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Socioeconomic Status and Hepatocellular Carcinoma in the United States

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Abstract

Background—Hepatocellular carcinoma (HCC) has a poor prognosis and, unlike most cancers, HCC incidence and mortality rates are increasing in the United States. While risk is known to vary among different racial and ethnic groups, less is known about the variability of risk within these groups by neighborhood socioeconomic status (SES).

Methods—HCC cases diagnosed in the Surveillance, Epidemiology and End Results (SEER) 11 cancer registries between 1996 and 2007, and the population of the SEER 11 catchment areas was studied. Analyses were conducted to compare census tract area family poverty, educational attainment, and unemployment by race and ethnicity. A multiple linear regression model, weighted by the number of cases and the number of individuals in each census tract, with adjustment for registry, was used to calculate mean differences in area-level attributes between HCC cases and the population.

Results—HCC cases in most racial/ethnic groups had lower mean neighborhood-level measures of SES than their referent population. An exception was seen among Hispanics. Comparing white cases with cases of other racial groups and to Hispanics, white cases lived in neighborhoods with less family poverty, fewer high-school dropouts, and lower unemployment. Compared with white cases, Asian and Pacific Islander and Hispanic cases lived in neighborhoods with a higher percentage of foreign-born population.

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Conclusions—Low neighborhood-level SES and immigrant status may be associated with greater risk of HCC within specific racial and ethnic groups.

Impact—These findings could help to focus control resources for HCC toward the most affected communities.

Introduction

Hepatocellular carcinoma (HCC) incidence and mortality rates have been increasing in the United States since 1980 (1, 2). Racial and ethnic differences in these rates are reported (3). In comparison with whites, other groups experience higher incidence and mortality rates. Whether racial/ethnic differences in HCC incidence can be explained by differences in area-level socioeconomic status (SES) merits investigation because HCC incidence is thought to increase as SES decreases (4).

The limited research that has been published on the relationship between HCC incidence and SES in the United States is restricted to specific geographic regions. For instance, a California study has examined neighborhood enclave status and indices of SES (4). In the United States, low SES and poverty (5-10) are associated with HCC risk factors (11) including diabetes (5), metabolic syndrome (6), obesity (8), alcoholism (9), hepatitis B (12), and hepatitis C infection (7, 13, 14). Low educational attainment is associated with viral hepatitis infection, alcoholism, and liver inflammation (15).

Underemployment was associated with increased rates of alcoholism in some Hispanic groups (16), and hepatitis B infection is more prevalent among some foreign-born Asian subgroups (17). In this report, census tract neighborhood–level measures of SES of HCC cases residing in Surveillance Epidemiology and End Results (SEER) 11 registries were compared with the general population of the registry catchment area. We hypothesized that low neighborhood-level SES and high percentage of foreign-born population was associated with greater risk of HCC. Such findings could help to focus control efforts for HCC toward communities that are most affected by HCC.

Methods

Cases and population

Incident HCC cases during 1996 to 2007 were reported to SEER 11 registries (18): Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, and San Jose-Monterey, covering more than 10% of the U.S. population. Cases were individuals with one primary tumor only, International Classification of Diseases for Oncology, 3rd Edition (ICD-O-3) topography code C22.0 (primary liver cancer), and morphology codes 8170 to 8175. Stage at diagnosis and the distribution of selected demographic attributes of cases (age, sex, and race/ethnicity) were determined. Hispanic ethnicity was classified using the North American Association of Central Cancer Registries (NAACCR) Hispanic Identification Algorithm (19). The racial group Asians and Pacific Islanders was classified using the Asian/Pacific Islander Identification Algorithm (20). Cases were compared with the general population residing in the SEER 11 catchment area during year 2000. The SEER Custom Data Use Committee provided approval to link census tract–level attributes to the incidence file.

Neighborhood-level attributes of persons living in the SEER catchment area were obtained by linking census tract of residence of cases and the population. Four determinants of health disparities (21) were examined on the basis of 2000 census tract–level attributes and 2 widely used variables (22): (i) percentage of families living below the year 2000 poverty

level, (ii) percentage of persons 25 years and older with less than a high-school diploma and 2 other HCC relevant variables, (iii) percentage of persons 16 years and older who were unemployed, and (iv) percentage of population born outside the United States (4, 23).

