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Marginalization-Related Diminished Returns

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Weaker Association Between Neighborhood Income and Health Behaviors in Census Tracts With Higher Proportions of Racial and Ethnic Minority Residents

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Abstract Objective. To examine whether associations between neighborhood economic circumstances and four adult health behaviors vary with neighborhood racial and ethnic composition.

Methods. We linked 2014–2018 American Community Survey measures to 2022–2023 Behavioral Risk Factor Surveillance System–based prevalence estimates from CDC PLACES. Separate tract-level linear models included state fixed effects, age composition, income, education, and interactions between three socioeconomic indicators and two population shares. We estimated county-clustered confidence intervals and two-sided nominal interaction P values.

Results. Among 56,112 tracts in 2,891 counties, a 10-percentage-point higher share living above poverty, at mean Black and Hispanic population shares, was associated with lower prevalence of no leisure-time physical activity (−2.052 percentage points) and short sleep (−0.744), and higher prevalence of dental visits (+3.203) and colorectal cancer screening (+1.801). Per 10-point higher non-Hispanic Black share, the respective slopes differed by +0.092, +0.029, −0.220, and −0.102 points (interaction P=.005 for sleep and P<.001 for the remaining three). At a 10-point higher Hispanic share, corresponding differences were +0.081, +0.063, −0.225, and −0.111 (all interaction P<.001). In companion models, the dental-visit slope was steeper at higher non-Hispanic White shares (+0.081; 95% CI, 0.050– 0.112).

Conclusions. The associations of neighborhood economic security with physical inactivity, short sleep, dental visits, and colorectal cancer screening were weaker at higher Black or Hispanic population shares. Policies to close socioeconomic gaps may need to be paired with investments in access to recreation and preventive care and in working conditions that allow adequate time for sleep.

Keywords: neighborhood poverty, health behaviors, physical activity, sleep, dental visits, colorectal cancer screening, racial and ethnic composition, Minorities' Diminished Returns

Abbreviations: ACS, American Community Survey; BRFSS, Behavioral Risk Factor Surveillance System; CDC, Centers for Disease Control and Prevention; CI, confidence

interval; MDRs, Minorities' Diminished Returns; PLACES, Population Level Analysis and Community Estimates.

Introduction Living above the federal poverty threshold describes an important difference in material circumstances. At the neighborhood level, however, the same percentage above poverty can describe places with different housing costs, transportation systems, recreational facilities, and access to care [1–2]. Research on neighborhoods and health has therefore examined conditions beyond the socioeconomic position of any single resident [3–5]. A central question for behavioral research is whether a given difference in neighborhood economic circumstances is associated with a similar difference in behavior across communities. The distinction matters when an area poverty statistic is used to identify where residents have opportunities for physical activity or timely preventive care.

Racial and ethnic composition gives this question a geographic context. The percentage of residents identifying with a particular group describes who lives in a tract; it does not establish how segregated that tract is within a metropolitan area [6]. Communities with similar population shares can have different histories of investment, housing choice, and access to institutions [7]. Studies of residential segregation distinguish these geographic scales and have examined their associations with health care provision [8], safety [9], sleep [10], and screening [11]. Interpreting composition as a marker of context leaves open which conditions vary across communities and whether residents share those conditions equally.

The Minorities' Diminished Returns framework addresses a related question at the individual and family levels: whether the health advantage associated with education or income is smaller for some racial and ethnic groups [12–13]. Research by several teams has examined variation in socioeconomic gradients across the life course [14], across population subgroups [15–17], and across countries [18]. An ecological extension changes both sides of the question. Here the resource is the share of residents whose income meets or exceeds a poverty threshold, and the outcome is the estimated prevalence of a behavior among eligible tract residents. A smaller area-level gradient would be consistent with MDRs at this scale without establishing an individual-level pattern.

Daily behaviors and the local environment Leisure-time physical activity requires both time and a usable setting. A map may show a nearby park while missing whether its paths are maintained, whether residents can enter when off work, or whether the available facilities suit their needs. Studies distinguish public parks from private recreation facilities [19–20] and identify variation by neighborhood income and racial composition in their distribution and features [21–22]. Studies using walkability scores [23], measures of green space, and accelerometers also illustrate why proximity, perceived access, and recorded activity should be treated as distinct measures [24–25]. This study examines the absence of leisure-time activity, which has a narrower meaning than total movement during the day.

Short sleep is also measured as a behavior, although the hours available for sleep depend partly on conditions outside the home. Studies have examined neighborhood noise [26], socioeconomic disadvantage [27–28], social cohesion [29–30], and residential history

alongside adult sleep [31]. Work schedules are another potential constraint: night work, nonstandard shifts, and weekend work may coincide with times when family responsibilities or daytime noise interrupt sleep [32–34]. These studies motivate examining geographic variation in short sleep without assuming that sleep duration measures sleep quality, work schedules, or an individual preference.

Behaviors involving a health care system A dental visit requires a provider, a means of payment, and an appointment that the patient can reach [35]. Studies of US adults document socioeconomic and racial differences in dental service use [36–37], including differences by disability and nativity [38–39]. Research on Medicaid dental benefits [40–41] distinguishes eligibility from access to a participating dentist [42]. A completed dental visit can therefore reflect several conditions at once. A high rate of visits may include care sought for pain as well as routine prevention; the tract measure gives no reason for the visit.

