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Review article

Parkinson's disease in Nigeria: A review of published studies and recommendations for future research

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ABSTRACT

Parkinson's disease (PD) affects 1–2% of individuals above 60 years amounting to over 7 million people worldwide. Thus, PD has become an important contributor to the neurological disease burden. Nigeria is the most populous country in Africa, and alarmingly, approximately 5.25 million Nigerians are above 65 years and are therefore at risk for developing PD. We carried out a critical review of published literature on PD in Nigeria to summarize the findings and to evaluate gaps in knowledge. Seven electronic databases were searched for studies published in English before 18th July 2018. Search terms were ["Parkinson's disease" OR "Parkinson disease" OR "parkinsonian disorders" OR "Parkinsonism"] AND "Nigeria". A total of 44 articles (including eight reviews) published since 1969 were identified and reviewed. Amongst the original research articles, most (23) were on PD symptoms or prevalence. There were only two studies on genetics and two on environmental factors. The estimated crude prevalence of PD in Nigeria was lower (10–249/100 000) compared to studies published in Europe (65.6–12 500/100 000). Our findings suggest that PD is under-diagnosed in Nigeria. Possible environmental risk factors identified include blacksmithing and well-water contaminated with trace metals. Given the rising numbers of the ageing population in Nigeria, more studies to evaluate the prevalence and causes of PD in this country are urgently needed. To this end, more funding, resources and a workforce of well-trained neurologists and scientists are essential to manage the impending health burden of PD and related disorders in this country.

1. Introduction

Worldwide, approximately 2% of people above the age of 60 and 4% above the age of 80 years are affected with Parkinson disease (PD) [1] but the prevalence varies widely according to geographic region. In Sub-Saharan Africa (SSA), the prevalence of this condition differs depending on the study cited and ranges from 10 to 235/100 000 in urban populations [2], compared to the crude prevalence in Europe which ranges from 65.6/100 000 to 12 500/100 000 [3]. Although studies conducted in rural areas in SSA are limited, a door-to-door study in rural Tanzania found a crude prevalence rate of 20/100 000, and notably, 78% of the patients were previously undiagnosed [4]. Based on findings from a systematic review, the prevalence of PD varied from 0.4 to 0.7% of neurological admissions/consultations in hospital-based studies in seven SSA countries [2]. Over the past 26 years, the burden of neurological disorders including PD has increased substantially, making PD one of the leading causes of disability and mortality worldwide [5]. To improve health-care planning and health outcomes of people with PD in Nigeria, we must understand not only the number and distribution of people with PD but also how these disorders affect population health.

There is a common misconception that there are few aged individuals (defined here as people aged 60 years and over) in SSA. However, it should be noted that the small increase in the proportion of the aged individuals in SSA masks a large increase in the actual number i.e. the number of people aged 60 and over is predicted to almost

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double from over 34 million in 2005 to over 67 million in 2030 [6,7]. Notably, the number of people aged 60 years is currently rising more rapidly in this region than in developed countries and this trend is set to continue in the future [8].

Consequently, the number of PD cases is expected to increase significantly especially in the most populous SSA countries such as Nigeria, Ethiopia, Democratic Republic of Congo, Tanzania, South Africa and Kenya [9]. Nigeria, the seventh most populous country in the world, with an estimated 182 million people in 2015 [10], is a multi-ethnic country inhabited by over 500 ethnic groups (Supplementary Fig. S1). It has a history of slave trade, inter-border trading, inter-marriage and cross-border migrations from neighboring countries making Nigerians a heterogeneous group of people [10]. In 2005, Nigeria was ranked among the top 30 countries internationally on the basis of its population aged 60 years and older [6]. According to data from the World Bank, approximately 2,75% of Nigerians, corresponding to 5.25 million people, are ≥65 years [11] and these could potentially be considered to be at risk for developing late-onset PD. Also, increasing industrialization in Nigeria without a proper way of handling the effects of industrialization is currently contributing to the environmental degradation mostly caused by carbon emission and other toxicities [12]. The effects of these environmental hazards may be linked to the causes of sporadic forms of PD in Nigeria.

If these predicted trends are realized, then the management and care of patients with PD in Nigeria need urgent attention. It has been noted that current problems to proper care of patients in low-resource settings include lack of access to sustainable, affordable drug treatment and medical supervision [13,14]. Also, the need to raise awareness of PD within the general population and that PD is a condition and not part of general ageing, has been highlighted. It has also been suggested that minimal consensus management guidelines for PD should be established to improve the consistency and quality of care to patients in SSA [15].

