Acta Scientific Neurology (ISSN: 2582-1121)

Volume 3 Issue 10 October 2020

Review Article

Publication Pattern of Clinical Parkinson's Disease Research in Saudi Arabia

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Received: August 19, 2020

Published: September 26, 2020

Abstract

Objective: To assess the progress in the field clinical Parkinson's disease (PD) in kingdom of Saudi Arabia (KSA), by analyzing in depth the research output productivity and publication pattern, and to identify the current situation of PD research and offer solutions.

Method: Literature search strategy was designed to retrieve accessible articles that are related to PD utilizing PubMed, Google Scholar, and Embase. The retrieved articles were analyzed with several parameters including "journal name, impact factor, year of publication, the affiliation of the first author, city, study design, population, citation numbers, study title and database".

Results: Of all identified articles, 41 were conducted in KSA and therefore were included. The included articles had a frequency of only 0.52% publications from 1992-2011, and growth of 75.6% between the periods of 2012-2020. Only 5% of the articles were related to surgical options to treatment of PD but the majority (95%) were related to medical treatment of PD. The most common study design was retrospective studies in 27.27%.

Conclusion: Pattern of publications in PD researches revealed a slow growth rate in the frequency and a lower significance in the quality throughout the past 28 years. Active institutional and national promotion of clinical research is needed to help assess and therefore improve the quality of the provided PD services.

Keywords: Parkinson's Disease; Parkinsonism; Levodopa; Movement Disorders; Neurodegenerative; Bradykinesia

Introduction

Parkinson's disease (PD) affects nearly 1.5 million Americans, and is a chronic, progressive syndrome in which neurons that contain dopamine become damaged over time. PD affects the central nervous system in elderly people and it is a neurological disorder. This is related to lose in the substantia nigra and other brain structures. According to the National Parkinson Foundation [1], it is estimated that 1% of elderly are diagnosed with this disease worldwide; in the Middle East, it has been reported that approximately three in one thousand people have PD [2]. This process causes symptoms of movement slowness, tremor, rigidity and imbalance. Although dopamine drug treatment is highly effective in the treatment of many motor symptoms, doses can become limited due to adverse side effects and certain symptoms such as gait freezing seem resistant to treatment [3]. In recent years, increasing attention has focused on non-motor symptoms associated with PD such as depression, apathy, sleep dysfunction, and cognitive impairment [4]. The reported rates of depression for PD patients are quite

high and range from 40% to more than 70% [1]. It is also not uncommon for PD patients with depression to be resistant to pharmacologic treatment. However, clinicians diagnose PD based on medical history and neurological examination conducted by interview and clinical observation. Progress in the age is the greatest risk factor for Parkinson's disease, but environmental factors are also responsible for the progression of PD. Environmental factors such as caffeine, pesticide exposure and smoking are responsible for inducing risk in PD [5]. Genetic contribution to Parkinson disease exist across range, extending from highly penetrant to DNA that has small increase in risk factor of Parkinson's disease [5]. Neuropathologically, PD is described by the presence of α-synuclein-containing Lewy bodies in the brain (substantia nigra). Loss of dopaminergic neurons leads to reduce facilitation of voluntary movements. Over last 20 years non-motors symptoms in the Parkinson's disease have taken considerable attention [6]. According to the diagnosis of PD, in early stages it remains quite inadequate while all the other signs emerge in the later stage of the disease. Certain difficulties arise during the diagnostics procedure for the symptoms of Parkinson's Disease (PD), by mixing the evidence of mix pathology [7]. Recently Parkinson's Disease have been identified with next generation sequencing, such as genome sequencing and exome. For the states of Parkinson's disease genetic state, the term monogenic is useful for oversimplification. The presence of the PD is likely to be affected by factors, such as genetic factors and non genetic factors. The study suggest in some cases of highly penetrants variants, the disease will not be obvious while those with the disease, their clinical manifestation and the age of onset, progression will differ among those with the same variants and within families. The study also concluded that other factors such as environmental factors and additional genetic factor can affect the process of the disease. However, the applicability of the genes responsible for the PD is highly debated but functional studies have not been done for further efforts to quantify the pathogenicity of variants and designated pathogenic genes [5]. According to study for past 20 years the genome base study for Parkinson's susceptibility has been performed, in which 800 genomic association has been shown. However, early gene study and meta-analyses have provided conclusive evidence showing that polymorphism in SNCA (encoding alpha-synuclein), MAPT (Microtubule associated protein tau), LRRK2 (leucine-rich repeat kinase) and GBA (acid beta glucosidase) expressively show an impact on PD [8]. Throughout the last few years, an additional Genome wide association (GWAS) studies has postulated a new loci. While early GWAS meta-analyses has shown inconsistent results, as recent studies identified a number of loci that are independently confirmed in a recent studies [8].

