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SYSTEMATIC REVIEW

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Exploring Parkinson's disease prevalence in regional, rural and remote Australia: A systematic scoping review

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Abstract

Introduction: Idiopathic Parkinson's disease (PD) is the second most prevalent neurodegenerative disorder worldwide. Due to ageing populations, prevalence estimates for PD are set to increase in western countries including Australia.

Objective: This study aims to investigate the prevalence of PD in regional, rural and remote areas of Australia, to inform the provision of equitable PD-specific care.

Design: A scoping review, following the Joanna Briggs Institute methodology for scoping reviews and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR), was conducted. An electronic search of four databases and the search engine google scholar was completed in May 2022 and updated in September 2023. Article screening and quality appraisal were undertaken independently by at least two reviewers.

Findings: Of 514 records screened, six articles (between 1966 and 2019) were identified and included for review. Wide variations in PD prevalence were evident, ranging from 0.58 to 8.5 per 1000 people. Two studies suggested

prevalence may be higher in regional, rural and remote areas of Australia than in urban localities.

Discussion: The limited number of studies identified, and wide variation in prevalence rates makes it difficult to draw firm conclusions to inform heath care planning and resource allocation.

Conclusion: A paucity of reliable prevalence data indicates the need for well-designed, country-specific epidemiological studies to be conducted to estimate the actual impacts of the disease to inform public health planning, particularly in regional, rural and remote areas where access to PD-specific care is already inequitable.

KEYWORDS

epidemiology, Parkinson's disease, prevalence, regional, rural and remote healthcare, scoping review

1 | INTRODUCTION

Idiopathic Parkinson's disease (PD) is the fastest-growing neurological disorder and second most prevalent neurodegenerative disorder worldwide after Alzheimer's disease.[1] Affecting between 1% and 3% of people in populations aged over 60 years, advancing age is the strongest disease risk factor reported globally.[2–4] Once thought to be a disease affecting motor function only, it is now understood that PD is a whole-body neurodegenerative disorder of the central and peripheral nervous systems characterised by both non-motor and motor symptoms.[4–6] These symptoms are often synonymous with the ageing process complicating diagnosis, disease awareness and the initiation of treatment and support strategies.[4–6]

In general, PD is diagnosed late in the disease process, when motor symptoms become evident.[4–6] The onset of motor symptoms such as bradykinesia (slowness of movement), tremor, rigidity, loss of postural control and gait impairment suggest that the disease has depleted dopaminergic neurons within the mid-brain (substantia nigra) that are responsible for voluntary movement control.[4,5,7] It is thought that by the time motor symptoms are evident between 40% and 70% of dopaminergic neuron loss has occurred through the aggregation of α-synuclein proteins, causing Lewy body formation and eventual dopamine neuron cell death.[2,5]

The overall progression and identification of symptoms particularly during the early stages of PD is poorly understood.[2–5,8] Braak et al.,[9] proposed that a pathogen or environmental toxin of unknown aetiology enters the brain causing α-synuclein proteins to misfold within susceptible neurons. These abnormally folded proteins then aggregate with each other forming Lewy body lesions with pathology beginning in the brain stem, progressing via the olfactory tract, and spreading via vagus nerve pathways towards the mid brain and eventually out towards the cerebral cortex.[4,5,9] This type of spread may not occur for all PD cases; however, the gradual degeneration of susceptible neurons via this pathway has led us to understand that neurodegeneration in PD occurs from a complex interplay between genetic and environmental factors with pathology beginning long before the onset of motor symptoms.[2,4,5,10,11]

What is already known on this subject

- Parkinson's disease is the second most prevalent neurodegenerative disorder globally.
- Ageing populations are driving an increase in Parkinson's disease prevalence, especially in Western countries like Australia.
- The provision of Parkinson's disease specific care is already inequitable within regional, rural and remote areas of Australia.

What this paper adds

- A thorough scoping review identifying Parkinson's disease prevalence in regional, rural and remote areas overtime has been conducted.
- Parkinson's disease prevalence rates vary substantially (0.58 to 8.5 per 1000 individuals).
- There is a need for high-quality epidemiological studies to be conducted particularly to ascertain the geographic diversity of Parkinson's disease prevalence in Australia.