With this information as a backdrop, we summarized all published studies on PD in Nigeria, and provide recommendations for future studies. Our goal is to highlight not only the research that has been done but also the lack or paucity of studies on this impending health burden in Nigeria. It should be noted however that the importance of the implications of this review is not limited to Nigeria but include all SSA countries.

2. Methods

We searched seven electronic databases (PubMed, HubMed, BioMedSearch, Ovid, Web of Science®, Scopus and Google Scholar) for articles on PD in Nigeria published on or before 18th July 2018. Search terms were ["Parkinson's disease" OR "Parkinson disease" OR "parkinsonian disorders" OR "Parkinsonism"] AND "Nigeria". Articles selected to be potentially relevant were downloaded to a reference manager, Zotero [16]. The full text of relevant articles was obtained and the contents critically evaluated in this review. Exclusion criteria include studies that were not published in English and studies that were not done on Nigerian PD patients or controls. Also, we did not consider articles that did not undergo a formal peer-review process.

3. Overview of retrieved articles

A total of 3496 items were identified in the seven databases searched, and of these 405 were selected for consideration. After duplicates, conference abstracts and non-human studies were removed, 46 articles were considered to be potentially relevant (Fig. 1; Supplementary Table 1). The full texts of these articles were retrieved, read and evaluated for content resulting in 44 articles being included in the review. For the two that were excluded; one was not on Nigerian PD patients, and the other was a letter to the editor of a journal. Among the 44 relevant articles, 10 studies investigated prevalence of PD in Nigeria, 13 reported on symptoms and signs in Nigerian PD patients (one study reported on prevalence and on symptoms [17]), two were genetic reports on PD in Nigerian individuals, two reported on environmental risks factors for PD in Nigeria, seven reported on other diseases mimicking the clinical features of PD, three studied biochemical or pathological findings and eight were review articles (Supplementary Fig. S2). Of the 44 articles, 40 (90.9%) articles had either a Nigerian as the first or the last author, and four articles had only non-Nigerian authors. Therefore, most of the studies published on PD in Nigeria were led by Nigerian investigators.

4. Prevalence of PD in Nigeria

A total of 10 publications involved estimation of the number of PD patients in Nigeria (Table 1). Four different study designs were used and included five neurological hospital admissions studies, two neurological out-patient, one hospital-based and one community-based study (Schoenberg et al. [18] re-analyzed the same data set as Osuntokun et al. [19], which was a community-based study, but included only the 3412 participants aged over 39 years). We calculated crude prevalence ratios of PD cases per 100 000 in each study and this ranged from 10 to 249 (Table 1). When compared with global PD prevalence per geographic location which ranged from 41 to 2953 [20], we found that PD prevalence is low in Nigeria.

The five neurological hospital admission studies were carried out in four different locations in Nigeria, and ranged in size from 781 to 9600 [21–25]. The number of PD cases in these studies varied from 0.4% to 2.2%. The estimated crude prevalence of PD was from 32 to 165/100 000, with the lowest estimate from the Niger Delta area [23] and the highest from Enugu in South East Nigeria [24].

Two studies analyzed neurological out-patient populations, one in Lagos in Southwest Nigeria and the other in Kano in Northwest Nigeria [17,26]. The number of PD patients among patients with neurological disorders varied between the two sites with the Kano study reporting an over four-fold greater number of PD patients (20/1360 for Lagos vs 80/1153 for Kano). The reason for this difference is not clear. It is, however, plausible to speculate that exposure to environmental hazards such as herbicides and pesticides might be a possible reason for this difference. Similarly, we could not rule out hereditary PD as one of the reasons for the increased PD prevalence in the Kano study. Marriages among related individuals are more frequent in Northwest Nigeria than Southwest, and this may contribute to the increased frequency of PD [12]. These two study sites are known to be the most populous places in Nigeria. In addition, Kano is situated in Northwest Nigeria where blacksmithing and commercial farming are some of the major occupations of the people living in the rural and urban communities, whereas Lagos is more urbanized, and the majority of the people living there are not farmers or involved in blacksmithing.

The hospital-based study investigated the prevalence of PD among all 8026 hospital admissions, 1220 of which were neurological admissions [27], and identified 20 PD patients. The crude prevalence estimate from this study was 249/100 000.

