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## Original Article

# Marital Status and Parkinson Disease in Eastern Compared to Western Countries: A Systematic Review and Meta-Analysis

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**ABSTRACT:** ***Background:*** Parkinson disease (PD) is a neurological disorder that affects more than 10 million people worldwide, impacting both quality of life and marital relationships. Divorce rates are higher in Western compared to Eastern countries. However, it is unclear if there are differences in marital status after PD onset between the two regions. ***Methods:*** We searched MEDLINE and Embase from inception to March 31, 2024. Original studies discussing marital status in participants with PD were included. An unmarried status includes single, widowed, divorced or separated. Outcomes included the prevalence of being unmarried, measured as proportions, and the risk ratio (RR) of being unmarried in participants with PD relative to controls. ***Results:*** Out of 567 studies screened initially, 55 studies involving 3,723,966 participants were included. The prevalence of being unmarried was evaluated in 55 studies (25.16%; 95% CI: 21.52–29.18). The prevalence of being unmarried was significantly higher in countries in the West compared to the East (28.83%; 95% CI: 25.09–32.89 vs 17.47%; 95% CI: 12.10–24.57, $p < 0.01$). Compared to controls, the risk of being unmarried in PD participants after the onset of PD was significantly higher in the East (RR: 1.21, 95% CI: 0.91–1.60) compared to the West (RR: 0.87, 95% CI: 0.65–1.15). ***Conclusions:*** Our meta-analysis showed significantly higher rates of being unmarried in Western compared to Eastern countries. After PD onset, participants in the East were at significantly higher risk of being unmarried compared to participants in the West, suggesting that differences in cultural practices, societal norms and healthcare systems may affect marital status outcomes in PD participants.

**RÉSUMÉ : État matrimonial et maladie de Parkinson dans les pays asiatiques par rapport aux pays occidentaux : une revue systématique et une méta-analyse.** ***Contexte :*** La maladie de Parkinson (MP) constitue un trouble neurologique qui touche plus de 10 millions de personnes dans le monde et qui affecte leur qualité de vie et leurs relations conjugales. Les taux de divorce sont aussi plus élevés dans les pays occidentaux que dans les pays asiatiques. Toutefois, il n'est pas clair s'il existe des différences d'état matrimonial entre ces ensembles de pays après l'apparition de la MP. ***Méthodes :*** Nous avons effectué des recherches dans MEDLINE et Embase depuis le début de cette étude jusqu'au 31 mars 2024. Des études originales portant sur l'état matrimonial des participants atteints de la MP ont été incluses. Ici, l'état de « célibataire » englobait le fait d'être célibataire, veuf, divorcé ou séparé. Nos résultats ont donc compris la prévalence du célibat, mesurée en proportion, et le rapport de risques (RR) du célibat chez les participants atteints de la MP par rapport à des témoins. ***Résultats :*** Sur les 567 études sélectionnées initialement, 55 d'entre elles impliquant 3 723 966 participants ont été incluses. La prévalence du célibat a donc été évaluée dans le cas de ces 55 études (25,16 % ; IC 95 % : 21,52–29,18). Il est à noter que cette prévalence était notablement plus élevée dans les pays occidentaux que dans les pays asiatiques (28,83 % ; IC 95 % : 25,09–32,89 contre 17,47 % ; IC 95 % : 12,10–24,57 ; p <0,01). Par rapport aux témoins, le risque d'être célibataire chez les participants après l'apparition de la MP était considérablement plus élevé au sein des pays asiatiques (RR :1,21 ; IC 95 % : 0,91–1,60) qu'au sein des pays occidentaux (RR : 0,87 ; IC 95 % : 0,65–1,15). ***Conclusions :*** Notre méta-analyse a montré des taux de célibat notablement plus élevés dans les pays occidentaux que dans les pays asiatiques. Après l'apparition de la MP, les participants des pays asiatiques ont donné à voir un risque nettement plus élevé d'être célibataires que les participants issus des pays occidentaux, ce qui suggère que des différences en matière de pratiques culturelles, de systèmes sociétaux et de systèmes de santé peuvent affecter l'évolution de l'état matrimonial des participants atteints de la MP.

**Keywords:** Marital status; Parkinson disease; global health; meta-analysis

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**Highlights**

- The prevalence of being unmarried was significantly higher in countries in the West compared to the East.
- Participants in the East were at significantly higher risk of being unmarried than the West after Parkinson disease onset.
- Differences in cultural practices, societal norms and healthcare systems may affect marital status outcomes.

## Introduction

Parkinson disease (PD), a common neurological disorder, affects more than 10 million people worldwide, causing bradykinesia, tremor, rigidity and gait disorders. In addition to motor symptoms, PD participants commonly experience non-motor symptoms and autonomic dysfunction such as constipation (50%), depression (36%), sleep disturbances (37%) and sexual dysfunction (80%).[1–3] The reduction in quality of life is worsened by the loss of independence and increased reliance on caregivers as PD progresses. Majority of the caregivers in PD participants are their spouses and in their 60s.[4] While effective medical therapies are available to control the progression of PD, the impact of PD on a patient's marital relationship has not been well studied. Studies on marital status and health outcomes found that unmarried individuals report poorer health and have higher mortality risk than their married counterparts, with men being particularly affected in this respect.[5] Furthermore, particularly in older adults, being married has been shown to help in discharge planning, compliance to hospital follow-ups and reducing hospital readmissions.[6]