Rather, PD progresses through an early asymptomatic stage, non-motor symptoms becoming evident in the prodromal disease stage, and motor symptoms appearing only later in the evolution of the disease.[5,9–11] Disease symptoms within the prodromal stage are often subtle, affecting autonomic nervous system, sleep, and olfactory functioning.[4,5,10,11] Symptoms include loss of smell, gastrointestinal disturbances (i.e., constipation), rapid eye movement sleep disorder, urinary dysfunction, orthostatic hypotension, and depression.[5,6,10,11] These non-motor symptoms have been suggested to be more debilitating compared to the more overt motor symptoms.[10,11] The problem in PD is that early disease signs are often attributed to normal ageing leading to misdiagnosis of symptoms, until the late motor symptoms are evident.[6] This means that the spread of PD can go undetected for many years before motor symptoms become apparent.[4,5,10,11] As PD progresses and symptoms manifest and worsen, physical and psychological functioning becomes impaired, decreasing personal independence, resulting in varied levels of disability and dependency, and impacting overall quality of life.[4–6]

2 | BACKGROUND

In response to increasing global prevalence and the anticipated overwhelming economic burden presented by PD, the World Health Organisation (WHO) recently published a technical brief[3] calling for urgent public health responses to meet the health, social, and economic needs associated with PD.[3] The identified areas for action include: (1) global health policies to implement strategies focused on PD; (2) prevention and reduction of risks for PD including education and awareness; (3) assured access to treatment and care including access to, and education from an interdisciplinary workforce trained in neurological disorders; (4) delivery of services and the management of PD at various levels of health systems.[3]

In Australia, the 2015 Deloitte Access Economics, "Living with Parkinson's Disease" report, utilised pharmaceutical benefits scheme prescription data to estimate national PD prevalence.[12] According to this report, it is predicted that over 200 000 people currently live with PD, resulting in an estimated economic burden totalling $9.9 billion, representing a 46% increase from 2005.[12] Australian health systems bare the highest economic burden with an estimated $567 million in 2014 (age care 48%, hospitals 23%, pharmaceuticals 15%). As Australia's population continues to age, the economic, societal and quality of life burdens associated with PD are set to escalate. Prevalence estimates suggest a projected increase of 36% by 2024 and 79% by 2034.[12] This presents significant public health challenges, particularly for those who reside outside of city areas where the provision of PD specific care is already inequitable.[3,4,12–15]

The Australian Institute of Health and Welfare's (AIHW) Rural and Remote Health Report,[13] acknowledges that people living outside of city areas face unique challenges due to their geographic location and often have poorer health outcomes than people living in metropolitan settings.[13] In general people living in regional, rural, and remote (RRR) areas of Australia have higher rates of hospitalisations, deaths, injury and have poorer access to, and use of, primary care services, than people living in major cities.[13] Of concern is that these inequities may be worse for people with PD living in RRR areas.[14,15]

Providing holistic specialist care and integrating health systems along a continuum of service in low-resource areas is challenging.[3] The diagnosis and treatment of PD is best facilitated by specialist neurologists, followed by an interdisciplinary care approach involving primary care physicians (PCP), specialist neurological nurses, allied health care professionals, and carers.[3] In Australia the highest concentration of specialist neurologists is within cities meaning significantly less specialists live outside these areas.[8,14] While PCP are well placed to diagnose PD the WHO acknowledge that increased awareness and upskilling is required to avoid delays with diagnosis and avoid misdiagnosis due to age related co-morbidities, particularly during the prodromal phases of the disease.[3] Delays in diagnosis of up to 2 years have been noted within RRR areas of Australia delaying supportive treatment and affecting the quality of life for people living within these settings.[12,16]

Furthermore, according to the AIHW Health Workforce Report,[17] there is a general deficit of allied health professionals within RRR settings compared to urban areas. Amongst the healthcare workforce, nurses appear to be the most abundant within these underserved geographical locations.[17] Additionally, there is increasing evidence that rural living and related occupational practices such as the use of chemicals including insecticides, pesticides, and exposure to heavy metals are probable risk factors of PD however, it is relatively unknown if this is true within RRR Australian populations.[2,3,5,8,14,18,19]

As the prevalence of the PD continues to rise, so will the need for the development of effective strategies, programmes and services tailored to meet the needs of people living with PD, their families and carers. There is an urgent need to generate additional knowledge and evidence to inform policy, planning and programming for PD.[3] Given that the Deloitte report did not consider PD prevalence by geographical variation, scoping the accessible published literature to ascertain PD prevalence within RRR areas is a necessary step required to address challenges and guide PD specific healthcare planning.[20] Therefore, the aim of this study was to undertake a systematic search of the

literature to identify studies that report PD prevalence within RRR areas, provide a narrative synthesis of findings and examine PD prevalence across time as an initial step towards informing PD healthcare planning, working towards ensuring resources are available to cope with the predicted increased burden of disease in RRR areas.