The community-based study was a door-to-door survey using simple questionnaires and clinical evaluations of nearly 20 000 individuals. The study identified a total of 699 individuals with neurological conditions, but only two of them had PD [19]. The crude prevalence estimates for PD from this study was 10/100 000 [19] without age-adjustment and 59/100 000 [18] when considering only the older population.

In summary, the estimated number of people with PD in Nigeria is low; the reason might be due to under-diagnosis or misdiagnosis of PD. There was evidence of regional variation in the prevalence of PD in Nigeria but the reasons for this are currently not known. The variation may also be linked to the lack of expert neurologists in some areas in Nigeria that can correctly diagnose PD. Also, the lack of adequately informed and trained non-specialists in rural regions is a factor leading

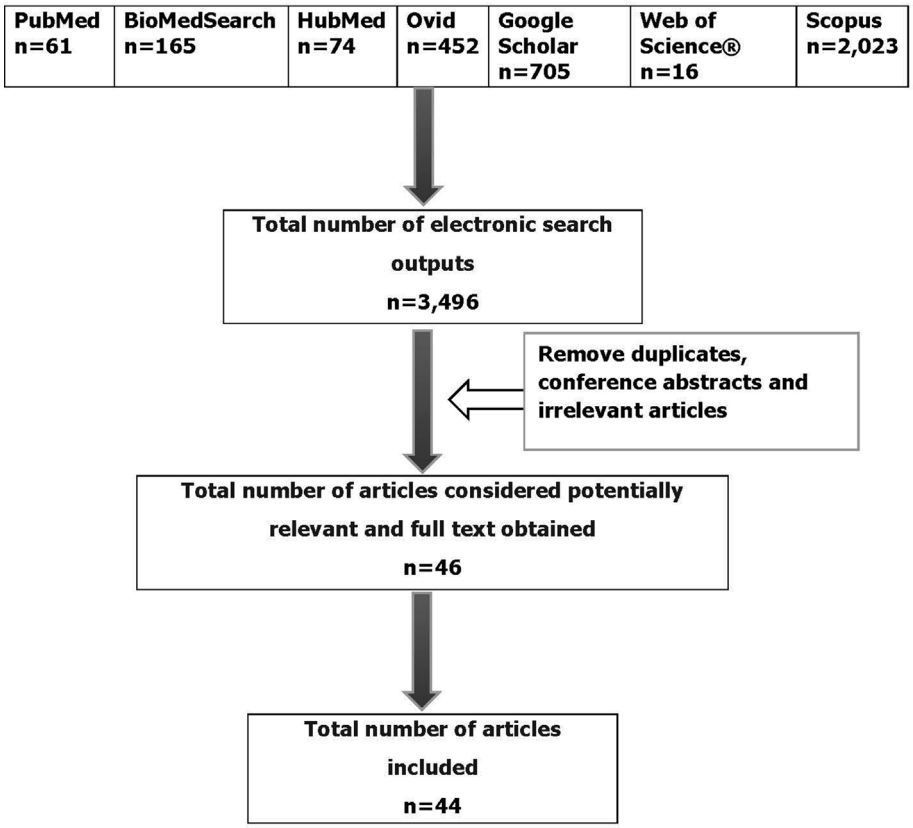

Fig. 1. Flow diagram of literature search strategy and results. Several electronic databases were searched as described in the methods. See Supplementary Table 1 for full listing of the.

to under- and misdiagnosis of PD in SSA. Not all of the epidemiological studies reported on PD in Nigeria described the diagnostic criteria they used [19]. It is noteworthy that there were five neurological hospital admissions studies, two neurological out-patient, one hospital-based and one community-based study reviewed in the present study, each with different limitations that could affect the overall estimates of PD prevalence.

5. Clinical profile of PD in Nigeria

Our literature search identified a total of 13 studies cataloguing the symptoms and signs of Nigerian PD patients (Table 2). In addition, seven Nigerian studies [28–33] reported patients with similar symptoms and signs of PD in other disorders including progressive supranuclear palsy [29], drug induced Parkinsonism [30], typhoid fever [31], Lewy body dementia [33], ischemic cerebrovascular disease [34], cranial meningiomas [32], and essential tremor [19]. It is important to note that PD symptoms vary widely from patient to patient. One of the Nigerian studies demonstrated clearly the difficulties in diagnosing PD patients stating that “none of the patients had received a definite diagnosis of PD prior to specialist consultation, instead the patient's referral letter stated ‘neurological disorder’ or `neurological symptoms' [26].