The significant mental and physical strain of caring for a patient with PD could lead to caregiver stress and burnout, straining the marital relationship.[7] Furthermore, both spouses and participants with PD report a reduction in sexual and marital satisfaction.[8] PD participants experience motor symptoms and autonomic dysfunction[1] such as erectile dysfunction, which could pose difficulties in the act of sexual intercourse in males, as well as vaginal dryness and decreased libido in females.[9] The association between sexual and marital satisfaction could be bidirectional, and negative marital satisfaction could lead to separation or divorce.[8]

Although the implication of PD on caregivers and marital satisfaction has been well documented in multiple studies, its impact on marital status has not been well examined. In addition, while attitudes toward marital relationship may differ due to generational and time factors, cultural practices and geographical differences, these have not been well evaluated in studies. A comparison between Western and Eastern countries in PD is not uncommon. Epidemiology studies has shown differences in the distribution of PD, with a lower incidence and prevalence of PD among Eastern countries compared to Western studies.[10] Further studies on marital status by Dyvik et al. found that in a global study of divorce rates, countries in the East has the lowest unmarried rates, while the highest unmarried rates were dominated by countries in the West.[11] Western and Eastern countries often have different cultural, philosophical and social norms. Western societies tend to prioritize individualism, while Eastern societies value communal goals. Understanding marital status in participants with chronic diseases such as PD could provide insights into the impact of societal influences.

To date, there has been no meta-analysis to examine the prevalence of unmarried rates in PD and no comparative studies between Western and Eastern countries. To address this gap in knowledge, we conducted a systematic review and meta-analysis to evaluate the following outcomes: (1) prevalence of unmarried rates in PD and (2) determine if there are differences between West and East regarding the risk of being unmarried in PD participants compared to controls.

## Methods

This systematic review and meta-analysis was registered with PROSPERO at CRD42024541080 and adhered to the reporting guidelines of Preferred Reporting Items for Systematic Reviews and Meta-analyses.[12]

### *Information source and search strategy*

A systematic search was conducted in MEDLINE and Embase using Medical Subject Headings (MeSH) and keywords. Keywords and MeSH terms synonymous with "Parkinson Disease" and "Marital Status" formed the basis of the search strategy. The search period includes articles from inception to March 31, 2024. Only full-text articles published in the English language were included. The full search strategy and search terms are included in Supplementary Table 1. References were imported into EndNoteX9 for the initial removal of duplicates.

### *Study selection*

Two authors (WYC and JDJW) reviewed each reference in a blinded manner, and any disagreements were resolved through discussion or referred to a third independent author for the final decision (CKMC). The review was carried out in two stages: first, the titles and abstracts were reviewed, and second, the full texts of selected references were retrieved and reviewed. Original studies, published in English, discussing marital status in participants with PD were included. Criteria for accepted PD include being in a PD registry, being on medications for PD or being diagnosed by a neurologist using the UK Parkinson's Disease Society Brain Bank Diagnostic Criteria or Movement Disorder Society Diagnostic Criteria for PD. Accepted study designs included case-control, cross-sectional and cohort studies. We excluded randomized control trials, non-peer-reviewed articles, review articles (including other systematic reviews and meta-analyses), editorials, letters to the editor and conference abstracts. Studies conducted in patients with severe cognitive dysfunction and dementia were excluded. Studies in patients with Parkinson-plus syndromes were excluded as well.

### *Data extraction*

Two investigators (CKMC and JDJW) independently extracted information from the included studies. The data collected included authors, year of publication, total number of participants, age and sex of study participants, sample size and marital status. Regarding discrepancies, a third author (WYC) were consulted to make the final decision regarding the data extraction process.

### *Quality assessment*

The Joanna Briggs Institute (JBI) Critical Appraisal Tools were used for the quality assessment of the included articles. Two investigators (CKMC and JDJW) independently reviewed all included studies, and in case of disagreements, a third independent author (WYC) was consulted, and a consensus was reached through discussion. The maximum score attainable (signifying high quality) is 8 points for analytical cross-sectional studies, 10 points for case-control studies and 11 points for cohort studies. A summary of the scoring can be found in Table 1.


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**Table 1.** Summary of included studies