3 | MATERIALS AND METHODS

The study was guided by the Joanna Briggs Institute (JBI) methodology for scoping reviews[21] and strengthened by following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for scoping reviews (PRISMA- ScR) as per the checklist.[22] An a priori eligibility criterion was devised, with consideration given to the broad research question, based on the Population, Concept and Context (PCC) elements.[21]

3.1 | Search strategy

A comprehensive electronic search of four databases and the search engine google scholar was conducted by the lead reviewer (SF) between 25th and 26th May 2022. The search strategy was updated prior to publication on 19th September 2023, with results from both searches displayed in File S1. Databases searched included: Medline, Emcare, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus. The following keyword search terms and Boolean operators were used in the search strategy: Parkinson's disease AND Prevalence AND Australia AND Rural OR Regional, OR Remote. Keywords were mapped to database subject headings where possible. All database search strategies were limited to English language and human studies for pragmatic reasons. No date limits were applied. The search results from all databases were imported into EndnoteX9.2 reference management software for removal of duplicate records and screening.

3.2 | Study selection

During initial screening, publication titles and abstracts were independently screened (blinded screening) by two reviewers (SF and PM) using a coding scheme according to the inclusion and exclusion criteria outlined in Table 1. All articles not meeting the eligibility criteria were screened out in hierarchical order of (i) not a population (NP), (ii) not a concept (NC) and (iii) not the context (Nc). Endnote libraries were then compared between reviewers with consensus achieved on all articles retrieved for inclusion. The reference lists of included studies were also hand searched to detect any relevant articles not identified by the primary electronic search strategy.

3.3 | Quality appraisal

Two authors (SF and PL) independently appraised all full text articles meeting the inclusion criteria. Although not a necessary step in scoping review methodology the reviewers thought this would assist in identifying the strengths and limitations of included studies. Given the heterogeneous nature of articles included within scoping reviews the quality appraisal tool developed by Hawker et al.[23] was chosen for its ability to appraise a wide variety of research methods. No articles were excluded from the review based on quality appraisal.

TABLE 1 Inclusion/Exclusion criteria (a priori).

Inclusion criteria	Exclusion criteria
Population	
People with Parkinson's disease	All other disease states and diagnosis People without Parkinson's disease
Concept	
Articles that report on the "prevalence" or "epidemiology" of Parkinson's disease	Articles not discussing or investigating prevalence of Parkinson's disease
Context	
Articles reporting prevalence within the Australian rural, regional or remote context only (defined as outside of a major Australian capital city) Articles: published in English Articles: Study papers (i.e., RCTs observational papers) discussion papers, review papers, opinion pieces and reports, conference abstracts, grey literature	Articles reporting prevalence from any other country other than Australia Articles from Australia reporting on prevalence within a major Australian city (defined as Sydney, Melbourne, Brisbane, Adelaide, Perth, Canberra, Darwin) Studies not published or translated in English Articles where no prevalence data is reported

3.4 | Data extraction

Study characteristics were extracted by two reviewers (DJ and PI) and checked by the primary reviewer (SF). Information extracted included: publication title, authors, year of publication, aim, sample /population, methodology, study outcomes and prevalence findings. The primary reviewer (SF) extracted the number of PD cases reported within studies and the total study populations, which were subsequently checked by a second reviewer (PI). The data was then transferred into Microsoft® Excel® Version 2209, for the reporting of within study prevalence.

