

Area Socioeconomic Status is a Predictor of the Overall Mortality of Patients with Metastatic Cancer to Bone

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INTRODUCTION: Area socioeconomic status (SES) has rarely been evaluated in patients with metastatic disease to bone. This study sought to identify associations between the Yost Index, a geocoded area SES score, and overall mortality among patients with metastatic cancer to bone.

METHODS: This retrospective cohort study used data from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) database from 1/1/2010 to 12/31/2018. Bone and joint sites were categorized using the International Classification of Diseases for Oncology (ICD-O-3) site recodes (Table 1). The Yost Index was categorized into quintiles using census tract-level American Community Service (ACS) 5-year estimates. Multivariate Cox regression models calculated crude and adjusted hazard ratios (aHRs) of overall survival and 95% confidence intervals (CIs), adjusting for age, sex, cancer site, and treatment modality.

RESULTS: A total of 138,220 patients were included (Table 2), of whom 79.8% (110,334) died during follow up. Compared with the highest SES quintile, Patients in the lowest Yost quintile had a 34% higher mortality rate (aHR of 1.34, 95% CI: 1.32-1.37, p<0.001) and greater racial heterogeneity (63.0% white, 33.5% black, 3.1% APAI vs. 83.9% white, 4.0% black, and 11.8% APAI, p<0.001, Table 3). Surgery was performed in 8-10% of patients, equivalent across all SES groups. The age-adjusted postoperative mortality rate for patients in the lowest quintile of the Yost Index was 30.3% higher than those in the highest (17.5 vs. 12.8 per 100,000, p<0.001).

DISCUSSION AND CONCLUSION: SES is a persistent independent predictor of mortality among patients with metastatic cancer to bone. Effective strategies for addressing these inequalities and improving the access and quality of care for patients from lower SES backgrounds are required.

Table 1. ICD-O-3 Site Recodes for the bone and joints.

Site description	ICD-O-3 Primary Site
Long bones of upper limb, scapula, and associated joints	C400
Short bones of upper limb and associated joints	C401
Long bones of lower limb and associated joints	C402
Short bones of lower limb and associated joints	C403
Overlapping lesion of bones, joints, and articular cartilage of limbs	C403
Bone of limb, NOS	C408
Bones of skull and face and associated joints (excludes mandible)	C409
Mandible	C410
Vertebral column	C411
Rib, sternum, clavicle, and associated joints	C413
Pelvic bones, sacrum, coccyx, and associated joints	C419
Overlapping lesion of bones, joints, and articular cartilage	C419
Bone, NOS	C400

Table 2. Baseline covariates of patients with metastatic cancer to bone, stratified by Yost Index Quintile, 2010-2018.