| Author (year) | Country | Study design | Marital status in relation to PD | Parkinson disease participants | | | Control participants | | | JBI scoring |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Participants (n) | Sex male, (%) | Age, mean (SD) | Participants (n) | Sex male, (%) | Age, mean (SD) | |
| Al-Khammash (2023) | Saudi Arabia | Prospective cross-sectional | During PD | 82 | 58.54% | NA | NA | NA | NA | 8/8 |
| Alfonso (2022) | United States of America | Prospective cross-sectional | During PD | 285 | 56.14% | NA | NA | NA | NA | 8/8 |
| Almeida (2021) | Brazil | Prospective cohort | During PD | 137 | 57.66% | 67.8(8.0) | NA | NA | NA | 10/11 |
| Andreadou (2011) | Greece | Prospective cross-sectional | During PD | 139 | 48.92% | 69.6(9.1) | NA | NA | NA | 8/8 |
| Augustine (2015) | United States of America | Retrospective cross-sectional | During PD | 1,741 | 64.50% | NA | NA | NA | NA | 8/11 |
| Barekatain (2021) | Iran | Retrospective case-control | During PD | 27 | 11.11% | 69.03 (10.82) | 27 | 40.74% | 65.44 (7.43) | 9/10 |
| Broen (2018) | Netherlands | Retrospective cross-sectional | During PD | 311 | 62.38% | 66.0(8.7) | NA | NA | NA | 8/8 |
| Bronner (2023) | Israel | Retrospective cross-sectional | During PD | 100 | 78.00% | NA | NA | NA | NA | 8/8 |
| Candel-Parra (2021) | Spain | Prospective cohort | During PD | 155 | 59.35% | 69.51 (8.63) | NA | NA | NA | 11/11 |
| Cao (2021) | China | Prospective cross-sectional | During PD | 221 | 47.06% | 65.77 (12.97) | NA | NA | NA | 8/8 |
| Cassidy (2022) | Ireland | Prospective cross-sectional | During PD | 208 | 61.54% | NA | NA | NA | NA | 8/8 |
| Celikel (2008) | Turkey | Retrospective case-control | During PD | 45 | 48.89% | 61.62 (8.52) | 45 | 48.89% | 61.62 (8.52) | 9/10 |
| Chekani (2016) | United States of America | Retrospective cross-sectional | During PD | 98,093 | 37.72% | 81.03 (0.34) | NA | NA | NA | 8/8 |
| Cubo (2023) | Spain | Prospective cross-sectional | During PD | 364 | 57.97% | 64.12 (10.28) | NA | NA | NA | 8/8 |
| Cui (2017) | China | Retrospective cross-sectional | During PD | 403 | 55.33% | 62.6 | NA | NA | NA | 8/8 |
| deAlmeida (2019) | Brazil | Prospective cross-sectional | During PD | 48 | NA | NA | NA | NA | NA | 8/8 |
| Fang (2010) | United States of America | Retrospective case-control | During PD | 992 | 75.00% | 64.4(4.8) | 279,958 | 58.76% | 61.8(5.3) | 10/10 |
| Feeney (2022) | United States of America | Prospective cross-sectional | During PD | 409 | 91.69% | 74(8.2) | NA | NA | NA | 6/8 |
| Feldmann (2020) | Germany | Retrospective cross-sectional | During PD | 125 | 60.80% | 70.0(8.0) | NA | NA | NA | 8/8 |
| Ghourchian (2023) | United States of America | Retrospective cross-sectional | During PD | 85 | 67.06% | 65.5(9.3) | NA | NA | NA | 8/8 |

**Table 1.** Summary of included studies (*Continued*)

| | | | | Parkinson disease participants | | | Control participants | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author (year)** | **Country** | **Study design** | **Marital status in relation to PD** | **Participants (n)** | **Sex male, (%)** | **Age, mean (SD)** | **Participants (n)** | **Sex male, (%)** | **Age, mean (SD)** | **JBI scoring** |
| Gómez-Esteban (2009) | Spain | Prospective cross-sectional | During PD | 118 | 54.24% | 60.4 (11.2) | NA | NA | NA | 8/8 |
| Hand (2010) | United States of America | Prospective cross-sectional | During PD | 167 | 49.10% | 75.5 (8.68) | NA | NA | NA | 8/8 |
| Hojjati (2019) | Iran | Prospective cross-sectional | During PD | 109 | 55.96% | NA | NA | NA | NA | 8/8 |
| Imaizumi (1995) | Japan | Retrospective cross-sectional | During PD | 17,234 | 47.77% | NA | NA | NA | NA | 8/8 |
| Kadastik-Eerme (2015) | Estonia | Prospective cross-sectional | During PD | 268 | NA | 74.2 (8.8) | NA | NA | NA | 8/8 |
| Keshtkarjahromi (2022) | United States of America | Prospective cohort | During PD | 1,393 | 63.46% | 70.3 (10.3) | NA | NA | NA | 11/11 |
| Khalil (2018) | Bangladesh | Retrospective cross-sectional | During PD | 137 | 74.45% | NA | NA | NA | NA | 8/8 |
| Kiakojuri (2021) | Iran | Prospective case-control | During PD | 110 | 41.82% | 69 (9) | 110 | 50.91% | 66 (9) | 9/10 |
| Knekt (2010) | Finland | Prospective cohort | Before PD | 50 | 48.00% | 60.4 (6.5) | 3,123 | 43.10% | 61.8 (8.0) | 11/11 |
| Koo (2018) | United States of America | Prospective case-control | During PD | 94 | 65.96% | 67.7 (8.4) | 86 | 53.49% | 69.0 (11.7) | 10/10 |
| Kyrozis (2013) | Greece | Prospective cohort | Before PD | 88 | 42.05% | NA | 25,407 | 40.71% | NA | 11/11 |
| Li (2016) | Singapore | Retrospective case-control | During PD | 136 | 61.76% | NA | 60 | 51.67% | NA | 10/10 |
| Liu (2021) | United Kingdom | Prospective cohort | During PD | 923 | 64.14% | 67.1 (9.59) | NA | NA | NA | 11/11 |
| Lyra (2022) | United States of America | Retrospective cross-sectional | During PD | 51 | 52.94% | 62.96 (14.71) | NA | NA | NA | 6/8 |
| Moreira (2017) | Brazil | Prospective cross-sectional | During PD | 100 | 50.00% | NA | NA | NA | NA | 8/8 |
| Myslobodsky (2001) | United States of America | Retrospective cross-sectional | During PD | 144,309 | 56.70% | NA | NA | NA | NA | 8/8 |
| O"Connor (2008) | Australia | Prospective cross-sectional | During PD | 143 | 49.65% | 68.91 (8.15) | NA | NA | NA | 8/8 |
| Prado (2020) | Philippines | Prospective cross-sectional | During PD | 33 | 51.52% | 58.4 (10.6) | NA | NA | NA | 6/8 |
| Riazi (2003) | United Kingdom | Retrospective cross-sectional | During PD | 227 | 59.47% | NA | 2,056 | 45.18% | NA | 8/8 |
| Rod (2010) | Denmark | Retrospective case-control | During PD | 13,695 | 54.20% | NA | 68,445 | 54.21% | NA | 10/10 |