3.5 | Data analysis

A narrative synthesis was applied to reporting of study characteristics. Within study prevalence of PD was calculated per 1000 people and tabled for ease of reporting. Within the study period prevalence rates were derived from PD cases and total population samples reported within the included studies. The estimated within study period prevalence was calculated using the method described in the article by Panegyres, Gray,[24] [(n = cases of PD × total study population) × 1000] = n per 1000). In the context of this review, the presentation of period prevalence estimates was approached with consideration of the heterogeneous nature of the studies and the potential variations in disease frequency across different populations and settings.[20] As discussed by Munn et al.,[20] the approach to displaying prevalence estimates is influenced by the goals of the review. In cases where the primary objective is to inform the likely prevalence of a condition within a specific population, such as Australia, it becomes crucial to identify studies that have similar population characteristics, therefore the decision to present period prevalence estimates in a tabular format aligns with the acknowledgement of the potential for prevalence estimates to vary due to population-specific and methodological characteristics.

4 | RESULTS

The flow chart displayed in Figure 1, details the identification, screening, and inclusion of articles from the primary search strategy. A total of 514 non-duplicate records were identified. Following screening, five articles were retrieved in full text and subjected to a reference list review. Handsearching of the reference lists revealed one additional article for inclusion. Therefore, a total of six articles were identified for inclusion from the primary search strategy and subjected to quality appraisal.

4.1 | Methodological quality

As per Table 2, the overall quality of included articles were assessed as being either Good or Fair. Those appraised as Fair were deemed to be lacking transparency in the reporting of the study methodology and reporting of results. Moreover, five out of the six included studies provided minimal information related to the ethical acquisition of data used within studies.

4.2 | Study characteristics

Of the six articles included in the review, two reported on the prevalence of PD within RRR localities from the state of Victoria (VIC),[19,25] two from Queensland (QLD),[26,27] one from New South Wales (NSW)[28] and one from Western Australia (WA). Publication dates spanned across six decades ranging between 1966 and 2019 as reported in Table 3. Period prevalence estimates of PD derived from included studies ranged between 0.58 per 1000 and 8.5 per 1000 as per Table 4.

The wide range in prevalence across studies are due to differences between study designs. Methods employed were primarily cross-sectional in nature but varied in terms of techniques used to identify the study populations and cases of PD within them. Jenkins,[25] surveyed PCP within the Gippsland region (n = 83 001) and derived their sample from PCP who self-reported cases of PD within their practices. McCann et al.[26] derived their sample from the rural town of Nambour in QLD (n = 51 700). A random sample of participants between the ages of 29 and 69 years were identified from the Australian Electoral Role. In this study consenting participants were examined for PD symptoms by two physicians using a specified diagnostic criterion.[26] Peters et al.[27] used a 10-item self-reported postal survey administered to a random sample of PCP obtained from the Queensland Medical Education Centre database. Mehta et al.[28] derived their sample from an established longitudinal cohort study using both self-reported and physician examinations to confirm diagnosis. Panegyres et al.[24] used data obtained from medical records from one specialist neurology clinic servicing the Geraldton, Midwest region of Western Australia with the most recent study by Ayton et al.,[19] deriving their sample from data obtained from the Australian Pharmaceutical Benefits Scheme (PBS). In this study individual patient prescriptions at the dispensing pharmacy level were used to identify people taking parkinsonism medications, as a proxy for PD diagnosis.[19]

While all studies reported the prevalence of PD within RRR localities, three articles[19,26,27] compared the prevalence of PD within the study populations to those living within urban/city localities. McCann et al. (1998),[26]