Colorectal cancer screening likewise involves contact with a delivery system, but its timing differs from an annual dental visit. A resident may be up to date through a stool-based test or an endoscopic procedure, each with a different interval and set of practical demands [43]. Studies have examined screening by neighborhood socioeconomic conditions [44–45], rural residence [46], nativity [47], screening modality [48], and insurance setting [49]. These distinctions matter when comparing a tract measure of screening among eligible adults with a measure of dental visits across the entire adult population [50]. A contrast in the sizes of the coefficients need not indicate a difference in the importance of those services.

We examined whether living above poverty was associated with lower tract prevalence of physical inactivity and short sleep and higher prevalence of dental visits and colorectal cancer screening. For each behavior, we estimated how the poverty slope differed with non- Hispanic Black and Hispanic population shares in a common model. A companion model examined the non-Hispanic White share. We distinguished absolute differences in prevalence across neighborhoods from differences in the slope of prevalence across economic circumstances. The latter comparison is the one that bears directly on a neighborhood-level MDRs interpretation [12].

Methods

Design and analytic population This ecological analysis linked 2014–2018 ACS five-year estimates to tract-level prevalence in the 2025 PLACES release [51–52]. The release incorporates 2023 BRFSS data for physical inactivity and carries forward 2022 survey data for short sleep, dental visits, and colorectal cancer screening [53]. The release year thus differs from the survey year for all four behaviors [43]. The ACS period preceded the underlying surveys, but the analysis compares different places and does not follow a cohort of residents.

We matched 11-digit census tract identifiers [51–52]. Of 83,522 tracts in the PLACES file, 60,168 had matching historical identifiers and 56,112 had complete variables for this analysis (67.2% of the release). Each retained tract contributed one observation to each

model. Equal weighting estimates associations across tracts; larger population centers consequently do not receive additional weight merely because more people live there. The 2,891 counties are the units used for variance estimation. Changes in tract identifiers and boundaries between geographic vintages restrict the set of places represented [3].

Economic conditions and composition From ACS table B17001, we calculated the percentage living above poverty as 100 minus the percentage below the federal poverty threshold among residents with known poverty status [51]. This convention includes residents exactly at the threshold. The variable measures the proportion crossing a threshold and cannot distinguish income just above it from substantially greater resources. We treated median household income (B19013, 2018 dollars) and the percentage of adults aged 25 years or older with at least a bachelor's degree (B15003) as separate indicators [51]. Including all three estimates the poverty association among tracts similar on the other two indicators.

We used table B03002 to estimate the percentages of all residents who were non-Hispanic Black alone, Hispanic or Latino of any race, and non-Hispanic White alone [51]. The composition denominator includes children, whereas the behaviors are adult measures. Models included the percentages of adult residents aged 45–64 years and 65 years or older (B01001), with ages 18–44 years as the reference [51]. Income was expressed in $10,000 units and shares in 10-percentage-point units. All continuous predictors were centered at their unweighted tract means before computing interactions.

Behavior definitions Physical inactivity denotes reporting no leisure-time physical activity or exercise during the past month, apart from one's regular job. Short sleep denotes usually sleeping less than 7 hours in a 24-hour period [43]. Dental visits refer to visiting a dentist or dental clinic for any reason during the past year. Colorectal cancer screening denotes being up to date according to the PLACES measure among adults aged 45–75 years [43]. The first three measures apply to adults aged 18 years or older. We used crude small-area prevalence estimates and adjusted for tract age composition in the regressions [52–53].

PLACES estimates are modeled from survey responses and population information [54–55]. They are valuable where sample sizes would otherwise preclude local estimates, but two tracts with similar survey information can receive different predictions because their population characteristics differ [56–57]. Research evaluating small-area prevalence estimation and its validation informs our interpretation of these dependent variables [58– 59]. The modeled estimate for a tract was the observation in our analysis; we did not have individual BRFSS responses for residents of that tract.

Models, interaction estimates, and joint prevalence For each outcome, we fitted a linear regression of percentage-point prevalence with state fixed effects. The first model included age and racial/ethnic composition and the share above poverty. The second added income and education. The third retained these main effects and added six products: each of the three socioeconomic indicators multiplied by the Black share and by the Hispanic share. A companion model substituted White share for Black share throughout and retained Hispanic share. A positive interaction makes a negative inactivity or sleep slope less negative. A negative interaction makes a positive visit

or screening slope less positive. We used county-clustered standard errors, a finite-sample correction, and a t reference distribution with 2,890 degrees of freedom. Reported P values are nominal and two-sided. The outcomes were selected after exploratory analysis.

For the continuous slope figures, we held the other included composition measure at its tract mean and varied the focal share from its 5th to its 95th percentile. Quartile plots evaluate the same fitted slope at the mean population share of each quartile. For joint prevalence, we classified tracts by quartiles of the above-poverty share and separately by quartiles of each composition measure [51]. Unadjusted values are arithmetic means of PLACES prevalence within the cells [52]. For adjusted values, we retained each tract's observed poverty and composition measures and their products, set income, education, and age terms to their sample means, and averaged state intercepts using the analytic sample's state distribution. We then averaged the predictions within each cell. Adjusted cells thus retain variation within quartiles. They are descriptive model predictions, not contrasts between hypothetical individual residents [60–61].