There are factors responsible for the cause of factors such as exogenous factors. In exogenous factors, regional differences and medication for PD add further for the heterogeneity of Parkinson's disease globally. For the treatment of PD and other neurodegenerative diseases it is important to prioritize research and public health [10]. It is generally estimated that the prevalence of the disease range from 1 - 2 per 1000 in the population unselected. This shows that the disease effect 1% of the population above the age of 60. PD is more common in those above 50 years and reaches the prevalence of 4% in the highest age groups [6].

Individual with PD have instability and gait disturbance which may lead to fall. This fear of falling causes the patient to avoid daily physical activities and increased mortality. Poor motor performance is typically associated with depression and anxiety which is associated with psychiatric problems in the Parkinson's disease. According to the study Gait was once considered as automatic physical activity but alternative theories have proven that cognition play an important role in gait especially when patients are engaged, such as executive function and attention. On older adults, few studies suggested that dual task training improved balance. This training included cognitive aspects and physical training [11].

The Arab countries constitutes to cover a large geographical area which is stretching over two continents, Asia and Africa. The population of Arabs are comprised of large family units demographically. They have high birth rates and consanguineous marriages which makes a genetic disease a common health issue. As living standards have been improved especially on oil-based economies. There is expected to increase the incidence of PD and survival. In this study medical service planning for PD was facilitated and the increase knowledge of PD in the population [12].

Methods

This study was carried out between February - April 2020 at King Fahad Specialist Hospital, Dammam, Kingdom of Saudi Arabia. A search strategy was designed to retrieve all articles that are related to either medical or surgical treatment for PD. Databases were accessed and the following phrases were utilized: "Search term" Parkinson's disease "Studi Arabia". Time interval was restricted to 1/1/1992-31/12/2020. Each article was identified by abstract screening, then inclusion criteria was applied, followed by accessing the full-text to retrieved more data.

Inclusion/exclusion criteria

Articles in PD published between January 1992 and December 2020 in English were included. Moreover, only publications with a first author affiliated with a KSA institution, and a population studied based on KSA institution were included. The published article should have a full text available and accessible for further analysis. All Publications published before January 1992, related to the basic neuroscience aspects of PD, study population based in a geographical area outside KSA, and articles with no available full text were excluded.

Information sources

Systemic search was carried out to retrieve each relevant article using both PubMed, Google Scholar, and Embase, by using search terms developed by the research team and related to PD (Table 1). Articles were reviewed by 2 independent reviewers.

	1992-2020
General Information	
Documents	40
Sources (Journals, Books, etc.)	34
Author's Keywords	77
Average citations per documents	17.53
Authors	
Authors	207
Author Appearances	229
Authors of single-authored documents	5
Authors of multi-authored documents	202
Single-authored documents	5
Authors-Documents	
Documents per Author	0.193
Authors per Document	5.17
Co-Authors per Documents	5.72
Collaboration Index	5.77

Table 1: Summary of descriptive bibliometric analysis.

Study selection process

After the review process, several parameters were collected from each article such as journal name, impact factor, year of publication, the affiliation of the first author, city, study design, population, citation numbers, study title, database, and corresponding sector. Those parameters were collected in Microsoft Excel spreadsheet. Search terms used in the acquisition of the data of this study.

Statistical analysis

(Microsoft Excel) Microsoft, Redmond, Washington, DC, USA was used for statistical analysis. Measures of central tendency such as mean and median were used for most parameters, along with parentage. A $p < 0.05$ and confidence interval of 95% were considered statistically significant.