**Table 1.** Summary of included studies (*Continued*)

| | | | | Parkinson disease participants | | | Control participants | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author (year)** | **Country** | **Study design** | **Marital status in relation to PD** | **Participants (n)** | **Sex male, (%)** | **Age, mean (SD)** | **Participants (n)** | **Sex male, (%)** | **Age, mean (SD)** | **JBI scoring** |
| Rosińczuk (2019) | Poland | Prospective cross-sectional | During PD | 50 | 52.00% | NA | NA | NA | NA | 8/8 |
| Rybicki (1995) | United States of America | Retrospective cohort | During PD | 588 | 47.11% | NA | 239,722 | NA | 77.7 | 9/11 |
| Sääksjärvi (2008) | Finland | Prospective cohort | Before PD | 101 | 45.54% | 62.7 | 6,609 | 47.60% | 60.7 | 11/11 |
| Salari (2024) | Iran | Retrospective cross-sectional | During PD | 105 | 64.76% | 57.01 (12.1) | NA | NA | NA | 8/8 |
| Santos GarcÃa (2022) | Spain | Prospective cohort | During PD | 33 | 60.61% | 63.3(7.91) | NA | NA | NA | 8/11 |
| Schrag (2003) | United Kingdom | Prospective cross-sectional | During PD | 141 | 41.13% | 60.1(10.5) | NA | NA | NA | 6/8 |
| Soyuer (2017) | Turkey | Prospective cross-sectional | During PD | 87 | 57.47% | 61.1 (12.13) | NA | NA | NA | 8/8 |
| Tavares (2020) | Canada | Retrospective cross-sectional | During PD | 15 | 66.67% | NA | NA | NA | NA | 5/8 |
| Vaughan (2017) | United States of America | Retrospective case-control | During PD | 95 | 60.00% | 68.28(29.9) | NA | NA | NA | 8/10 |
| Wandell (2020) | Sweden | Retrospective cohort | Before PD | 35,833 | NA | NA | 2,775,736 | NA | NA | 11/11 |
| Wang (1992) | Canada | Retrospective case-control | During PD | 40 | 70.00% | 65.5(10.4) | 101 | 67.33% | 64.3(10.0) | 8/10 |
| Wei (2010) | United States of America | Retrospective cohort | During PD | 571 | 45.01% | NA | NA | NA | NA | 10/11 |
| Wu (2014) | China | Prospective cross-sectional | During PD | 649 | 56.24% | 61.7(11.8) | NA | NA | NA | 8/8 |
| Zaman (2021) | United States of America | Prospective cross-sectional | During PD | 30 | 40.00% | 69.9(8.0) | NA | NA | NA | 8/8 |
| Zeng (2024) | China | Retrospective cross-sectional | During PD | 253 | 44.66% | 61.3(1.10) | 506 | 42.49% | 57.9(0.17) | 8/8 |

PD = Parkinson disease; NA = not applicable; JBI = Joanna Briggs Institute.

### Marital status

In this study, unmarried is defined as single, widowed, divorced or separated based on data reported by the studies included in the analysis.

### Data analysis

All analyses were undertaken using RStudio version 4.3.3. Prevalence estimates of unmarried rates were calculated by pooling the study-specific estimates using random-effects models. Pooled risk ratios (RRs) were meta-analyzed using the Mantel–Haenszel method. The level of significance is defined as $p < 0.05$. The choice between the fixed-effect and random-effects models was made depending on the $I^2$ index and Cochran's $Q$ test $P$ value. An $I^2$ of less than 25% is indicative of low heterogeneity, 25%–75% of moderate heterogeneity and more than 75% of high heterogeneity. In cases with minimal heterogeneity, a fixed-effect model was used. Otherwise, a random-effects model was used. All results were presented as their effect sizes with the accompanying 95% CIs, along with the $P$ values where applicable. In addition, we conducted subgroup analysis according to geographical region and onset of PD in relation to marital status. We divided geographical region into East and West. In this study, the categorization of "West" include nations and states in Western and Eastern Europe, Northern and Latin America and the Mediterranean region, whereas "East" includes nations and states in Asia and the Arab world.

For meta-analyses that have high heterogeneity, we performed an influence analysis to determine the contribution of each study to the overall heterogeneity. Based on the resultant Baujat plots and leave-one-out analyses, as well as inspection of the forest plots, we performed a sensitivity analysis in which outliers were excluded.

## Results

### Overview

A total of 567 studies were found after searching MEDLINE and Embase. Among these, 145 were duplicates and 422 studies remained following duplicate removal. We screened the titles and abstracts of these studies and included 55 studies for further review (Supplementary Figure 1). Subsequently the full texts of 55 studies and all 55 studies involving 3,723,966 participants (321,946 PD and 3,402,020 controls) were included in the final analysis.[1,9,13–65]

### Characteristics of included studies

Of the 55 studies that were included, there were 35 cross-sectional, 11 cohort[23,25,28–30,39,41,43,44,57,62] and 9 case-control studies[16,24,26,32,40,42,50,54,59]. All 55 studies reported marital status, and this was classified as either married or unmarried (single, divorced, separated and widowed). Seventeen studies were conducted in the East, while the remaining 38 studies were conducted in the West. Fifteen studies compared the prevalence of unmarried between PD and non-PD participants[16,20,24,25,29,30,32,33,40–43,50,54,59]. Among the 15 studies, there were 2 cross-sectional, 4 cohort and 9 case-control studies. A summary of the quality of studies using the Joanna Briggs Institute Critical Appraisal Tools can be found in Table 1.