Results

The average tract had 84.7% of residents living above poverty, compared with a median of 87.8%. The mean Black and Hispanic shares (13.8% and 17.0%) also differed from their medians (3.9% and 7.9%). Thus the tract at which the main poverty coefficient is evaluated differs from the median tract. Short sleep was more common than leisure-time inactivity in the average tract (36.6% vs 26.4%). The mean prevalence of a dental visit was 60.4%, and 63.9% of screening-eligible adults were estimated to be up to date in the average tract (Table 1).

Table 1. Characteristics of the 56,112 analytic tracts

Tract characteristic	Mean	SD	25th percentile	Median	75th percentile
Living above poverty	84.7	11.7	79.1	87.8	93.4
Median household income, $	64,286	32,640	42,035	56,682	78,125
Bachelor's degree or higher	29.9	19.2	15.1	24.6	41.1
Non-Hispanic Black residents	13.8	22.3	0.9	3.9	15.0
Hispanic residents	17.0	21.7	2.8	7.9	21.5
Non-Hispanic White residents	60.6	30.3	37.2	68.9	86.9
Adults aged 45–64 y	34.0	6.9	30.3	34.5	38.4
Adults aged ≥65 y	20.4	8.8	14.7	19.8	24.8
No leisure-time physical activity	26.4	8.3	20.3	25.5	31.5
Short sleep	36.6	5.5	32.7	36.2	39.9
Dental visit	60.4	11.7	53.6	62.0	68.9

Tract characteristic	Mean	SD	25th percentile	Median	75th percentile
Colorectal cancer screening	63.9	7.4	59.7	65.0	69.1

Note. Values are percentages except household income (2018 US dollars). Each tract contributes once. ACS population denominators and PLACES eligibility differ by measure as specified in Methods. SD indicates standard deviation.

The association with living above poverty was smaller after adding education and income for every behavior. The dental-visit difference, for example, was 5.15 points per 10-point higher above-poverty share in the age-, composition-, and state-adjusted model and 3.41 points with income and education included. For short sleep the corresponding differences were −1.52 and −0.77 points (Table 2). These are comparisons of conditional coefficients; the change does not quantify mediation.

Table 2. Above-poverty slopes under progressively more detailed adjustment

Behavior	Age, composition, state	Add income and education	Add socioeconomic interactions
No leisure-time physical activity	−3.697 (−3.823, −3.572)	−2.403 (−2.494, −2.312)	−2.052 (−2.147, −1.957)
Short sleep	−1.516 (−1.618, −1.414)	−0.773 (−0.841, −0.705)	−0.744 (−0.813, −0.675)
Dental visit	5.151 (5.007, 5.296)	3.410 (3.312, 3.507)	3.203 (3.103, 3.304)
Colorectal cancer screening	2.428 (2.321, 2.534)	1.940 (1.851, 2.030)	1.801 (1.690, 1.912)

Note. Entries are prevalence differences in percentage points (95% CI) per 10 points higher above-poverty share. The interaction-model slope is evaluated at mean Black and Hispanic shares. All models use the same tracts, state fixed effects, and county-clustered intervals. Sources: ACS and PLACES.

In the fully adjusted main-effects models, the poverty, income, and education coefficients describe different comparisons. For example, a difference in area poverty at similar median household income and educational attainment need not imply the same circumstances as a difference in median income at similar poverty prevalence. Table 3 gives the main-effects estimates for every included continuous covariate so that the composition coefficients can be interpreted alongside the economic and age coefficients.

Table 3. Fully adjusted main-effects models for all four behaviors

Tract covariate	Inactivity	Short sleep	Dental visit	Screening
Living above poverty	−2.403 (−2.494, −2.312)	−0.773 (−0.841, −0.705)	3.410 (3.312, 3.507)	1.940 (1.851, 2.030)
Median household income, $	0.009 (−0.053, 0.072)	0.034 (−0.030, 0.098)	0.177 (0.116, 0.239)	−0.209 (−0.308, −0.110)
Bachelor's degree or higher	−1.958 (−2.039, −1.877)	−1.187 (−1.268, −1.106)	2.210 (2.135, 2.285)	1.195 (1.059, 1.331)
Non-Hispanic Black residents	0.676 (0.588, 0.764)	1.066 (0.999, 1.132)	−0.707 (−0.771, −0.644)	0.131 (0.060, 0.202)
Hispanic residents	1.063 (0.978, 1.148)	0.027 (−0.039, 0.092)	−0.719 (−0.807, −0.631)	−0.966 (−1.081, −0.850)
Adults aged 45–64 y	0.662 (0.536, 0.789)	−0.054 (−0.135, 0.027)	0.534 (0.411, 0.658)	0.650 (0.494, 0.805)
Adults aged ≥65 y	1.348 (1.275, 1.421)	−1.165 (−1.241, −1.090)	0.911 (0.838, 0.983)	2.490 (2.407, 2.573)

Note. Entries are adjusted differences in estimated prevalence (95% CI). Units are 10 percentage points for shares and $10,000 for median income. Models include all listed terms and state fixed effects; intervals are clustered by county. Screening denotes colorectal cancer screening. Sources: ACS and PLACES.