Biblomateric analysis

The 41 articles were acquired from different databases and to perform the bibliometric analysis, we used bibliometrix tool by Aria and Cuccurullo. Bibliometrix is an open-source tool and coded in R Language. The tool is flexible and can be rapidly upgraded and integrated with other statistical R-packages. It is therefore useful in a constantly changing science such as bibliometrics. The bibliometric analysis by Bibliometrix required metadata extraction from well-known bibliographic databases such as SCOPUS, Clarivate Analytics Web of Science, Cochrane Database of Systematic Reviews (CDSR) and RISmed PubMed/MedLine. Apart from those databases, the available metadata extraction is limited. Therefore, among 41 articles, there are 40 articles which are coming from Clarivate Analytics Web of Science and can be analyzed by bibliometrix as shown in table 2.

Sources	Articles
Parkinsons Disease	3
Saudi Medical Journal	3
European Neurology	2
Movement Disorders	2
2018 11th international conference on developments in esystems engineering (dese 2018)	1
American Journal of Human Genetics	1
Annals of Saudi Medicine	1
Archives of Neurology	1
BMC Research Notes	1
Brain	1
Case Reports in Dentistry	1
CNS and Neurological Disorders-Drug Targets	1
CNS Neuroscience and Therapeutics	1
Current Drug Metabolism	1
Frontiers in Aging Neuroscience	1
IEEE access	1
Indian Journal of Experimental Biology	1
International Journal of Health Sciences-IJHS	1
Journal of Family Medicine and Primary Care	1
Journal of Infection and Public Health	1

Table 2: Source of articles.

Result and Discussion

Out of 104 articles identified in our literature search, only 41 met the eligibility criteria of this study. The rest of screened studies were excluded due to the failure to meet the pre-set inclusion criteria (Table 1). The degree of agreement between the 2 reviewers was very good. KSA institutions produced 41 clinical articles over the period of 28 years, with a frequency of 0.5 publications per year, and growth of 75.6% between 1992 - 2011 and 2012-2020. The (5%) of the articles were related to surgical options for PD, (95%) were related to medical PD.

The most common study design was meta analysis studies with 12 (27.27%), then prospective, cross-section reports; 5 articles each, and comprising (11.3%) Cohort studies and controlled studies were 4 articles each (9%), systemic study and case report were 3 articles each (6.81%) of all publications output was from Riyadh 22 (50%), followed by Jeddah 7 (15.9%), Baha with 2 articles (4.54%) and the remainder of 13 (29.54%) from 8 different cities.

Table 3 represent the top 10 KSA institutions and their contribution to PD literature. The King Faisal Specialist Hospital and Research Centre became the leader with 16 articles followed by King Abdulaziz University with 12 articles, and King Saud University with 6 articles in this field (Table 3).

Sources	Articles
Movement disord	88
Neurology	71
Ann neurol	37
J pineal res	34
Parkinsonism relat d	31
J neurochem	26
Plos one	25
Science	25
Brain	24
Arch neurol chicago	23
J neurol neurosur ps	23
J neurosci	22
P natl acad sci usa	22
New engl j med	21
J biol chem	20
Nature	19
Nat genet	18
Lancet neurol	17
Am j hum genet	16
Neurosci lett	16

Table 3: Most Local Cited Sources (from Reference Lists).

In regard sectors, the majority of the articles produced by academic institutions 22 (50%), governmental institutions 10 (22.7%), and military institutions 3 (6.81%). The International collaboration was present only in 12 (27.27%) of articles, whereas there was no international collaboration in 32 (72.7%) of articles.

Table 4 showed the top 10 journals with their respective number of publications.

Affiliations	Articles
King faisal specialist hosp and res ctr	13
King abdulaziz univ	12
King saud univ	6
Suez canal univ	5
Univ otago	5
Univ toronto	5
Umea univ	4
Univ tabuk	4
King faisal specialist hospital and research center	3
Natl neurosci inst	3

Table 4: Top 10 institutions.