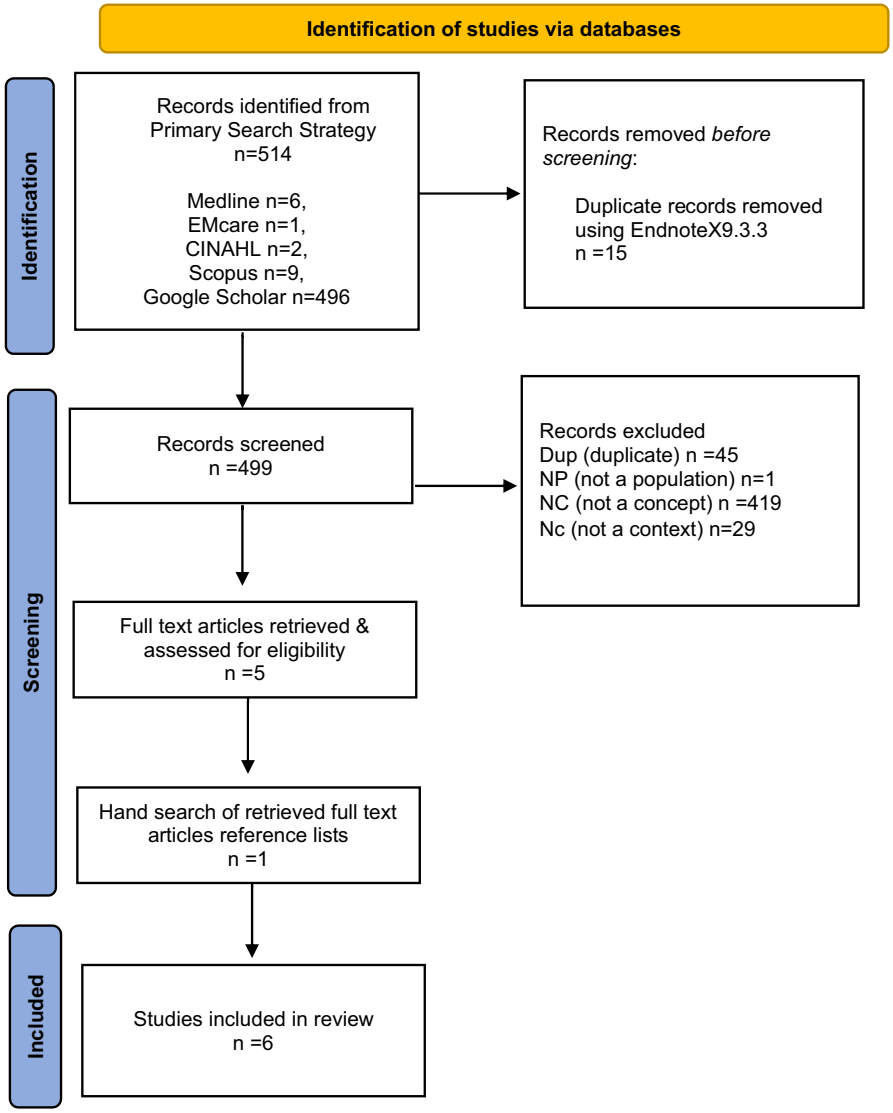

FIGURE 1 Study selection flow chart. *Adapted From*: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n7.

conducted a separate case control study using a sample of participants from southeast QLD and the central west regions of NSW. In this phase of the study univariate regression was used to identify risk factors for PD amongst the sample. Family history and rural residency were positively associated with risk of PD ($p < 0.05$); however, when adjusted for age and gender, family history was found to be the strongest predictor of PD amongst the sample (Odds Ratio (OR) 3.7, 95% Confidence Interval (CI), 2.01–6.63, $p < 0.001$), with rural residence no longer retained as a statistically significant risk factor.[26] Peters et al.[27] compared the prevalence of PD across rural, remote, and metropolitan areas of QLD. The prevalence rates of PD were highest amongst PCP reporting diagnosis within remote areas (208 per 100 000) compared to rural (164 per 100 000) and metropolitan (130 per 100 000). This study additionally identified that 85% of PCP in metropolitan areas indicated having easy or good access to specialist neurologists compared with 52% of PCP in rural areas and 40% in remote areas.[27]

In the analysis by Ayton et al.,[19] the average crude percentage prevalence for the state of Victoria (79 LGA's) was 0.94% (SD 0.32). For cases of PD identified within urban areas the average crude prevalence was 0.80% and in rural areas 1.03%. The difference in prevalence between urban and rural areas was initially found to be statistically significant ($p < 0.001$); however, in the adjusted percentage prevalence model (adjusted for median age, gender, socioeconomic status and rurality), rurality no longer remained a statistically significant predictor of PD.[19] Ayton et al.[19] also set out to investigate the agricultural determinates of PD prevalence identifying four rural local government areas clustered together geographically with a higher percentage prevalence than the reported state average. The Yarriambiack (1.24%), Buloke (1.73%), Horsham (1.59%), and Northern Grampians (1.43%) regions were all geographically clustered (share a border), observing higher percentage prevalence of PD (p 0.001), with the rural area of Ballarat also observed to have an increased percentage prevalence (1.35%) compared to the state average.[19]

TABLE 2 Quality appraisal.

