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Community socioeconomic status and rural/racial disparities in HPV−/+ head and neck cancer

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ABSTRACT

Background: Head and Neck Cancer (HNC) is a major cause of cancer morbidity and mortality in the United States, but the burden is not evenly distributed. Rural and racial disparities are obvious across the HNC continuum. Most HNC disparities research have emphasized individual factors perpetuating rural and racial disparities, ignoring the role of community-level factors.

Methods: We analyzed data from the Surveillance Epidemiology and End Results (SEER) program's "Specialized HNC-Human Papillomavirus (HPV) Census-Tract SES" datafile (2010–2016). In addition to cancer patient characteristics, this data includes a socioeconomic status (SES) quintile based on the patient's census-tract. Our outcome variables included whether the HNC patient 1) was diagnosed at a distant stage, 2) received initial treatment two or more months after diagnosis, 3) received radiation therapy, 4) survived two years after diagnosis. We tested for differences across SES quintiles, in the full sample and then within rural/racial categories. We then tested for differences between each rural/racial category conditional on SES quintile.

Results: For both HPV(−) and HPV + HNCs, patients in higher SES census-tracts have 8–10% lower rates of distant stage diagnoses and delayed treatment initiation, and 12.0–14.5% higher survival rates than patients in lower SES census-tracts. Radiation treatment only varied across SES quintiles in HPV + HNC patients. We find little evidence of rural–urban differences within each socioeconomic quintile. However, within lower SES quintiles, we found significant racial disparities in delayed detection and treatment. These differences were largest in the lowest SES quintile, as non-Hispanic Black patients reported 10–11% higher rates of delayed detection and treatment initiation than non-Hispanic White patients.

Conclusions: Our research illustrates the value and constraints in leveraging community-level factors in health disparities research that can ultimately assist in designing effective policies that address and achieve rural and racial cancer equity.

Background

Oral Cancer in America

Head and Neck Cancer (HNC) of the oral cavity represents a major contributor to morbidity and mortality in the United States. Accounting for approximately 2% of all cancers, 50,000–60,000 adults are diagnosed with oral cancer each year[1]. In 2022, over 11,000 adults are expected to die from oral cancer[1]. Over the past two decades, the risk factors for developing and dying from oral cancer have shifted. Incidence of oral cancer not associated with Human Papillomavirus (HPV) has declined while the incidence of oral cancer associated with HPV has increased[2–5]. These two types of oral cancer have distinct clinical features, with implications for the detection, treatment, and survival [6–9]. National stakeholders have committed to improving oral cancer outcomes but have faced considerable challenges given the persistence of disparities across the HNC continuum[10–15].

Existing literature on oral cancer disparities

Adverse oral cancer outcomes are not evenly distributed. Specifically, non-Hispanic Black men and men residing in rural regions have been identified as facing elevated risk of oral cancer mortality[7,16–22]. Evidence has also highlighted disparities across ethnic groups both

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internationally and in the United States[23]. These racial/ethnic and rural survival disparities have, in part, been attributed to "upstream" disparities in detection and treatment.

Staging at time of diagnosis remains a critical factor for survival prognosis, as the probability of five-year survival differs dramatically between oral cancers diagnosed at local versus distant stages for multiple oral cancer sites[24,25]. Unfortunately, <30% of oral cancers are diagnosed at early stages[26]. But again, the burden of late-stage oral cancer differs by sociodemographic factors. Specifically, low-income adults, non-Hispanic Black adults, and rural adults with oral cancer have been found to be more likely to be diagnosed at late or distant stages[27–30]. Conditional on staging at diagnosis, these same population groups have been also found to be less likely to receive high-quality or guideline concordant therapy[6,31]. Evidence also suggests that cancer patients who are low-income, identify as people of color, and/or live in rural areas experience delays for initiating treatment [32,33].

*Evidence **gaps***

Despite the in-depth evidence documenting HNC disparities, our understanding of how rural and racial sociodemographic disparities persist across the HNC continuum remains limited. A systematic review has described the extensive research on oral cancer disparities as contributed by individual-level factors[34]. This evidence base, however, has largely been unable to identify or explain the mechanisms linking individual-level risk factors to poor outcomes[34]. The contemporary and dynamic trends in oral cancer also warrants analyzing HNC disparities as related to HPV-type[7].Most critically, research has primarily focused on individual-level risk factors, while giving limited attention to studying the role of community-level socioeconomic status (SES), not to mention the potential intersection of individuals and their community[35–37]. These knowledge gaps hinder progress for developing interventions aimed at alleviating oral cancer disparities and advancing oral health equity[38]. To address these gaps, our study aims to investigate HNC staging, treatment, and survival disparities by HPV and census tract-level SES status, and then examine the intersection of community and patient-level rural and racial disparities.