In the authors and authors-documents section, it is clear that the number of authors and their collaboration are quite much. The authors of multi-authored documents also growing. On the other hand, the number of single authored document and single-authored documents is almost stagnant. It indicates that the collaborative work is preferred than individual work, strengthened by collaboration index, but still limited to approximately five authors per document. The distribution of articles was spread evenly among the sources and 2 journals were containing 3 articles from this collection (Table 2). It is reasonable since the search of articles was restricted to the study in Saudi Arabia, but the sources of journal are varied such as from Europe, America and India.

Table 5 shows the sources that get the most citations from other articles in our collection which means among the 40 articles, these journals got the citations referred to each journal reference section. Journals title of "Movement Disorders" and "Neurology" got 88 and 71 citations, respectively which are the top 2 influential journals. Rest of the sources have a slightly difference in citations they received.

Earlier studies still seems to be cited more as shown in table 5. From the list, the first five was not coming from the most cited sources/journals. The most cited article with 255 citations, "Unilateral Pedunculopontine Stimulation Improves Falls in Parkinson's Disease" seems going to get more citations since its Total Citation per year is good even the article was from 2010.

Paper	Total Citations	TC per Year
MORO E, 2010, BRAIN	255	23.182
PARNETTI L, 2014, FRONT AGING NEUROSCI	67	9.571
JONES AC, 1998, AM J HUM GENET	50	2.174
TABREZ S, 2012, CNS NEUROL DISORD-DR	47	5.222
JABIR NR, 2015, CNS NEUROSCI THER	26	4.333
MUSHTAQ G, 2016, MED CHEM	23	4.6
BENAMER HTS, 2008, MOVEMENT DISORD	21	1.615
ALGHAMDI BS, 2018, J NEUROSCI RES	18	6
SOURSOU G, 2015, CURR DRUG METAB	18	3
BOHLEGA SA, 2013, NEUROSCIENCES	14	1.75
CHISHTI MA, 2006, ARCH NEUROL-CHICAGO	13	0.867
ALHUSSEIN M, 2017, IEEE ACCESS	12	3
AL-MUBARAK BR, 2015, PLOS ONE	12	2
AL-AMRI JS, 2013, INDIAN J EXP BIOL	12	1.5
LUNDGREN S, 2011, PARKINSONS DIS-US	11	1.1
ALZAHRANI H, 2016, J PARKINSON DIS	10	2
BOHLEGA S, 2015, EUR NEUROL	9	1.5
AL-BUNYAN MA, 2000, SAUDI MED J	8	0.381
ZAITONE SA, 2019, PHARMACOL REP	8	4
ALAMRI Y, 2015, EUR NEUROL	7	1.167

Table 5: The most cited documents.

Important concepts of each article is depicted in keywords within the article to make search easy for authors. The constant change of top 10 keywords usage by authors in this field is shown in figure 1 and revealed interesting facts. Began in 1998, the keywords usage kept on fluctuating. "degeneration" is the most used keywords nowadays. Looking to other keywords, "Alzheimer's-disease", "diagnosis", and "central-nervous-system" were following the most used keywords.

Figure 2 shows the co-occurrence network of article titles of our collection. In a network, each node represents an item (such as country, word, author, etc.), the node size is proportional to the item occurrence and the line size is proportional to item co-occurrence. For example, we see the "disease" and "parkinsons" are linked with wide line therefore they were used together frequently in title of an article. This network is useful for future search in the database which some words such as "parkinsonism" and "genetic" are not having any strong linkage with other words. Bibliographic co-citation can be defined as the appearance of two articles in references of an article. The number of common references simply defines the co-citation strength of two articles. Hence, the smaller number of references will lead to weaker bibliographic co-citation level. Figure 3 shows an example of author's co-citation network of our collection. The node size shows the number of cited articles for the corresponding author. It indicates that "olanow cw", "spillantini mg", and "shapira ahv" are three authors who got the most citation. In other hand, "zheng b" and "moretti r" are cited but had no link with other authors or their co-citation level is low.

