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Structural Invisibility and Policy Decoupling: The Racialized Geography of End-of-Life Care Among Hip Fracture Decedents(1999–2020)

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Abstract

Background

The shift from hospital-based to community-based end-of-life care has reshaped patterns of dying in the United States. However, whether this transformation has unfolded equitably across racial groups and geographic contexts remains insufficiently understood. This study examines racial and spatial disparities in place of death among older adults with hip fracture, with a focus on temporal dynamics and policy-relevant mechanisms.

Methods

We constructed a retrospective ecological cohort of 330,969 hip fracture decedents aged ≥ 65 years using U.S. mortality records from the CDC WONDER database (1999–2020). Outcomes included place of death (hospital vs. hospice/home). Temporal trends were assessed using joinpoint regression, and racial disparities were examined through two-way fixed effects models incorporating state-level Medicare Advantage penetration. Geospatial analyses were used to identify within- and between-state patterns of service availability.

Results

Overall hospice utilization increased substantially over the study period; however, these gains were unevenly distributed. Non-Hispanic White decedents experienced sustained growth in hospice deaths, while non-Hispanic Black decedents exhibited a marked post-2016 reversal, with hospice use declining sharply. Geographic analyses revealed extensive “service deserts,” where hospice utilization among Black decedents was effectively absent in many states despite adequate population size. Policy expansion in Medicare Advantage was associated with increased hospice use among White decedents but yielded substantially weaker effects among Black decedents, indicating a decoupling between coverage expansion and service access.

Conclusions

Racial disparities in place of death are deeply spatialized and persist despite broad policy expansion. These findings highlight the need for place-based approaches that address structural barriers to end-of-life care, moving beyond uniform coverage toward geographically and racially responsive interventions.

Introduction

Over the past two decades, end-of-life (EOL) care in the United States has undergone a profound paradigm shift, characterized by a significant "de-hospitalization" of death from acute care hospitals to

community and home settings (1–3).While the public health community widely heralds this trend as a landmark achievement in enhancing patient autonomy and the quality of death, this generally optimistic narrative obscures profound and disturbing racial disparities. For White decedents, the transition away from hospitals typically implies admission to specialized hospice facilities, ensuring access to palliative comfort and dignity. In stark contrast, for racial and ethnic minorities—particularly Non-Hispanic Black and Hispanic populations—this shift often manifests as a forced "Passive Home Death," characterized by a lack of essential medical support and pain management (4–6).This dichotomy suggests that the rising trend of home deaths may not reflect universal autonomy, but rather the consequences of structural exclusion (7).

Running parallel to this transformation in care models is the drastic privatization restructuring of the U.S. geriatric insurance system (8).The Medicare Advantage (MA) program, designed to improve service quality through market competition, has seen its penetration rate surge from less than 10% in 1999 to 54% by 2024 (approximately 40% at the end of our study period in 2020) (9).While this marketization has expanded nominal coverage, it has ignited fierce debate regarding equity: has the expansion of the insurance market truly enhanced accessibility through competition, or has it exacerbated de facto racial segregation through the design of "narrow networks" and cost-containment mechanisms (10–12)? Existing explanatory frameworks, which often resort to "cultural preferences" or "resource scarcity," fail to adequately explain why the gap in service access is widening even as insurance coverage rates rise (13–15).

To resolve this paradox, this study introduces two core theoretical concepts: "Structural Invisibility" and "Policy Decoupling" (16).We hypothesize that despite the rise in nominal insurance coverage, minority populations remain "invisible" to policy dividends due to exclusionary network designs and uneven geographic distribution of services. This results in a severe mechanistic fracture—or decoupling—between insurance coverage and actual service acquisition (12).Within this framework, we utilize hip fracture not merely as a clinical condition, but as a methodological "tracer". Given its acute, non-discretionary nature, hip fracture minimizes selection bias related to care-seeking behaviors, thereby serving as a critical metric to interrogate the spatial and structural limits of the U.S. healthcare transition. As confirmed by recent analyses of long-term mortality trends using CDC WONDER data (1999–2023), the evolution of its care pathways precisely maps the trajectory of systemic exclusion (17–22).

Leveraging national mortality data from the CDC WONDER database (1999–2020) (23),this study constructs a retrospective ecological cohort of over 330,000 decedents with hip fracture to fill gaps in the existing literature. By integrating Joinpoint trend analysis, critical geospatial mapping, and Two-Way Fixed Effects (TWFE) models, we first quantify whether there are widening "divergent trajectories" in end-of-life care across racial groups, specifically examining the correlation between the "S-curve" diffusion of hospice use among Whites and the trajectory reversal observed among Blacks. Second, we test whether race remains an independent structural barrier to hospice admission after rigorously controlling for demographic and geographic factors. Furthermore, we map the geographic distribution of EOL resources to identify potential "service deserts" targeting specific racial groups. Finally, we critically examine how

Medicare Advantage policy (MA penetration rate) moderates the association between race and care utilization to verify the "policy decoupling" phenomenon—whereby market expansion fails to benefit, or even harms, marginalized communities. Through these inquiries, this study aims to demonstrate that without addressing structural invisibility, mere policy expansion will fail to bridge existing health inequities.

Methods

2.1 Study Design and Data

We conducted a retrospective ecological study using the CDC WONDER Multiple Cause of Death Database (1999–2020). The cohort included all decedents aged ≥ 65 years with hip fracture (ICD-10: S72.0–S72.2) listed as a cause of death. We constructed a longitudinal panel dataset by linking mortality records with state-level Medicare Advantage (MA) penetration rates from CMS files, using "State-Year" as the linkage key.

2.2 Variables

The primary outcome was the specific setting of death, operationalized to capture varying degrees of medicalization and institutional support. We categorized outcomes into four distinct end-of-life trajectories: inpatient hospital (reference category, representing high-intensity medicalized death), hospice facility (specialized palliative support), nursing home/long-term care (LTC), and decedent's home.Race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic, and Other) served as the primary exposure. Within our theoretical framework, race is conceptualized not as a biological determinant, but as a proxy for social stratification and exposure to structural racism.To examine the mechanism of policy decoupling, the state-level Medicare Advantage (MA) penetration rate (0–100%) was included as a time-varying ecological variable to quantify the intensity of healthcare privatization and market competition.Covariates included age (stratified into 10-year groups), sex, and the NCHS urbanization classification, which was utilized to control for spatial context and inherent rural-urban disparities in resource allocation.