Data were available for all races combined and for non-Hispanic whites, blacks, Asians and Pacific Islanders, and Hispanics (all races). Among cases, whites had the highest proportion of Hispanic ethnicity (30%), followed by American Indian and Alaska Native (4%), black (1.2%), and Asian and Pacific Islander (1%) cases. Population estimates were unavailable for bridged race, accounting for multiracial individuals at the census tract–level by age and gender. In the 2010 census, a small proportion of the population designated multiple race (<5%), supporting the use of nonbridged race categories. Percentage of foreign-born population was only available for all races combined. Spearman and Pearson correlations of census tract–level variables were examined.

Comparison of census tract SES of cases and the population

Mean census tract SES measures and 95% confidence intervals (CI) of HCC cases and the population were compared. Multiple linear regression models using the census tracts as the units of analysis were weighted by the number of cases or population size in each census tract and adjusting for registry. These regression models were used to estimate mean differences in census tract attributes between HCC cases and the population. Models were developed for all cases and by race/ethnicity. Differences in census tract percentage of foreign-born population could only be estimated between all cases and the overall population. Stratified analyses were conducted for localized stage and regional/distant stage cases, combined. Because of the differential weighting of the census tracts in our sample, we used robust variance estimation to estimate standard errors, a method that is used in the analysis of weighted survey data (24). The use of robust variances avoids assumptions that the residuals from the regression analyses have homogeneous variances and applies a large sample theory to justify using normality for statistical testing and establishing confidence interval (CI) limits (24).

Case–case comparisons of census tract SES by race/ethnicity

Multiple linear regression modeling adjusted for age, sex, and stage was used to make case–case comparisons where non-Hispanic whites were the reference group. Nonoverlapping racial groups were examined: non-Hispanic blacks, non-Hispanic Asians/Pacific Islanders, and Hispanics (all races combined).

All statistical analyses were conducted with SAS software (SAS 9.2). We used the procedures Proc Survey-means to obtain means and CIs and Proc Surveyreg to conduct the weighted multiple linear regression analyses when comparing census tract SES of cases to the population.

Results

The study compared 18,473 HCC cases with the general population of the SEER 11 catchment areas (Table 1). Compared with the general population, HCC cases were more likely to be male and 45 years of age or older. In addition, compared with the population distribution, a smaller proportion of cases were non-Hispanic white and a higher proportion of cases were Asians or Pacific Islanders.

The mean census tract SES attributes among cases and the population by race and Hispanic ethnicity are shown in Table 2. Statistically significant correlations existed between population census tract attributes, most notably for family poverty, educational attainment, and unemployment (data not shown). The mean census tract percentage of families living

below the poverty level was 10.8% among cases compared with 8.8% among the population. This pattern held true for most racial/ethnic groups, including non-Hispanic whites (4.9% vs. 4.1%), blacks (21.0% vs. 18.5%), and Asians and Pacific Islanders (10.2% vs. 8.4%). All these differences were statistically significant. In contrast, among Hispanics, the mean census tract percentage of poverty of cases was slightly lower than the referent population (18.5% vs. 20.0%). Compared with the population, cases resided in census tracts with a higher mean percentage of adults without a high-school education. This pattern was seen for all races combined (23.2% vs. 19.0%), non-Hispanic white (11.8% vs. 10.3%) black (25.5% vs. 22.4%), and Asians and Pacific Islanders (23.6% vs. 19.2%). The mean census tract percentage of non–high-school graduates was slightly lower among Hispanic cases than the Hispanic population (50.9% vs. 53.1%). The mean census tract percentage of people 16 years of age and older that were unemployed was higher among cases than the population for the overall population (6.9% vs. 6.0%), non-Hispanic white (4.6% vs. 4.2%), and blacks (14.0% vs. 11.8%). A small but statistically significant elevated percentage of unemployment was seen among the Asian and Pacific Islander cases compared with their referent population (5.3% vs. 4.9%). Among Hispanics, no difference in mean census tract unemployment was observed between cases and the population (9.5% vs. 9.5%). Overall, cases resided in neighborhoods with a higher mean percentage of foreign-born individuals than the population (31.9% vs. 19.3%).

