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INTRODUCTION

- Elite tackle football play has been associated with dementia and several neurodegenerative pathologies, including chronic traumatic encephalopathy.
- However, these associations were identified in highly selected brain banks or among professional players.
- Here we leveraged recent United States (US) county-level football participation and dementia rates to investigate the football-dementia relationship at a national level.

METHODS

- Ecological geospatial analysis evaluating association between US county-level football play and dementia
- 3,139 US Counties defined by FIPS code maintained by US Census Bureau
- Predictors: County-level tackle football participation rates were previously determined based on survey data obtained from a nationally representative sample of adults (aged 16+, 2024) and modeled with socio-demographic data from census tracts Information accrued on county-level sports play (The Kinetica Group); County level basketball participation rate (negative control)
- Outcome: County level dementia prevalence among Medicare beneficiaries (NORC Dementia DataHub⁵, 2017-2019),
- Covariates: Socioeconomic Status (Multidimensional Deprivation Index (MDI)- US Census), Life Expectancy (US Census), Cardiovascular Risk Factors (CDC PLACES Survey)
- Model: Multivariable mixed-effects linear regression leveraging a U.S. spatial correlation matrix; Assumes that relative county-level geospatial relationships for football play have remained stable over time

RESULTS

- Across 3,139 counties, mean U.S. tackle football participation in the past 5 years was 9.5%, mean basketball participation in the past 5 years was 21.6%, and mean dementia prevalence was 12.4% among Medicare beneficiaries (Table 1)
- For a 1% increase in football participation, there was a 0.13% (95% CI: 0.04 – 0.22) increase in dementia prevalence (Table 2)
- Association sizes did not change after additional covariate adjustment (Table 2)
- Assuming recent rates of play and dementia, football play would explain an additional 128,425 dementia cases across the US among Medicare beneficiaries (Figure 4)
- Increases in basketball play were not associated with an increase in dementia prevalence

REFERENCES

1. Elahi, F.M. and B.L. Miller, *A clinicopathological approach to the diagnosis of dementia*. Nat Rev Neurol, 2017. **13**(8): p. 457–476.
2. Dintica, C.S. and K. Yaffe, *Epidemiology and Risk Factors for Dementia*. Psychiatr Clin North Am, 2022. **45**(4): p. 677–689.
3. Bellomo, G., et al., *A systematic review on the risk of neurodegenerative diseases and neurocognitive disorders in professional and varsity athletes*. Neurol Sci, 2022. **43**(12): p. 6667–6691
4. The Kinetica Group. Available from: <https://thekineticagroup.com/>
5. Dementia DataHub. Available from: <https://www.dementiadatahub.org/>
6. College Football Data. [cited 2025; Available from: collegefootballdata.com.

RESULTS

Table 1: Descriptive statistics across US counties (N=3139 counties)

Variable	Mean (SD)
Dementia prevalence rate	12.4 (2.59)%
Adult 5-yr football participation rate	9.5 (0.95)%
Adult 5-yr basketball participation rate	21.6 (1.51)%
Male Medicare beneficiaries	47.2 (2.08)%
Life expectancy at 15-24 yrs of age	63.7 (2.48) yrs
Life expectancy at 65-74 yrs of age	19.5 (1.61) yrs
Multidimensional Deprivation Index (MDI)	16.3 (11.64) units
Race	
White	83.8 (17.74)%
Black	7.6 (13.28)%
Hispanic	4.0 (9.98)%
Binge Drinking*	18.0 (3.18)%
High Blood Pressure*	32.4 (4.72)%
Smoking history*	21.3 (4.15)%
Diabetes*	10.9 (2.32)%
High Cholesterol*	30.2 (2.31)%
Obesity*	35.2 (4.52)%
Coronary Heart Disease*	3.4 (0.67)%

* Vascular risk factors listed are age-adjusted prevalence rates

Table 2: Associations between US county-level athletic play and dementia (N=3139 counties)

Predictor	Model	Estimate (95% CI)
Adult 5-yr football participation ¹	base	0.131 (0.038 – 0.223)
Adult 5-yr football participation ²	base + additional risk factors	0.110 (0.011 – 0.210)
Adult 5-yr basketball participation ¹	base	-0.066 (-0.132 – -0.001)

¹ Base: adjusted for male medicare beneficiaries, life expectancies at age 15-24 and 65-74, MDI, race (Black and Hispanic)

² Additional risk factors: binge drinking, high BP, smoking history, diabetes, high cholesterol, obesity, coronary heart disease

CONCLUSION

- County-level tackle football participation was associated with dementia prevalence independent of smoking and vascular risk factors
- Evidence for football-dementia relationship beyond elite professional level
- Football participation and Dementia prevalence in the US overlap geospatially specifically in the Southeast and South Central
- Negative association of dementia and basketball play despite significant overlap of relative football and basketball participation rates
- Future directions: geospatial analyses incorporating the amount of football play and college recruitment data simulating intensity of play