Quality appraisal questions	Jenkins et al. 1966	McCann et al. 1998	Peters et al. 2006	Mehta et al. 2007	Panegyres 2010	Ayton et al. 2019
1. Abstract and title: Is a clear description of the study provided?	G	G	G	G	G	G
2. Introduction and aims: Was there a good background and clear statement of the aims of the research?	G	G	G	G	G	G
3. Method and data: Is the method appropriate and clearly explained?	F	G	G	G	G	G
4. Sampling: Was the sampling strategy appropriate to address the aims?	G	G	G	G	G	G
5. Was the description of the data analysis sufficiently rigorous?	G	G	G	G	G	G
6. Ethics and bias: Have ethical issues been addressed, and was necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?	P	P	P	G	P	P
7. Results: ls there a clear statement of the findings?	G	G	G	G	G	G
8. Transferability or generalisability: Are the findings of this study transferable (generalisable) to a wider population?	F	F	F	F	P	F
9. Implications and usefulness: How important are these findings to policy and practice?	F	F	G	G	P	G
Overall Appraisal Rated as Good (G), Fair (F), Poor (P), Very Poor (VP)	F	G	G	G	F	G

5 | DISCUSSION

To our knowledge this is the first scoping review conducted to identify and report on studies that have investigated the prevalence of PD within RRR areas of Australia. The comprehensive systematic search strategy identified a small but diverse collection of studies spanning a period of over six decades. The heterogeneity in methodological approaches employed across studies has led to a range of prevalence outcomes being reported. This variation reflects the complexities of PD epidemiology and highlights the need for robust nationwide data collection that can be used to inform the equitable distribution of resources to support the development and delivery of PD specific care for people living in under resourced geographic locations. Additionally, the scarcity of recent and relevant data derived from Australian public health services such as hospital and aged care facilities presents a limitation in our ability to inform PD specific heath care planning.

These findings are consistent with observations made by WHO's technical brief, which points to a deficit of consistent and comprehensive data on disease incidence and prevalence within and across countries especially in rural areas.[3] The discord between the burden of PD and the available data underscores the need for well-designed country specific epidemiological studies to be conducted to estimate the actual impacts of the disease and enable public health planning particularly within RRR settings where healthcare resourcing may already be scarce.[12,19,27] Moreover, while there is limited evidence to suggest rural residency as a direct predictor of PD, the potential interaction between genetic susceptibility and occupational exposures prevalent in rural environments offers an avenue for further exploration. Occupational factors such as exposure to pesticides, insecticides, herbicides, and heavy metal exposures have been implicated as potential contributors to disease aetiology.[2,8,18,19]

The significance of assessing PD specific care to ensure prompt diagnosis, early treatment and for the management of progressive disease symptoms over time is undeniable.[3] However, for people living in RRR of Australia the reality is that accessing specialist care remains a challenge affecting overall quality of life for those living with PD and their carers.[29] Without PD specific care, delays in

TABLE 3 Study characteristics.