	Yost Index Quintile					P-value
	Quintile 1 (Lowest) (N=24924)	Quintile 2 (N=24411)	Quintile 3 (N=25376)	Quintile 4 (N=10044)	Quintile 5 (Highest) (N=33266)	
Age at Diagnosis						<0.001
Mean (SD)	65.9 (11.9)	66.8 (12.0)	67.7 (12.1)	68.4 (12.1)	69.1 (12.5)	
Median (Min, Max)	66.0 (0, 100)	67.0 (0, 100)	68.0 (0, 100)	69.0 (0, 100)	70.0 (0, 100)	
Sex						<0.001
Female	9613 (38.6%)	10072 (41.3%)	10516 (41.1%)	12603 (41.3%)	14302 (43.0%)	
Male	15311 (61.4%)	14339 (58.7%)	15060 (58.9%)	17640 (58.7%)	18964 (57.0%)	
Race						<0.001
White	15687 (63.0%)	19334 (79.2%)	21221 (83.0%)	25117 (83.6%)	27918 (83.9%)	
AFAN	113 (0.5%)	142 (0.6%)	138 (0.5%)	130 (0.4%)	90 (0.3%)	
Black	8389 (33.5%)	3691 (15.1%)	2847 (10.8%)	2128 (7.2%)	1322 (4.0%)	
APAI	773 (3.1%)	1244 (5.1%)	1670 (6.5%)	2638 (8.8%)	3935 (11.8%)	
Marital Status						<0.001
Married	14710 (59.0%)	16354 (67.0%)	17929 (70.1%)	21941 (73.0%)	23782 (71.5%)	
Nonmarried	10214 (41.0%)	8057 (33.0%)	7656 (29.9%)	8102 (27.0%)	7484 (22.5%)	
Urban/Rural						<0.001
Urban	18338 (73.6%)	19661 (79.3%)	21718 (84.9%)	28448 (88.7%)	33088 (99.2%)	
Rural	6586 (26.4%)	5350 (21.9%)	3642 (14.1%)	1595 (5.3%)	202 (0.6%)	
Surgery						<0.001
No	22011 (88.2%)	22304 (91.4%)	23370 (91.4%)	27403 (91.8%)	30228 (90.9%)	
Yes	1993 (8.0%)	2107 (8.6%)	2206 (8.6%)	2640 (8.8%)	3038 (9.1%)	
Primary Site						<0.001
Pancreas	579 (2.3%)	594 (2.4%)	642 (2.5%)	721 (2.4%)	961 (2.9%)	
Breast	3232 (13.1%)	3276 (13.4%)	3495 (13.7%)	4224 (14.3%)	5080 (15.0%)	
Colorectal	721 (2.9%)	685 (2.8%)	673 (2.6%)	791 (2.6%)	845 (2.5%)	
Esophagus	428 (1.7%)	482 (2.0%)	498 (1.9%)	573 (1.9%)	549 (1.7%)	
Kidney	1149 (4.6%)	1238 (5.1%)	1317 (5.1%)	1433 (4.8%)	1514 (4.6%)	
Liver & Bile Duct	701 (2.8%)	593 (2.4%)	608 (2.4%)	653 (2.2%)	639 (1.9%)	
Lung & Bronchus	12971 (52.0%)	12741 (52.2%)	13082 (51.1%)	15224 (50.7%)	16162 (48.6%)	
Prostate	4388 (17.6%)	4016 (16.3%)	4417 (17.3%)	5439 (18.1%)	6436 (19.3%)	
Stomach	364 (1.5%)	424 (1.7%)	451 (1.7%)	508 (1.7%)	596 (1.8%)	
Urinary Bladder	352 (1.4%)	365 (1.5%)	424 (1.7%)	493 (1.6%)	544 (1.6%)	

Table 3. Adjusted hazard ratios of overall mortality in patients with metastases to the bone stratified by clinical covariates.

	Adjusted Hazard Ratio	P-value
Age at Diagnosis		<0.001
(Per additional year)	1.02 (1.02-1.02)	
Sex		<0.001
Female	1.00	
Male	1.15 (1.14-1.17)	
Race		
White	1.00	
AFAN	1.02 (0.93-1.11)	0.72
Black	1.00 (0.96-1.02)	0.73
APAI	0.77 (0.76-0.79)	<0.001
Marital Status		<0.001
Married	1.00	
Nonmarried	1.20 (1.13-1.22)	
Urban/Rural Status		
Urban	1.00	
Rural	0.98 (0.96-1.00)	0.026
Surgery		<0.001
No	1.00	
Yes	0.59 (0.57-0.60)	
Yost Index		<0.001
Quintile 5 (Highest)	1.00	
Quintile 4	1.12 (1.10-1.14)	
Quintile 3	1.20 (1.17-1.22)	
Quintile 2	1.27 (1.24-1.29)	
Quintile 1 (Lowest)	1.34 (1.32-1.37)	
Primary Cancer Site		
Pancreas	1.00	
Breast	0.26 (0.25-0.27)	<0.001
Colorectal	0.68 (0.65-0.71)	<0.001
Esophagus	0.81 (0.77-0.86)	<0.001
Kidney	0.55 (0.53-0.58)	<0.001
Liver and Bile Duct	0.87 (0.83-0.92)	<0.001
Lung and Bronchus	0.70 (0.68-0.73)	<0.001
Prostate	0.17 (0.16-0.18)	<0.001
Stomach	0.91 (0.86-0.96)	<0.001
Urinary Bladder	0.97 (0.92-1.03)	0.33