Associations generally retained statistical significance after stratification by localized versus regional and distant stage HCC. The most notable exceptions were seen among blacks with localized stage HCC, for whom associations between HCC and neighborhood poverty and low high-school graduation rates lost statistical significance. In addition, the association between neighborhood-level unemployment and HCC among Asians and Pacific Islanders was no longer statistically significant after stratification by stage.

After finding that HCC cases often lived in neighborhoods with lower SES or higher percentages of foreign-born individuals than the overall population (Table 2), case–case comparisons were conducted between non-Hispanic white cases, cases of other racial origin, and Hispanic cases. Compared with white cases, cases in other racial and ethnic groups lived in census tracts with higher mean percentages of family poverty, high-school dropout, and unemployment rates (Table 3). Compared with white cases, the mean difference in census tract–level percentage of poverty among black cases and Hispanic cases was 10.8% and 8.2%, respectively. Compared with white cases, Hispanic cases had the highest mean census tract excess percentage of adults without high-school diplomas (19.3%) followed by black cases (12.0%). Compared with white cases, mean census tract differences in percentage unemployment for black and Hispanic cases were 5.7% and 3.3%, respectively. Among Asian and Pacific Islander cases, area measures of low SES were also elevated compared with white cases, although the magnitude of the differences was more modest. Compared with white cases, Asian and Pacific Islander cases had the largest difference in mean census tract percentage of foreign birth (18.9%) followed by Hispanic cases (15.7%). Mean census tract percentage of foreign birth was similar among white and black cases.

Discussion

In this SEER 11 study, HCC cases in all racial and ethnic groups except Hispanics lived in census tracts with lower mean SES than their referent population. Black and Hispanic HCC cases lived in areas with the highest mean percentage of family poverty, unemployment, and high-school dropouts. Asian and Pacific Islander and Hispanic cases lived in census tracts with the highest mean percentage of foreign-born population. The results support the hypothesis that HCC cases tend to live in neighborhoods with lower SES and more immigration than the population. This may reflect the prevalence of risk factors for HCC

such as obesity, hepatitis infection, and alcoholism. These findings could help to allocate HCC control efforts to the most adversely affected communities.

This study supports targeting some HCC control resources to specific low SES and immigrant communities. HCC risk is influenced by access to care, social support, and lifestyle (25, 26). This study of registries across the United States expands on evidence of an association between low neighborhood SES and high HCC incidence in California (4) and is consistent with reports from other nations on HCC risk and income (27-32), occupation (30), and foreign birth (31, 32). Many HCC cases are preventable through hepatitis B virus vaccination, antiviral therapy, treatment of alcoholism, and weight reduction (33). Furthermore, HCC is increasingly amenable to screening and early treatment (34).

Other research (4-9, 13, 14, 16, 17) documents relationships between poverty, low educational attainment and unemployment, and known HCC risk factors. In the United States, low SES and poverty (5-9) are associated with diabetes (5), metabolic syndrome (6), obesity (8), alcoholism (9), and hepatitis C infection (7, 13, 14). Particularly, strong relationship between SES and these risk factors are seen among blacks (5, 7, 8). Furthermore, low educational attainment is associated with viral hepatitis infection, alcoholism, and liver inflammation among men (15). In a multistate study (8), obesity was associated with unemployment especially among blacks. In California, marginally employed migrant workers had high rates of alcoholism (16). We found that Asian and Hispanic HCC cases lived in neighborhoods with the highest percentages of foreign-born residents. Data from the National Health and Nutrition Examination Survey (NHANES) indicate that hepatitis B infection is more prevalent among foreign than U.S.-born Asians (17). In California, foreign birth was associated with HCC among Asians, whereas living in an ethnic enclave was associated with HCC among both Asians and Hispanic (4).

In this study, there was an attenuation of associations between HCC and high neighborhood poverty and high-school dropout rates among black cases with localized stage HCC. As screening and curable therapy for this cancer become more widely available, a higher proportion of cases are being diagnosed with localized stage HCC (34). To the extent that people living in high SES census tracts are most likely to benefit from HCC screening technology (21), associations between low SES and HCC might be expected to diminish among cases with localized stage HCC.