Materials & methodologies

Data and sample

We analyzed data from the Surveillance Epidemiology and End Results (SEER) program's "Specialized HNC-Human Papillomavirus (HPV) Census-Tract SES" datafile (2010–2016)[39]. This specialized SEER data contains HPV status for patients with Head and Neck tumors, based on the CS Collaborative Stage Data Collection System. We excluded all HNCs with an unknown HPV status. Our sample included all the oral cancer tumor schemas available in SEER: Hypopharynx, Nasopharynx, Oropharynx, Pharyngeal Tonsil, Pharynx Other, Palate Soft, Tongue Base. All analyses were stratified by HPV status. Additionally, the HNC-HPV SEER datafile includes a socioeconomic status (SES) quintile based on the patient's census tract of residence. These"Yost" quintiles use employment, housing, education, and poverty metrics to construct a validated measure which quantifies community-level SES[40,41]. The SEER HNC-HPV datafile also includes reported race/ethnicity and rural residency, based on Rural Urban Commuting Area (RUCA), which we use to categorize patients as either Rural or Urban. Given sample size limitations, we categorize patients into four race/ethnic groups: non-Hispanic Black, non-Hispanic White, Hispanic, and non-Hispanic Other (which includes Asian American/Pacific Islanders, Native Americans, and patients with an unknown race). SEER removes all Alaska Native cases from the SES-HPV datafile to limit the possibility of identifying individual patients. Patients with missing or unknown outcome data were also excluded from the analysis.

Variables & analysis

We have four distinct binary outcome variables indicating if the patient: 1) was diagnosed at a distant stage; 2) initiated treatment two or more months after diagnosis; 3) received any radiation therapy; and 4) survived at least two years. For each outcome, we construct a probability linear regression model. By excluding a constant term, we compare proportions between groups and conduct tests to determine if the proportions are statistically different with linear models specified as follows:

(1) $Y = \beta' QUINTILE^{1-5}$
(2) $Y = \beta' QUINTILE^{1-5} * RURAL^{R,U}$
(3) $Y = \beta' QUINTILE^{1-5} * RACE^{NHB,\ NHW,\ HISP,\ NHO}$

In each of the above equations, the vector β' measures the mean of outcome-Y for the corresponding group. Equation 1 estimates the mean proportion of each outcome for the five SES quintiles (modeled as a set of mutually exclusive binary variables). We then test for significant differences in proportions across quintiles. Equation 2 then interacts each of the five quintile variables with a rural binary variable and an urban binary variable. Here, we test for differences across SES quintiles within each rural/urban category. We also test for differences within each SES quintile by testing for differences in proportions between rural and urban patients. Finally, equation 3 interacts the five SES quintile variables with a set of four mutually exclusive race/ethnicity variables. Again, we test for differences in proportions both across SES quintiles, within each racial group, and within SES quintiles, across each racial group. We use the Bonferroni method to adjust for multiple hypotheses (alpha = 0.01). In addition to plotting and reporting the mean and standard errors of our estimates, we also report the p-values associated with each Wald test statistic.

Results

Full sample

The analytical sample includes 6,050 patients with a confirmed HPV (−) HNC and 11,507 patients with a confirmed HPV + HNC. The supplemental file reports the sample sizes within each SES quintile and descriptive statistics of the key independent variables (rural status and race/ethnic group) as well as age, gender, insurance status, and marital status. The supplemental file also includes the sample-specific proportions of each group and comprehensive results of significance tests.

Distant stage diagnoses

For both HPV(−) and HPV + HNCs, we find higher proportions of distant stage diagnoses in lower, compared to higher, SES quintiles (Fig. 1A, 1B). In the lowest SES quintile, 29.4% of HPV(−) HNCs and 22.6% of HPV + HNCs were diagnosed at distant stages, whereas in the highest SES quintile only 18.8% of HPV(−) and 14.2% of HPV + HNCs are diagnosed at distant stages (Wald Test p-value < 0.0001; Table 1).

Delayed treatment initiation

We find that the proportion of HNC patients delaying treatment initiation varies by SES quintile (Wald test p-value p < 0.0001; Table 1). This result holds for both HPV(−) and HPV + HNCs. The largest disparities are found when comparing the lowest and highest SES quintiles (Fig. 2A, 2B). In the lowest SES quintile, 39.7% and 28.6% of patients with HPV(−) and HPV + HNC, respectively, delay treatment initiation for at least two months compared to just 29.8% of HPV(−) and 20.5% of HPV + HNC patients in the highest SES quintile.