5.1. Preclinical symptoms of PD

Preclinical symptoms of PD precede the onset of the characteristic motor features of PD, and include olfactory dysfunction, sleep disturbances, depression, anxiety, apathy and constipation (Table 2). Although, these conditions are not a definite indication to develop PD, cataloguing the presence of these preclinical symptoms in patients is helpful when actual PD is to be diagnosed. There were no published studies that described preclinical symptoms of PD in Nigeria.

5.2. Motor symptoms of PD

Cardinal motor symptoms of PD are rigidity, resting tremor, gait abnormalities and bradykinesia, which have been reported extensively also in Nigerian PD patients (Table 2) [17]. These signs are required for PD diagnosis. One Nigerian study reported that frequent falls with sustained injuries were about three times more common in PD patients than controls, and that the risk for falls increased with increasing age and disease severity [35].

5.3. Non-motor symptoms of PD

Non-motor symptoms (NMS), which include cognitive disorders, visual dysfunction related to object and face perception, autonomic impairment, and mood disorders, are seen very frequently in PD patients, and were also reported in many Nigerian PD patients [36–44] (Table 2). Neurobehavioral disorders can occur in PD patients at any stage of the disease, whereas psychotic symptoms occur more commonly during treatment with dopamine agonists. About 90% of PD patients will have at least one neuropsychiatric symptom during the course of the disease [45]. Neuropsychiatric symptoms such as depression, visual hallucinations, delusion, aggression and apathy have also been reported in Nigerian PD patients (Table 2) [36,37].

NMS greatly impact the quality of life of PD patients and their caregivers [36,46]. In addition, NMS vary significantly from patient to patient. For example, several Nigerian PD patients had respiratory impairments related to difficulties in breathing, while others had cardiovascular dysfunction or gastrointestinal disorders [38–40]. In summary, psychiatric symptoms, gastrointestinal disorders and cardiovascular autonomic dysfunction were the most common NMS observed in

Table 1
Summary of prevalence studies on PD in Nigeria.

Study year	Study site	Geographic region in Nigeria	Study design	Total hospital/ community population	Number of patients with neurological disorders	Number (%) of PD patients	Family history of PD patients	Age at onset for PD (mean ± SD; years)	Crude prevalence ratio cases/100 000	Reference
Neurological admission studies										
1970	University of Ibadan	South West	Analysis of neurological admissions during 1957–1969	220 000	9600	90 (0.9)	1	N/A	47	[21]
2003	University of Ibadan	South West	Analysis of neurological admissions during Jan 1998–Dec 2000	26 355	781	4 (0.5)	N/A	N/A	75	[22]
2004	University of Port Harcourt	South South	Analysis of neurological admissions during April 1993–March 2003	92 544	1393	30 (2.2)	N/A	N/A	32	[23]
2010	University of Nigeria Teaching Hospital Enugu	South East	Analysis of neurological admissions during Jan 2003–Dec 2007	8440	1249	14 (1.1)	N/A	N/A	165	[24]
2010	Aminu Kano Teaching Hospital	North West	Analysis of neurological admissions during Jan 2005–July 2007	6282	980	4 (0.4)	N/A	N/A	63	[25]
Neurological out-patient studies										
2010	Lagos State University Teaching Hospital	South West	Analysis of neurological outpatient clinic during Jan 2005–Dec 2006	N/A	1360	20 (1.5)	1	61.5 ± 10	N/A	[26]
2012	Two Tertiary Health Facilities in Kano	North West	Analysis of neurological out-patient clinic during June 2007–June 2011	N/A	1153 (96 with parkinsonism)	80 (6.9)	3	58.2 ± 6.72	N/A	[17]
Hospital based studies										
1970	Lagos State University Teaching Hospital	South West	Analysis of hospital admissions during 1962–1967	8026	1220	20 (1.6)	N/A	N/A	249	[27]
Community based studies										
1987[a]	Igbo-Ora	South West	Community surveys used questionnaire and simple clinical evaluation in 1982	18 954	699	2 (1.4)	N/A	N/A	10	[19]
1988[a]	Igbo-Ora	South West	Community surveys used questionnaire and simple clinical evaluation in 1982	3412	N/A	2 (0.05)	N/A	> 39	59	[18]

N/A, not available.
Crude prevalence ratio is given as the number of PD cases/100 000 individuals.
[a] Community-based door-to-door survey. Both studies used the same primary data from Nigeria. Schoenberg et al. [18]. analyzed data from individuals > 39 years.

