi realizada uma revisão sistemática de acordo com os critérios de *Preferred Reporting Items for Systematic Reviews and Meta-Analyses*. Foram consultadas as bases de dados PsycINFO, PubMed, Scopus e Web of Science. A busca inicial resultou em 232 estudos, e 11 deles foram selecionados para análise completa. Os traços de personalidade mais frequentemente associados à doença de Parkinson foram o elevado neuroticismo e baixos níveis de extroversão e de conscienciosidade. Estes resultados não podem ser atribuídos apenas à doença de Parkinson, uma vez que outras doenças associadas estavam presentes nos trabalhos avaliados. Não há evidências suficientes nestes estudos para afirmar que existe um perfil de personalidade típico associado à doença de Parkinson, visto que esse perfil é inespecífico e encontrado em muitos transtornos psicopatológicos que diferem consideravelmente entre si. Este estudo foi registrado na plataforma International Prospective Register of Systematic Reviews — PROSPERO (número CRD4202127151526).

Palavras-chave: Doença de Parkinson, personalidade, neuroticismo, extroversão, revisão sistemática.

INTRODUCTION

Personality is intrinsically related to general health, and in particular to mental health.[1-3] Since the beginning of the 20th century, studies have suggested the existence of a typical personality profile that may coincide with or even precede the clinical motor onset of Parkinson's disease (PD).[4-6] A "Parkinsonian personality" was initially characterized by rigid thoughts and attitudes and introversion. However, over the years, it has been speculated that these personality traits may be early manifestations of neurochemical changes associated with PD.[7,8] Empirical evidence supports the "indirect" effect of personality on the development of neurodegenerative diseases, as certain traits would be associated with habits that improve or worsen the patient's health.[7,9] Some traits, for instance, may contribute to a sedentary lifestyle, tobacco addiction, and behavioral and metabolic risk factors for chronic diseases and may also increase the likelihood of developing impulse control disorders (ICDs) during PD treatment.[10,11] However, it should be noted that many diseases are associated with a combination of some personality traits, so the results need to be interpreted with caution.

One of the contemporary personality theories is the Five-Factor Model (FFM). This model, originally described by Costa and McCrae,[12] is currently one of the most widely used models in health sciences, is broadly recognized in the literature, and has been accepted as a powerful theoretical framework for synthesizing most of the variation in cognitions, beliefs, and behaviors.[7,12-14] The FFM describes personality as consisting of the following traits: *Neuroticism* (N), which refers to the level of emotional instability and the degree to which a person experiences the world as threatening; *Extraversion* (E), which reflects a positive mood, optimism, need for attention, and social interaction; *Openness to Experience* (O), which is related to exploratory behaviors; *Agreeableness* (A), which shows the quality of interpersonal relationships throughout life; and *Conscientiousness* (C), which is the degree of concentration, motivation, discipline, and orientation toward the future.[3,8,15]

There are several instruments available to assess personality based on the FFM. In general, these instruments are self-report questionnaires containing questions about an individual's common behaviors and attitudes. The combination of responses allows for establishing personality dimensions, which are interpreted based on the proposed theory.[15] These instruments include the NEO Personality Inventory (NEO-PI),[16-18] the NEO Five-Factor Inventory (NEO-FFI),[16,19,20] and the revised NEO Personality Inventory (NEO-PI-R).[16,21,22]

Some behavioral features seem to characterize individuals who have developed PD, such as the repression of emotional reactions, persistent anxiety, and depression, but it remains unknown which FFM personality traits may be related to such behaviors.[7] This is probably due to the plurality of theories and instruments used, the use of patient or proxy assessments, and the possible interference of other disorders with PD.[7,8,23,24] Determining the personality profile of patients with PD is important because the diagnosis of this disease negatively impacts the quality of life of patients and caregivers. In addition, it may be helpful in the early diagnosis of PD and timely institution of specific interventions.[5,25] Therefore, this study aimed to analyze personality profiles in PD based on the FFM, using the following 3 instruments as parameters: NEO-PI, NEO-FFI, and NEO-PI-R.