### Prevalence of being unmarried in participants with PD

Fifty-five studies involving 321,946 participants with PD and 164,962 events of unmarried were pooled, and the prevalence of being unmarried was found to be 25.16% (95% CI: 21.52–29.18). The $I^2$ index was 99.8%, and the Cochran's $Q$ test was significant at $p < 0.0001$ (Supplementary Figure 2). Influence analysis revealed three outliers: Rod et al., Chekani et al. and Wandell et al. A sensitivity analysis excluding them was conducted and found the prevalence to be 24.75% (95% CI: 21.25–28.63) (Supplementary Figures 3 and 4). The $I^2$ index was 98.6%, and the Cochran's $Q$ test was significant at $p < 0.001$. A subgroup analysis based on geographical region was conducted. Studies conducted in the East (n = 17) found an unmarried prevalence of 17.47% (95% CI: 12.10–24.57) (Figure 1), whereas studies conducted in the West (n = 35) revealed an unmarried prevalence of 29.10% (95% CI: 25.00–33.58) (Figure 2). The subgroup differences demonstrated a significantly higher prevalence of unmarried participants with PD in studies conducted in the West ($p = 0.0036$).

### Risk ratio of being unmarried in participants with PD and controls

#### Geographical region

Fifteen studies comparing marital status in participants with PD and controls were pooled. Compared to controls, the risk of being unmarried in participants with PD was significantly higher ($p < 0.05$) in the East (RR: 1.21; 95% CI: 0.91–1.60; $n = 5$) compared to the West (RR: 0.90; 95% CI: 0.78–1.04; $n = 10$) (Figure 3).

#### Onset of PD

Excluding 4 studies with marital status collected before onset of PD, the remaining 11 studies comparing the marital status of 15,714 participants after onset of PD and 351,424 controls were pooled. Compared to controls, the risk of being unmarried after the onset of PD was significantly higher ($p < 0.05$) in the East (RR: 1.21; 95% CI: 0.91–1.60, $n = 5$) compared to the West (RR: 0.87; 95% CI: 0.65–1.15; $n = 6$) (Figure 4).

## Discussion

To address the prevalence of being unmarried in PD and the association between risk of being unmarried and PD, we conducted the first systematic review and meta-analysis involving 55 studies and 3,723,966 participants (321,946 PD and 3,402,020 controls). To account for disparities in marital status between different geographical regions, we conducted a subgroup analysis based on countries in the East and West. Our main findings are the prevalence of being unmarried was significantly higher in countries in the West compared to the East (28.83% vs 17.47%). We also found that compared to controls, there was a significant 21% increased risk of being unmarried in PD participants from the East (RR: 1.21; 95% CI: 0.91–1.60), but this observation was not found in the West. A subgroup analysis of marital status after onset of PD found that the risk of being unmarried in PD participants remained significantly higher ($p < 0.05$) in the East (RR: 1.21; 95% CI: 0.91–1.60; $n = 5$) compared to the West (RR: 0.87; 95% CI: 0.65–1.15; $n = 6$).

Differences in cultural practices, societal norms and healthcare systems may affect marital status outcomes in participants with PD. In this meta-analysis, we found that the prevalence of being unmarried was higher in countries in the West compared to the East. In a global study of divorce rates, Dyvik et al. found that countries in the East has the lowest unmarried rates, while the highest unmarried rates were dominated by countries in the West.[11] An estimated 90% of marriages in Portugal and Spain result in divorce, whereas in Eastern countries like Vietnam and Sri Lanka, fewer than 1 in 1000 marriages end in divorce.[11] Even in studies of older adults aged 65 and above, countries in the West consistently have higher rates of being unmarried compared to


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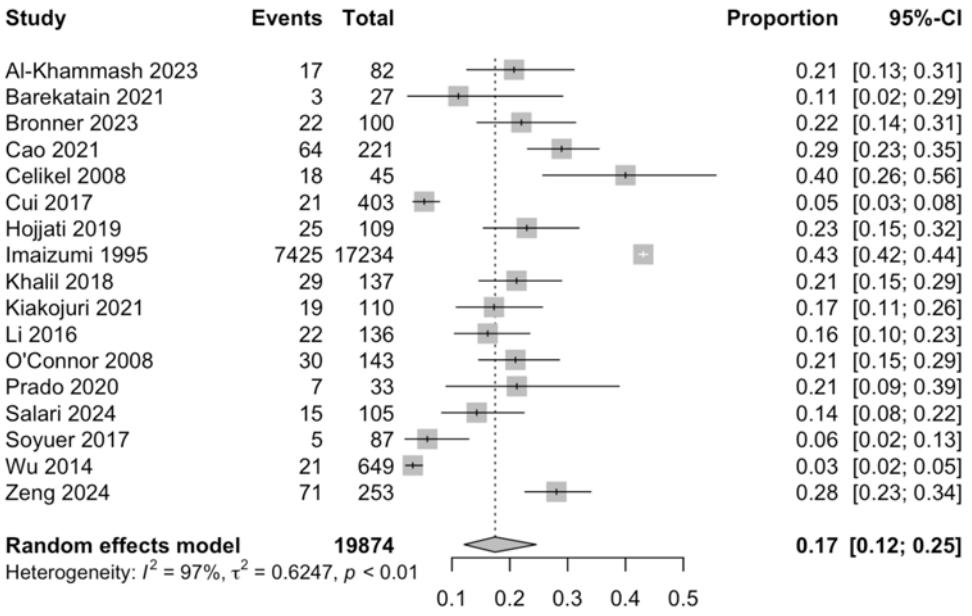