Table 2
Symptoms and signs of PD identified in Nigerian patients.

Category	Symptom or sign	Brief description	Reported in Nigerian PD patients	Reference
Preclinical symptoms	Olfactory problems	Loss of smell	No	
	Gastrointestinal disorders	Indigestion and abdominal pain	No	
	Sleep disorder	Episode sleep	No	
	Mood disorder	Lack of motivation	No	
	Orthostatic hypotension	Low blood pressure when standing up	No	
Primary motor symptoms	Resting tremor	Slight tremor in the hand or foot on one side of the body	Yes	[17,21,42,44,59]
	Bradykinesia	Difficulty with repetitive movements	Yes	[17,21,44,47,59]
	Rigidity	Stiffness and inflexibility of the limbs, neck and trunk	Yes	[17,21,42,44,59]
	Postural instability	Tendency to be unstable when standing upright	Yes	[17,21,42,44,59]
Secondary motor symptoms	Freezing of gait	Hesitating before stepping and exaggerated first step	Yes	[17,21,44]
	Micrographia	Shrinkage in handwriting	Yes	[17,44]
	Mask-like expression	Decreased unconscious facial movements	No	
	Akathisia	Unwanted accelerations	No	
	Falls	Falling due to instability	Yes	[35]
	Speech problem	Drooling and excess saliva	Yes	[17,21,44,47]
Non-motor symptoms	Cognitive disorders	Delusion, hallucination, depression, anxiety, apathy and irritability,	Yes	[21,36,37,47]
		Difficulty remembering events	Yes	[36,44]
	Poor vision	Sight problem	No	
	Autonomic dysfunction	Cardiovascular disorders	Yes	[21,39]
	Obesity or weight loss	Excessive weight gain or weight loss	No	
	Pulmonary problems	Reduced vital capacity	Yes	[38]
	Sexual dysfunction	Low libido	No	
	Mood disorder	Persistent low mood	Yes	[42]
	Sweating	Excessive night sweating	No	
	Gastrointestinal disorders	Indigestion and abdominal pain	Yes	[40]

For more information see http://www.pdf.org/en/symptoms.

Nigerian PD patients [39,40,43,47].

6. Biochemical and pathological findings in Nigerian PD patients

Findings from biochemical and pathological studies can provide clues to disease mechanisms. Only three biochemical or pathological studies were identified in our search. One study compared the melanized nigral neuronal count between neurologically normal Nigerians (n = 23) and normal British (n = 7) individuals as this has been postulated to have a link to PD [48]. The results of the study showed no significant differences in the number of melanized neurons between the two groups [48]. Another group studied brains (n = 94) of neurologically normal Nigerians and found Lewy bodies in four male individuals [49], suggesting that incidental Lewy body disease is at least as frequent in Nigeria as in industrialized nations. Furthermore, a study investigating the level of homocysteine in plasma samples of 40 Nigerian PD patients and 40 age- and sex-matched healthy controls identified increased levels of homocysteine in nine (22.5%) patients known to be on long-term regimen of levodopa [50]. This corroborates the hypothesis that homocysteine levels are significantly increased in levodopa-treated PD patients compared to controls. Also, elevated levels of homocysteine are an emerging risk factor for neurological disorders such as stroke, dementia and Alzheimer's disease [51]. It is possible that further studies on biochemical and pathological findings in Nigerian PD patients could provide unique insights into differences in disease mechanisms between Africans and non-Africans.

7. Environmental risk factors for PD in Nigeria

Regional variation in the incidence of a disease could suggest that there are environmental risk factors contributing to the disease and that long-term exposure to these agents may accelerate the disease process. For example, the use of pesticides that inhibit mitochondrial functions has been associated with PD in the USA [52]. Some early reports showed five times higher prevalence of PD in the USA than in Nigeria, and suggested that environmental risk factors could account for this difference in prevalence [18]. Furthermore, in Nigerian studies, prevalence of PD varied from one environment (region) to another (Table 1). Although these discrepancies may be due to methodological differences between the studies, it is worthwhile to investigate whether dietary and lifestyle factors such as neurotoxins in certain diets may account for regional variations in the prevalence of PD. One such example is the possible link identified in Guam and New Caledonia between an atypical Parkinsonism phenotype and *Annonaceae's* consumption [53].

