

- **Rurality was associated with lower odds of ADRD. In AI/AN, availability of medical specialists (e.g., neurologists, psychiatrists) explains a large proportion of the rural-urban differences in prevalence of diagnosed ADRD.** Accounting for rurality × specialist-density interaction increases the proportion explained.
- GPs, hospital resources, and other healthcare resources does not explain the rural-urban differences
- **The pathway is different between AI/AN and White populations.** Medical specialists does not explain the rural-urban differences in White.

BACKGROUND

- Alzheimer’s disease and related dementias (ADRD) disproportionately burden American Indian and Alaska Native (AI/AN) communities, yet the link between rural residence and recorded ADRD remains inconclusive.
- Lower ADRD rates in rural areas may reflect a true difference, or under-ascertainment from limited access to diagnostic and specialty care.
- Whether healthcare-resource availability explains rural–urban ADRD differences, and whether the pathways differ by race, is unknown.

OBJECTIVE

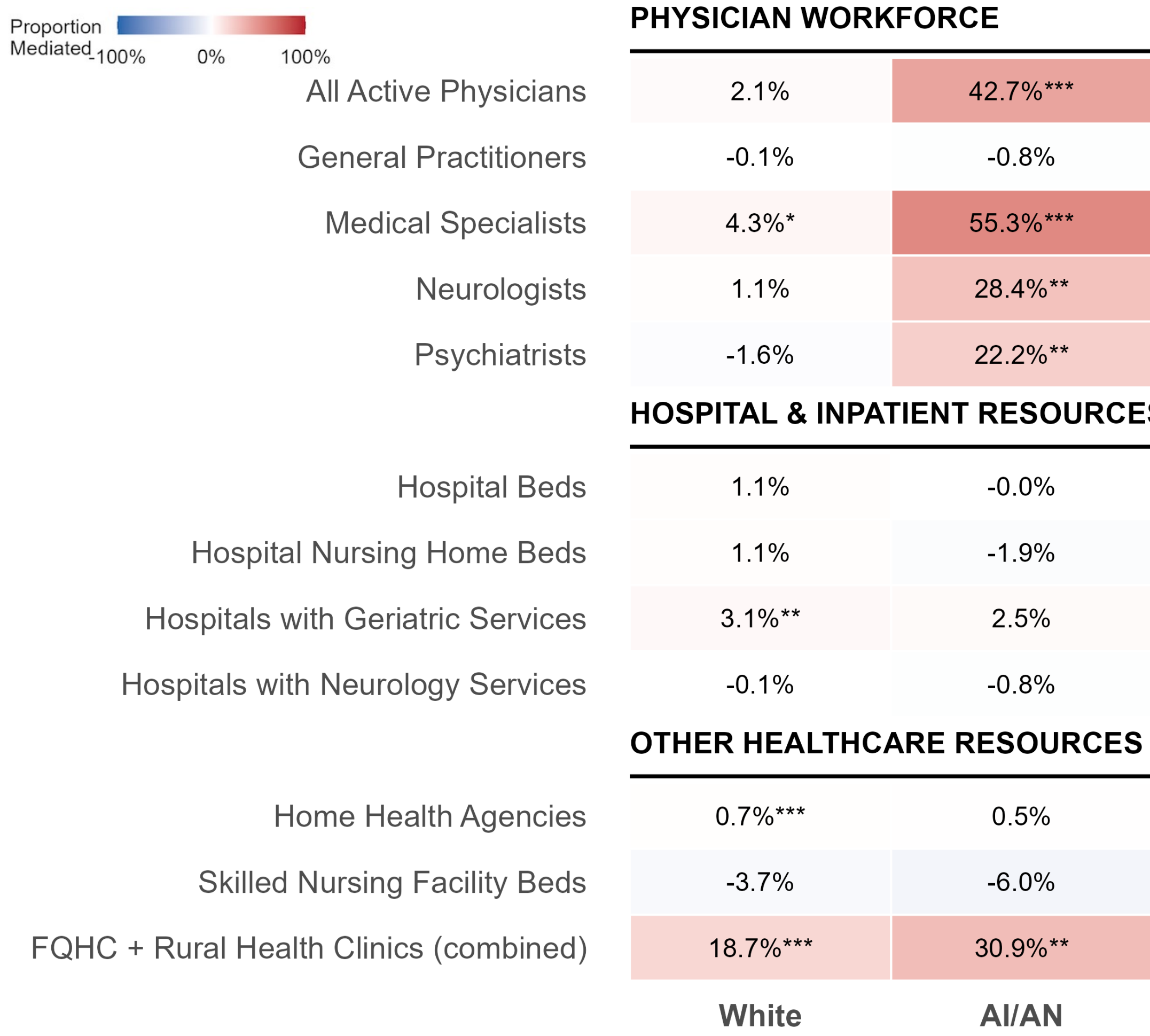
- Examine whether county-level healthcare-resource density explains (partially) the association between rural residence and recorded ADRD
- Compare these pathways between AI/AN and White Medicare beneficiaries.

