

# Supplemental Online Content

Krzyzanowski B, Mullan AF, Dorsey ER, et al. Proximity to golf courses and risk of Parkinson disease. *JAMA Netw Open*. 2025;8(5):e259198. doi:10.1001/jamanetworkopen.2025.9198

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This supplemental material has been provided by the authors to give readers additional information about their work.

**eTable 1:** Sensitivity analysis for RUCA

Categorical	Individuals in Urban Areas (RUCA = 1)		Further Adjusted for Region Characteristics <sup>2</sup>	
	PD Patients (N = 337)	Controls (N = 1557)	aOR (95% CI)	P-Value
Proximity to Golf Course				
Less than 1 mile	60 (18.0%)	274 (82.0%)	2.71 (1.41, 5.22)	0.003
1-2 miles	188 (20.7%)	719 (79.3%)	3.31 (1.80, 6.09)	< 0.001
2-3 miles	76 (17.8%)	350 (82.2%)	2.54 (1.34, 4.81)	0.004
More than 3 miles	13 (5.7%)	214 (94.3%)	Reference	---
Cubic Splines	All Patients <sup>1</sup>		Further Adjusted for Region Characteristics <sup>2</sup>	
Proximity to Golf Course	PD Patients (N = 337)	Controls (N = 1557)	aOR (95% CI), per ½ mile	P-Value
0-3 miles	324 (19.4%)	1343 (80.6%)	0.99 (0.91, 1.09)	0.94
More than 3 miles	13 (5.7%)	214 (94.3%)	0.49 (0.30, 0.79)	0.003

<sup>1</sup>Percentages were calculated row-wise

<sup>2</sup>Demographics included age, sex, race, and ethnicity. Region characteristics included median household income, and healthcare utilization

**eTable 2:** Differences between Olmsted and non-Olmsted controls

	<b>Olmsted Controls (N = 1727)</b>	<b>Non-Olmsted Controls (N = 3386)</b>
Age at index, years		
Median (Q1, Q3)	71 (63, 78)	73 (66, 80)
Sex, n (%)		
Female	702 (40.6%)	1368 (40.4%)
Male	1025 (59.4%)	2018 (59.6%)
Race, n (%)		
American Indian/Alaskan Native	4 (0.2%)	5 (0.1%)
Asian	26 (1.5%)	28 (0.8%)
Black/African American	27 (1.6%)	2 (0.1%)
Hawaiian/Pacific Islander	1 (0.1%)	0 (0%)
White	1406 (81.4%)	3098 (91.5%)
Other/Mixed Race	21 (1.2%)	46 (1.4%)
Unknown/Did not disclose	242 (14.0%)	207 (6.1%)
Ethnicity, n (%)		
Hispanic or Latino	18 (1.0%)	28 (0.8%)
Not Hispanic or Latino	1468 (85.0%)	3153 (93.1%)
Unknown/Did not disclose	241 (14.0%)	205 (6.1%)
Median household income, thousands of dollars		
Median (Q1, Q3)	61.3 (48.7, 78.5)	54.0 (45.8, 63.3)
RUCA classification, n (%)		
Urban	1157 (67.0%)	400 (11.8%)
Suburban	519 (30.1%)	1810 (53.5%)
Rural	51 (3.0%)	1176 (34.7%)
Water source, n (%)		
Ground water	1440 (83.4%)	2473 (73.0%)
Surface water	0 (0%)	56 (1.7%)
Private well water	287 (16.6%)	857 (25.3%)
Pre-index healthcare utilization, days		
Median (Q1, Q3)	2.6 (0.0, 8.8)	0.2 (0.0, 3.0)
Any utilization within 5 years, n (%)	1148 (66.5%)	1842 (54.4%)
Distance to nearest golf course, miles		
Median (Q1, Q3)	1.75 (1.17, 2.58)	2.30 (1.20, 5.34)

**eTable 3: Primary analysis with Olmsted controls**

Proximity to Golf Course	All Patients			PD versus Olmsted Controls		PD versus non-Olmsted Controls	
	PD Patients (N=419)	Olmsted Controls (N=1727)	Non-Olmsted Controls (N=3386)	aOR (95% CI)	P-Value	aOR (95% CI)	P-Value
Less than 1 mile	78 (7.3%)	334 (31.4%)	653 (61.3%)	2.33 (1.10, 4.94)	0.027	2.78 (1.26, 6.12)	0.011
1-2 miles	207 (11.4%)	737 (40.7%)	868 (47.9%)	2.90 (1.41, 5.97)	0.004	4.27 (2.04, 8.91)	< 0.001
2-3 miles	82 (9.3%)	309 (35.0%)	492 (55.7%)	2.93 (1.13, 5.06)	0.022	2.31 (1.05, 5.06)	0.037
3-6 miles	43 (4.5%)	265 (27.7%)	648 (67.8%)	1.60 (0.74, 3.50)	0.24	1.43 (0.64, 3.18)	0.38
More than 6 miles	9 (1.1%)	82 (10.0%)	725 (88.8%)	Reference	---	Reference	---

<sup>1</sup>aORs were adjusted for patient demographics (age, sex, race, and ethnicity), median household income, RUCA classification, and healthcare utilization.