Our literature search identified two studies carried out in Nigeria investigating the role of environmental risk factors for PD. In a multicenter case-control study, trace metals identified in well-water were associated with PD [54]. Also, xenobiotics thought to be associated with PD were studied in Nigerian PD patients but their use was not associated with the disorder [55]. In one study, blacksmithing, which is a common occupation in Nigeria, mostly among the people from the Northern part of the country (e.g. Kano state), was found to be associated with PD [56,57]. As well-water is one of the main sources of water supply in Nigeria, it is plausible that environmental factors such as trace metal contamination in well-water as well as blacksmithing may contribute to development of PD but further studies are needed to confirm this.

Nigeria is perceived as a homogeneous group of people. It should be noted, however, that each region in the country has different tribes that make the country quite diverse in terms of culture, language and ancestral origin (Supplementary Fig. S1). Also, other factors such as vegetation, climate, topography, lifestyle, diets and the socioeconomic factors differ extensively across different regions of the country; all of these could contribute to the prevalence of PD. For example, people living in South-Western Nigeria are more likely to be exposed to industrial-derived toxins, whereas people living in the oil-rich Southern region could be more exposed to toxic chemicals and aquatic foods contaminations due to oil-spillages.

8. Genetic studies on PD in Nigeria

Approximately 5–10% of PD patients have a monogenic form of PD, which is due to highly penetrant, rare pathogenic mutations [58]. The

Table 3
Genetic studies conducted on Nigerian PD patients.

Gene analyzed	Number of patients	Number of controls	Method	Findings	Reference
Parkin (*PRKN*)	57	51	Sanger sequencing of all exons and exon/intron boundaries	No pathogenic mutations found	[59]
Ataxin 3 (*ATXN3*)	57	51	Screen for repeat expansions	No pathogenic mutations found	[59]
Leucine-rich repeat kinase (*LRRK2*)	57	51	Sanger sequencing of exons 31 and 41	No pathogenic mutations found	[59]

genetics of PD is complex as common genetic variants may act in concert with environmental factors. Genome-wide association studies have identified 26 PD risk loci [58], but none of these loci have been studied in Nigerian PD patients. Familial PD cases in Nigeria have been mentioned (Table 1), but to date no genetic causes have been identified in these patients. Currently, only one genetic study on Nigerian PD patients has been published [59] (Table 3). The study analyzed mutations in *LRRK2*, *PRKN* and *ATXN3* in 57 Nigerian PD patients who showed cardinal signs of PD such as tremor, rigidity, bradykinesia and gait abnormality, of which nine patients presented with at least one first-degree relative with a history of tremors. No pathogenic mutations in the genes commonly known to cause PD in European, North American or North African populations were found [59]. Interestingly, the study identified two heterozygous variants (p.A46T and p.R334H in *PRKN*) of unknown pathogenicity in two PD patients from different ethnic groups in Nigeria [59]. Notably, the fact that nine of the PD cases presented with a first-degree relative with a history of tremor, indicates that an autosomal dominant mode of inheritance is possible in these families. The study did not rule out the possibility of mutations in any of the known autosomal dominant PD genes such as *SNCA* and *GBA*.

In another study, Tucci et al. [60] screened 26 Yoruba (Nigerian) individuals from the Human Genome Diversity Cell Line panel to estimate the frequency and diversity of coding variants in the *EIF4G1* gene [60]. No pathogenic mutations were identified.

The limitations of these genetic studies are the small sample sizes and the fact that only a few PD genes were screened. In conclusion, further genetic studies on the Nigerian population are warranted since the frequency of certain pathogenic mutations have been shown to differ widely between different population groups. For example, the frequency of the p.G2019S substitution in *LRRK2* varies from approximately 40% in North African Arabs, to roughly 28% in Ashkenazi Jews and to only 3% in Caucasian populations from southern Europe [61]. To date, no Black PD patient has been found to harbor p.G2019S [15,62] further providing support for the striking differences observed in the genetic etiology between various ethnicities.