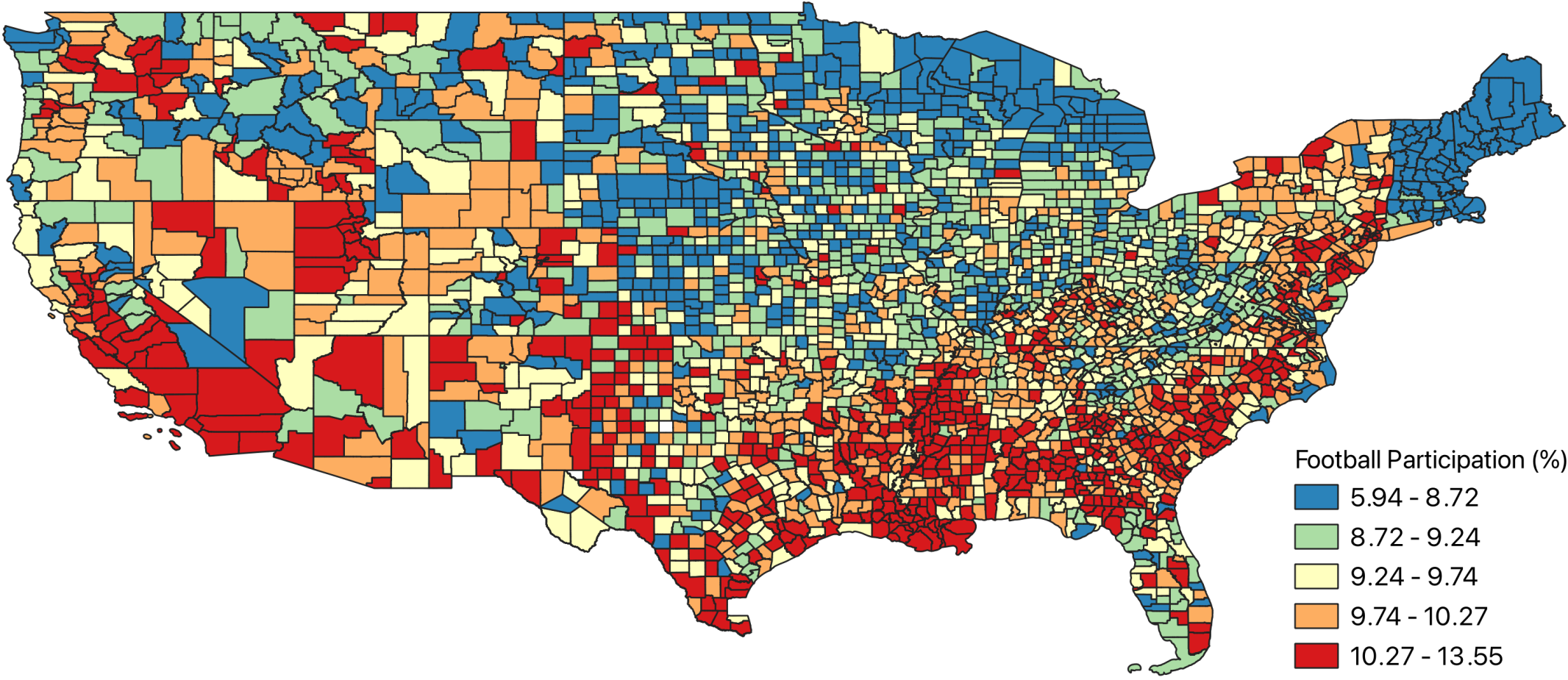


Figure 1: Prevalence of tackle football play in adults (16+ years) showing variation by county, Kinetica Group, 2024