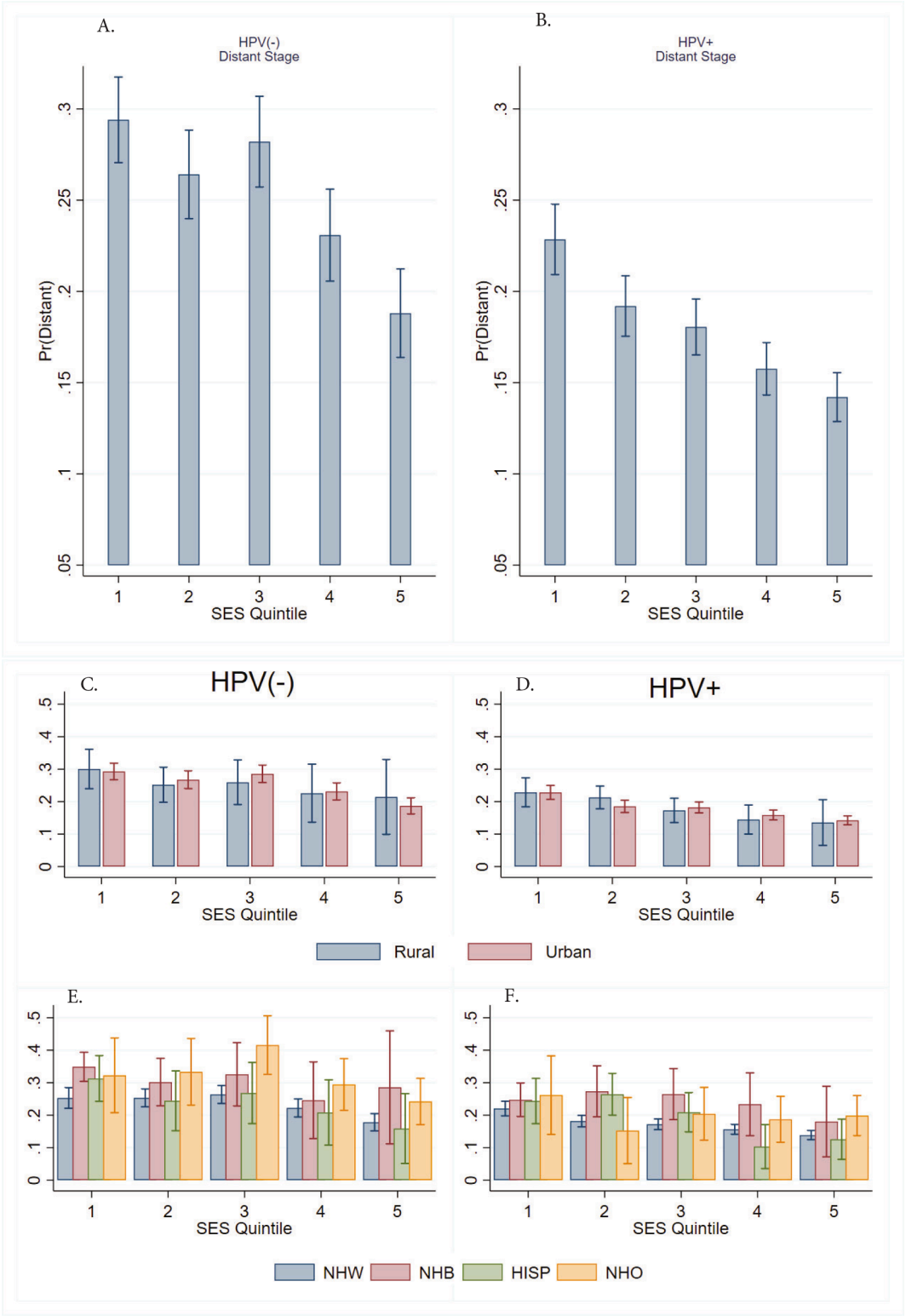

Fig. 1. Distant Stage Diagnoses (%). F1 shows the proportion of HPV(−) and HPV + HNCs diagnosed at distant stages in each SES Quintile for the total, rural/urban, and racial groups. P(Distant) = the proportion of group-specific oral cancer patients diagnosed at a distant stage among all group-specific oral cancer patients.

Radiation therapy

HPV(−) HNC rates of radiation therapy were substantially lower than HPV + rates (Fig. 3A, 3B). In HPV(−) HNCs, we find no evidence that radiation treatment rates vary across SES quintiles (Table 1). Conversely in HPV + HNCs, we find higher rates of radiation therapy in the highest SES quintiles (88.9%) compared to the lowest (84.4%) (Wald test p-value < 0.0001).

Two-year survival

Two-year survival rates differed significantly across all SES quintiles,

Table 1
Joint-Tests of Statistical Significance Across Socioeconomic Status Quintiles.

Outcome	HPV-Type	Full Sample	Rural	Urban	NHW	NHB	HISP	NHO
Distant Stage	negative	0.0000	0.5465	0.0000	0.0001	0.3999	0.1507	0.0334
	positive	0.0000	0.0159	0.0000	0.0000	0.5843	0.0007	0.7012
>= 2 Mo. to Tx	negative	0.0000	0.0055	0.0000	0.0385	0.1089	0.3971	0.0009
	positive	0.0000	0.2058	0.0000	0.0039	0.0674	0.0193	0.0083
Radiation Tx	negative	0.0000	0.8895	0.0843	0.5138	0.6970	0.1239	0.6790
	positive	0.1909	0.5692	0.0000	0.0630	0.0080	0.2724	0.0027
Two-Year Survival	negative	0.0000	0.0004	0.0000	0.0000	0.0119	0.0062	0.6949
	positive	0.0000	0.0291	0.0000	0.0000	0.0158	0.1447	0.1630

Table 1 reports the p-values from the corresponding joint-tests of significance for each population sample of adults with Head and Neck Cancer across census-tract level community socioeconomic status quantiles. SES 1 = lowest socioeconomic status, SES 5 = highest socioeconomic status. NHW = non-Hispanic White adults, NHB = non-Hispanic Black adults, HISP = Hispanic adults, NHO = non-Hispanic adults reporting a race category not White or Black. Each test statistic was a result of a Robust Wald joint-test of proportions with Bonferroni correction, where $p < 0.01$ is considered a statistically significant difference.

regardless of HPV status (Wald test p-value < 0.0001; Table 1). Moreover, the two-year survival rate in every SES quintile was significantly higher than the rate in the lowest SES quintile (Fig. 4A, 4B).