Citation	Aim/region	Sample	Methods	Outcomes
Jenkins, A.C. 1966 Medical Journal of Australia	Population-based survey of PD prevalence Gippsland, VIC	83001 people living in the Gippsland area in 1965	Cross sectional survey distributed to PCPs within the Gippsland area	70 cases of PD were identified 31 males and 39 females aged between 32 and 93 years Prevalence – 85 people per 100 000 with PD across all age groups A PD incidence of 1:1186
McCann et al. 1998 Journal of Neuroepidemiology	Estimate PD rural Australia & conduct a case control study to investigate risk factors for PD Nambour, QLD	8500 people living in Nambour 1207 adults participated in the prevalence study The case control study derived participants from hospitals, aged care facilities and community groups in the southeast QLD region and from the central west area of NSW	Participants were examined by two physicians for the presence of PD PD was diagnosed when two or more listed symptoms were present Case control study – participants were matched for age, gender, ethnicity, and residential area & reviewed to determine diagnosis for PD based on diagnostic criteria by Calne et al. (1992)	PD prevalence 414 per 100000 (95% CI 53–775) Case control study- positive relationship between family history (hx) and rural residency The ingestion of well, spring or bore water, hx of stroke and hx of hypertension were negatively associated with risk of PD Multivariate analysis- rural residency not a significant predictor of PD
Peters et al. 2006 Journal of Clinical Neuroscience	To ascertain PD prevalence & physician (GP) adequacy of support received from specialist neurologists QLD (statewide)	639 GP practices identified for participation in the primary study	A 10-item questionnaire was posted to GP practices to ascertain estimates of patients with confirmed diagnosis of PD and numbers of suspected PD	PD prevalence estimates 130:100 000 in metropolitan areas. 164:100 000 in rural areas 208:100 000 in remote areas Crude prevalence for the state of QLD was 145:100 000 people
Mehta et al. 2007 Internal Medicine Journal	To determine prevalence and 10-year incidence of PD in a regional Australian community Blue Mountains, NSW	Cross sectional and longitudinal data from the Blue Mountains Eye study in NSW PD prevalence derived from 3509 participants who attended follow up examinations and who were identified from the door-to-door survey 2545 participants were used to estimate the 10-year incidence of PD	Medical practitioners of participants that reported a diagnosis of PD or listed medications used in the treatment of PD were contacted to confirm participant diagnosis All with a diagnosis with PD had the condition further confirmed by a specialist neurologist	Prevalence estimates were determined to be 0.46% (95% CI 0.23–0.68) A prevalence of 362 per 100 000 persons aged 50 years or older 104 per 100000 amongst all age groups 19 new cases were identified over the 10 years resulting in a 10-year incidence of 0.84% (95% CI, 0.54–1.33)
Panegyres et al. 2010 Internal Medicine Journal.	A descriptive analysis of neurological disorders reported from one neurology clinic Geraldton and Midwest regions, WA	Participant information and diagnosis of PD were obtained over a 12-month period from one neurology clinic Clinic population – 160 patients Total population for the region 51748	Frequency of neurological disorders including PD were reported Prevalence calculations were made for the population by diagnosed disorder	15 classes of neurological disorders were identified Prevalence of PD was reported as 185.5 per 1000 people
Ayton et al. 2019 Parkinsonism and Related Disorders	To ascertain prevalence of PD in rural and urban Victorian LGAs VIC (Statewide)	Australian Bureau of Statistics data 5339933 across 79 LGAs	Rates of PD were obtained from PBS patient prescriptions, by dispensing pharmacy used as a proxy for PD diagnosis	Average crude PD prevalence rates across all VIC LGA's were 0.94% Significant differences between the average % prevalence between rural 1.03% and urban 0.80% localities were reported ($p = 0.001$). Following adjustment for covariates the difference was no longer significant Four adjacent LGAs were identified as having a higher % prevalence compared to the adjusted state % prevalence

Abbreviations: GP, General Practice; hx, History; LGA, Local Government Area; NSW, New South Wales; PBS, Pharmaceutical Benefits Scheme; PCP, Primary Care Physician; PD, Parkinson's Disease; QLD, Queensland; VIC, Victoria; WA, Western Australia.

TABLE 4 Within study period prevalence of Parkinson's disease per 1000 people.

Publication year	Australian state study conducted	Rural, regional, remote locality	Within study prevalence (per 1000 people)
1966	Victoria	Gippsland region	0.84
1998	Queensland	Nambour	0.59
2006	Queensland	State-wide survey	7.08
2007	New South Wales	Blue mountains region	4.56
2010	Western Australia	Geraldton/Midwest region	0.58
2019	Victoria	State-wide survey	8.50

diagnosis and treatment can lead to worsening symptoms, heightened morbidity from falls, prolonged recovery periods, increased hospital admissions, escalated healthcare expenditures, translating to lower health-related quality of life and suboptimal PD management for those living outside urban centres.[15]

The WHO has emphasised the critical importance of enhancing the capacity of healthcare professionals in low-resourced settings as one of the key strategies for delivering effective services for people with PD.[3] Initiatives including the upskilling and integration of nurses into specialist Parkinson's nursing roles have gradually emerged in both metropolitan and rural areas of Australia. Since being first described as PD movement disorder nurse specialists by the Parkinson's society of Western Australia (WA) in 1997,[30] a recent national survey published in 2021, reported that at least 61 PD nurse specialist positions existed nationally.[31] However, the geographical concentration of these positions was in metropolitan areas, with only 13 (21%) positions located in regional areas and 6 positions (10%) located within rural areas.[31]