Unlike all other racial groups in this study, Hispanic cases lived in neighborhoods with lower mean percentage of family poverty and fewer adults without high-school diplomas compared with their referent (i.e., Hispanic) population. Studies indicate that most U.S. Hispanic HCC cases are born in the United States (1, 3). Compared with foreign-born Hispanics, those born in the United States have higher mean family income (35) and are more likely to be high-school graduates (36). The relatively low and more homogeneous socioeconomic position of Hispanics compared with other racial groups (35-39) may have impeded detection of area-level differences in unemployment between Hispanic HCC cases and their referent population. The Hispanic workforce is susceptible to unemployment due to comparatively low educational attainment (37). However, as low neighborhood measures of SES were not clearly associated with HCC among Hispanics, a broader HCC control effort for Hispanic Americans may have advantages over efforts targeting specifically to only low SES Hispanic neighborhoods (40).

In the United States, Hispanics account for about half of the foreign-born population followed by Asians, who account for 30% of immigrants (41). These large and fast growing minority groups experience a disproportionate burden of HCC (1). Along with other area-level SES measures highlighted in this report, control efforts might be partially targeted

toward enclaves with high percentages of foreign-born Asians and Hispanics, given the elevated proportions of HCC cases living in these areas (4, 17).

This study has strengths including a population-based design with more than 18,000 incident HCC cases from the SEER 11 population, which resembles the U.S. population, with regard to poverty and education. The analysis of 2000 census tract–level data for cases and the catchment population focused on 4 census–tract level SES measures: poverty, education, unemployment, and foreign birth. While studies that use an index of area-level socioeconomic position (4, 28, 29, 42) limit multiple comparisons, specific area-level attributes used in the present study revealed tendencies for black cases to live in neighborhoods with elevated rates of poverty and unemployment, Hispanic cases to reside in areas with low educational attainment, and Asian and Pacific Islander cases to live in communities with a high percentage of residents born outside the United States.

Limitations of the present study include absence of data on etiologic risk factors of HCC including viral hepatitis infection, alcohol, and obesity. When interpreting area-level attributes, caution is urged as characteristics of case and of people residing in a census tract may differ from one another. Thus, use of area measures as proxies for individual SES is not recommended as they can operate independently of each other (43, 44).

In summary, our data support the hypothesis that HCC cases often reside in neighborhoods with lower mean SES and a higher percentage of foreign-born individuals than the general population. Exceptions were seen among Hispanics for SES but not foreign birth. Our results may help target HCC control efforts to underserved racial and ethnic populations identified in this study.

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Table 1

Demographic characteristics of HCC cases and population of the SEER-11 cancer registry area, 1996 to 2007

	Case N (%)	Year 2000 population No. (%)
Total	18,473 (100)	38,733,536 (100)
Stage[a]		
Localized	7,148 (38.7)	–
Regional/distant	8,496 (46.0)	–
Gender		
Female	4,703 (25.5)	19,601,837 (50.6)
Male	13,770 (74.5)	19,131,699 (49.4)
Age, y		
<45	1,151 (6.2)	26,192,037 (67.6)
45–<65	9,059 (49.0)	8,277,262 (21.4)
65+	8,263 (44.7)	4,264,237 (11.0)
Race/ethnicity[b]		
Non-Hispanic White	7,651 (41.4)	22,285,501 (57.5)
Black	2,212 (12.0)	4,350,944 (11.2)
Asian/Pacific Islander	5,026 (27.2)	4,342,196 (11.2)
Hispanic (all races)	3,357 (18.2)	7,732,353 (20.0)

[a] Unstaged and unknown stage not shown.

[b] Hispanic ethnicity may overlap with race.