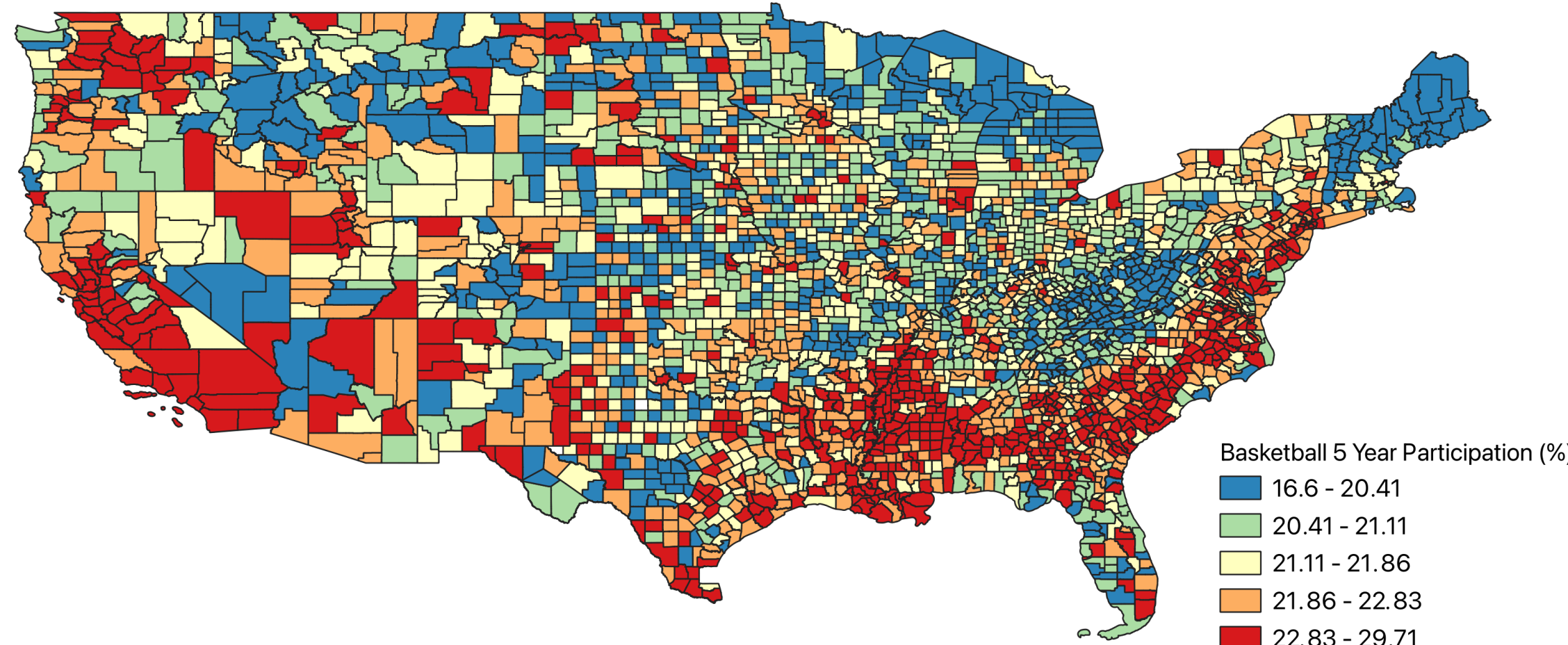


Figure 2: Prevalence of basketball play in adults (16+ years) showing variation by county, Kinetica Group, 2024