Concerted efforts have been initiated to address the geographic disparity in access to specialist Parkinson's nurses. Bramble, Rossiter and colleagues, have emphasised the potential benefits including cost effectiveness of implementing PD nurse specialist models within RRR areas.[15,32] However, it is important to note that Australian nurse led models implemented in RRR areas have not been empirically evaluated, rather they have been implemented by small, proactive nurse led institutional teams.[32] Of particular concern is the uncertainty surrounding the sustainability of PD nurse specialist roles. Williams et al.[31] from their national survey identified that over 30% of PD nurse specialist roles were operating without the assurance of permanent funding and succession planning. Such uncertainty can lead to the abrupt closure of specialist PD nursing services further impacting on the quality of life of people relying on these services. Furthermore, it is crucial to acknowledge the evolving landscape of healthcare delivery and the immense potential of integrating technology, such as telehealth, into specialist PD nursing models.[33] While technological advancements have enhanced healthcare accessibility in rural and remote areas, Australia has seen limited application of telehealth services for movement disorders like Parkinson's disease. Le and Aggarwal[34] suggest that the integration of specialist neurological telehealth services hold promise for improving healthcare access. They particularly emphasise that cost reductions related to travel and convenience were perceived as being especially beneficial for people with chronic neurological conditions.[34] Future research in this area should focus on advancing the integration of telehealth for sustainable and equitable healthcare delivery in RRR areas. Additionally, ongoing investigation into telehealth's integration with PD nurse specialist models to enhance access to multidisciplinary movement disorder consultants, essentially linking-in urban specialists, will be pivotal in ensuring the long-term viability of, and access to nurse led models of care for individuals with Parkinson's disease living in RRR areas of Australia.[33]

5.1 | Strengths

This study's exploration into PD prevalence within Australia's RRR areas unveils a dearth of epidemiological understanding and emphasises the pressing need for improved access to specialised care for people with PD living in RRR areas. This is particularly relevant given that PD diagnosis tends to occur later for people living in RRR areas, delaying treatment and affecting overall quality of life.

5.2 | Limitations

Variations in study design, measurement instruments, disease classification, and definitions across different geographical areas and timeframes pose inherent limitations to this study. Consequently, statistical combination

of these studies is not appropriate. However, it is important to highlight the substantial benefit of conducting reviews of prevalence and incidence data to aid in informing healthcare planning.[20]

One additional limitation was the absence of a search of RRR specific prevalence data from Australian based Parkinson's disease organisations. As such we conducted a post-hoc, web search of the seven different PD peak bodies that exist in Australia. A search of these websites revealed an absence of RRR specific prevalence data.[35–41] While all websites included national prevalence statistics, only Parkinson's NSW supplied a source from which their prevalence data was derived, citing the 2015 Deloitte Access Economics report[12] and the study by Ayton et al.[19] Utilising these organisations' member registries may be one avenue of future research providing further insights into the prevalence of PD within RRR areas of Australia.

6 | CONCLUSION

This scoping review has identified a notable scarcity of prevalence studies conducted within RRR areas of Australia, offering little insight into informing PD specific health service planning. By synthesising the available evidence, we have illustrated the variability in PD prevalence rates within RRR areas revealing a range of 0.58 to 8.5 per 1000 people across included studies. Current evidence suggests that the provision of PD specific care for people living within RRR areas of Australia is inequitable compared to metropolitan regions. Well-designed country specific epidemiological studies leveraging existing health service and aged care data is required to estimate prevalence particularly within RRR settings ensuing adequate allocation of resources and provision of specialist health care professionals to meet the holistic needs of people with PD living in RRR areas of Australia.

AUTHOR CONTRIBUTIONS

Shanna Fealy: Conceptualisation; methodology; data curation; writing – original draft; writing – review and editing. **Patricia A. Logan:** Writing – review and editing. **Peter S. Micalos:** Writing – review and editing; data curation. **Rachel Rossiter:** Writing – original draft; writing – review and editing. **Donovan Jones:** Writing – original draft; writing – review and editing; methodology; conceptualisation. **Pauletta Irwin:** Writing – original draft; writing – review and editing; conceptualisation; methodology. **Deborah Schwebel:** Writing – review and editing. **Vincent Carroll:** Writing – review and editing. **Alfred Wong:** Writing – review and editing. **Victor S. C. Fung:** Writing – review and editing; resources. **Hugo Morales-Briceno:** Writing – review and editing; resources. **Marguerite Bramble:** Conceptualisation; writing – review and editing; writing – original draft.

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CONFLICT OF INTEREST STATEMENT

All authors report no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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