**Figure 1.** Forest plot of prevalence of being unmarried in participants with Parkinson disease in the East.

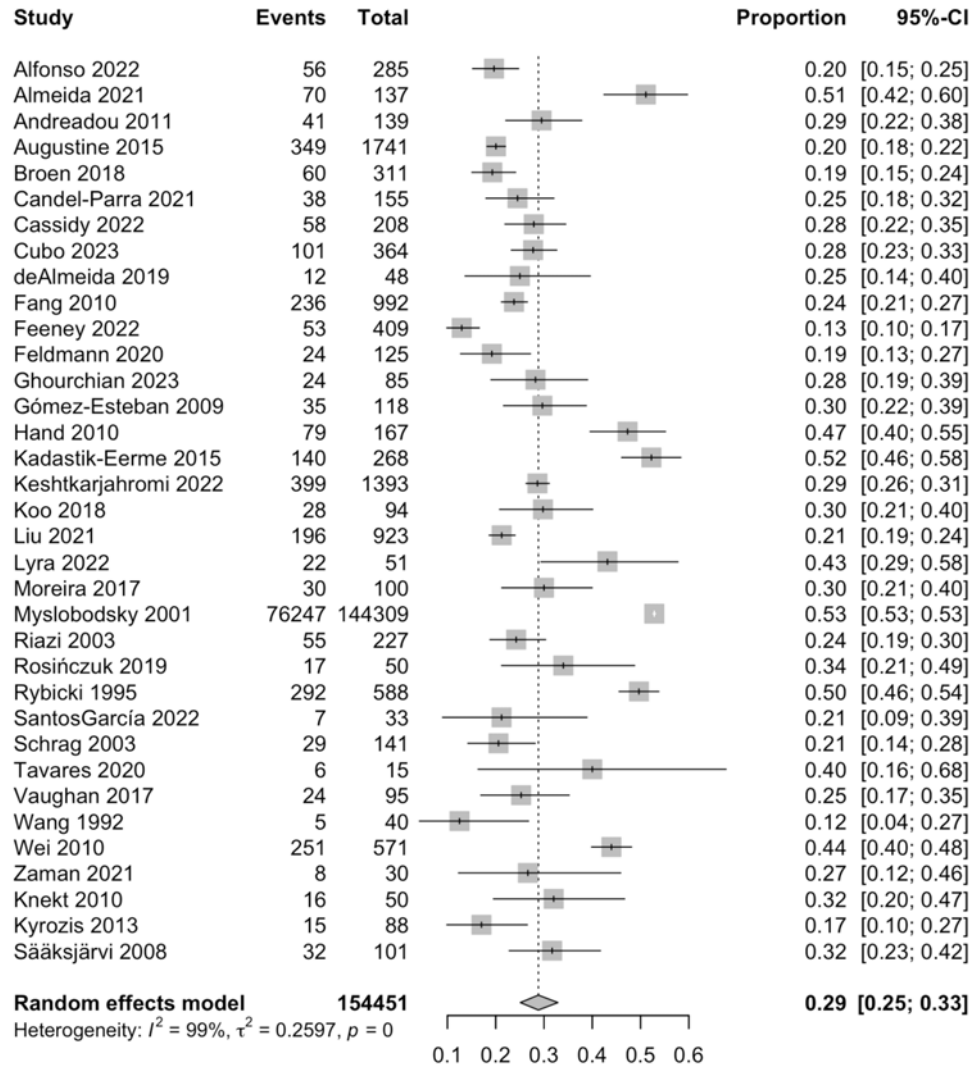


**Figure 2.** Forest plot of prevalence of being unmarried in participants with Parkinson disease in the West.


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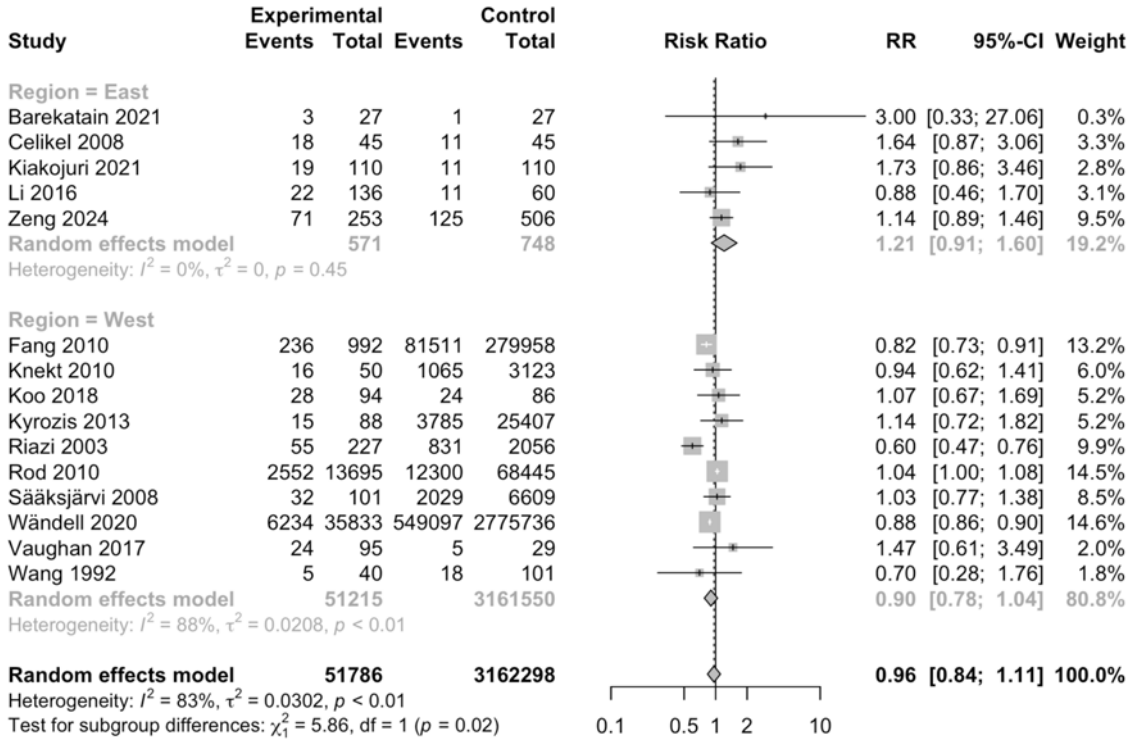