Table 2

Census tract socioeconomic attributes, HCC cases, and population, SEER 11, 1996 to 2007

2000 Census tract attribute/race and Ethnicity	All cases Mean percent (95% CI)	Year 2000 population Mean percent (95% CI)	All case population difference[a, b] β (95% CI)	Localized stage population difference[a, b] β (95% CI)	Regional/distant stage population difference[a, b] β (95% CI)
Percent of families living below poverty level					
All races combined	10.8 (10.5–11.1)	8.8 (8.6–9.0)	1.6 (1.3–2.0)	1.1 (0.6–1.5)	2.3 (6.0–7.0)
Non-Hispanic white	4.9 (4.7–5.1)	4.1 (4.0–4.2)	0.9 (0.7–1.1)	0.7 (0.4–1.0)	1.2 (0.9–1.5)
Black	21.0 (20.1–22.0)	18.5 (17.8–19.2)	1.9 (0.8–3.0)	0.7 (−0.8–2.2)	3.2 (1.6–4.8)
Asian and Pacific Islander	10.2 (9.5–11.0)	8.4 (8.0–8.8)	1.4 (0.7–2.1)	1.2 (0.2–2.2)	1.5 (0.6–2.4)
Hispanic	18.5 (18.3–19.5)	20.0 (19.6–20.5)	−0.9 (−1.6–0.2)	−1.5 (−2.5–0.4)	−0.5 (−1.4–0.5)
Percent, no high school diploma (25+ years of age)					
All Races combined	23.2 (22.3–23.6)	19.0 (18.6–19.3)	3.3 (2.7–3.9)	2.5 (1.6–3.3)	4.3 (3.5–5.1)
Non-Hispanic white	11.8 (11.5–12.1)	10.3 (10.1–10.5)	1.6 (1.3–1.9)	1.5 (1.0–1.9)	1.9 (1.4–2.4)
Black	25.5 (24.7–26.4)	22.4 (21.7–23.1)	2.5 (1.5–3.6)	1.1 (−0.2–2.4)	4.1 (2.7–5.5)
Asian and Pacific Islander	23.6 (21.2–24.8)	19.2 (18.5–19.9)	4.3 (2.9–5.7)	4.0 (1.8–6.1)	4.7 (2.9–6.5)
Hispanic	50.9 (50.0–51.9)	53.1 (52.4–53.8)	−1.2 (−2.3–0.1)	−2.2 (−3.7–0.7)	−0.5 (−1.9–0.9)
Percent unemployed (16+ years of age)					
All races combined	6.9 (6.8–7.1)	6.0 (5.8–6.1)	0.7 (0.6–0.9)	0.6 (0.3–0.8)	1.0 (0.8–1.3)
Non-Hispanic white	4.6 (4.5–4.8)	4.2 (4.1–4.3)	0.4 (0.2–0.6)	0.4 (0.1–0.6)	0.4 (0.2–0.7)
Black	14.0 (13.4–14.7)	11.8 (11.4–12.2)	1.7 (1.0–2.4)	1.4 (0.4–2.4)	2.2 (1.2–3.1)
Asian and Pacific Islander	5.3 (5.0–5.5)	4.9 (4.7–5.2)	0.4 (0.1–0.7)	0.4 (−0.04–0.8)	0.3 (−0.1–0.7)
Hispanic	9.5 (9.3–9.8)	9.5 (9.3–9.7)	−0.01 (−0.3–0.3)	−0.1 (−0.6–0.4)	0.2 (−0.3–0.6)
Percent born outside the United States					
All races combined	31.9 (31.2–32.7)	19.3 (18.9, 19.7)	5.6 (4.8–6.4)	5.4 (4.3–6.6)	5.9 (4.9–7.0)

[a] Models weighted by number of individuals in each strata.

[b] Models adjusted for registry.

Table 3

HCC case census tract socioeconomic attributes of non-Hispanic white versus other racial/ethnic groups

2000 Census tract	Non-Hispanic	Non-Hispanic black alone	Non-Hispanic asian alone	Hispanic (all races)
Attribute	White alone	Mean difference (95% CI)	Mean difference (95% CI)	Mean difference (95% CI)
Percent of families living below poverty level	Reference	10.8 (10.3–11.2)	2.9 (2.5–3.2)	8.2 (7.8–8.6)
Percent, no high school diploma (25+ years of age)	Reference	12.0 (11.2–12.8)	7.1 (6.5–7.7)	19.3 (18.6–20.0)
Percent unemployed (16+ years of age)	Reference	5.7 (5.5–6.0)	1.0 (0.8–1.2)	3.3 (3.1–3.5)
Percent born outside the United States	Reference	0. 6 (−0.3–1.4)	18.9 (18.3–19.5)	15.7 (15.0–16.4)

NOTE: Multiple linear model; adjusted for age, sex, and stage.