With interactions included, a 10-point higher Black share corresponded to an inactivity slope 0.092 points closer to zero and a dental-visit slope 0.220 points closer to zero. The corresponding differences at a 10-point higher Hispanic share were 0.081 and 0.225 points. For short sleep, the Black-share interaction was smaller than its Hispanic-share counterpart (0.029 and 0.063 points, respectively). Those two estimates describe conditional associations; we did not formally test their difference. Screening showed a similar attenuation for both composition measures (Table 4).

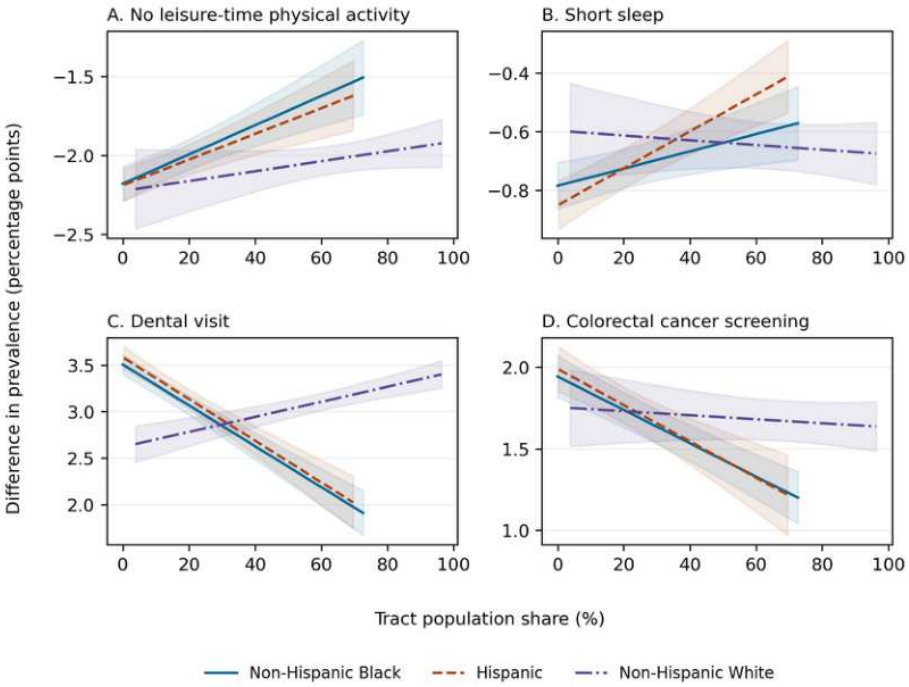
Table 4. Change in the above-poverty slope by population composition

Behavior	Non-Hispanic Black interaction (95% CI)	P	Hispanic interaction (95% CI)	P	Non-Hispanic White interaction (95% CI)	P
No leisure-time physical activity	0.092 (0.056, 0.129)	<.001	0.081 (0.046, 0.116)	<.001	0.031 (−0.007, 0.070)	.111
Short sleep	0.029 (0.009, 0.050)	.005	0.063 (0.041, 0.085)	<.001	−0.008 (−0.032, 0.016)	.504
Dental visit	−0.220 (−0.256, −0.184)	<.001	−0.225 (−0.272, −0.177)	<.001	0.081 (0.050, 0.112)	<.001
Colorectal cancer screening	−0.102 (−0.129, −0.076)	<.001	−0.111 (−0.155, −0.068)	<.001	−0.012 (−0.043, 0.019)	.439

Note. Each estimate is the change in the above-poverty slope per 10 points higher population share. The Black and Hispanic interactions come from the same model; the White interaction comes from a companion model that includes Hispanic share. Each model adjusts for age, income, education, and state, and includes all six socioeconomic interaction terms. P values are two-sided and county clustered. Sources: ACS and PLACES.

Only the dental-visit slope clearly varied with White share in the companion models: the positive gradient was 0.081 points steeper per 10-point higher White share (95% CI, 0.050 to 0.112). The corresponding intervals for inactivity, short sleep, and screening included zero. The continuous plots display these differences over the range supported by each composition measure. The slope for a given share is a difference in predicted prevalence, so the vertical axis cannot be read as the prevalence of the behavior itself.

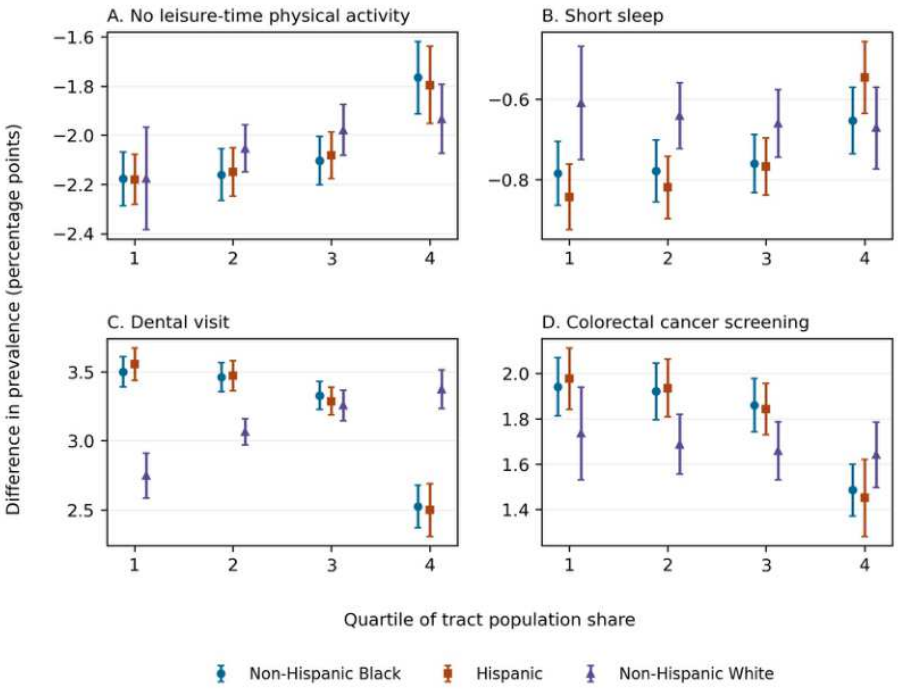
Figure 1. Adjusted above-poverty slopes across continuous population shares