**Figure 3.** Forest plot of risk ratio of being unmarried in participants with Parkinson disease versus controls between East and West.

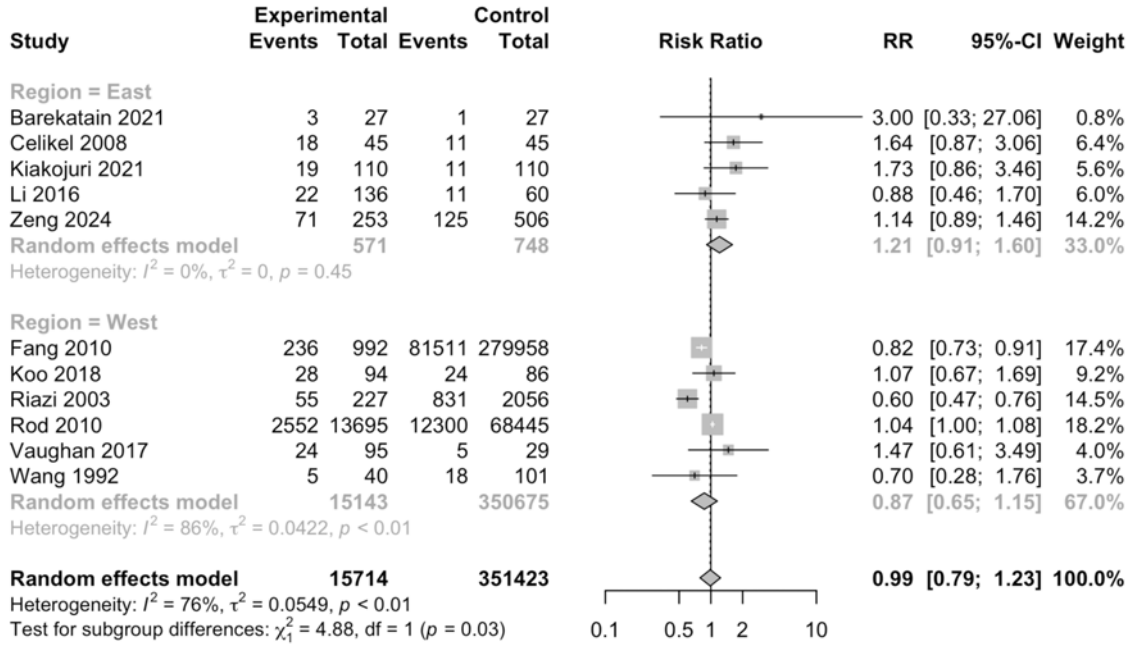


**Figure 4.** Forest plot of risk ratio of being unmarried in participants with Parkinson disease versus controls between East and West after onset of Parkinson disease.

countries in the East. In America, a national census found that 42.6% of older adults were unmarried, while in Singapore, only 18.7% of male seniors were unmarried.[66,67] Although life expectancy and matrimonial law may differ between countries, the stark contrast in marital status suggests strong inherent regional and cultural differences toward marriage. In many Eastern countries, being unmarried carries a considerable stigma, and the pressure to remain in a marriage for the sake of children, appearances and family honor is strong.[68] As a result, spouses would choose to remain in the marriage in spite of the personal challenges and sacrifices. Furthermore in Eastern cultures, the concept of "face," a social concept that incorporates elements of pride, societal value and avoidance of embarrassment at all costs, reduces the desire to seek a divorce and live unmarried.[69] Additionally, familial support systems are crucial in maintaining familial and spousal relationships. In general, Eastern societies


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have extended family systems, while Western societies tend to have more nuclear family structures.[70] Such extended family systems may play a crucial role in supporting participants with chronic diseases like PD. This is because there is a high degree of interdependence among families, and extended families and kinship networks are an important source of social support.[71] Particularly in East Asia, the proportion of offspring caregivers is large because filial piety is perceived as an important virtue, where a child is raised to respect and care for their parents.[72] With a greater network of caregivers, this could reduce the burden on a single spouse and preserve marital relations. In contrast, with the nuclear family structures of Western societies, the caregiver burden on the spouse might be higher, and this could lead to the breakdown of the marriage.[70] Therefore, due to inherent cultural and societal attitudes toward marriage, the unmarried rates of participants with PD are higher in the West compared to the East.