2.3 Statistical Analysis

First, we used Joinpoint Regression to identify inflection points in mortality trends and calculated Annual Percentage Changes (APC). Second, to assess racial disparities, we fitted weighted multinomial logistic regression models, adjusting for age, sex, and secular trends. Aggregated death counts were used as frequency weights to account for population size.To test the "Policy Decoupling" hypothesis, we employed a Two-Way Fixed Effects (TWFE) model.The interaction term β_3 estimates the differential return on MA penetration by race, controlling for state ($\gamma_{s)}$ and year (δt) fixed effects. Finally, geospatial analysis utilized 2016–2020 pooled data with a "Zero-Threshold Protocol," coding suppressed data (< 10 deaths) as 0% utilization to identify service deserts. Analyses were performed using R (version 4.4.2) and Joinpoint (5.4.0.0).

Results

3.1 Demographic Characteristics and Distributions of Place of Death

A total of 330,969 decedents aged ≥ 65 years were identified from 1999 to 2020 (Table 1). The cohort was predominantly female (64.4%) and Non-Hispanic White (93.0%), with a significant skew toward advanced age (64.7% aged ≥ 85 years).

Place of death varied significantly by age and sex ($P < .001$). Inpatient hospital deaths decreased progressively with age (from 63.2% in the 65–74 age group to 45.1% in the ≥ 85 group), while nursing home deaths nearly doubled (19.8% to 38.3%). Compared with men, women were less likely to die in hospitals (46.2% vs. 55.1%) but significantly more likely to die in nursing homes (37.0% vs. 29.3%).

Significant racial and ethnic heterogeneity was observed in end-of-life trajectories ($P < .001$). Non-Hispanic Black decedents exhibited the highest reliance on acute care, with 59.4% dying in inpatient hospital settings—substantially higher than Non-Hispanic Whites (48.7%). Conversely, Black decedents had the lowest utilization of hospice facilities (5.7%), compared with Whites (7.8%) and Hispanics (9.3%). Hispanic decedents demonstrated a distinct polarization: they had the highest rate of home deaths (15.4%) and the lowest rate of nursing home deaths (19.9%). In contrast, Non-Hispanic Whites were most likely to die in nursing homes (35.2%) compared to all other racial groups.

Table 1
Demographic Characteristics and Place of Death Distribution (1999–2020).

Characteristic	Total Deaths, n (%)	Medical Facility - Inpatient, n (%)	Hospice Facility, n (%)	Nursing Home /LTC, n (%)	Decedent's Home, n (%)
Age (years)					
65–74 years	24,755 (100%)	15,646 (63.2%)	1,737 (7.0%)	4,904 (19.8%)	2,468 (10.0%)
75–84 years	92,066 (100%)	51,166 (55.6%)	6,489 (7.0%)	26,280 (28.5%)	8,131 (8.8%)
85 + years	214,148 (100%)	96,570 (45.1%)	17,353 (8.1%)	82,097 (38.3%)	18,128 (8.5%)
Sex					
Female	213,003 (100%)	98,339 (46.2%)	16,582 (7.8%)	78,773 (37.0%)	19,309 (9.1%)
Male	117,966 (100%)	65,043 (55.1%)	8,997 (7.6%)	34,508 (29.3%)	9,418 (8.0%)
Race/Ethnicity					
Non-Hispanic White	307,723 (100%)	149,949 (48.7%)	23,970 (7.8%)	108,282 (35.2%)	25,522 (8.3%)
Non-Hispanic Black	9,930 (100%)	5,898 (59.4%)	570 (5.7%)	2,241 (22.6%)	1,221 (12.3%)
Hispanic	9,151 (100%)	5,068 (55.4%)	851 (9.3%)	1,822 (19.9%)	1,410 (15.4%)
Non-Hispanic Other	4,165 (100%)	2,467 (59.2%)	188 (4.5%)	936 (22.5%)	574 (13.8%)

3.2 Temporal Trends and the COVID-19 Disruptions on Place of Death

Joinpoint regression analysis revealed distinct non-linear trajectories in the place of death from 1999 to 2020 (Fig. 1).

Deaths in hospice facilities exhibited a rapid initial expansion (1999–2006 APC: 179.4%, 95% CI 149.3% to 3286.9%) that progressively decelerated over time (2006–2011 APC: 19.6%; 2011–2015 APC: 11.9%). Notably, hospice growth plateaued after 2015, with a statistically non-significant APC of 1.6% (P = .15) observed during 2015–2020. Concurrently, traditional institutional deaths declined: inpatient hospital deaths decreased steadily after peaking in 2002 (2002–2018 APC: -3.0%), and nursing home deaths saw a significant annual decline of 3.7% between 2002 and 2010.

Home deaths showed moderate growth in the early period (1999–2007 APC: 6.3%). However, a significant structural break was identified in the 2018–2020 interval, coinciding with the COVID-19 pandemic. During this period, the growth rate of home deaths accelerated sharply, with the APC rising to 18.8% (95% CI 5.9% to 27.3%, *P* < .001), marking a distinct departure from pre-pandemic trends.

Figure 1. The "Great Divergence" in Place of Death: Temporal Trends and the Shift from Hospitals to Community Settings (1999–2020).

3.3 Dynamic Evolution of Racial Disparities: Baseline Differentials and Trend Reversals

Joinpoint regression models quantified the heterogeneous evolution of end-of-life care patterns across racial groups, revealing a complex transition from long-term lags to recent trend reversals (Fig. 2).

Although inpatient hospital mortality rates declined across all racial groups, substantial absolute disparities persisted. At the 1999 baseline, the risk of hospital death for minority populations was nearly double that of Whites: 93.5 per 100,000 for Non-Hispanic Blacks and 96.3 per 100,000 for Hispanics, compared with 55.8 per 100,000 for Non-Hispanic Whites. This magnitude of disparity, established at the turn of the millennium, fluctuated but remained significant throughout the 20-year study period.