9. Implications and recommendations

It is important that PD patients are diagnosed early and accurately as epidemiological studies and other clinical studies on PD in Nigeria are dependent on this. Primary care physicians play an important role in this regard. There are a number of differential diagnoses including essential tremor, vascular Parkinsonism, normal pressure hydrocephalous, brain tumors, multiple system atrophy, supranuclear palsy, and Huntington's disease, and an initial brain computed tomography (CT) scan should be performed to exclude the major causes of secondary Parkinsonism. If the history obtained however suggests rarer causes, where possible, appropriate biochemical or genetic tests should be requested. Also, in a SSA setting the management of PD should have a multidisciplinary approach as well as integration into the primary health care systems of each country. The team members could include neurologists, nurses, physiotherapists, occupational therapists, speech therapists, neuroscientists, neuropathologists, neuro-geneticists, social workers as well as community health workers. Furthermore, strategies and support services e.g. telemedicine, where patients can be diagnosed and treated remotely via telecommunication technology, should be established to facilitate diagnosis of patients in rural settings. In addition, educational courses focused on non-specialist physicians, nurses and community health officers on the diagnosis and management of neurodegenerative disorders, should be provided as well as country-wide PD awareness campaigns to educate the general public about PD. This may help to alleviate issues of stigmatization, victimization or abandonment experienced by PD patients and their families within their communities. It is also critical to investigate family history of the disorder in PD patients. A positive family history and a young age-at-onset (below 40 years) are both strong indicators of a genetic

component underlying the disease in an individual.

Treatment for PD needs to be more accessible and affordable to Nigerian patients. It would be important to conduct surveys on the availability and affordability of anti-parkinsonian medications in SSA countries, similar to the study conducted in Kenya [14]. Anti-parkinsonian drugs should be available and covered under the National Health Insurance Scheme, and the Federal Ministry of Health, policy makers, and politicians need to take action and remove the barriers and obstacles that limit broader availability of these drugs. In 2012, The International Parkinson and Movement Disorder Society established a Task Force on Africa, and its main mission is assisting with diagnosis of PD in Africa, together with ensuring affordable and sustainable treatment.

(http://www.movementdisorders.org/MDS/Regional-Sections/Task-Force-on-Africa.htm).

Additional studies on the prevalence of PD are needed to determine the extent of the problem in Nigeria. Problems with the existing prevalence studies include the fact that there were only two door-to-door studies (regarded as the most accurate method for determining prevalence), and that most studies were hospital-based. Since not every individual is taken to a hospital for diagnosis, the true prevalence of PD in the country cannot be ascertained. Worldwide trends indicate rapidly growing numbers of PD cases [63] and it is anticipated that this is also true for Nigeria but more studies are required to confirm this. More studies are also needed on the genetic causes of PD in Nigeria since this population is likely to harbor novel mutations. It is possible that future treatments might be based on the genetic etiology identified in overseas populations, which may not be transferable to Nigerian populations. Furthermore, more studies on clinical manifestations of PD in Nigerian PD patients are required, since this might identify clinical symptoms unique to this population. Also, neuroimaging using at least CT, and if available magnetic resonance imaging, can often help in differential diagnosis to exclude other causes of Parkinsonism [64].

The limitations of this review include restricting the search to only English articles. It is also possible that even though our search was performed using seven different search engines, some relevant articles were missed because they did not contain the key words used here.

10. Conclusions

This review summarizes all the published human studies on PD in Nigeria. It can be concluded that, although 44 studies have been published since 1969, much more research is still needed. Also, the comparability of the existing studies is limited, due to differences in study designs. There was little information on neuroimaging to aid differential diagnosis of PD and there were very few genetic studies on PD in Nigeria. It should be noted that Nigeria comprises many different ethnic groups and geographic regions, and this should be taken into account when analyzing epidemiological, genetic, biochemical and pathological findings on PD.

We believe that primary care physicians have an important role in the timeous diagnosis of patients. They need to be aware of prodromal PD and its symptoms, including depression, constipation, hyposmia, and sleep disturbances, which could occur 10–20 years prior to the typical PD signs, as well as non-motor features. Similarly, they need to document the family history, other concomitant diseases, occupational records and history of exposure to environmental hazards for patients as this information may strengthen future etiological studies and the management of PD in Nigeria.

Conflicts of interest

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this review.

Authors' contributions

OGO carried out literature searches, appraised the articles, summarized results, prepared the tables and figures, and wrote the first draft of the manuscript; HK carried out literature searches, reviewed the articles and edited the manuscript; SB and MAK conceptualized the idea for the research, obtained funding, supervised the project and wrote sections of the manuscript; JC, MOO and OR provided clinical expertise, critically reviewed and edited the manuscript. All authors approved the final version of the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.parkreldis.2018.12.004.

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