**eTable 4.** Association between minimum municipal well depth within a water service area (WSA) and risk of Parkinson’s Disease and association between presence of municipal well on a golf course and risk of Parkinson’s Disease in the 27-county Rochester Epidemiology Project study area.

Minimum Well Depth	All Patients <sup>1</sup>		All WSAs		WSAs with a golf course	
	PD Patients (N = 115)	Controls (N = 1526)	aOR <sup>2</sup> (95% CI)	P-Value	aOR (95% CI)	P-Value
Shallow, <100ft	6 (10.2%)	53 (89.9%)	Reference	---	Reference	---
Deep, >100ft	109 (6.9%)	1,473 (93.1%)	0.63 (0.24, 1.64)	0.34	0.56 (0.21, 1.50)	0.25

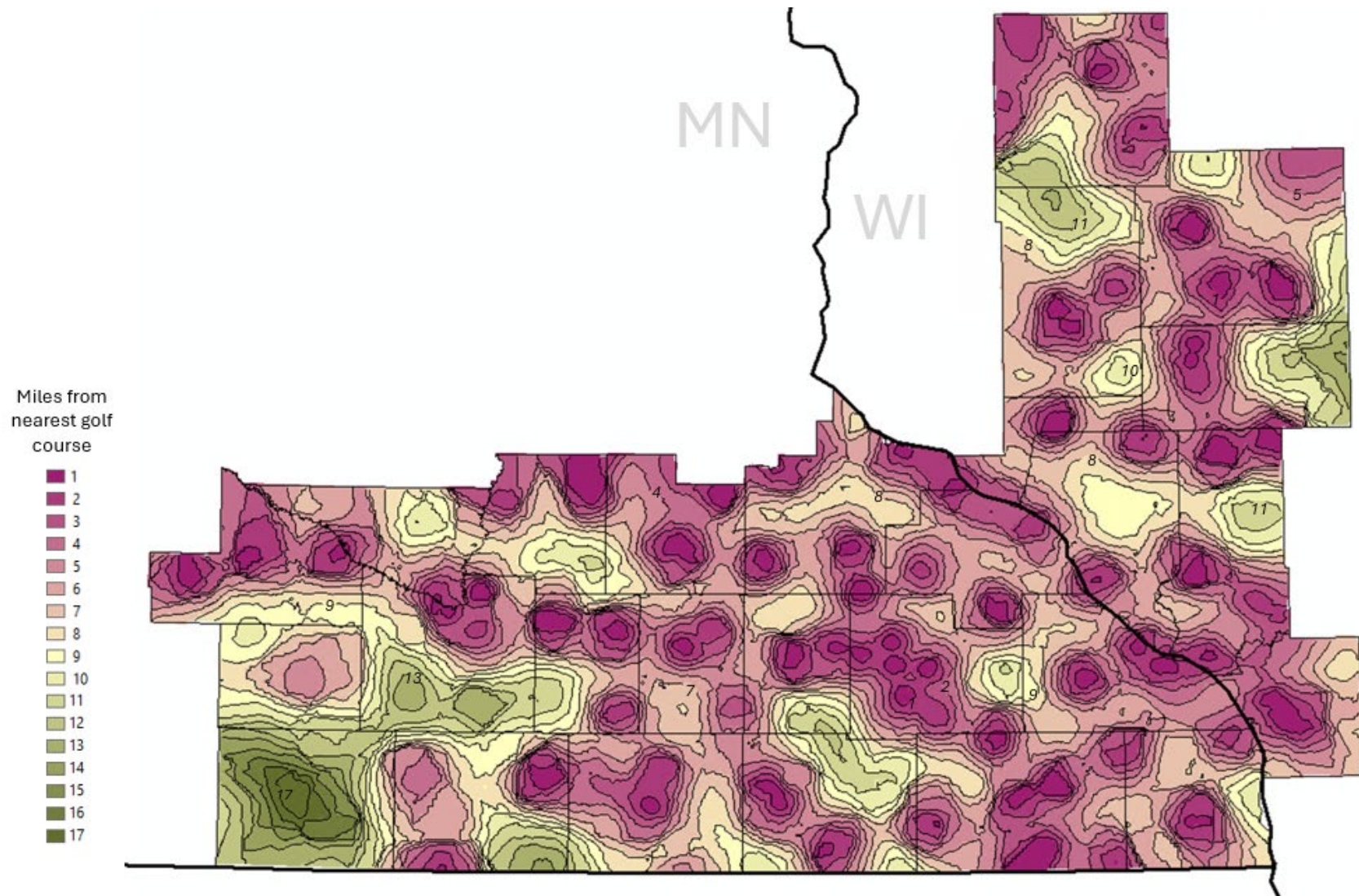
  

Municipal Well Location	All Patients <sup>1</sup>		All WSAs		WSA with vulnerable groundwater	
	PD Patients (N = 239)	Controls (N = 3448)	aOR <sup>2</sup> (95% CI)	P-Value	aOR <sup>2</sup> (95% CI)	P-Value
No wells on a golf course	115 (5.9%)	1839 (94.1%)	Reference	---	Reference	---
At least one well on a golf course	124 (7.2%)	1609 (92.8%)	1.25 (0.94, 1.66)	0.12	1.13 (0.84, 1.52)	0.41