Hospice utilization trajectories exhibited three distinct racial patterns:1)Steady Diffusion for Whites: Non-Hispanic Whites demonstrated a classic diffusion curve characterized by continuous and robust growth without significant structural breaks. 2)"Growth-Reversal" for Blacks: Non-Hispanic Blacks exhibited a distinctive and statistically significant reversal. Following a period of early growth, hospice mortality rates experienced a sharp downturn after 2016, with an Annual Percentage Change (APC) of -17.1% (*P* < .05). 3)"Catch-up" for Hispanics: In contrast, Hispanic decedents showed a marked acceleration in hospice use during the recent period (2015–2020), with an APC of 13.9%, indicating a rapid narrowing of the utilization gap.

3.4 Racial Patterning of Place of Death After Adjustment for Policy and Time

After adjusting for age structure, sex, and secular trends, multinomial logistic regression analysis identified race/ethnicity as a robust independent predictor of the place of death among hip fracture decedents (Table 2).

Compared with Non-Hispanic Whites, Non-Hispanic Black decedents exhibited significantly lower odds of dying in a hospice facility (adjusted Odds Ratio [aOR] = 0.63; 95% CI 0.58–0.69; *P* < .001). This indicates that, holding demographic and temporal factors constant, Black patients were approximately 37% less likely to access specialized hospice services than their White counterparts. In contrast, Hispanic decedents did not exhibit a lower likelihood of access relative to Whites (aOR = 1.08; *P* = .048).

The model further delineated divergent pathways for non-hospital deaths. Both Non-Hispanic Blacks (aOR = 1.24) and Hispanics (aOR = 1.65) had significantly higher odds of dying at home compared with Whites. Conversely, both minority groups demonstrated substantially lower odds of dying in nursing homes or long-term care facilities (Blacks: aOR = 0.56; Hispanics: aOR = 0.52), highlighting a distinct racial stratification in institutional care reliance.

Table 2
Adjusted Multinomial Logistic Regression Analysis.

Characteristic	**OR (95% CI)**	***P*-value**
Hospice Facility		
75–84 years	1.12 (1.06–1.19)	< 0.001
85 + years	1.56 (1.48–1.65)	< 0.001
Male	0.85 (0.83–0.87)	< 0.001
Non-Hispanic Black	0.63 (0.58–0.69)	< 0.001
Hispanic	1.08 (1.00-1.16)	0.048
Non-Hispanic Other	0.48 (0.42–0.56)	< 0.001
Nursing Home/LTC		
75–84 years	1.58 (1.53–1.64)	< 0.001
85 + years	2.52 (2.44–2.61)	< 0.001
Male	0.70 (0.69–0.71)	< 0.001
Non-Hispanic Black	0.56 (0.54–0.59)	< 0.001
Hispanic	0.52 (0.49–0.55)	< 0.001
Non-Hispanic Other	0.54 (0.50–0.58)	< 0.001
Decedent's Home		
75–84 years	1.01 (0.96–1.06)	0.636
85 + years	1.17 (1.12–1.23)	< 0.001
Male	0.75 (0.73–0.77)	< 0.001
Non-Hispanic Black	1.24 (1.16–1.32)	< 0.001
Hispanic	1.65 (1.55–1.75)	< 0.001
Non-Hispanic Other	1.37 (1.25–1.51)	< 0.001

3.5 Geographic Fragmentation in Hospice Utilization Across States

By aggregating data from 2016 to 2020 and applying a zero-threshold protocol, Fig. 3 illustrates substantial geographic heterogeneity in hospice utilization that is not apparent in national-level estimates. Across racial groups, distinct spatial patterns of access were observed, ranging from widespread utilization to highly localized or absent use.

Geographic ubiquity among non-Hispanic White decedents.

Hospice utilization among non-Hispanic White hip fracture decedents demonstrated broad geographic coverage across the United States (Fig. 3A). Nearly all states met analytic thresholds, with no regions exhibiting systematic data suppression. Utilization rates showed relatively limited spatial variation, indicating that hospice deaths among White decedents occurred across diverse regional contexts, including both urbanized and rural states.

Spatial concentration among Hispanic decedents.

In c**o**ntrast, hospice utilization among Hispanic decedents was geographically concentrated (Fig. 3C). Elevated utilization rates were observed primarily in a small number of states, including those in the U.S. Southwest (e.g., Arizona and Texas), Florida, and New York. Outside these regions, hospice utilization was minimal or absent, reflecting a markedly uneven spatial distribution across states.

Extensive hospice deserts among non-Hispanic Black decedents.

The most pronounced geographic fragmentation was observed among non-Hispanic Black decedents (Fig. 3B). Of the 23 states meeting the predefined statistical threshold (five-year cumulative deaths ≥ 30), more than half (52.2%) exhibited a hospice utilization rate of 0%. These zero-utilization states included not only states with historically limited healthcare resources (e.g., Alabama, Louisiana, Mississippi) but also states with comparatively extensive healthcare infrastructures (e.g., New York, Illinois, Michigan). Across these states, hospice deaths among Black hip fracture decedents were not observed during the study period, despite sufficient mortality counts for analysis.

3.6 Within-State Racial Stratification in End-of-Life Care

To examine within-state variation in hospice utilization, we compared racial groups under identical state policy and healthcare environments. Figure 4 presents race-specific hospice utilization rates across the 20 states with the highest hip fracture mortality volumes, allowing direct comparison of relative positioning within states.

Relative positioning of hospice utilization across racial groups.

Across most evaluated states, non-Hispanic White decedents exhibited the highest hospice utilization rates (Fig. 4). This pattern was observed in both higher-utilization states (e.g., Florida, North Carolina) and lower-utilization states (e.g., New York, California). In contrast, utilization rates for racial minority groups were consistently lower within the same states.

Persistence of within-state gaps across utilization contexts.

Two recurring patterns were observed. First, in states with higher overall hospice utilization, hospice use among non-Hispanic Black decedents increased modestly but remained substantially lower than that of non-Hispanic Whites, with within-state differences typically ranging from 10 to 20 percentage points. Second, in states with lower overall utilization, hospice use among non-Hispanic Black decedents was compressed near zero, while non-Hispanic White decedents in the same states continued to demonstrate non-trivial levels of utilization.