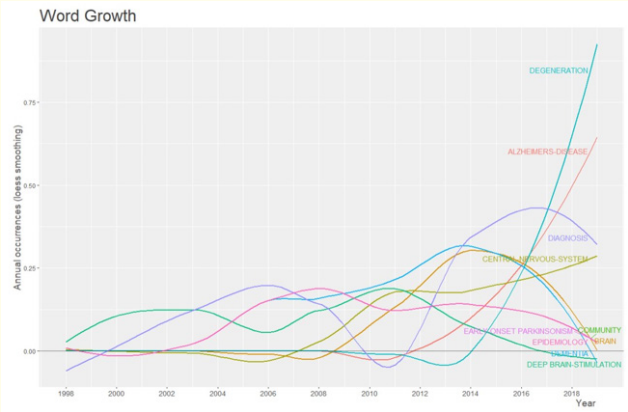

Figure 1: Word dynamics of authors' keywords.

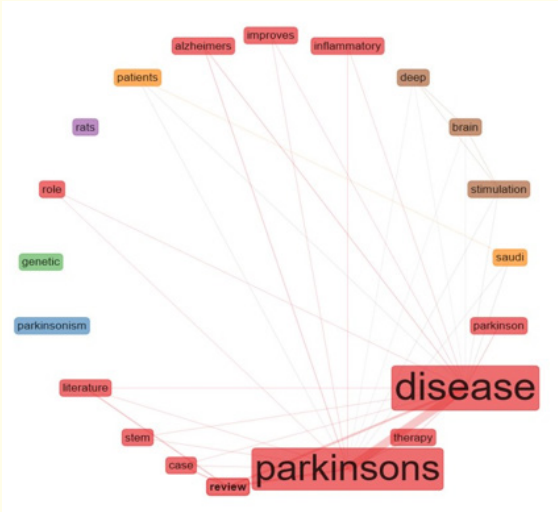

Figure 2: Co-occurrence network of article titles.

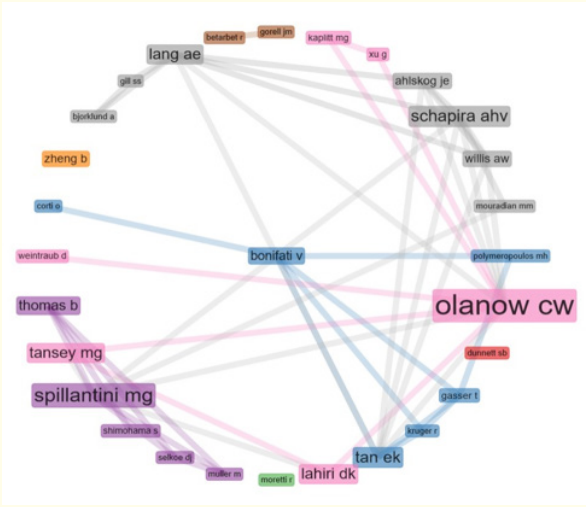

Figure 3: Authors co-citation network.

Figure 4 shows the number of articles published from 1992 - 2020, which indicates that the publication was at peak in the year 2015. Out of 44 publications most publications were from the year 2015 and in between 2020. Our study indicates low number of publication on PD for the knowledge of awareness from the year 1992 - 2015.

Figure 4: Given above graph shows the research articles published from 1992-2020 on Parkinson 's disease.

Conclusion

Our study documented that there is a lack of literature that addresses publications patterns in PD. These studies are the cornerstone of evaluating the advancement of the field of PD. Looking at KSA data across the time of 28 years, we find that 41 clinical articles with frequency of 0.5 publications per year, and growth rate of 75.6% between 1992 - 2011 and 2012 - 2020.

This study has limitations; firstly, the data of this current study did not include other basic sciences types of publications such as animal studies and lab bench studies, as it might of strong study design, good data collection, and solid recommendation that can affect both patient care and publication pattern, regardless of it being of level V-LOE in scales designed only for clinical articles. The factor of bias cannot be eliminated. We conclude from this review that the publications' pattern of clinical PD revealed a slow growth rate in the frequency of research with a lower significance in the quality throughout the past 28 years. The current growth of PD centers in Saudi Arabia and post- training PD fellowship program should encourage and promote a larger scale and higher quality research.