Note. Lines span the group-specific 5th–95th percentile. Shading gives pointwise county-clustered 95% CIs. Income, education, age, and state are included. The other modeled population share is held at its mean. White-share estimates come from the companion model. Axes differ by behavior. Sources: ACS and PLACES.

For the dental-visit outcome, the adjusted slope was 3.50 points at the mean Black share of the lowest quartile and 2.52 at the mean share of the highest. For short sleep, the comparable Hispanic-share slopes were -0.84 and -0.55. Quartile ranks are useful for describing where the sampled tracts lie. Because Black, Hispanic, and White shares have different distributions, the same quartile label corresponds to different population percentages.

Figure 2. Adjusted above-poverty slopes at the mean composition of each quartile



Note. Points are slopes predicted by the continuous interaction models, with county-clustered 95% CIs. Q1–Q4 denote increasing group share. The three series use separately defined quartiles. Covariates and companion-model specification match Figure 1. Sources: ACS and PLACES.

The joint distributions answer a different question from the interaction models. Within the highest Black-share quartile, mean inactivity was 36.4% in the lowest above-poverty quartile and 22.7% in the highest. Dental visits in the same comparison averaged 45.8% and 65.3%. These comparisons describe the tracts that actually occupied each cell, including their differences in age, income, education, state, and exact composition within a quartile.

Table 5. Unadjusted prevalence by joint quartiles

Panel A. Non-Hispanic Black population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	1,782	34.4	38.5	49.7	55.5
Q1	Q2	1,934	31.7	38.1	51.7	56.5
Q1	Q3	3,094	32.3	39.4	50.5	56.5
Q1	Q4	7,218	36.4	44.3	45.8	59.4
Q2	Q1	3,410	27.9	35.4	59.9	63.6
Q2	Q2	3,267	27.2	35.9	59.6	62.5
Q2	Q3	3,771	27.0	36.9	58.7	62.4
Q2	Q4	3,580	29.2	40.3	55.4	63.8
Q3	Q1	4,274	24.1	33.4	65.5	67.1
Q3	Q2	3,987	22.9	34.0	65.7	66.0
Q3	Q3	3,726	22.9	35.2	64.5	65.5
Q3	Q4	2,041	25.4	38.8	60.9	66.0
Q4	Q1	4,562	19.5	31.7	71.6	69.4
Q4	Q2	4,840	18.9	32.2	71.7	68.6
Q4	Q3	3,437	19.9	33.7	69.4	67.5
Q4	Q4	1,189	22.7	37.9	65.3	67.7

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 0.9%, 3.9%, 15.0%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are unweighted means of PLACES tract estimates. No regression adjustment was applied. Sources: ACS and PLACES.

Within the highest non-Hispanic Black–share quartile, mean prevalence of no leisure-time physical activity was 36.4% in above-poverty Q1 and 22.7% in Q4. The corresponding cells contained 7,218 and 1,189 tracts.

Table 5 (continued). Unadjusted prevalence by joint quartiles

Panel B. Hispanic population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	3,193	36.4	43.9	46.2	61.8
Q1	Q2	2,547	32.8	41.4	50.3	61.4
Q1	Q3	2,809	31.7	40.8	50.9	59.9
Q1	Q4	5,479	35.9	40.9	46.9	52.8
Q2	Q1	3,353	29.1	37.2	58.6	66.3
Q2	Q2	3,117	26.7	36.4	60.5	66.3
Q2	Q3	3,325	25.7	36.8	60.0	64.2
Q2	Q4	4,233	29.4	38.0	55.3	57.3
Q3	Q1	3,659	24.8	34.3	65.3	69.0
Q3	Q2	3,659	22.7	33.9	66.3	68.4
Q3	Q3	3,864	22.0	35.0	65.3	65.8
Q3	Q4	2,846	25.5	36.5	60.6	60.2
Q4	Q1	3,823	20.2	32.0	71.6	71.2
Q4	Q2	4,705	18.7	32.1	72.2	69.8
Q4	Q3	4,030	19.1	33.7	69.8	66.8
Q4	Q4	1,470	22.9	35.5	64.6	62.3

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 2.8%, 7.9%, 21.5%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are unweighted means of PLACES tract estimates. No regression adjustment was applied. Sources: ACS and PLACES.

Within the highest Hispanic–share quartile, mean prevalence of short sleep was 40.9% in above-poverty Q1 and 35.5% in Q4. The corresponding cells contained 5,479 and 1,470 tracts.