Ordering of hospice utilization among racial and ethnic groups.

Despite considerable interstate variation, a consistent ordering of hospice utilization was observed across racial and ethnic groups within states. Non-Hispanic White decedents generally occupied the highest utilization levels, followed by Hispanic decedents and those classified as “Other,” while non-Hispanic Black decedents were most frequently positioned at the lowest utilization levels. Utilization among the “Other” category showed greater variability across states, including instances of relatively high utilization in select states.

3.7 Racial Differences in the Association Between Medicare Advantage Penetration and Hospice Utilization

Two-way fixed effects models were used to estimate the association between state-level Medicare Advantage (MA) penetration and hospice utilization, adjusting for time-invariant state characteristics and common temporal trends. Figure 5 and Supplementary Material 1 present race-specific estimates of the marginal association between MA penetration and hospice utilization.

Association among non-Hispanic White decedents.

Among non-Hispanic White decedents, MA penetration was strongly and positively associated with hospice utilization (coefficient = 20.3, $P < .001$). This association represented the largest estimated effect size across all racial and ethnic groups examined.

Association among Hispanic decedents.

For Hispanic decedents, MA penetration was also positively associated with hospice utilization, though the magnitude of the association was substantially smaller than that observed among non-Hispanic Whites (coefficient = 8.3, $P < .01$).

Association among non-Hispanic Black decedents.

Among non-Hispanic Black decedents, the association between MA penetration and hospice utilization was markedly attenuated (coefficient = 4.3) and did not reach conventional levels of statistical

significance (*P* = .06). The estimated effect size was considerably smaller than that observed for non-Hispanic White decedents.

Association among other racial groups.

For decedents classified in the “Other” racial category, the estimated association between MA penetration and hospice utilization was negative and not statistically significant (coefficient = − 3.6, *P* > .10).

Discussion

The end-of-life care trajectories of hip fracture decedents provide a revealing lens through which to examine racial inequality within the U.S. healthcare system. By using hip fracture as a methodological tracer, this study highlights substantial racial divergence in how the broader shift toward hospice and community-based end-of-life care has unfolded across space. While aggregate trends suggest an overall movement toward de-hospitalization, stratified analyses indicate that these gains have been unevenly distributed across racial groups and geographic contexts.

Taken together, our findings—including the post-2016 reversal in minority hospice utilization, the emergence of extensive service deserts, and the differential associations between insurance market expansion and hospice access—point to mechanisms that extend beyond individual-level explanations. We conceptualize these patterns through the complementary lenses of structural invisibility and policy decoupling, which emphasize how minority populations may be systematically overlooked within service infrastructures and how nominal policy expansion may fail to translate into substantive access in racially stratified spaces.

4.1 Beyond “Cultural Preference”: Structural Constraints on Choice

Prior research has often attributed lower hospice utilization among racial and ethnic minorities to cultural preferences, framing these patterns as the result of individual beliefs, religious values, or treatment preferences (24–27).However, multiple lines of evidence from this study raise questions about the adequacy of purely cultural explanations.

First, race remained strongly associated with hospice utilization even after adjustment for demographic characteristics and geographic clustering, suggesting the presence of constraints not captured by individual choice alone. Second, the geospatial analyses demonstrate that in many regions, particularly for non-Hispanic Black decedents, hospice services were effectively unavailable. In such contexts, the absence of observable utilization reflects not a refusal of care, but the lack of a viable option from which to choose. Moreover, the temporal instability observed in minority utilization patterns—particularly the sharp reversals in recent years—stands in contrast to the relative stability typically associated with cultural explanations.

These findings suggest that what appears as “preference” in administrative data may, in many settings, reflect constrained decision-making under conditions of limited service availability. While historical discrimination and mistrust may shape patient–provider interactions, such dynamics are themselves embedded within broader structural conditions rather than operating independently of the healthcare system.

4.2 Mechanisms of Policy Decoupling in Market-Based Reform

Our results further indicate that insurance expansion alone—exemplified by the growth of Medicare Advantage (MA)—does not guarantee equitable improvements in end-of-life care access. Instead, the association between MA penetration and hospice utilization varied substantially across racial groups, consistent with a decoupling between nominal coverage and realized service use.

Several supply-side mechanisms may contribute to this pattern. First, MA plans commonly rely on narrow provider networks as a cost-containment strategy. Hospice agencies serving minority communities are often smaller and less capitalized, potentially limiting their inclusion in preferred networks and weakening the link between insurance enrollment and accessible care (10).Second, network design processes driven by actuarial and algorithmic assessments may inadvertently disadvantage areas with higher concentrations of racial minorities, echoing concerns raised in broader discussions of digital and spatial redlining (28).

Through these mechanisms, similar levels of insurance market penetration may generate markedly different service landscapes across communities, producing patterns of “insurance without access” that are spatially and racially differentiated.

4.3 Toward Place-Based Structural Interventions

Identifying structural invisibility and policy decoupling is a necessary step toward designing more effective and equitable interventions. Rather than relying solely on aggregate performance metrics, regulatory and policy approaches may benefit from greater spatial and demographic specificity.

One potential avenue is enhanced reporting of network adequacy stratified by race, ethnicity, and local geography, allowing regulators to detect within-state and within-market disparities that remain hidden in aggregated data. In addition, incorporating equity-sensitive measures into payment and quality evaluation frameworks—such as Medicare Advantage star ratings—could strengthen incentives for insurers to address disparities within their enrolled populations. Finally, in regions characterized by persistent service deserts, targeted public investment in community-based hospice infrastructure may help stabilize access where market mechanisms alone appear insufficient.

Together, these approaches underscore the importance of moving beyond universal policy expansion toward place-based strategies that recognize how healthcare access is produced at the intersection of race, geography, and institutional design.

