

# Association Between Social Vulnerability Index and Timing of Metastases in Patients with Bone Metastases: A Spine Oncology Database Study

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## Introduction

Timely diagnosis of primary and secondary musculoskeletal cancers is essential for optimizing long-term treatment and management. Many studies have outlined how social determinants of health (SDOH) play a role in delaying access to cancer care. However, few studies have looked at the role of neighborhood-level vulnerability and its role on the timing of cancer diagnosis and management. The contribution of structural factors to metastases is poorly understood. This study aims to understand the association between Social Vulnerability Index (SVI) and timing of secondary bone metastases within a Level 1 safety-net hospital.

## Methods

We conducted a retrospective analysis of 81 patients (41 females and 40 males) with secondary bone metastases treated at county level hospital from September 2009 - October 2023. Our institutional IRB approved this retrospective study with a waiver of informed consent. Patients were categorized as being synchronous metastases (present at time of primary cancer diagnosis) or metachronous metastases (developed after diagnosis). Zip code level variables were identified based on the Social Vulnerability Index (SVI), a CDC metric that calculates social vulnerability of a population based on neighborhood environment, identified through patient zip codes. The four thematic components of SVI were also assessed: 1) Socioeconomic Status 2) Household composition 3) Minority status and language, and 4) Housing type and transportation. A Mann-Whitney U statistic was performed to determine the significance between neighborhood level parameters between the two groups.

## Results

Synchronous metastases were significantly associated with a higher SVI ( $p = 0.043$ ). None of the individual themes of Socioeconomic Status (1), Household composition (2), Minority status and language (3), and Housing type and transportation (4) were individually significant in their association with timing to metastases.

## Discussion

Higher social vulnerability is associated with synchronous bone metastasis, suggesting the role that geography can play in timing of bone metastases. The presence of metastases at time of initial diagnosis reflects delays in both detection and access to timely oncologic care, suggesting that patients from disadvantaged neighborhoods face structural barriers that can contribute to worse outcomes. Addressing these disparities will require not only clinical innovation but also health system-level strategies to improve early detection, access to diagnostic resources, and continuity of care in vulnerable populations. Addressing these disparities will require clinical innovation and health system-level strategies to improve early detection, access to diagnostic resources, and continuity of care in vulnerable populations. Further research into how neighborhood-level and institutional factors influence both diagnosis and prognosis are indicated.

## Clinical Significance:

This study demonstrated the role of neighborhood-level vulnerability indexes in identifying geographic risk for delayed cancer diagnosis and care, underscoring the need for strategies that improve early detection and timely treatment in vulnerable populations.

Table 1: Association Between Social Vulnerability Index and Synchronous Bone Metastases

	Theme 1: Socioeconomic Status	Theme 2: Household	Theme 3: Minority	Theme 4: Housing type	Total SVI
p-value	0.0675	0.0644	0.1686	0.4192	0.0434