Table 5 (continued). Unadjusted prevalence by joint quartiles

Panel C. Non-Hispanic White population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	7,690	37.7	43.8	44.6	55.2
Q1	Q2	3,534	31.4	39.8	51.1	60.1
Q1	Q3	1,720	29.0	37.8	54.2	61.8
Q1	Q4	1,084	31.7	38.4	54.3	62.9
Q2	Q1	3,433	31.1	40.2	53.6	57.5
Q2	Q2	3,924	26.5	37.2	58.5	63.0
Q2	Q3	3,364	25.8	35.5	60.9	65.7
Q2	Q4	3,307	28.1	35.7	60.6	66.3
Q3	Q1	1,876	27.3	39.0	59.3	60.2
Q3	Q2	3,452	22.6	35.7	63.8	64.1
Q3	Q3	4,056	21.9	33.7	66.3	67.7
Q3	Q4	4,644	24.5	33.6	65.9	68.9
Q4	Q1	1,029	23.9	38.0	64.5	62.7
Q4	Q2	3,118	19.7	34.3	68.9	65.3
Q4	Q3	4,888	18.3	32.1	71.7	69.2
Q4	Q4	4,993	20.1	31.7	71.8	71.1

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 37.2%, 68.9%, 86.9%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are unweighted means of PLACES tract estimates. No regression adjustment was applied. Sources: ACS and PLACES.

Within the highest non-Hispanic White–share quartile, mean prevalence of dental visit was 54.3% in above-poverty Q1 and 71.8% in Q4. The corresponding cells contained 1,084 and 4,993 tracts.

Standardizing the distributions of age, education, income, and state narrowed several contrasts. For example, within the highest Hispanic-share quartile, the Q4–Q1 dental-visit difference was 17.8 points in the unadjusted estimates and 8.0 points after standardization. The adjusted cells preserve the economic and composition distributions observed within each joint quartile. Consequently, a contrast between cells is not the continuous interaction coefficient in Table 4.

Table 6. Adjusted prevalence by joint quartiles

Panel A. Non-Hispanic Black population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	1,782	30.2	36.2	56.4	59.5
Q1	Q2	1,934	30.0	36.5	56.2	59.8
Q1	Q3	3,094	30.3	37.2	55.7	59.9
Q1	Q4	7,218	30.7	41.7	54.5	62.5
Q2	Q1	3,410	25.5	35.3	61.3	63.7
Q2	Q2	3,267	26.2	35.5	60.9	63.2
Q2	Q3	3,771	26.4	36.2	60.5	63.4
Q2	Q4	3,580	27.1	39.3	59.2	64.6
Q3	Q1	4,274	23.5	34.7	64.0	65.6
Q3	Q2	3,987	24.0	34.9	63.6	65.2
Q3	Q3	3,726	24.4	35.6	63.1	65.1
Q3	Q4	2,041	25.5	38.4	61.4	65.8
Q4	Q1	4,562	22.1	34.2	66.1	66.9
Q4	Q2	4,840	22.4	34.4	65.8	66.7
Q4	Q3	3,437	22.9	35.1	65.2	66.5
Q4	Q4	1,189	24.3	37.9	63.1	66.8

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 0.9%, 3.9%, 15.0%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are model predictions standardized for age, income, education, and state as described in Methods. Sources: ACS and PLACES.

Within the highest non-Hispanic Black–share quartile, adjusted prevalence of short sleep was 41.7% in above-poverty Q1 and 37.9% in Q4. The corresponding cells contained 7,218 and 1,189 tracts.

Table 6 (continued). Adjusted prevalence by joint quartiles

Panel B. Hispanic population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	3,193	29.3	41.5	54.9	63.5
Q1	Q2	2,547	29.2	40.0	55.1	62.6
Q1	Q3	2,809	29.4	39.3	55.5	62.0
Q1	Q4	5,479	32.2	37.8	55.3	58.7
Q2	Q1	3,353	24.8	36.5	61.2	65.2
Q2	Q2	3,117	25.1	36.6	61.1	65.0
Q2	Q3	3,325	25.9	36.8	60.6	64.3
Q2	Q4	4,233	28.7	36.5	59.3	61.2
Q3	Q1	3,659	23.0	35.3	64.1	66.5
Q3	Q2	3,659	23.4	35.4	63.8	66.2
Q3	Q3	3,864	24.2	35.7	63.2	65.4
Q3	Q4	2,846	26.7	35.8	61.6	62.9
Q4	Q1	3,823	21.7	34.6	66.2	67.5
Q4	Q2	4,705	22.1	34.7	65.9	67.2
Q4	Q3	4,030	22.9	35.0	65.2	66.4
Q4	Q4	1,470	25.3	35.3	63.4	64.1

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 2.8%, 7.9%, 21.5%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are model predictions standardized for age, income, education, and state as described in Methods. Sources: ACS and PLACES.

Within the highest Hispanic–share quartile, adjusted prevalence of dental visit was 55.3% in above-poverty Q1 and 63.4% in Q4. The corresponding cells contained 5,479 and 1,470 tracts.