4.4 Strengths and Limitations

This study has several distinct methodological strengths. First, as one of the few studies to examine end-of-life trajectories among hip fracture patients over a 22-year period (1999–2020), we provide a rare longitudinal perspective that captures dynamic trends—such as the reversal in Black hospice utilization—that cross-sectional studies might miss. Second, the selection of hip fracture as a "tracer condition" is strategic. Unlike cancer or dementia, hip fracture is an acute, non-discretionary event; its urgent need for medical attention minimizes selection bias related to care-seeking behaviors. Third, our integration of geospatial analysis with Two-Way Fixed Effects (TWFE) models offers a robust analytical framework. Specifically, the application of the "Zero-Threshold Protocol" allowed us to visualize "invisible" regions often masked in traditional statistics, while the TWFE model provided rigorous control for unobserved state-level heterogeneity in evaluating policy impacts.

Several limitations should be considered when interpreting these findings. First, due to the ecological nature of CDC WONDER data, we lacked individual-level data on socioeconomic status (SES) (e.g., income, education) or specific insurance types. Although race is often a strong proxy for SES in the U.S., the absence of individual SES controls means we cannot fully rule out the mediating role of poverty. However, given the persistent racial hierarchy observed even in affluent states, economic factors alone are unlikely to explain the entire variance. Second, the study is subject to potential ecological fallacy. Linking state-level MA penetration rates to aggregated mortality outcomes reflects environmental associations rather than individual causal effects; we cannot verify whether specific minority decedents without hospice access were personally enrolled in MA plans. Third, while ICD-10 codes (S72) have high specificity, cause-of-death reporting on death certificates may be subject to misclassification and does not capture fracture severity or comorbidity burden (e.g., Charlson Comorbidity Index), which could influence clinical decision-making. Finally, this study focused on access (whether hospice was used) rather than quality of care. Even when minority patients access hospice facilities, they may still experience disparities in pain management or family satisfaction, suggesting that our findings may underestimate the true extent of inequity.

4.5 Methodological Implications

Beyond its empirical findings, this study highlights the importance of spatially explicit and population-level approaches for examining racial inequities in end-of-life care. Individual-level preference data, while valuable, may obscure the structural conditions under which “choices” are made when service availability itself is unevenly distributed across space. By combining a tracer condition with geospatial analysis and policy-sensitive modeling, our approach demonstrates how structural barriers can be rendered visible only at aggregated and geographic scales. Such methods are particularly relevant for studying end-of-life care, where access depends not only on individual decisions but also on the organization of local service infrastructures and insurance markets.

Conclusion

The end-of-life care trajectories of hip fracture decedents offer a revealing perspective on racial inequality within the U.S. healthcare system. While the broader shift toward hospice and community-based care is often framed as a marker of healthcare modernization, our findings demonstrate that the benefits of this transition have been unevenly realized across racial groups and geographic contexts.

By introducing the complementary frameworks of structural invisibility and policy decoupling, this study clarifies how racial disparities in end-of-life care persist despite aggregate improvements in coverage and service availability. Spatially, minority populations are disproportionately located in service deserts where hospice access is limited or absent. Institutionally, insurance market expansion—particularly through Medicare Advantage—does not translate into comparable gains in hospice utilization across racial groups, underscoring a disconnect between nominal coverage and realized access.

These findings suggest that addressing racial inequities in end-of-life care requires moving beyond uniform, color-blind policy approaches toward interventions that are explicitly responsive to place-based and population-specific barriers. Policies that incorporate geographically disaggregated accountability, equity-sensitive payment incentives, and targeted support for underserved service infrastructures may be better positioned to reduce disparities. Ensuring equitable access to dignified end-of-life care for all older adults will depend on recognizing how race, space, and institutional design jointly shape healthcare trajectories.

Declarations

Ethics approval and consent to participate

This study utilized publicly available, de-identified aggregate data from the Centers for Disease Control and Prevention (CDC) WONDER database. According to the U.S. Department of Health and Human Services regulations (45 CFR 46.102), this study does not classify as human subjects research and is therefore exempt from Institutional Review Board (IRB) review and approval. Requirement for informed consent was waived as the data are anonymized and aggregated.

Consent for publication

Not applicable.

Availability of data and materials

The raw mortality data analyzed during the current study are available in the CDC WONDER Multiple Cause of Death database repository, [https://wonder.cdc.gov/mcd.html]. The processed datasets generated and analyzed during the current study are included in this published article and its additional files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Conceptualization: D.Z. and M.Z.; Methodology: M.Z.; Software: M.Z.; Validation: L.W. and D.Z.; Formal Analysis: M.Z.; Investigation: M.Z. and L.W.; Resources: D.Z.; Data Curation: M.Z.; Writing – Original Draft: M.Z.; Writing – Review & Editing: D.Z., L.W. and M.Z.; Visualization: M.Z.; Supervision: D.Z.; Project Administration: D.Z. All authors have read and agreed to the published version of the manuscript.