METHODS

- **Design & sample**
 - 2022 Medicare Master Beneficiary Summary File
 - Fee-for-service beneficiaries aged ≥65
 - AI/AN 100% (n = 103,197)
 - White: 5% random sample (n = 1,036,698)
- **Exposure:** Rural residence (2023 National Center for Health Statistics Urban–Rural Classification Scheme codes 5–6).
- **Outcome:** Recorded ADRD (prevalent, claim-based, from MBSF chronic-conditions segment, end-of-year indicator).
- **Mediators**
 - Density of 15 county-level healthcare resources (2022 Area Health Resource File) across three domains: physician workforce, hospital/inpatient, and other healthcare resources.
 - Density defined as count of each resource by 100K population in each county, then z-scored for analysis.
- **Analysis**
 - Counterfactual mediation decomposing the total effect (odds ratio) into natural direct and indirect effects, race-stratified
 - Adjusted for age, sex, Medicaid, county poverty & education, and region
 - Compared 2-way decomposition with and without exposure×mediator interaction
 - Further examined 4-way decomposition to quantify the effect of exposure × mediator interaction
 - Calculated controlled direct effects across specialist density values

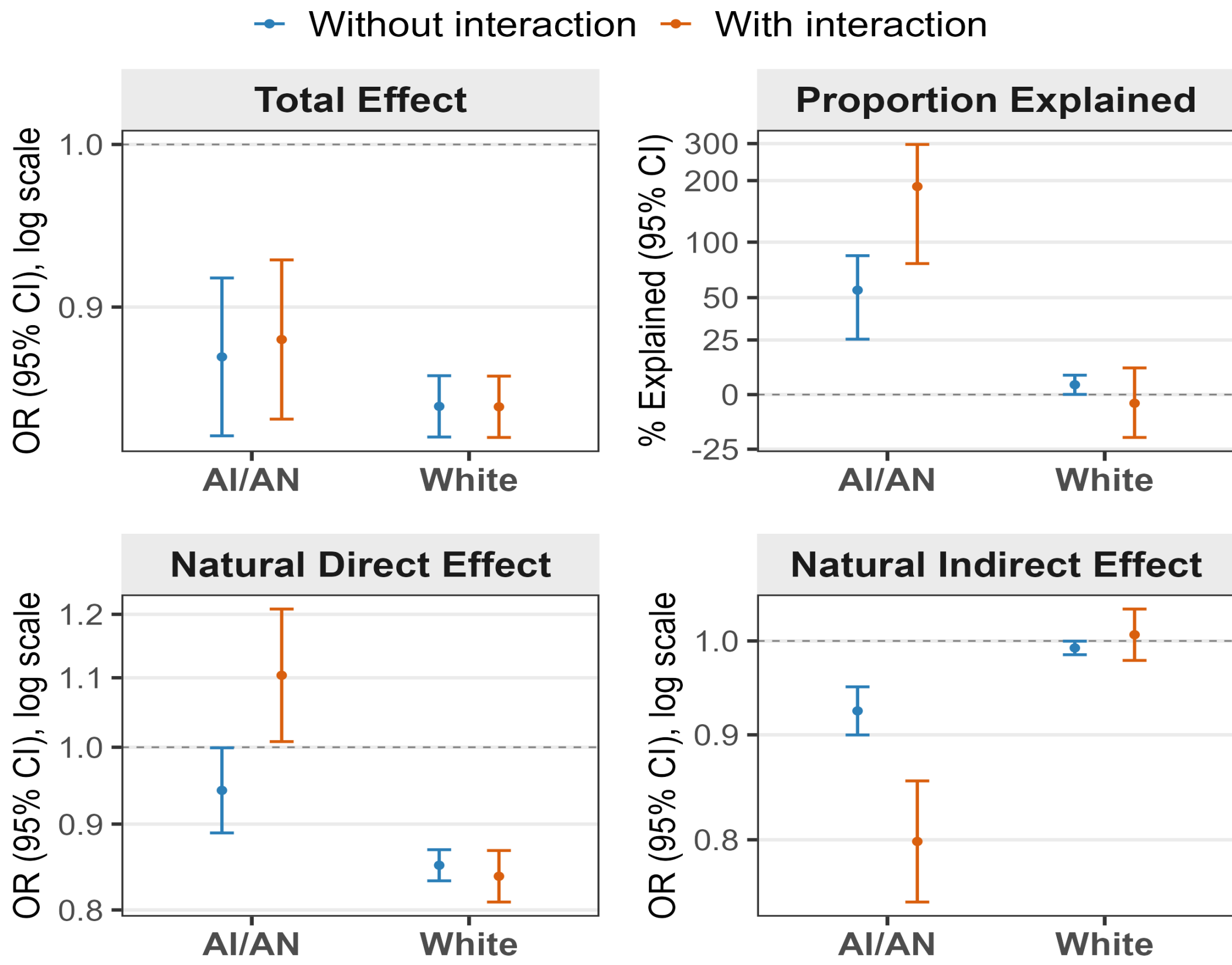
RESULTS

Figure 1. Proportion of the rural–urban ADRD difference explained by selected county-level healthcare resource density (2-way, no interaction), by race



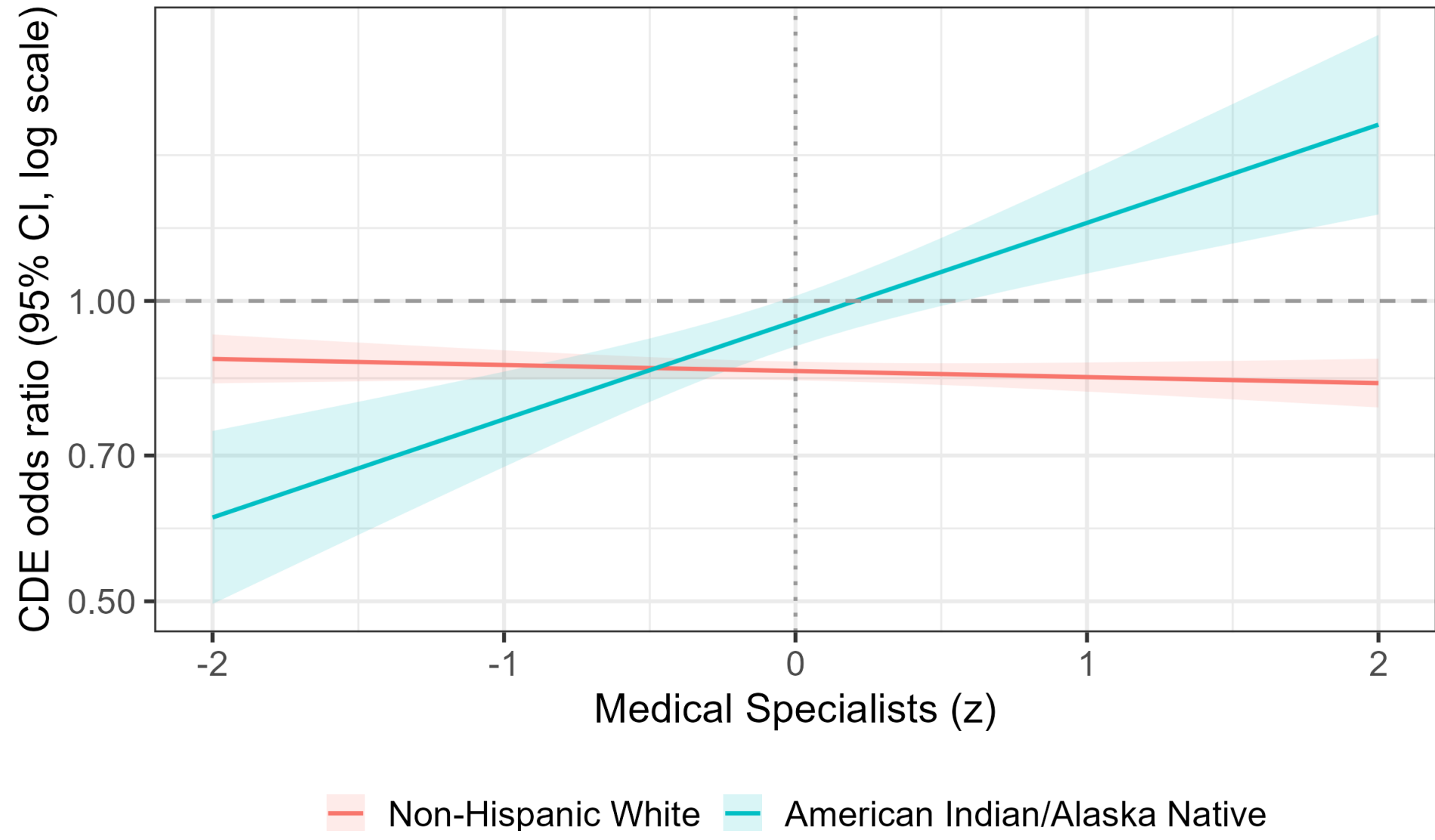
Reduced physician-workforce supply (medical specialists ≈55%, all active physicians ≈43%, neurologists ≈28%, psychiatrists ≈22%, but not general practitioners) explained the rural–urban ADRD difference in AI/AN. Little mediation was seen in White. *p<0.05, **p<0.01, ***p<0.001.