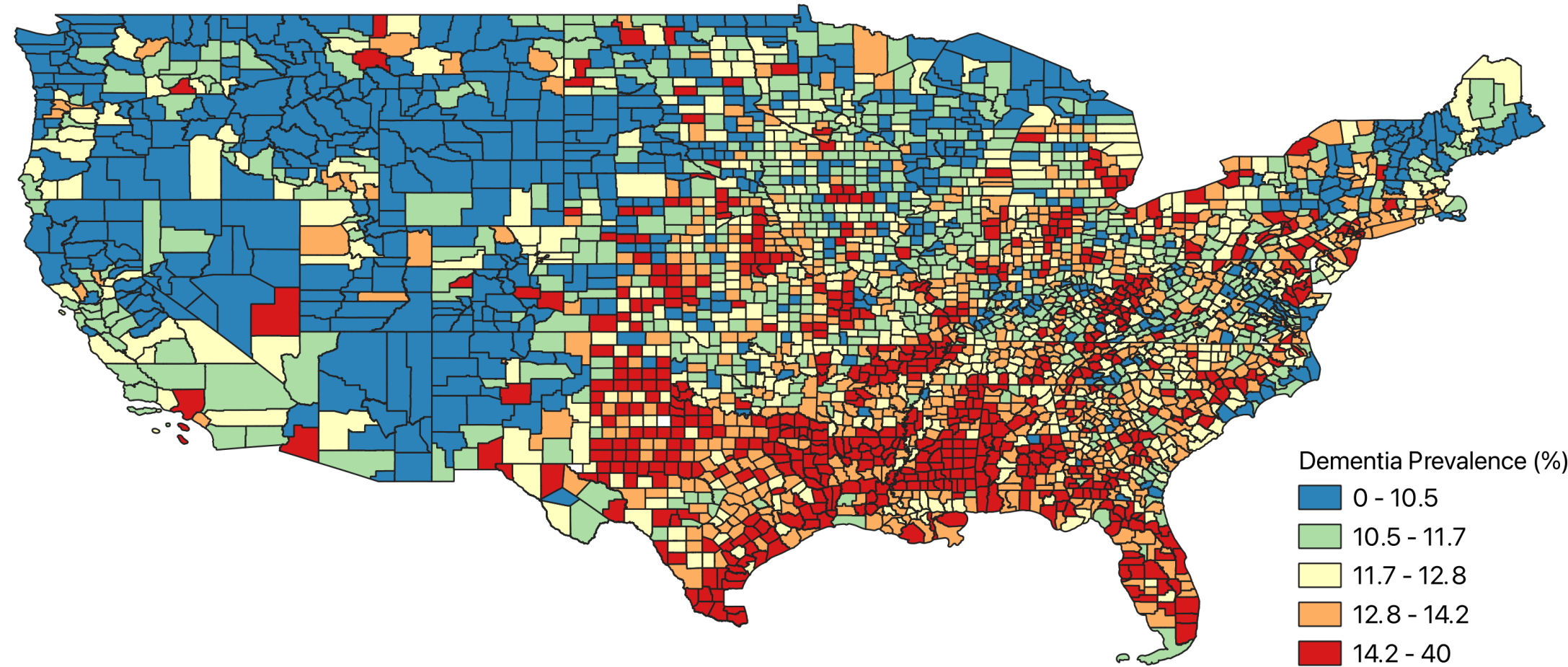


Figure 3: Prevalence of dementia in Medicare beneficiaries showing variation by county, NORC Dementia DataHub 2016 -2017

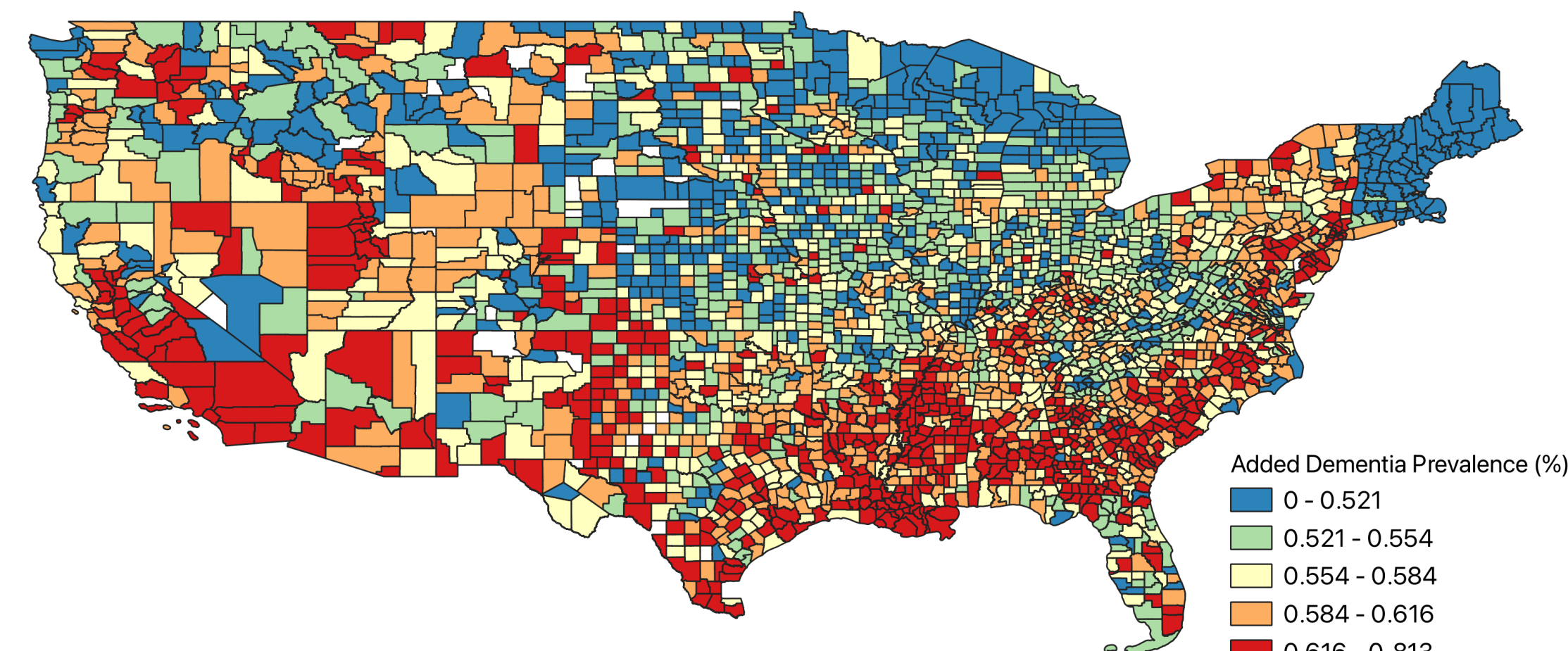


Figure 4: County-level increase in dementia prevalence attributable to football.