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Figures

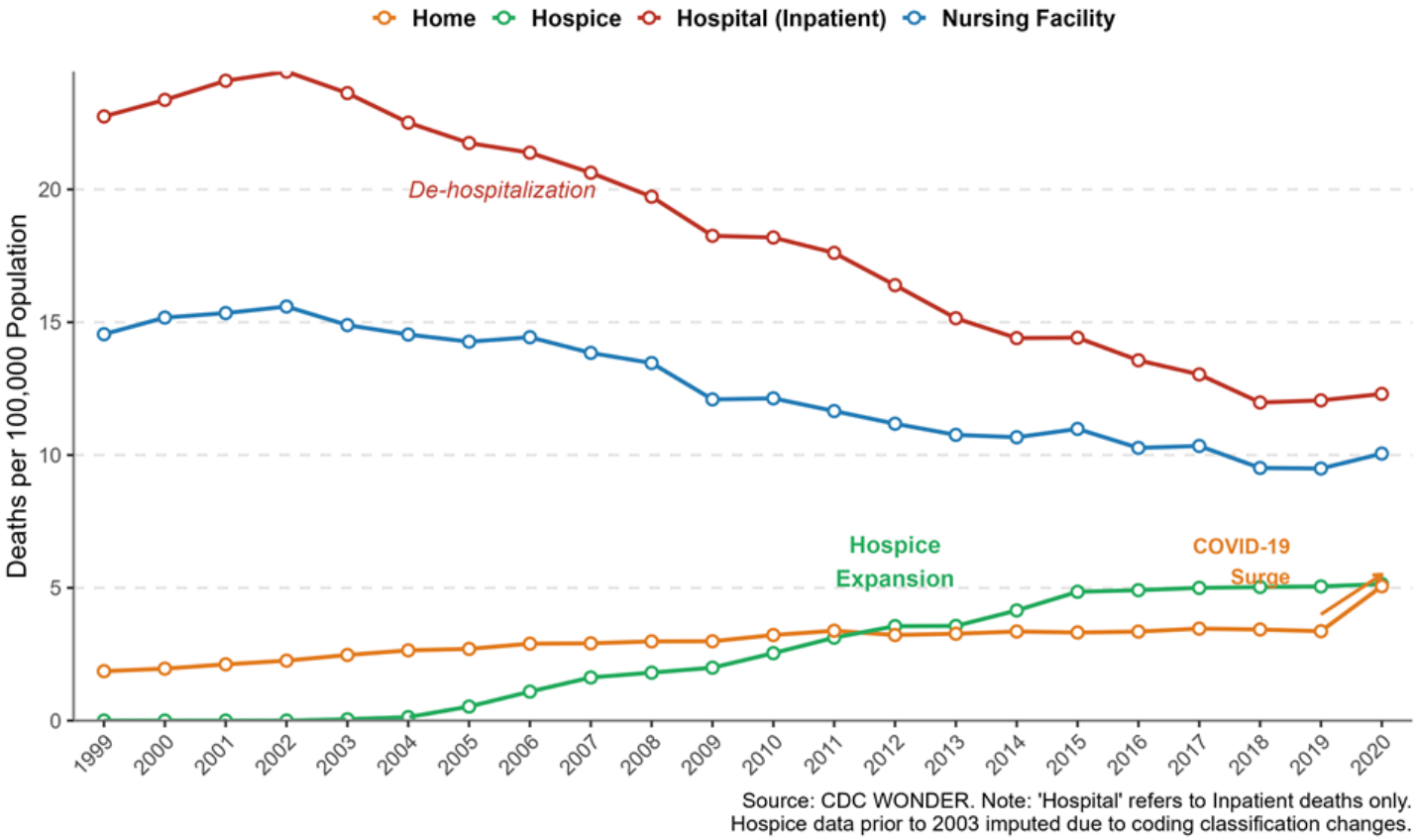


Figure 1

The "Great Divergence" in Place of Death: Temporal Trends and the Shift from Hospitals to Community Settings (1999–2020).

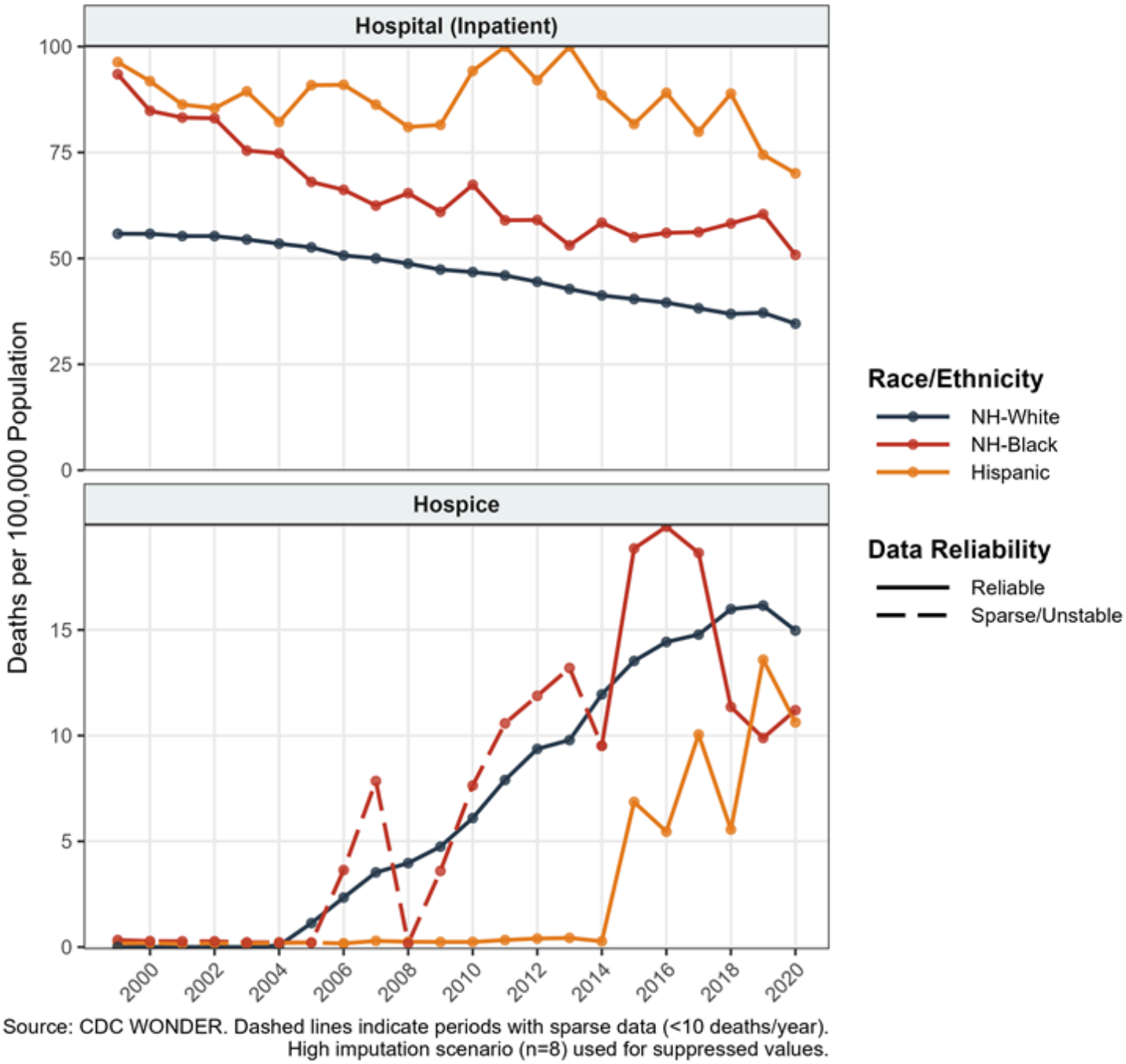


Figure 2

Divergent Trajectories: Racial and Ethnic Disparities in Place of Death Among Hip Fracture Decedents.