Figure 2. Rurality-ADRD associations explained by specialist density, using counterfactual mediation analysis: ± A–M interaction



In AI/AN, this mediation is driven by the rurality × specialist-density interaction, which lifts the proportion explained from ≈55% to ≈187%. Values >100% arise because the direct and indirect effects act in opposite directions (direct OR >1, indirect OR <1). This interaction was absent in White.

Figure 3. Controlled direct effect of rural vs urban residence on ADRD across levels of medical-specialist density, by race



The slope is the rurality×specialist interaction: for AI/AN, the rural effect depends on specialist density: protective where specialists are scarce, reversing where abundant; for White it is essentially flat. Shaded = 95% CI; z = standardized specialist density.

Table 2. Results of 4-way decomposition of the rural effect on ADRD through medical-specialist density

Component	AI/AN	White
Total effect (TE)	0.88 (0.84, 0.93)	0.84 (0.83, 0.86)
Sum of following individual effects = TE-1		
Controlled direct effect (CDE)	-0.04 (-0.06, -0.03)	-0.15 (-0.15, -0.14)
Reference interaction (INTref)	0.15 (0.06, 0.23)	-0.01 (-0.04, 0.01)
Mediated interaction (INTmed)	-0.17 (-0.25, -0.09)	0.01 (-0.01, 0.04)
Pure indirect effect (PIE)	-0.05 (-0.08, -0.02)	-0.01 (-0.02, -0.00)

The total effect was similar in AI/AN and White populations (0.88 vs. 0.84), but the decomposition revealed distinct pathways.

- Among AI/AN individuals, the effect was driven primarily by mediated interaction and pure indirect effects (significant negative INTmed = -0.17, PIE = -0.05)
- Among White individuals, the effect was largely attributable to a stronger negative controlled direct effect, with minimal contribution from indirect or interaction effects.

CONCLUSIONS

- **Reduced medical-specialist density** substantially explains the lower recorded ADRD among rural AI/AN beneficiaries, but not among White; hospital and other healthcare resources contribute little.
- The **mediated rurality×specialist-density interaction explains a large proportion** of the rural-urban ADRD difference in AI/AN: accounting for it raises the proportion explained to ≈187% from 55%.
- The rural effect is conditional on specialist density for AI/AN only, indicating the rural “advantage” likely reflects diagnostic under-ascertainment rather than lower disease burden.
- Expanding access to dementia-specialty care in rural and AI/AN communities may close diagnostic gaps and advance equity.

LIMITATIONS

- Cross-sectional analysis; causal pathways cannot be definitively established.
- Claims-based ADRD may reflect diagnostic ascertainment rather than true disease burden.

Acknowledgments

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