Intersection of community-SES and rural/racial disparities

Distant stage diagnoses

When testing for differences across SES quintiles within urban patients (Fig. 1C, 1D), we find lower rates of distant stage diagnoses for both HPV(−) and HPV + HNCs ($p < 0.0001$; Table 1). However, for rural patients with HPV(−) HNC, we fail to reject the null hypothesis that distant stage diagnoses differ across SES quintiles (Table 1). Within each SES quintile, however, there are no statistically significant differences in the proportion of distant stage diagnoses between rural and urban HNC patients (Table 2).

We also find that distant stage diagnoses vary by race/ethnicity (Fig. 1E, 1F; Table 1). For non-Hispanic White and non-Hispanic other race/ethnicity patients, distant stage diagnoses rates are vary across SES quintiles for HPV + HNCs and in HPV(−) HNCs ($p < 0.0001$; Table 1). Distant stage diagnoses for Hispanic HPV + HNC patients also vary across SES quintiles ($p = 0.0007$). We find no statistically significant differences in distant stage diagnoses rates across SES quintiles for non-Hispanic Black patients.

When testing across racial/ethnic groups and within each SES quintile, we find statistically significant differences in distant stage diagnoses in the lowest three quintiles for HPV(−) and HPV+ ($p = 0.0037 – 0.0065$; Table 3). For both HPV(−) and HPV + HNC, the disparities are most pronounced when comparing non-Hispanic Black patients (who have the highest rates of distant stage diagnoses) with non-Hispanic White patients. In the lowest SES quintile, we estimate that the rate of distant stage HPV(−) HNC is 25.5% in non-Hispanic White patients and 33.9% in non-Hispanic Black patients.

Delayed treatment initiation

The differences in delayed treatment initiation vary across SES quintiles for both HPV(−) and HPV + HNCs for urban patients ($p < 0.0001$) and statistically significant for HPV(−) HNCs for rural patients ($p < 0.0055$; Table 1). Within most SES quintiles, there are no statistically significant differences in delayed treatment rates between rural and urban HNC patients. (Table 2). However, two main exceptions are the highest and lowest SES quintiles (Fig. 2C, 2D). Within the lowest SES quintile, 17.5% of HPV + HNC patients in rural areas delayed treatment initiation, compared to 31.4% of urban counterparts ($p < 0.0001$). Within the highest SES quintile, 12.5% of HPV(−) HNC patients in rural areas delayed treatment initiation compared to 30.7% of urban counterparts ($p < 0.0051$).

Rates of initiation delays are statistically significantly different across SES quintiles for both HPV types for non-Hispanic White and non-Hispanic Other racial/ethnic groups (Fig. 2E, 2F; Table 1). Only for HPV (−) oral cancer did we observe differences in initiation delays across SES quintiles for Hispanic and non-Hispanic Black patients (Table 1). The joint tests across racial/ethnic groups reveal that delayed treatment rates significantly differ within three of the five lowest SES quintiles (Table 3). In the lowest SES quintile, delayed treatment rates range from 27.4% (non-Hispanic Other) to 46.8% (non-Hispanic Black) for HPV(−) HNCs and from 24.9% (non-Hispanic White) to 42.2% (Hispanic) for HPV + HNCs.

Radiation therapy

There appear to be no statistically significant rural–urban disparities in the proportion of HNC patients receiving radiation therapy within any SES quintile (Table 2). Only among urban adults with HPV + HNC did radiation treatment rates vary across SES (Wald test p-value < 0.0001; Table 1). Only for HPV + non-Hispanic Black and non-Hispanic Other racial group patients did radiation therapy rates significantly differ across SES quintiles ($p = 0.008$ & 0.0027; Table 1). For these two racial/ethnic groups, we found a 10–20% point difference in proportions receiving radiation therapy between the lowest and highest SES quintiles (Fig. 3F). We also found that radiation treatment rates varied by race/ethnic group in the lowest SES quintiles for HPV + HNCs ($p = 0.0014$ & 0.0007; Table 3). In the lowest SES quintile, 85.9% of non-Hispanic White HPV + HNC patients received radiation therapy, which was significantly higher than the proportion of HPV + non-Hispanic Black (85.6%) and non-Hispanic Other (66.7%) patients.

Two-year survival

For rural HPV(−) HNCs, we find lower two-year survival rates in lower SES quintiles ($p < 0.0001$). We find similar associations between SES quintiles and survival for both HPV(−) and HPV + urban patients (Fig. 4D). Within each SES quintile, we find no rural–urban differences in survival (Table 2). Regardless of HPV status in non-Hispanic White patients, and in HPV(−) Hispanic patients, two-year survival rates significantly differed across SES quintiles (Fig. 4E, 4F; Table 1). Differences by SES quintile were only marginally significant for non-Hispanic Black patients ($p = 0.0119$ & 0.0158). When testing across SES quintiles, we find no statistically significant tests suggesting that two-year survival rates vary by racial group (Table 3). However, when examining differences between two groups separately, we find lower survival rates in non-Hispanic Black HPV+ (SES Q1 = 34.7%) and HPV(−) (SES Q2 = 28.3%) patients in the lowest two quintiles, compared to survival rates in non-Hispanic White HPV+ (SES Q1 = 42.3%) and HPV(−) (SES Q2 = 40.6%). See supplemental file for these disaggregated significance test results.