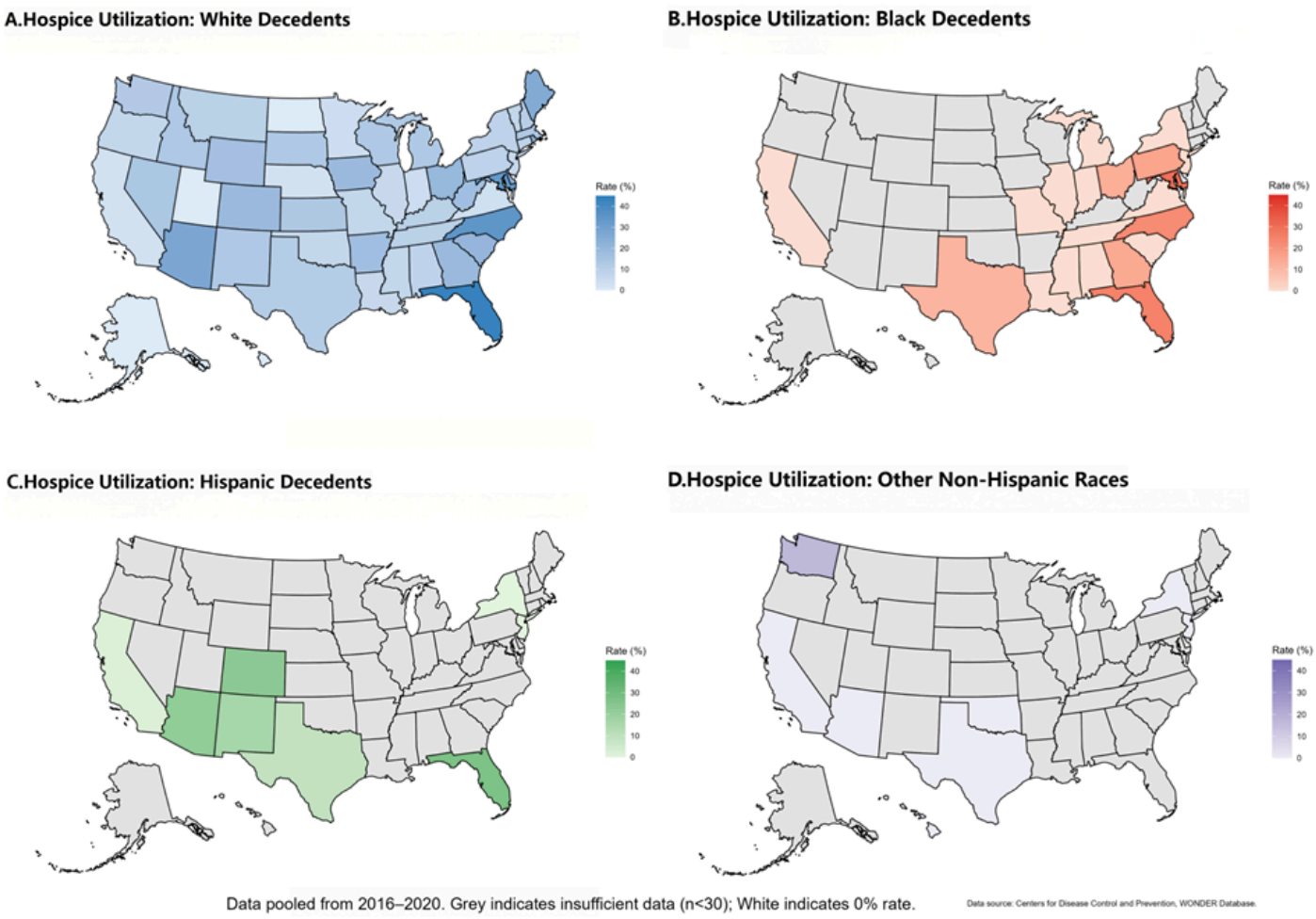


Figure 3

The Geography of Invisibility: State-Level Hospice Utilization Rates and "Service Deserts" (Pooled Data, 2016–2020).