METHODS

This systematic review was registered with PROSPERO (registration number CRD42021271526). The following terms were used in the full search strategies for all databases: "Parkinson's disease" AND (neuroticism OR extraversion OR agreeableness OR "openness to experience" OR conscientiousness). The PsycINFO, MEDLINE (via PubMed), Scopus, and Web of Science Core Collection (Clarivate) databases were searched for articles published from inception to February 20, 2023. Access to the databases was via the CAPES Journal Portal, the official scientific search engine of the Brazilian government. The search strategy was adapted for each database, and no restrictions were imposed. The full electronic search strategy can be accessed at bit.ly/42pKwZR.

Two reviewers independently screened titles and abstracts, and then screened candidate full-text articles for selection on the basis of our inclusion and exclusion criteria. Studies eligible for inclusion were cross-sectional, longitudinal, or experimental studies published in English that were fully available online and used the NEO-PI, NEO-FFI, and NEO-PI-R instruments. We excluded case reports, reviews and/or meta-analyses, book chapters, letters, errata, and patents, as well as studies on the development and validation of psychometric measures and studies of personality not based on the FFM (ie, not using NEO-PI, NEO-FFI, and NEO-PI-R).

Potential studies for inclusion were selected according to:

1. Study design;
2. Use of the NEO-FFI, NEO-PI, and NEO-FFI-R instruments; and
3. Study objective (to assess personality traits in patients with PD based on the FFM).

Their full texts were retrieved and fully examined for eligibility for inclusion by the two reviewers. If both reviewers agreed that the study could contribute to the objective of this review, it was included. If the study's objective of assessing personality in PD based on the chosen instruments was summarily different from the objective of this review, the study was excluded.

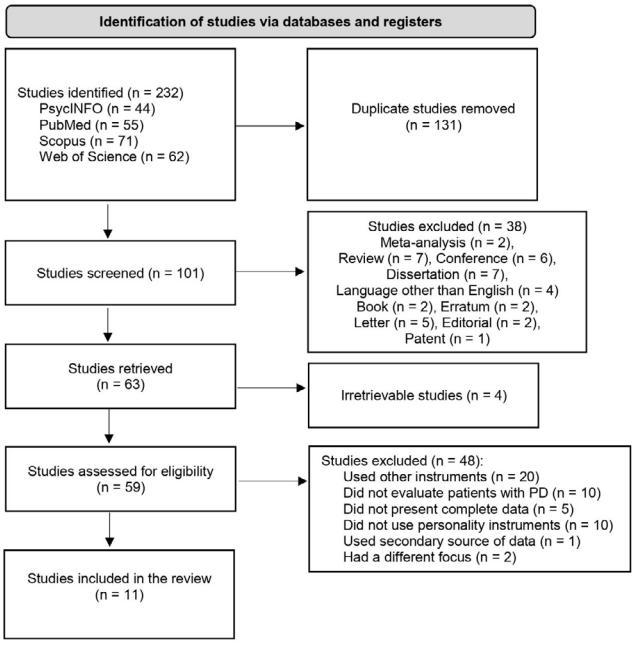
For studies meeting eligibility, data were extracted and arranged in an Excel spreadsheet. Data extracted included author, year of publication, sample size, age of participants, level of education, assessment instruments, and the main results of each article. Subsequently, the results of each study in the domains of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness were extracted.

The Mixed Methods Appraisal Tool (MMAT) was used to determine the quality of the studies.[26] The items were rated on a 6-point scale ranging from 0 (lowest score) to 5 (highest score), and the final mean score was calculated. Then, the studies were grouped according to methodological quality into satisfactory (scores of 3 to 4), good (scores of 4.1 to 4.5), and very good (scores of 4.6 to 5). Methodological quality was independently assessed by the two reviewers, and there were no disagreements between them. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed to report the review process.[27]

A meta-analysis was not possible due to incomplete data on personality domains, statistical heterogeneity, methodological differences between the included studies, and lack of information about disease duration and stage and medications used.