Discussion

In summary, we find significant disparities across census-tract SES quintiles. Except for treatment initiation, there is less evidence of rural/urban disparities after conditioning on SES quintile. However, racial disparities appear to persist for all outcomes, but only within the lowest

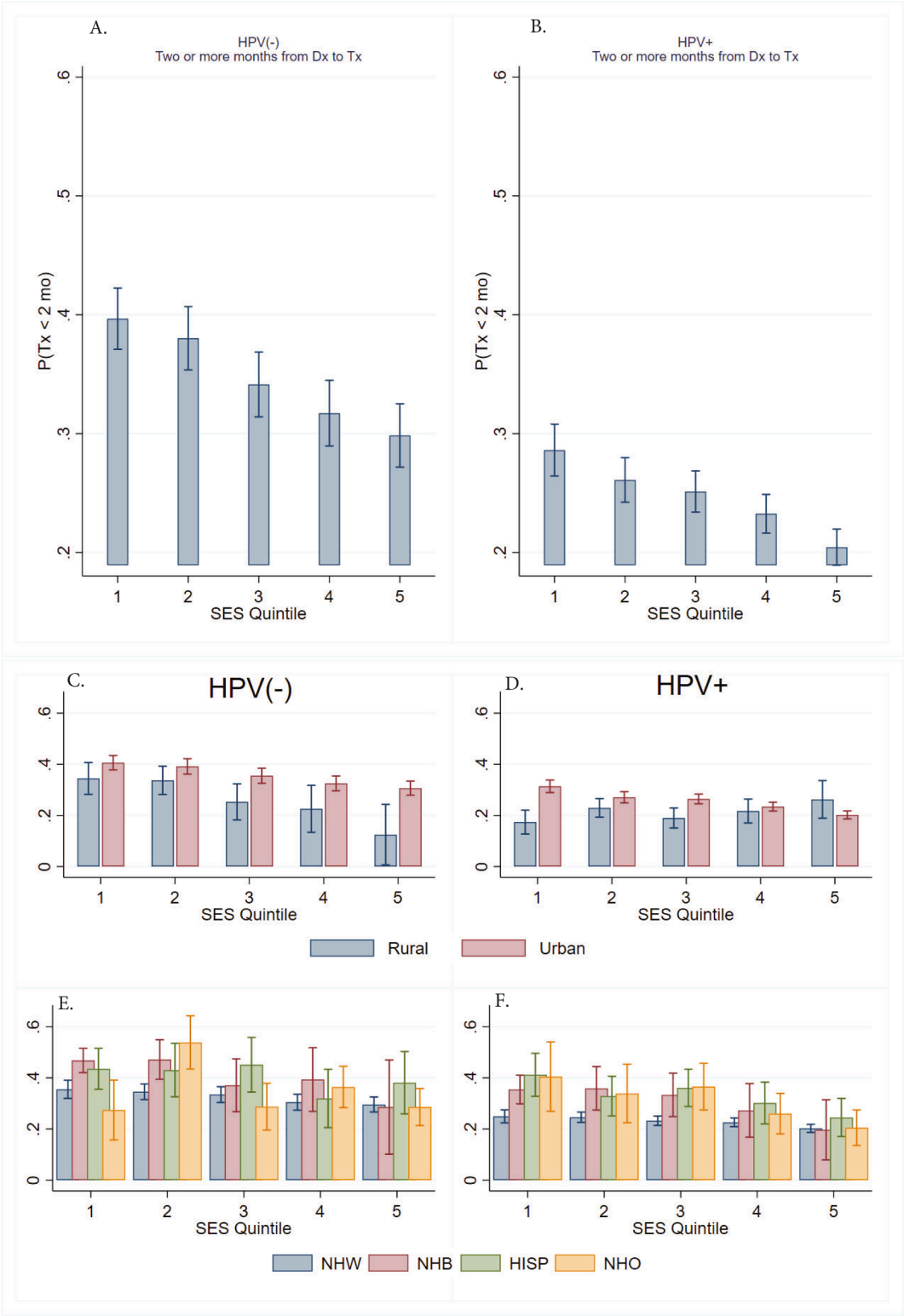

Fig. 2. Delayed Treatment Two Months After Diagnosis (%). F2 shows the proportion of HPV(−) and HPV + HNC patients who initiated treatment two or more months after initial diagnosis in each SES Quintile for the total, rural/urban, and racial groups. P(Tx < 2 mo) = the proportion of group-specific oral cancer patients initiating treatment among all group-specific oral cancer patients.

SES quintiles.