Table 6 (continued). Adjusted prevalence by joint quartiles

Panel C. Non-Hispanic White population share

Above poverty	Group share	Tracts, No.	Inactivity, %	Short sleep, %	Dental visit, %	Screening, %
Q1	Q1	7,690	33.8	40.2	52.7	58.4
Q1	Q2	3,534	29.9	38.2	55.4	61.2
Q1	Q3	1,720	27.9	36.8	56.7	62.4
Q1	Q4	1,084	26.0	35.7	58.6	63.7
Q2	Q1	3,433	30.1	38.3	57.6	60.9
Q2	Q2	3,924	26.9	36.9	60.0	63.4
Q2	Q3	3,364	24.9	35.7	61.6	64.9
Q2	Q4	3,307	23.6	34.8	62.7	65.7
Q3	Q1	1,876	28.4	38.3	59.4	62.4
Q3	Q2	3,452	25.4	36.4	62.1	64.6
Q3	Q3	4,056	23.5	35.1	63.9	66.0
Q3	Q4	4,644	22.3	34.3	65.0	66.8
Q4	Q1	1,029	27.0	38.7	60.6	64.0
Q4	Q2	3,118	24.2	36.2	63.8	65.7
Q4	Q3	4,888	22.3	34.8	65.7	67.0
Q4	Q4	4,993	21.3	34.0	66.8	67.7

Note. Quartile cutoffs for the above-poverty share are 79.1%, 87.8%, and 93.4%; those for this population share are 37.2%, 68.9%, 86.9%. Darker shading means higher prevalence within an outcome across all three panels of this table. Cells are model predictions standardized for age, income, education, and state as described in Methods. Sources: ACS and PLACES.

Within the highest non-Hispanic White–share quartile, adjusted prevalence of colorectal cancer screening was 63.7% in above-poverty Q1 and 67.7% in Q4. The corresponding cells contained 1,084 and 4,993 tracts.

Income and education did not consistently reproduce the poverty pattern. For example, the dental-visit gradient for above-poverty share was smaller at higher Black share, but the interaction coefficients for income and education were positive. Table 7 reports these secondary estimates to show how the interpretation depends on which economic resource is measured. The units for income and education differ, so their coefficient magnitudes cannot be compared directly.

Table 7. Interactions of household income and educational attainment with tract composition

Behavior	Income × Black share	Income × Hispanic share	Education × Black share	Education × Hispanic share
No leisure-time physical activity	−0.060 (−0.090, −0.030)	−0.089 (−0.112, −0.065)	−0.201 (−0.243, −0.160)	−0.076 (−0.128, −0.024)
Short sleep	−0.010 (−0.039, 0.019)	−0.044 (−0.063, −0.025)	−0.037 (−0.073, −0.001)	0.044 (0.010, 0.078)
Dental visit	0.087 (0.055, 0.118)	0.119 (0.081, 0.158)	0.173 (0.140, 0.207)	0.136 (0.085, 0.188)
Colorectal cancer screening	0.036 (0.010, 0.061)	0.091 (0.051, 0.131)	0.102 (0.071, 0.133)	0.029 (−0.028, 0.087)

Note. Entries are changes in the slope (95% CI) per 10 points higher population share. Income slopes are per $10,000 higher median household income and education slopes are per 10 points higher bachelor's degree attainment. All estimates are from the fully adjusted

Black/Hispanic interaction models in Table 4. The poverty interaction estimates remain the primary comparisons. Sources: ACS and PLACES.

Discussion Across 56,112 US tracts, a larger share living above poverty was associated with less inactivity, less short sleep, more dental visits, and more colorectal cancer screening. All four economic gradients were shallower at higher Black and Hispanic population shares. The consistency in direction is informative because the behaviors have different eligibility criteria, time windows, and practical requirements. The interaction estimates were small per 10-point difference in composition, particularly for short sleep. Their meaning lies in how the association varies across places, rather than in the identification of any resident's behavior from the demographic characteristics of a neighborhood [1, 12, 60].

What an area-level diminished return might represent A tract-level economic gradient combines household circumstances with the conditions households share [62]. Two tracts could have the same percentage above poverty while differing in how far incomes extend above the threshold, in residents' accumulated wealth, or in the local prices of housing and transportation. They could also differ in the availability of health or recreational services [63]. Any of these differences might contribute to a smaller slope. Conversely, social networks or community institutions may sustain opportunities even in economically constrained areas [64]. The estimates cannot distinguish these possibilities. Neighborhood and multilevel research provides reasons to investigate resources and barriers directly, including how residents describe them [65–66].

Prior MDRs research generally compares people with similar measured resources [12, 14– 16]. Our result concerns neighborhoods with similar measured economic circumstances. These are distinct units of analysis, and a within-tract socioeconomic gradient may differ from the between-tract gradient [67–68]. The White-share results underscore this point. Only the dental-visit interaction was clearly distinguishable from zero in that specification. Because composition shares sum to 100% across all groups, increasing a given share while holding a second share fixed necessarily changes the combined share of the remaining groups. The White model consequently describes a different comparison and cannot supply a White-versus-Black individual contrast [69].

Interpreting physical inactivity and short sleep The activity gradient remained appreciable even after adjustment for income and education. One hypothesis is that tracts with similar economic circumstances differ in access to places residents can actually use for recreation [70]. Measurements of park features and observed park use offer ways to test that hypothesis [71–72]. Studies of park refurbishment and community-led design are especially relevant because a new facility, a change in programming, and a change in use are distinguishable events [73–74]. Studies of adults with mobility or visual limitations also highlight how a facility that is geographically near residents may still be inaccessible [75]. Future tract analyses could pair information on opening hours, programming, accessibility, and resident-reported safety with device- measured activity and its location.