RESULTS

Figure 1 shows the flow diagram of the search and selection of studies. The initial search resulted in 232 studies. A total of 131 duplicates were removed, leaving 101 articles for analysis. After applying the inclusion and exclusion criteria, 38 studies were excluded and 63 remained for analysis. Of these, 4 could not be retrieved, bringing the number of studies retrieved for full-text review to 59. When analyzing the instruments used and the objectives assessed in each of the 59 studies, 20 used other instruments, 10 did not specifically evaluate patients with PD, 5 had insufficient data, 10 did not use instruments for personality assessment, 1 used secondary source of data, and 2 used the chosen instruments but had different goals for personality assessment in PD. As a result, 11 studies were included in this review.



PD: Parkinson disease.

FIGURE 1. Study flow diagram.

General characteristics

Table 1 describes the main data and the most important conclusions of each included study.[23,28-37] Regarding sample size, 54.00% of studies had up to 100 participants. Participants had 12 years or more of education in 63.00% of studies, but 3 studies did not report data on education. The mean age of participants was over 60 years in 72.00% of studies. The NEO-FFI was the most used instrument, used in 7 of 11 studies, followed by the NEO-PI used in 3 studies and the NEO-PI-R in only 1 study. Only 1 study performed a personality assessment in PD as the primary analysis. Ten studies assessed personality in PD as a secondary analysis of the study; they focused mainly on factors associated with depression, the impact of brain transplants/implants, ICDs, quality of life, executive functions, and harm prevention.

The personality trait most commonly associated with PD was high neuroticism, reported in 6 studies. Low extraversion and conscientiousness were reported in 3 studies. High openness was associated with PD in 2 studies. Low agreeableness was present in only 1 study. Overall, the personality traits most commonly associated with PD were low extraversion and conscientiousness and high neuroticism.

Methodological quality

Table 2 shows the results of the classification of the quality of the studies according to the MMAT criteria. Seven were cross-sectional studies, 1 was a case-control study, 1 was a

TABLE 1. Studies included in the review.

Author	Years	Participants (n)	Age (years), mean (SD)	Education (years), mean (SD)	Instrument	Main conclusion
Glosser et al.,[28]	1995	29	66.00 (8.90)	14.90 (3.40)	NEO-PI	Before PD: ↑ extraversion After PD: ↓ extraversion ↓ openness to experience ↓ consciousness ↑ neuroticism
McRae et al.,[29*]	2003	30	56.70 (8.90)	16.30 (2.40)	NEO-FFI	↓ consciousness between the first and second year of surgery. The personality in general remained stable during the follow-up period and was not influenced by the transplant or surgery
Damholdt et al.,[30]	2011	118	71.20 (7.40)	15.80 (2.10)	NEO-PI	PD and depression: ↓ extraversion ↑ neuroticism when compared with PD without depression
Buchman et al.,[31]	2014	969	80.40 (7.40)	14.60 (30.00)	NEO-PI	High scores of harm avoidance (anticipatory worry, fear of uncertainty, shyness, and fatigability) accelerated Parkinsonism. ↑ neuroticism did not contribute to PD acceleration
Callesen et al.,[32]	2014	490	71.00 (9.60)	Not reported	NEO-PI-R	↑ neuroticism increased the risk of developing symptoms of impulse control disorders (ICD) and medication abuse. ↑ openness was associated with symptoms of impulsive and compulsive behaviors (ICB)
Damholdt et al.,[33]	2014	409	70.60 (9.60)	Not reported	NEO-FFI	PD and depression: ↑ neuroticism ↓ extraversion ↓ consciousness when compared with PD without depression
Sachdeva et al.,[34]	2014	73	62.00 (8.50)	12.00 (2.00)	NEO-FFI	PD and compulsive sexual behavior (CSB): ↑ openness ↓ agreeableness
Pontone et al.,[35]	2017	100	54.60 (7.80)	16.70 (3.00)	NEO-FFI	↑ neuroticism was associated with worse quality of life in PD, ↑ consciousness was a protective factor to cope with the challenges of PD
Chardosim et al.,[23]	2018	30	68.90 (6.30)	12.20 (5.10)	NEO-FFI	PD with ↑ extraversion was associated with ↑ verbal fluency PD with ↑ extraversion and ↑ openness was associated with ↑ verbal episodic memory
Ma et al.,[36]	2018	134	65.30 (7.80)	Not reported	NEO-FFI	Neuroticism was associated with higher physical and mental health scores in patients with PD (beta = 0.27), and conscientiousness was associated with a lower mental health score (beta = -0.20)
McRae et al.,[37]	2022	34	56.10 (10.00)	16.40 (2.80)	NEO-FFI	Openness was significantly related to age (p = 0.007), with ↑ openness reported by younger participants and better results in cognitive measurements in survivors