From the patient perspective, survival is among the most valuable end points. It is here where we highlight several disparities. Across all quintiles, we found two-year survival rates were significantly associated with higher community level SES for both HNCs. Rural HPV(−) patients in the lowest quintile experienced the lowest two-year survival rates overall. Considering the low HPV(−) survival rate and lack of medical resources in underserved rural communities, this is not surprising. However, as community level SES increases, rural areas' HPV(−) two-year survival almost doubles, slightly surpassing urban survival rates.

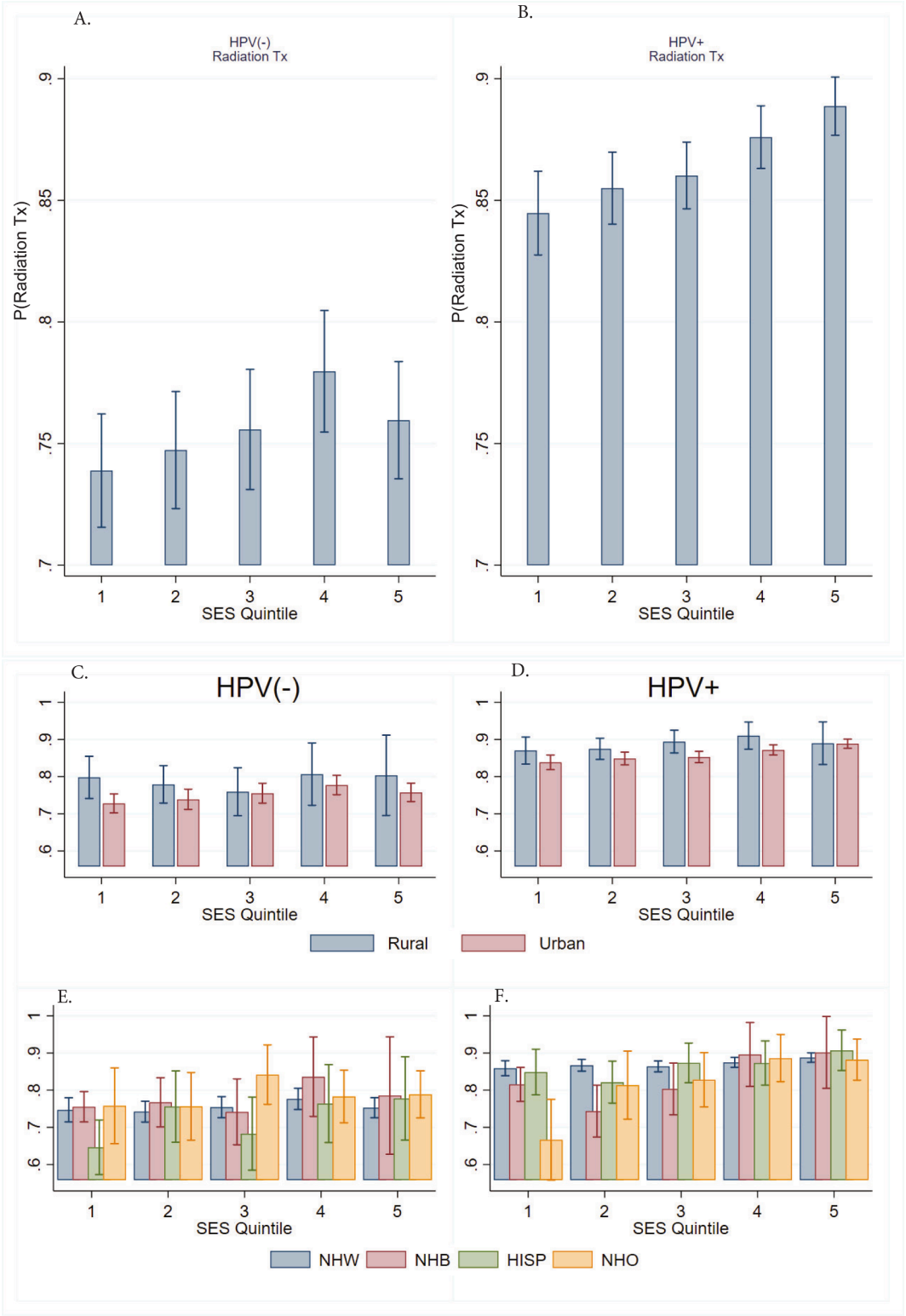

Fig. 3. Receiving Radiation Therapy (%). F3 shows the proportion of HPV(−) and HPV + HNCs receiving radiation therapy in each SES Quintile for the total, rural/urban, and racial groups. P(Radiation Tx) = the proportion of group-specific oral cancer patients reiving radiation therapy among all group-specific oral cancer patients.

Two-year survival rates for HPV(−) patients in urban areas are also positively associated with increases in community-level SES. Our mixed findings reflect the inconsistent literature on the impact of rural versus urban residence on cancer survival[42,43].