Author Contributions

NA, EN, TH and SB conceived and designed the study. MA, MS and RU conducted data gathering. MA performed statistical analyses. NA, EN, TH and SB wrote the article.

Funding Information

"This research received no specific grant from any funding agency, commercial or not-for-profit sectors".

Conflict of Interest

All authors declare no conflict of interest.

Bibliography

1. Al-Bunyan MA. "Parkinson`s disease. Clinical and electrophysiology evaluation". *Neurosciences (Riyadh)* 5.1 (2000): 46-49.

2. Bohlega S., *et al*. "Levodopa-Carbidopa Intestinal Gel Infusion Therapy in Advanced Parkinson's Disease: Single Middle Eastern Center Experience". *European Neurology* 74 (2015): 227-236.

3. Chishti MA., *et al*. "T313M PINK1 mutation in an extended highly consanguineous Saudi family with early-onset Parkinson disease". *Archives of Neurology* 63.10 (2006): 1483-1485.

4. Al-Omari FA., *et al*. "Oral rehabilitation of Parkinson's disease patient: a review and case report". *Case Reports on Dentistry* (2014): 432475.

5. Dirk Deleu., *et al*. "Current and emerging strategies in the management of Parkinson's disease: a critical reappraisal". *Saudi Medical Journal* 18.2 (1997): 115-126

6. Rana AQ., *et al*. "Association between nocturia and anxiety in Parkinson's disease". *Neurology Research* 37.7 (2015): 563-567.

7. El-Sadik AO. "Potential sources of stem cells as a regenerative therapy for Parkinson's disease". *Stem Cells Cloning* 3 (2010): 183-191.

8. Riyazuddin Shamsul Haq Ansari and Hany Murtada Al Hasan. "Parkinson's Disease with Sigmoid Volvulus". *International Journal of Case Reports in Medicine* (2013).

9. H Alaskar and A Hussain. "Prediction of Parkinson Disease Using Gait Signals". 11th International Conference on Developments in eSystems Engineering (DeSE), Cambridge, United Kingdom (2018): 23-26.

10. Awada A., *et al*. "Outpatient neurological practice in Saudi Arabia and its implications for education in neurology". *Annals of Saudi Medicine* 12.5 (1992): 503-505.

11. M Alhussein. "Monitoring Parkinson's Disease in Smart Cities". in IEEE Access 5 (2017): 19835-19841

12. Jones AC., *et al*. "Autosomal recessive juvenile parkinsonism maps to 6q25.2-q27 in four ethnic groups: detailed genetic mapping of the linked region". *American Journal of Human Genetics* 63.1 (1998): 80-87.

13. Al-Tawfiq JA., *et al*. "Sterile cyst formation after intrathecal stem cell transplant for Parkinson's disease: A case presentation and literature review". *Journal of Infection and Public Health* 8.4 (2015): 382-385.

14. Bohlega SA and Al-Foghom NB. "Drug-induced Parkinson`s disease. A clinical review". *Neurosciences (Riyadh)* 18.3 (2013): 215-221.

15. Yemni EA., *et al*. "Integrated Analysis of Whole Exome Sequencing and Copy Number Evaluation in Parkinson's Disease". *Scientific Report* 9.1 (2019): 3344.

16. Alamri Y., *et al*. "Parkinson's Disease in the Gulf Countries: An Updated Review". *European Neurology* 74 (2015): 222-225.

17. Fouly RT., *et al*. "Knowledge of Saudi Population about Parkinson Disease". *International Journal of Innovative Research in Medical Science* 5.1 (2020): 49-51.

18. Abdulrahman Muallith Alsuhaymi. "Compliance among parkinsonism in al-madinah region" (2020).

19. Alamri Y., *et al*. "Anxiety and depression in Parkinson's disease patients in Saudi Arabia Global neurology". *Journal of the Neurological Sciences* 358 (2015): 457-458.