NEO-PI: NEO Personality Inventory; NEO-FFI: NEO Five-Factor Inventory; NEO-PI-R: revised NEO Personality Inventory, PD: Parkinson disease SD: standard deviation. *Evaluation results 12 months after transplant – 12 transplant group, 18 initially placebo group.

TABLE 2. Methodological quality of included studies according to Mixed Methods Appraisal Tool.

Author	Year	Study design	Classification
Glosser et al.,[28]	1995	Cross-sectional	Satisfactory
McRae et al.,[29]	2003	Randomized	Good
Damholdt et al.,[30]	2011	Cross-sectional	Satisfactory
Buchman et al.,[31]	2014	Longitudinal	Good
Callesen et al.,[32]	2014	Cross-sectional	Satisfactory
Damholdt et al.,[33]	2014	Cross-sectional	Satisfactory
Sachdeva et al.,[34]	2014	Case-control	Satisfactory
Pontone et al.,[35]	2017	Cross-sectional	Satisfactory
Chardosim et al.,[23]	2018	Cross-sectional	Good
Ma et al.,[36]	2018	Cross-sectional	Satisfactory
McRae et al.,[37]	2021	Randomized	Very good

longitudinal study, and 2 were randomized trials. Seven studies had their methodological quality classified as satisfactory, 3 as good, and 1 as very good.

Instrument results

Table 3 describes the outcomes of personality assessment in each included study. One study using the NEO-PI did not report numerical values for any domain.[28] Two studies did not report the values for all 5 domains, one using the NEO-PI and the other using the NEO-FFI.[1,36] The lack of such data may have influenced the highest and lowest scores obtained in each domain of the respective instruments.

Regarding the NEO-PI, the lowest neuroticism score was found in patients with PD without comorbidities,[31] and the highest score was found in patients with PD positive for depression (PDpd).[30,31] The latter study reported values for all domains and compared patients with PDpd with a group of patients with PD negative for depression (PDnd). Low extraversion and conscientiousness scores were found in the PDpd group, and low openness and agreeableness scores were found in the PDnd group.

Regarding the NEO-FFI, neuroticism scores were lower in brain implant non-survivors,[37] and higher in patients with compulsive sexual behavior (CSB).[34] Patients with PD without comorbidities had the lowest extraversion scores,[23] and those with CSB had the highest extraversion scores.[34] The lowest conscientiousness scores were found in the PDpd group[33] and the highest scores in the CSB group.[34] Openness to experience scores were lower in the PDpd group[33] and higher in the CSB group.[34] Both the PDpd and PDnd groups had the lowest scores in the agreeableness domain,[33] whereas the highest scores were found in the CSB group.[34]

The NEO-PI-R was used in only 1 study.[32] Two groups were compared in this study: patients with PD without impulsive and compulsive behaviors (ICBs) vs patients with PD and ICBs. The group without ICBs had low levels of neuroticism, extraversion, and openness and high levels of agreeableness and conscientiousness, whereas the ICB group had high levels of neuroticism, extraversion, and openness and low levels of agreeableness and conscientiousness.[32]

Overall, considering all 5 domains, we observed that the highest neuroticism scores were from patients with comorbidities (PDpd, CSB, and ICBs), whereas the lowest neuroticism scores were from patients with PD, patients with PD without ICBs, and patients with PD non-survivors of transplant. Patients with PDpd, patients with PD and those without ICBs had the lowest extraversion scores, whereas patients with CSB, ICBs, and PDnd had the highest scores in this domain. The same result was observed in the openness to experience domain, with the highest scores in the CSB, ICB, and PDnd groups, whereas the lowest scores were found in the PDpd group (in 2 studies) and in the group without ICBs. Low agreeableness was found in patients with PDpd, ICBs, and in one PDnd group, whereas high scores in this domain were found in the PDpd, CSB, and PD without ICB groups. Finally, in the conscientiousness domain, the lowest scores were found in patients with ICBs, PDpd, and in one PDnd group, whereas the highest scores were found in the CSB, PDpd, and PD without ICB groups. Neuroticism and extroversion are the domains that can most negatively compromise health, and high levels of neuroticism and low levels of extroversion were observed in patients with PD with comorbidities rather than in those with PD alone.