Although the prevalence of unmarried rates of participants with PD are higher in the West compared to East, we found that compared to controls, the risk of being unmarried in participants with PD was 31% higher in the East than the West. The disparity in the findings of lower prevalence of unmarried rates in the general population but higher risk of being unmarried in the East among PD population suggests some contribution of the disease to the difference. Compared to countries in the East, there is a greater emphasis on healthcare spending by countries in the West, coupled with greater social service support beyond hospital care.[73] Based on World Health Organization Global Health Expenditure Database, countries in the West have the highest total health spending as a percentage of GDP, while countries in the East spend a smaller fraction of their GDP on health care.[74] A lower healthcare spending would create a financially and resource constrained system, limiting resources toward clinical services. Especially in participants with PD where the role of caregiver is highly important and majority of caregivers are the patient's spouse, the provision of resources toward caregiver training and supporting families with PD participants is essential.[75] The importance of social support beyond clinical treatment is highly essential. For example, in the United Kingdom, resources and helplines are available for participants with PD and their family members. Furthermore, there are integrated systems and multi-agency plans to help participants with PD cope in the community.[75] Resources are also in place to support caregivers to mitigate caregiving-related distress and burnout. Notably, a study of caregivers in America by Bayram et al. found significantly higher caregiver burnout rates in caregivers of Eastern origin.[76] Caregiver burnout has been shown to be correlated significantly with caregivers' satisfaction with their marital relationships, and this could potentially affect marital outcomes negatively (3). In the West, medical facilities are well-developed, with accessibility to effective treatment facilities and physicians. Furthermore, there is also a higher physician-to-population ratio in countries in the West compared to the East.[77] The accessibility and higher physician ratio allow better management and control of the motor and non-motor features of PD. This is essential as motor and non-motor symptoms afflicted by PD are a common cause of frustration due to the loss of independence from daily activities of living and employment.[57] This could result in decreased quality of life, fulfillment and interest in daily activities, consequently resulting in psychological issues and affecting marital relationship.[78]

In a subgroup analysis after the onset of PD, the risk of being unmarried in participants with PD was significantly higher in the East (RR: 1.21, 95% CI: 0.91–1.60) than the West (RR: 0.87, 95% CI: 0.65–1.15) as compared to controls. After the onset of PD, the risk of being unmarried in participants with PD was 34% higher in the East than the West. This highlights that differences in societal norms and healthcare systems may be important in determining marital status outcomes in participants with PD. Although unmarried rates of participants with PD are higher in the West compared to the East, this could be attributed to an inherent societal trend of increased divorce rates and reduced married rates.[11] Meanwhile, the increased risk of being unmarried in participants after the onset of PD in the East indicates a severe implication of PD on marital relationships and quality. As majority of the caregivers in PD participants are their spouses and in their 60s,[4] at a time when their peers are preparing for retirement, spouses of participants with PD face a marital obligation to support their spouse through PD. In a study of caregivers, it was found that 65% of carers felt their social life had suffered as a result of caring for participants with PD and expressed significantly lower social support satisfaction compared to PD participants themselves.[7] Furthermore, the lack of access to quality health care and physicians, coupled with poor social support services, may inevitably contribute to the increased risk of participants with PD being unmarried in the East compared to the West.

Our study has some inherent limitations. First, it was not possible to compare changes in marital status as PD progresses as all the studies collected marital status either before or after the onset of PD. There were no retrospective or prospective studies that compared marital status before and after the onset of PD. Second, there was some heterogeneity in the reporting of marital status. We have defined widely used unmarried status as either single, divorced, widowed or separated. While all the studies reported if patients were married or unmarried, most studies were not explicit in reporting whether patients were "single, divorced, widowed or separated." Future studies should be more explicit in identifying the marital status of patients. Nevertheless, we recognize that the lack of further data or percentage on each of these four subgroups in unmarried status will restrict the interpretations of the findings. Third, while there are many other factors that can have an effect on marital status such as average age of participants, gender proportion, disease duration and year of study, we were not able to perform a meta-analysis on marital status based on those factors. Majority of the studies were already conducted in patients with mean age of 60 and above, and marital status of different genders were not specified. In addition, studies with large population sample recruited patients over a long period of time, with varied disease duration and year of inclusion into study. While we recognize that these have possible impact on marital status, we are not able to perform a meta-analysis for it. Lastly, although the methodological quality may differ due to the large number of studies involved, marital status is an objective data, and the risk of bias is low.

Future prospective studies should evaluate PD participants longitudinally and determine their marital status over time before onset and after the onset of PD. Relationship between duration of PD, availability of social support services and marital status should be also be further examined.

## Conclusion

Our meta-analysis showed a prevalence of 25.16% unmarried rate in participants with PD, with significantly higher rates in Western compared to Eastern countries. After the onset of PD, participants in the East were at significantly higher risk of being unmarried


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compared to participants in the West, suggesting that differences in cultural practices, societal norms and healthcare systems may affect marital status outcomes in PD participants. Future prospective studies should evaluate changes of marital status before and after the onset of disease.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/cjn.2024.362.

**Availability of data and materials.** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Author contributions.** WYC and EKT were involved in the initial planning, study design and methodology of the study. WYC worked on the search strategy and performed all the analysis. JJDW and CKMC screened the articles, collected the data and assessed the risk of bias. WYC and CKMC drafted the manuscript. JJDW, LLC and EKT performed critical revisions of the manuscript for intellectually important content. All authors provided critical conceptual input, interpreted the data analysis and read and approved the final draft. WYC and EKT have accessed and verified the data. WYC and EKT were responsible for the decision to submit the manuscript.

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