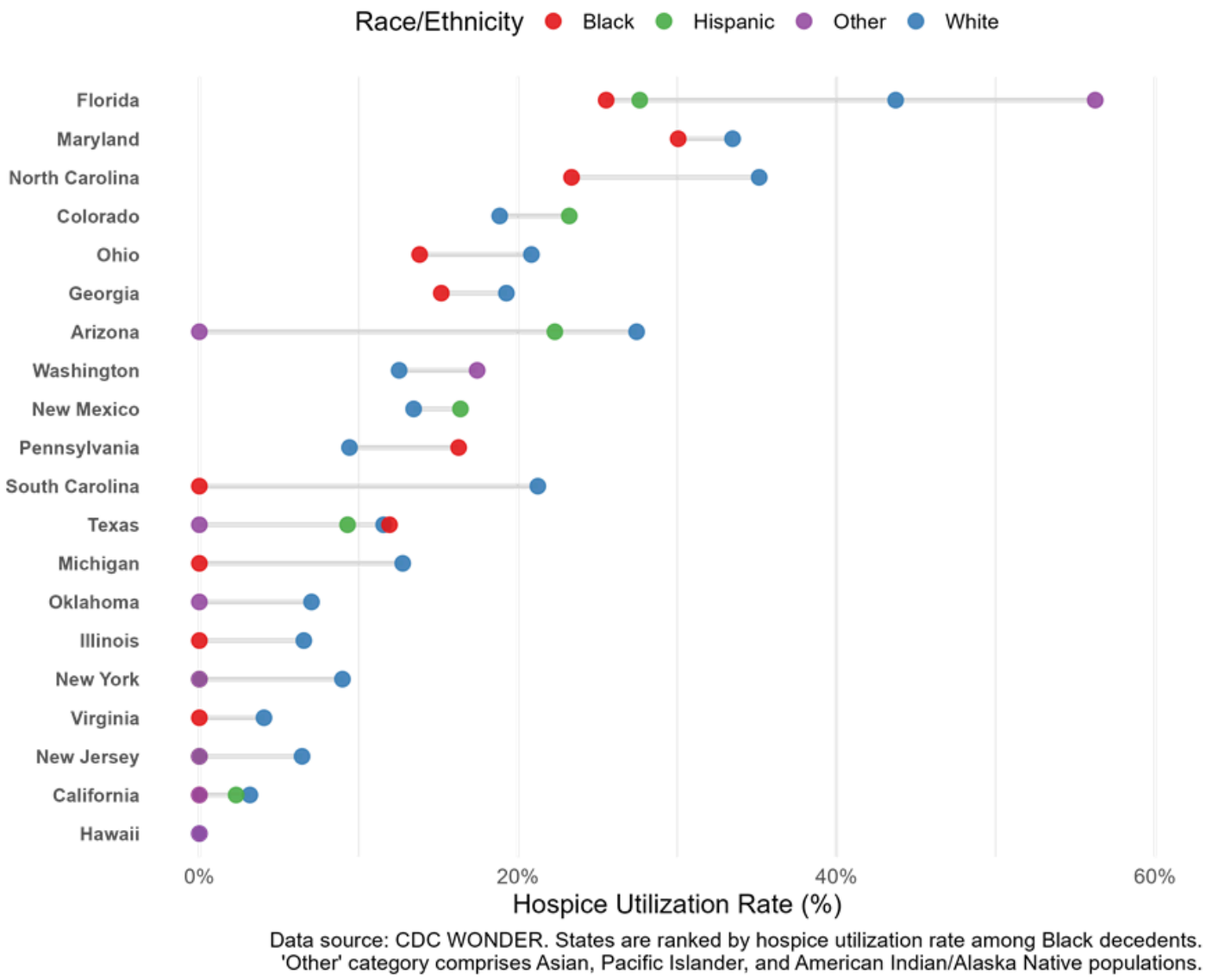


Figure 4

Intrastate Racial Stratification: The Immutable "Racial Hierarchy" of Hospice Access Across High-Burden States.

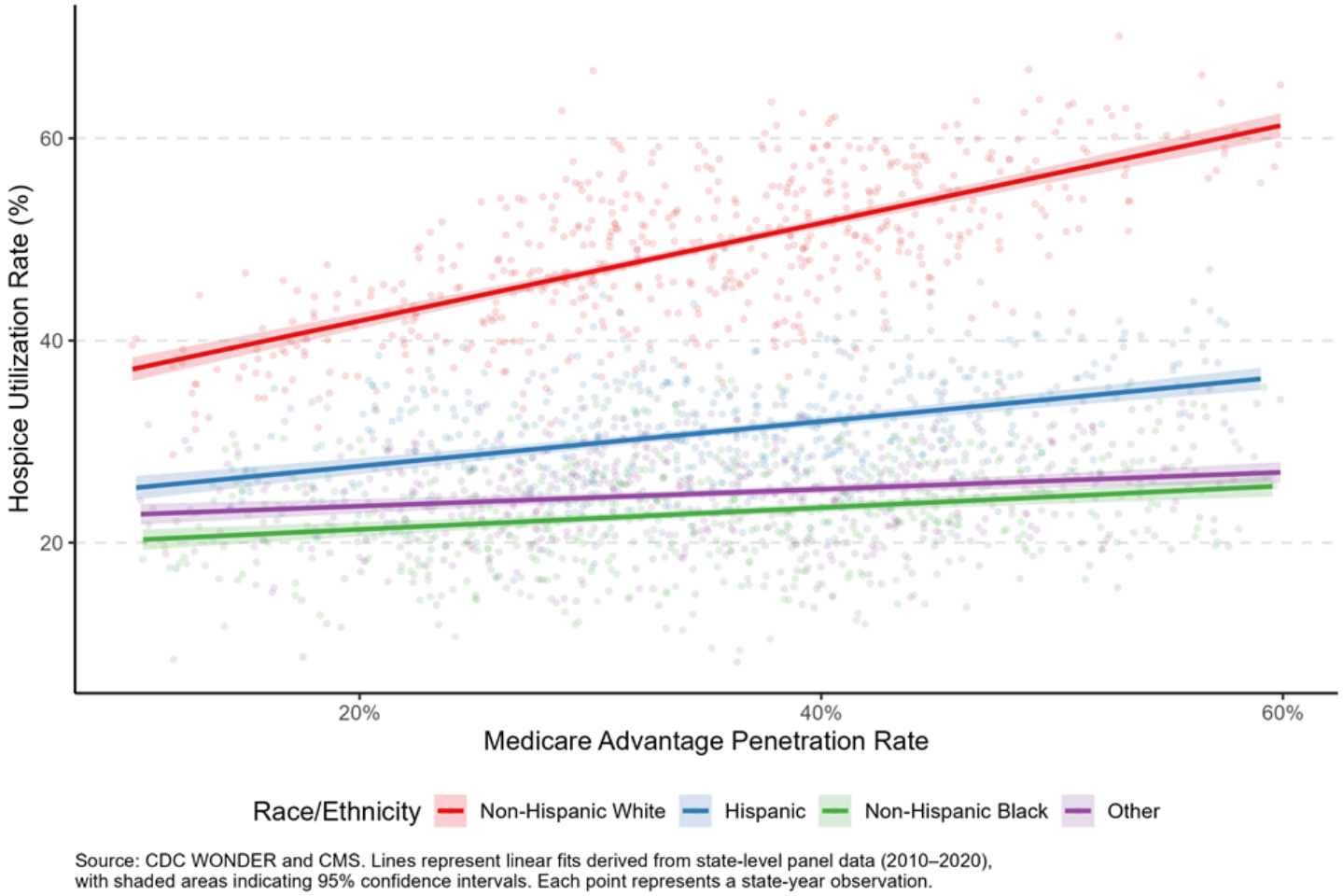


Figure 5

Mechanism of Policy Decoupling: The Differential Impact of Medicare Advantage (MA) Penetration on Hospice Utilization by Race.

Supplementary Files

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- SupplementaryMaterial1.doc