TABLE 3. Personality assessment.

Author	Year	Instrument	Neuroticism	Extraversion	Openness to experience	Agreeableness	Conscientiousness
Glosser et al.,[28]	1995	NEO-PI	Not reported	Not reported	Not reported	Not reported	Not reported
Damholdt et al.,[30*]	2011	NEO-PI	PDnd 18.00 (6.30), PDpd 24.10 (6.90)	PDnd 27.40 (6.80), PDpd 22.20 (5.30)	PDnd 24.20 (7.40), PDpd 20.40 (6.40)	PDnd 34.50 (4.90), PDpd 35.50 (5.00)	PDnd 31.80 (5.40), PDpd 29.40 (7.90)
Buchman et al.,[31]	2014	NEO-PI	14.70 (7.00)	Not reported	Not reported	Not reported	Not reported
Damholdt et al.,[30*]	2014	NEO-FFI	PDnd 18.40 (6.50), PDpd 25.80 (6.70)	PDnd 26.90 (6.70), PDpd 22.00 (6.90)	PDnd 23.60 (5.80), PDpd 21.70 (5.90)	PDnd 34.20 (5.00), PDpd 33.00 (6.20)	PDnd 31.90 (5.30), PDpd 27.70 (6.60)
McRae et al.,[29†]	2003	NEO-FFI	T 20.80 (9.90), P 15.30 (6.90)	T 27.60 (6.40), P 27.20 (7.20)	T 30.70 (4.80), P 30.40 (5.90)	T 35.70 (3.80), P 35.10 (3.80)	T 33.50 (6.70), P 31.00 (7.20)
Sachdeva et al.,[34‡]	2014	NEO-FFI	CSB 56.70 (9.10)	CSB 48.80 (12.50)	CSB 55.60 (10.10)	CSB 44.00 (11.00)	CSB 49.00 (13.50)
Pontone et al.,[35]	2017	NEO-FFI	49.20 (9.30)	47.00 (9.30)	51.30 (11.70)	54.30 (8.40)	47.80 (9.20)
Chardosim et al.,[23]	2018	NEO-FFI	23.60 (9.10)	25.10 (10.80)	29.50 (6.00)	34.70 (6.20)	34.30 (5.60)
Ma et al.,[36]	2018	NEO-FFI	20.90 (8.40)	Not reported	Not reported	Not reported	27.80 (7.30)
McRae et al.,[37§]	2021	NEO-FFI	S 20.20 (11.00), NS 14.80 (6.60)	S 29.20 (7.60), NS 26.90 (5.40)	S 37.00 (3.70), NS 29.80 (4.70)	S 35.40 (5.10), NS 36.20 (4.00)	S 32.00 (4.10), NS 33.40 (7.20)
Callesen et al.,[32//]	2014	NEO-PI-R	N 19.30 (7.40), ICB 22.30 (7.40)	N 25.80 (6.80), ICB 25.10 (7.60)	N 22.60 (5.90), ICB 23.90 (6.10)	N 34.80 (5.20), ICB 32.70 (5.90)	N 31.60 (6.10), ICB 29.70 (6.00)

Values are described as mean (SD). NEO-PI: NEO Personality Inventory; NEO-FFI: NEO Five-Factor Inventory; NEO-PI-R: revised NEO Personality Inventory. *PDnd: results of patients with PD negative for depression. PDpd: results of patients with PD positive for depression. †T: results of transplant patients. P: results of placebo. Both groups at 12 months after the transplant.

‡CSB: results of patients with compulsive sexual behavior. §S: results of implant survivors. NS: results of implant non-survivors. //N: results of patients without impulsive and compulsive behaviors. ICB: results of patients with impulsive and compulsive behaviors.