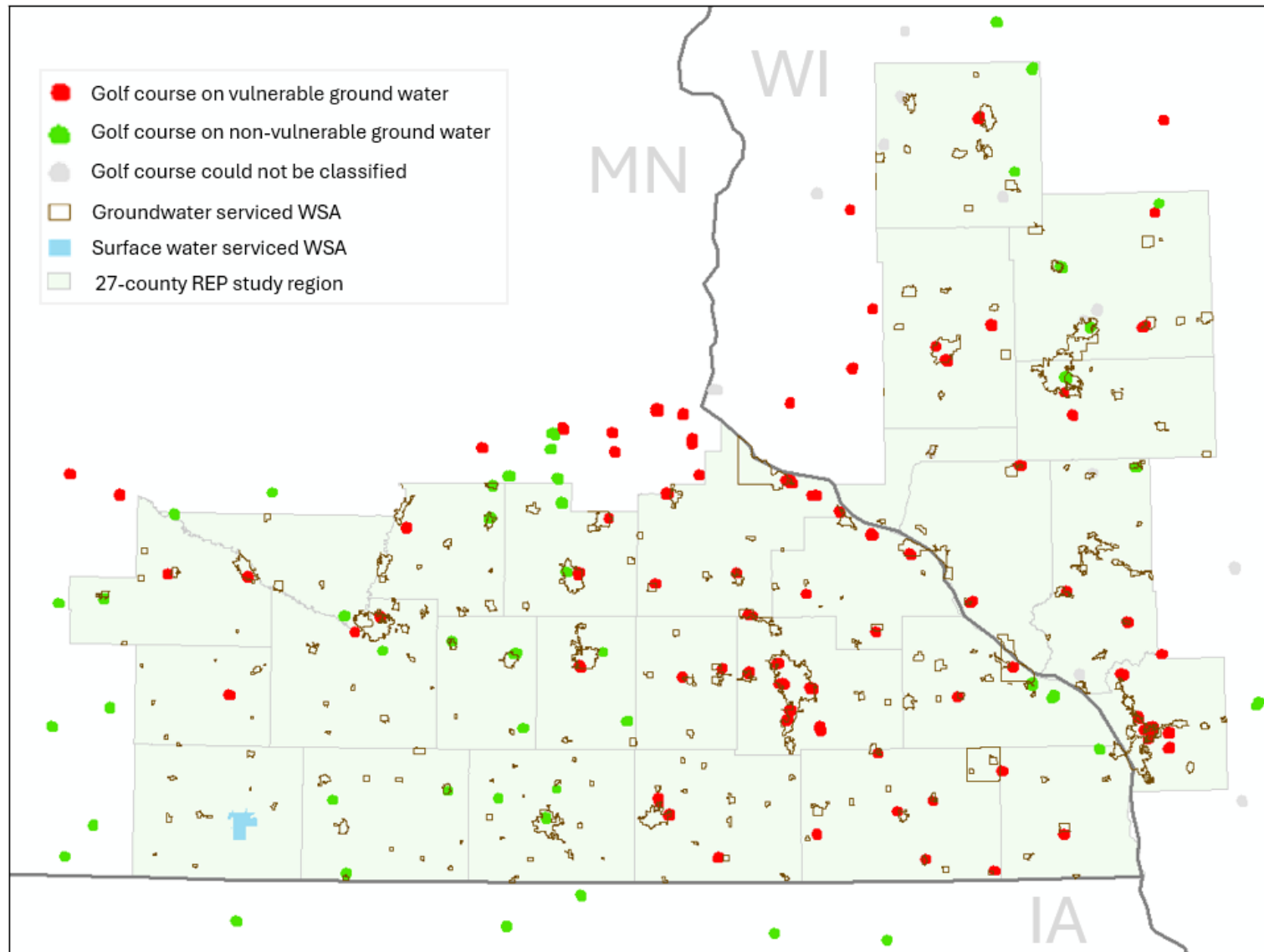
<sup>1</sup> Percentages were calculated row-wise

<sup>2</sup> Odds ratios were adjusted for demographics (age, sex, race, and ethnicity) and region characteristics (median household income, RUCA classification, and healthcare utilization).

**eFigure 1:** A contour map showing the distance in miles to the edge of the nearest golf course in Southeast Minnesota and Northwest Wisconsin.



**eFigure 2:** A map of water service areas and golf courses on vulnerable and non-vulnerable ground water.



**eFigure 3.** Standard calibration plot for predicting risk of PD using categorical proximity to golf course, patient demographics, and region characteristics (Brier score 0.060)