20. AlSwaiti FY., *et al*. "The Parkinson's Disease and Movement Disorders Program at King Fahad Medical City" (2015).

21. Alzahrani H., *et al*. "Apathy in Mild Parkinson's Disease: Neuropsychological and Neuroimaging Evidence". *Journal of Parkinson's Disease* 6.4 (2016): 821-832.

22. Al-Mubarak BR., *et al*. "Parkinson's Disease in Saudi Patients: A Genetic Study". *PLoS One* 10.8 (2015): e0135950.

23. Bohlega SA., *et al*. "Clinical heterogeneity of PLA2G6-related Parkinsonism: analysis of two Saudi families". *BMC Research Notes* 9 (2016): 295.

24. Jabir NR., *et al*. "Synopsis on the linkage of Alzheimer's and Parkinson's disease with chronic diseases". *CNS Neuroscience and Therapeutics* 21.1 (2015): 1-7.

25. Ansari SA., *et al*. "Current surgical treatment of Parkinson's disease". *Saudi Medical Journal* 23.11 (2002): 1319-1323.

26. Ahmed MR., *et al*. "Neuroprotective role of chrysin in attenuating loss of dopaminergic neurons and improving motor, learning and memory functions in rats". *International Journal of Health Sciences (Qassim)* 12.3 (2018): 35-43.

27. Perumal V., *et al*. "Instruction prioritization in task-based balance training for individuals with idiopathic Parkinson's disease". *Somatosensory Research* 34.1 (2017): 27-33.

28. Alyamani AM., *et al*. "Public knowledge and awareness about Parkinson's disease in Saudi Arabia". *Journal of Family Medicine and Primary Care* 7.6 (2018): 1216-1221.

29. Alghamdi BS. "The neuroprotective role of melatonin in neurological disorders". *Journal of Neuroscience Research* 96.7 (2018): 1136-1149.

30. Khalil H and Bajwa JA. "Barriers and Facilitators in Physical Rehabilitation for Parkinson's Disease in the Arabian World". *Movement Disorders Clinical Practice* 2.3 (2015): 227-229.

31. Orayj K and Lane E. "Patterns and Determinants of Prescribing for Parkinson's Disease: A Systematic Literature Review". *Parkinsons Disease* (2019): 9237181.

32. Khalil H., *et al*. "Parkinson's disease in the MENASA countries". *Lancet Neurology* 19.4 (2020): 293-294.

33. Benamer HT., *et al*. "Parkinson's disease in Arabs: a systematic review". *Movement Disorder* 23.9 (2008): 1205-1210.

34. Moro E., *et al*. "Unilateral pedunculopontine stimulation improves falls in Parkinson's disease". *Brain* 133 (2010): 215-224.

35. Mushtaq G., *et al*. "miRNAs as Circulating Biomarkers for Alzheimer's Disease and Parkinson's Disease". *Medicinal Chemistry* 12.3 (2016): 217-225.

36. Parnetti L., *et al*. "Differential role of CSF alpha-synuclein species, tau, and Aβ42 in Parkinson's Disease". *Frontiers in Aging Neuroscience* 6 (2014): 53.

37. Tabrez S., *et al*. "A synopsis on the role of tyrosine hydroxylase in Parkinson's disease". *CNS and Neurological Disorders - Drug Targets* 11.4 (2012): 395-409.

38. Karlsson F., *et al*. "Deep brain stimulation of caudal zona incerta and subthalamic nucleus in patients with Parkinson's disease: effects on diadochokinetic rate". *Parkinsons Disease* (2011): 605607.

39. Soursou G., *et al*. "Applications of Nanotechnology in Diagnostics and Therapeutics of Alzheimer's and Parkinson's Disease". *Current Drug Metabolism* 16.8 (2015): 705-712.

40. Al-Amri JS., *et al*. "Effect of epigallocatechin-3-gallate on inflammatory mediators release in LPS-induced Parkinson's disease in rats". *Indian Journal of Experimental Biology* 51.5 (2013): 357-362.

41. Zaitone SA., *et al*. "Caffeic acid improves locomotor activity and lessens inflammatory burden in a mouse model of rotenone-induced nigral neurodegeneration: Relevance to Parkinson's disease therapy". *Pharmacological Reports* 71.1 (2019): 32-41.