The short-sleep gradient was smaller than the inactivity gradient on the absolute scale. Its size should be interpreted in relation to a thresholded measure that distinguishes fewer than seven hours from seven or more. It cannot identify interruptions, irregular timing, daytime sleep, or inadequate opportunity to sleep. Research on perceived neighborhood stressors and social cohesion [76–78], including studies in Latino populations, suggests questions about exposures that a Census composition measure cannot capture [79]. Studies of night schedules and total work hours offer a separate explanation that can be investigated with work diaries and repeated sleep measurements [80–82]. Residents of the same tract may have widely different schedules even when exposed to similar outdoor noise.

Interpreting dental visits and colorectal cancer screening Dental visits showed the largest absolute estimated interaction in the primary models. The association with economic security was also larger than for the other behaviors, so rankings of absolute interaction coefficients alone should not be read as rankings of inequity. A tract may have many dental offices but few accepting a resident’s insurance; residents of another tract may have coverage but lack appointment times compatible with their work [42]. Studies of adult Medicaid coverage [83–86], dental expenditures [87], enrollee experience [88], and provider participation give distinct ways to investigate the gap between nominal eligibility and completed care [89]. State fixed effects account for average differences across states, while leaving differences among communities within a state largely unresolved.

The screening pattern was compatible with several different steps in care. Someone may receive a recommendation yet never receive a kit, complete a stool test but have difficulty returning it, or require an appointment for an endoscopic test [90–91]. Research in federally qualified health centers and insured populations has documented differences across settings and periods [92–93]. Studies of mailed outreach [94–95], reminders, patient navigation [96–97], and follow-up colonoscopy demonstrate that these stages can be measured separately [98]. A tract screening percentage collapses them into a single indicator of being up to date. Linking local data on invitations, test returns, and follow-up with neighborhood characteristics could clarify where a smaller poverty gradient appears.

Implications for practice and future research If a health department uses poverty to allocate resources, these estimates suggest a practical follow-up question: among neighborhoods with similar poverty rates, where do residents report difficulty finding time for activity or obtaining preventive services? The response may differ by behavior and by community. A parks agency could compare use during evenings and weekends with facility hours [71, 74], while a dental program could compare directories of participating dentists with appointments actually available to new patients [42]. Screening programs could ask whether missed opportunities arise at invitation, completion, or follow-up [99–101]. Composition can help identify differences for closer examination, but observed local barriers and resident priorities provide a stronger basis for choosing a service.

A useful replication would specify these four outcomes and the interaction scale in advance, harmonize tract boundaries, and use data collected independently of PLACES [102–103]. Individual income, education, race and ethnicity, and residential history would allow comparison of within- and between-neighborhood gradients [5]. A longitudinal component

could follow provider participation, public recreation investment, or working schedules together with repeated measures of visits, activity, or sleep. Analyses stratified by region and urbanicity could examine where the pattern recurs [3]. Alternative specifications could compare absolute and relative gradients, weight by the eligible population, allow nonlinear associations, and propagate uncertainty in the ACS and PLACES estimates [104–105].

Limitations PLACES incorporates demographic and socioeconomic information in estimating local prevalence [53, 55]. Overlap between its predictors and those in our regression may contribute to the associations and their consistency across measures [58–59]. The four outcomes also share aspects of the survey and estimation process and cannot serve as independent replications of one another. County clustering addresses residual dependence within counties but does not propagate uncertainty from either source, account for correlation across neighboring counties, or correct error in the population shares used in the interactions [104]. Statistical precision conditional on the input data may therefore overstate the precision of population inferences.

Eligibility for the analytic sample depended on identifier matching and data completeness. Rapidly changing or subdivided tracts may differ from retained areas; even a stable identifier does not establish identical boundaries [3]. Residential mobility further limits interpretation of the separation between ACS and survey years [65]. The poverty indicator omits assets, debt, depth of poverty, and regional differences in living costs [51]. The population shares group together residents with different national origins, experiences, and lengths of residence [6]. Finally, the analyses were exploratory and the nominal P values do not account for selection. These findings warrant replication before they are used to characterize a particular community [61].

Conclusion A higher share of residents living above poverty was associated with less leisure-time physical inactivity and short sleep and with more dental visits and colorectal cancer screening. Each association was weaker in neighborhoods with higher proportions of non- Hispanic Black or Hispanic residents. Closing socioeconomic gaps alone may therefore be insufficient to narrow disparities in these behaviors. In communities with higher proportions of Black or Hispanic residents, policymakers should pair economic investment with locally identified priorities, such as accessible places for recreation, predictable work schedules that allow time for sleep, affordable dental care, and easier access to colorectal cancer screening.

Declarations Author contributions. Shervin Assari contributed to study conceptualization, analysis, and manuscript revision and supervised the use of ChatGPT. Babak Najand contributed to drafting and revising the manuscript.

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Ethics and consent. This secondary analysis used publicly available, aggregate census tract estimates. The authors had no contact with participants and accessed no identifiable individual records. Individual informed consent was inapplicable.

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Data sharing. The ACS detailed tables [51] and CDC PLACES tract data used in the analysis are public [52]. Sources and table identifiers appear in Methods. No individual participant records were used.

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