DISCUSSION

There was a lack of convergence between the 11 included studies. Therefore, no consensus was reached on the personality traits associated with PD, and empirical and clinical studies are still needed. Based on the results of the included studies, the personality profile of patients with PD may be summarized as a tendency to be more worried, rigid, and resistant to change, to be less open to new experiences, and to have more difficulty coping with stress.[32,35] In terms of FFM personality traits, patients with PD tend to have high levels of neuroticism and low levels of extraversion and openness. The present results only partially agree with previous reports in the literature. Although there are some personality traits that seem to characterize patients with PD, it is not clear whether this occurs solely as a result of PD, since the included studies involved heterogeneous populations of patients. In addition, a trait that has not been repeatedly described as prevalent in patients with PD was observed in this review: low conscientiousness.[8,9,38,39] Low conscientiousness has been associated with the manifestation of other disorders, such as depression.[33,40] This association may be related to the degenerative progression of the disease and its impact on patients' quality of life, changing their way of feeling and thinking about the future, and on their ability to follow social norms and rules.

High levels of neuroticism are associated with an increased risk of PD incidence, and studies that followed patients for up to 40 years concluded that neuroticism may precede the diagnosis of PD.[24,41] Individuals who score high on neuroticism tend to develop poor health throughout their lives, and neuroticism is a risk factor for a negative self-assessment of health, anxiety, and mood disorders. In this respect, most of the studies included in this review showed high levels of neuroticism associated with PD. In the studies reporting these results, patients with PD had concomitant disorders, such as ICDs and depression. This observation supports previous reports of an association between neuroticism and the incidence of other diseases concomitantly with PD. Moreover, genetic factors along with other risk factors, such as physical inactivity and smoking, may also be related to these results.[24,42,43] However, high levels of neuroticism have been reliably correlated with depression, alcohol abuse, debilitating anxiety, and panic disorder, as well as with skin problems, sciatica, urinary problems, ulcers, asthma/respiratory disease, and other lung problems.[44] Therefore, it is not possible to conclude that high levels of neuroticism are related only to PD, even though this relationship has been observed in some studies.

Patients with PD tend to be more cautious and introverted.[45] Low levels of extraversion were observed in most studies included in this review. However, in 2 of the 3 studies that specifically reported this association, low extraversion was present in patients with PD and depression.[30,33] Depression and ICDs are the main psychiatric manifestations of PD, and the traits of a "Parkinsonian personality" might therefore be the consequence of a pre-existing psychiatric condition, thus influencing the results in this domain.[7,33] In one of the included studies,[46] there was no association between PD and traits related to introversion and extraversion preceding the onset of motor symptoms. However, in another included study, higher extraversion was reported before and lower extraversion after the onset of motor symptoms.[28] This result, although dated, highlights the need to longitudinally observe people with the potential to develop PD, such as those with a family history of PD and other potentially associated diseases. This would possibly allow us to determine whether a more introverted behavior is associated with PD itself (after PD diagnosis) or with a person's personality and other typical behaviors throughout the person's life (before PD diagnosis).

High conscientiousness scores have widespread protective effects on health.[47] Because this factor contributes to avoiding risk-taking behaviors and increasing the intention to be physically active, the risk of chronic diseases is reduced, including neurodegenerative diseases.[42] Low levels of conscientiousness were generally reported in the studies included in this review. In PD, this result may be related to the difficulty patients have in planning the future, which may result from uncertainties related to a degenerative disease as well as from the impact of PD on other functions, such as executive function, memory, language, and planning, among others, hindering the patient's ability to imagine future events.[48-50]

Openness to experience and agreeableness were rarely reported in the studies included in the present review. It is known that low levels of openness to experience are characteristic of patients with PD.[45] In general, these patients have established routines and, therefore, are not naturally open to novelties. It is also known that patients with PD have little flexibility in the face of different opinions, which further contributes to a more rigid behavior.[51] High agreeableness can be seen as a protective factor, especially against depression, since it stimulates social interaction. Low agreeableness was reported in only 1 included study, associated with patients with PD and CSB, and may be more related to a compulsive behavior than to PD.