More consistent with ample literature, are the significantly low survival rates for both HNCs for non-Hispanic Black patients in the lowest quintiles. However, when comparing the lowest quintile to the highest, we see a dramatic increase in HPV(−) survival rate for non-Hispanic Blacks, and also for Hispanics. These findings suggest a positive role that higher SES community-level factors can play in health

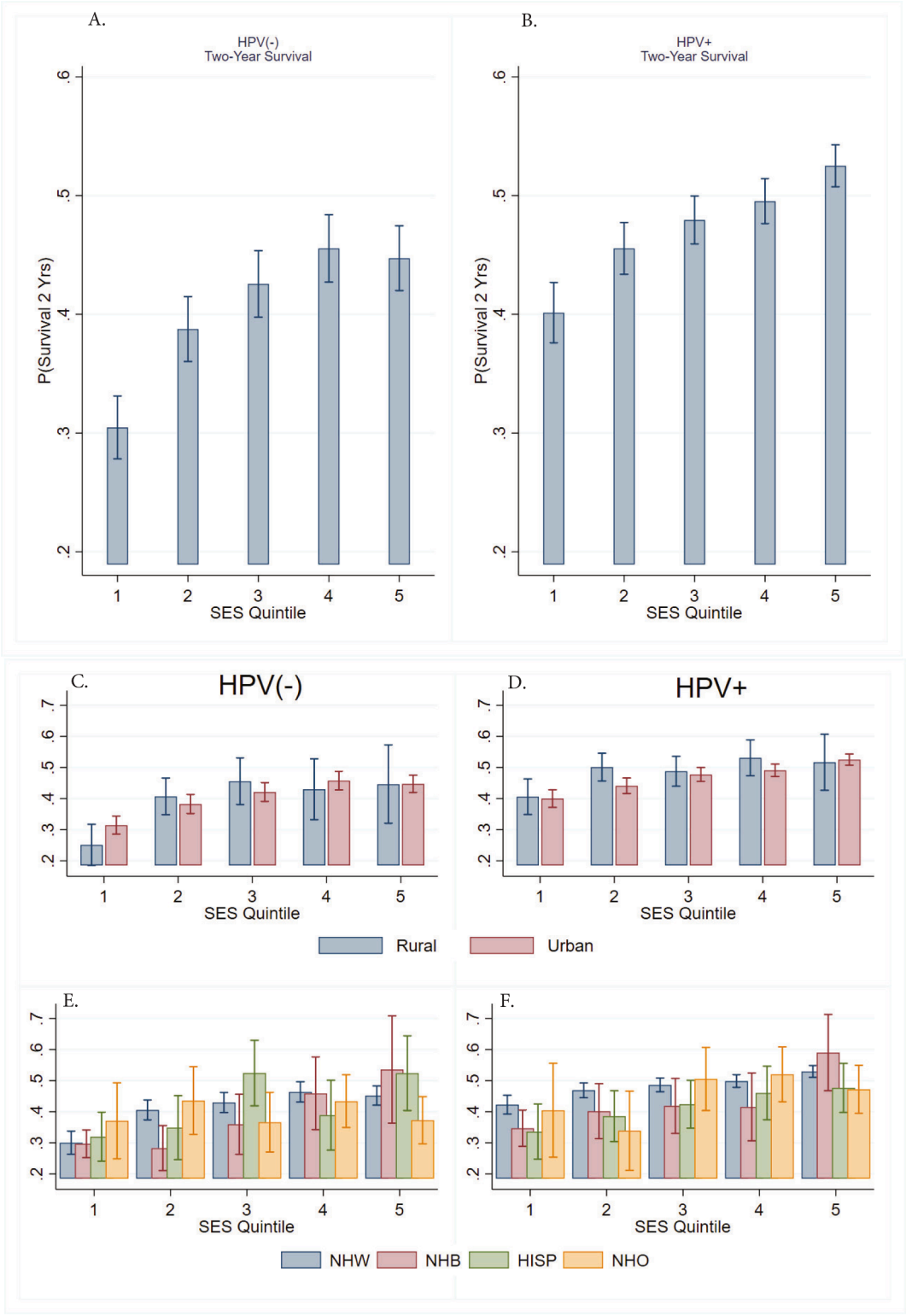

Fig. 4. Two-Year Survival (%). F4 shows the proportion of HPV(−) and HPV + HNC patients surviving at least two-years in each SES Quintile for the total, rural/urban, and racial groups. P(Survival 2 Yrs) = the proportion of group-specific oral cancer patients surviving more than two years among all group-specific oral cancer patients.

outcomes for Black and Brown people. However, considering HPV + HNC are increasing among white men and white women, and non-Hispanic whites represented a larger proportion of patients in the sample than non-Hispanic Blacks and Hispanics, these findings still reveal inequities in the healthcare system for people of color.

As we compare rural and urban areas further, we must acknowledge that non-Hispanic Whites comprise most cases our sample and head and neck cancer cases in the nation. Furthermore, non-Hispanic White patients represent 100% of the highest rural quintile for HPV(–) and 95% of the HPV + cases in the highest quintile in our sample, reflecting, and even overrepresenting, the non-Hispanic white racial makeup of rural areas. Meanwhile, our sample of urban areas have more people of color,

Table 2
Tests of Statistical Significance Between Rural and Urban Status.