High neuroticism and extraversion and low conscientiousness were found mainly in the PD with CSB group and in the PDpd group. This profile, however, may be more closely related to the comorbidities than to PD itself. High levels of neuroticism may contribute to the development of ICDs,

which affect 6,00 to 40,00% of patients with PD[7] and include CSB.[32] The PD with CSB group also had high agreeableness and openness scores, which may be related to the exploratory and impulsive behavior inherent in this disorder, in addition to other individual variables in this condition.

Except for high agreeableness, all other scores were more negatively present in patients with PD who had a concomitant disease or disorder. This result suggests that personality may also contribute to the development of other comorbidities in PD. Improvement in the subjective condition, in turn, was pronounced in patients with personality traits such as high agreeableness, conscientiousness, openness, and extraversion.[25] These results might be explained by taking into account the genetic and neurophysiological structure of patients with this personality profile. However, it is not possible to determine whether the patient's physiological structure gives rise to a personality characteristic of PD or whether the characteristic personality of PD leads to behaviors that impair the patient's neurobiological structure. Although we have gained a better understanding of personality traits in PD, it is still not possible to identify a single profile that characterizes these patients, since most of the included studies did not have a control group and involved patients with comorbidities, making the analysis unfeasible.

Despite contributing to the diagnosis of PD, non-motor characteristics and symptoms, such as personality traits, should not be used to reach an extremely early diagnosis. There is currently no effective therapy that can delay the progression of PD. Therefore, informing patients of their predisposition to PD based only on personality traits might not contribute to their well-being, and it is necessary to take into account the other non-motor factors that contribute to the manifestation of PD. Once the disease is established, alternative treatments should be considered, including non-drug treatments aimed at improving patient quality of life.[52,53]

The present review has some methodological limitations, among which the small number of included studies stands out. Also, it was not possible to perform a meta-analysis because of incomplete data on personality domains, statistical heterogeneity, methodological differences between the included studies, and lack of information about disease duration and stage and medications used. The only change in the protocol was the start and end date of data collection, but this information was included in the protocol and in the Methods section. Weak conclusions about the association between personality and PD based on the chosen instruments, the heterogeneity of samples with different comorbidities, and the different objectives of each study prevented us from drawing strong conclusions from the present data. The literature search in only 4 databases and by only 2 researchers and the use of a few criteria for the final study selection also need to be considered. In addition, different treatments used for PD can influence personality traits since some medications may have side effects as mentioned earlier. For instance, deep brain stimulation (DBS) is a surgical treatment that can affect areas adjacent to the subthalamic nucleus leading to personality changes, such as increased irritability, lack of empathy, and aggressive behavior. Furthermore, the natural progression of PD itself, as a result of frontal lobe cognitive dysfunction, may also lead to personality changes. Nevertheless, the present findings can contribute in a practical way to the deconstruction of the "Parkinsonian personality". This review also contributes by supporting an individualized treatment that considers each patient's well-being and quality of life. Future studies should assess personality using other statistical analyses and other instruments based on the FFM, as well as patients with PD receiving other treatments, such as DBS. Further studies of this population are also warranted to investigate potential associations between personality and other variables, such as sex and level of education.

CONCLUSIONS

Based on data from this review, patients with PD have a personality profile characterized predominantly by high levels of neuroticism and low levels of extraversion and conscientiousness. However, the personality traits described as related to PD may be associated not only with PD but also with other comorbidities, such as ICDs and depression. This study highlighted the role of low conscientiousness, which had not been reported in most previous studies. Therefore, the main contribution of this review is to highlight a personality profile based on the FFM and to emphasize the importance of factors associated with PD comorbidities. Finally, the results highlight the need to conduct more empirical studies of personality in patients with PD comparing them with healthy controls and patients with other comorbidities.

Conflicts of interest

The authors declare no conflicts of interest.

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Other information

The PROSPERO protocol can be accessed at https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=271526,

no changes have been made since the protocol was submitted. All data collection forms can be accessed at bit.ly/42pKwZR.

Authors' contributions

ACH: data curation, supervision. TLSA: data curation, writing – original draft, writing – review & editing.

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