Outcome	HPV-Type	SES 1	SES 2	SES 3	SES 4	SES 5
Distant Stage	negative	0.8169	0.6114	0.4816	0.9069	0.6427
	positive	0.9921	0.1639	0.6568	0.5429	0.8484
>= 2 Mo. to Tx	negative	0.0905	0.1012	0.0120	0.0526	0.0051
	positive	0.0000	0.0648	0.0012	0.5163	0.1299
Radiation Tx	negative	0.0329	0.1817	0.9075	0.5313	0.4330
	positive	0.1476	0.1422	0.0233	0.0663	0.9715
Two-Year Survival	negative	0.0887	0.4715	0.4040	0.5999	0.9896
	positive	0.8542	0.0218	0.6989	0.1955	0.8560

Table 2 reports the p-values from the corresponding tests of significance between Rural and Urban adults with Head and Neck Cancer. All tests were conducted as a *t*-test and separately analyzed within each group of census-tract level socioeconomic status categories. SES 1 = lowest socioeconomic status, SES 5 = highest socioeconomic status. Rural and Urban differences were considered statistically significant based on $p < 0.01$.

Table 3
Joint-Tests of Statistical Significance Across Racial/Ethnic Groups.

Outcome	HPV-Type	SES 1	SES 2	SES 3	SES 4	SES 5
Distant Stage	negative	0.0037	0.2658	0.0065	0.3308	0.1902
	positive	0.6463	0.0059	0.0439	0.0884	0.1909
>= 2 Mo. to Tx	negative	0.0002	0.0001	0.0993	0.3249	0.5551
	positive	0.0000	0.0031	0.0000	0.1674	0.6916
Radiation Tx	negative	0.0500	0.9102	0.0899	0.7531	0.7524
	positive	0.0014	0.0007	0.1982	0.9365	0.8894
Two-Year Survival	negative	0.6934	0.0197	0.0867	0.6017	0.0955
	positive	0.0651	0.0351	0.2300	0.3915	0.2123

Table 3 reports the p-values from the corresponding joint-tests of significance for each census-tract level socioeconomic category sample of adults with Head and Neck Cancer across racial/ethnic group status. NHW = non-Hispanic White adults, NHB = non-Hispanic Black adults, HISP = Hispanic adults, NHO = non-Hispanic adults reporting a race category not White or Black. Each test statistic was a result of a Robust Wald joint-test of proportions with Bonferroni correction, where $p < 0.01$ is considered a statistically significant difference.

which may possibly explain the poorer outcomes for the urban areas, even as community level SES increased, suggesting that the inequities and barriers people of color face in urban communities have a negative effect on health outcomes despite higher SES. Low-income urban areas can often be deprived of community-level support systems that promote healthy behaviors and improve health outcomes. Essentially, our rural–urban findings may also be indicative of the same racial disparities that appear to especially persist within the lowest SES quintiles in our study. We may expect to see disparities between the poorest rural and urban areas, but we do not, possibly because the lowest quintiles in both groups have a larger proportion of people of color. We also see how, despite representing a smaller proportion of HNC cases, patients of color, in many cases, still had higher proportions of poorer outcomes compared to their white counterparts in the same quintile. This suggests that racism, and the personal, structural, and systemic barriers it causes, may play a role in the receipt of accessible, timely, quality care[44]. We recommend further studies continue examining the intersection of rural inequities by race/ethnicity to highlight the racial inequities within rural areas.

Limitations

Our study is not without limitations. Our aim was to investigate the intersection of racial/rural and community SES disparities in HNC. While guided by a multi-level framework, our data and limited sample size prohibited us from exploring the interaction between rurality and racial/ethnic factors. Moreover, our sample may not have had the power to control for other factors associated with HNC outcomes (i.e., age, gender). Our results were also limited by the especially low sample sizes of racial/ethnic groups categorized as "non-Hispanic Other." We acknowledge the heterogeneity found in our study within NHO oral cancer diagnoses, treatment and outcomes given the variation between Asian American/Pacific Islanders and Native Americans, groups that each have unique cultures and histories in the US. Including these groups individually was, unfortunately, infeasible. Rather than exclude these populations altogether, we opted to categorize them as one group. In addition, while not necessarily a limitation to our interpretations, readers should be aware that the SEER HNC-HPV data has become more robust over time, with less missing or mismeasured HPV status in recent years. Like time, place matters, but so does policy and environment. Although our analysis would benefit from including state or regional variables related to HNC outcomes, to ensure patient privacy the specialized SEER data removes all geographic identifiers. Finally, while five-year survival is the standard in disparities analysis, SEER recommends against such analyses given the short window for follow-up (2010–2016).

Conclusion

Despite changing trends in oral cancer risks, incidence, and mortality, rural and racial disparities have persisted in the cancer care continuum. As expected, lower community SES was associated with poor HNC outcomes. Interestingly, we found less evidence of rural–urban disparities within each SES quintiles. However, even within SES quintiles, we found statistically significant evidence of racial disparities. Especially in the lowest SES census-tracts, non-Hispanic Black adults with HNC were more likely to experience delays in detection and treatment initiation, to not receive radiation therapy, and to die within two years of diagnosis. Our evidence illustrates the value and limitations of leveraging community-level factors to address health disparities. Future research informing policies to achieve socioeconomic, rural, and racial cancer equity must continue to be prioritized.

Ethics Statement

This study used publicly available SEER cancer registry data and is not Human Subjects Research.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tipsro.2023.100205.

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