

Does Health Disparity Exist in the Management of Benign Bone Tumors?

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Abstract

Background: Healthcare disparity in the United States has been a concern in multiple fields of medicine, resulting in unequal distribution of resources among different populations based on race, location, and socioeconomic status. Healthcare providers seek to offer equal care to all, but access to care may be limited by multiple factors. Whether this applies to the management of benign bone lesions is unknown. The objective of this study was to assess how race and socioeconomic factors may affect patient treatment in the setting of benign bone lesions.

Methods: This multicenter retrospective observational study investigated the relationship between socioeconomic status and race with diagnosis (lesion type) and treatment (operative vs. non-operative), using a large database of benign bone lesion patients collected from suburban New York (N = 689). Patients of all ages diagnosed with a benign bone lesion between 2007 and 2021 were included in this study and 2021 US Census Bureau data for each patient's zip code was used as a proxy for socioeconomic and racial status. Multivariate analyses of variance and cross tabulations were performed with bootstrapping to examine differences regarding tumor diagnosis and surgical intervention by racial/ethnic and socioeconomic variables.

Results: There were no statistically significant differences at the .05 level of probability (applying two-tailed tests) for diagnosis and intervention by these variables.

Conclusion: Diagnosis and intervention were not affected by various racial/ethnic and socioeconomic factors in this suburban New York cohort. In benign bone lesion treatment, healthcare disparities may be less prevalent than previously anticipated.

Keywords: Health disparity; Benign bone lesion; Race and socioeconomic status

Introduction

The standard of care for the treatment of benign bone lesions has been widely debated in the literature. Patients frequently present with unique considerations and challenges related to a multitude of factors including diagnosis, age, anatomic location, stage, and surgeon preference, leading to a wide variability in treatment course. Often, lesions remain undiagnosed if asymptomatic, only to be discovered incidentally on imaging studies. While the global clinical picture should solely drive management, it is unclear if social factors such as race and socioeconomic status play a role in the diagnosis and management of this patient population as well. Access to healthcare has been an ongoing concern with the widening income gap in the United States [1]. Non-white race, Hispanic ethnicity, and low socioeconomic status have been shown to be negative prognostic factors for primary malignant bone tumors [2], but no study has yet assessed if this disparity is also present in the treatment of appendicular benign bone tumors. The variability in treatment also brings into question whether socioeconomic and racial disparities could be a cause of discrepancies in treatment amongst minority groups.

Benign bone lesions include any nonmalignant growths or neoplasms of the bone, categorized by their tissue derivative (bone, cartilage, connective tissue, vasculature or idiopathic). The most common lesions include osteochondroma, solitary bone cyst, aneurysmal bone cyst, nonossifying fibroma, giant cell tumor, fibrous dysplasia, and chondroblastoma. Benign bone lesions are often diagnosed in younger patients during skeletal growth and 60% of cases occur in the knee region [3]. Thus, age and anatomic considerations are important in determining surgical management and limiting the risk of

future leg length discrepancies.

Treatment options for patients vary on a case-by-case basis, but can include surveillance/nonoperative management, casting, or any combination of interventions including local/extended curettage, adjuvant treatment, bone grafting, cementation, or complex reconstruction with instrumentation. Conservative management is less costly and has the benefit of avoiding surgical complications, but also carries the risk of progression of an underlying aggressive process. Surgical management may offer more definitive and immediate care but requires more resources and may lead to surgical complications. In both situations, overtreatment or undertreatment may lead to unnecessary patient suffering and morbidity, therefore clinical expertise and experience are paramount to achieve the optimal balance of care. These potential risks and benefits must be communicated effectively to patients, who should ultimately be involved in the final treatment decision. Racial and cultural barriers have been shown to play a role

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in the patient-physician relationship, [4,5] which could affect patients' understanding of treatment options available.

Furthermore, socioeconomic and racial disparities in healthcare access have been well documented in surgical settings and orthopedic literature [6–8]. For example, minority groups have been shown to have increased risks of minor and major complications following surgery and increased length of stay in hospitals compared to White patients. New York and the greater tri-state area in particular has been shown to have widespread health disparities leading to poorer outcomes in Black and Hispanic patient populations [9]. More recently, studies have begun to address whether health disparities exist in settings of benign bone lesion treatment; [10] however, the data is limited to benign craniomaxillofacial bone lesions and does not encompass the variety of lesion types and the different anatomic locations in which they arise.

This retrospective study aims to evaluate the relationship between socioeconomic and racial factors with the incidence and treatment of benign bone lesions. Our goal is to create and use a large modern and racially diverse database of patients with benign bone lesions within a suburban New York health system to compare patient treatment across racial and socioeconomic statuses. Patient demographics and zip code data will be compiled to compare treatments to address what, if any, disparities exist in this health system, and how we can ensure fair and adequate treatment amongst all patient demographics.

Methods

Data acquisition

This was a single institution, multicenter retrospective observational study, approved by our institutional review board, of patients diagnosed with a benign bone lesion during the period from 2007 until 2021. The following 9th and 10th International Classification of Disease codes (ICD9 and ICD10) were included: D16.0-D16.9, M85.0, M85.4-M85.6, D48.0, 213.7, 213.9, and 733.9. Inclusion criteria included patients of all ages with a diagnosis of a benign bone lesion. Exclusion criteria included all malignant bone tumors (except atypical cartilaginous neoplasms), soft tissue tumors, or tumors involving the skull, or maxillofacial bones.

Assessment of socioeconomic status

Zip codes for each patient in the database were obtained and used as a proxy for socioeconomic, educational, racial and ethnic status. Each patient's zip code was entered in the US Census Bureau website, [11] and values (from the 2021 census report) for the following variables were obtained for each patient and their corresponding zip code: median household income, persons in poverty (%), white alone (%), Black or African American alone (%), Asian alone (%), Hispanic or Latino (%), White alone, not Hispanic or Latino (%), high school degree or higher (% of persons age 25+), and bachelor's degree or higher (% of persons age 25+). The values for each of these variables/zip codes were assigned to the appropriate patient and then used in our subsequent analyses.

Statistical analysis

Descriptive statistics include frequency data for ethnicity (Hispanic versus non-Hispanic), as well as means and standard deviations for median income, poverty percentage, race breakdown, and education level by geographic area in New York urban and suburban regions. Cross tabulations (CROSSTABS) with a bootstrapping procedure were performed to look at ethnicity (2 conditions) by tumor diagnosis (12 conditions) and operative intervention (2 conditions). In addition, a series of multivariate analyses of variance (MANOVAs) also with a bootstrapping application was performed to examine differences by

tumor diagnosis and surgical intervention. All analyses were conducted using SPSS (IBM SPSS Statistics Version 28.0.0.0). Two-tailed tests with p-values of .05 were used to establish statistical significance. In order to control for experiment wise error rate and to address variable interdependence, multivariate analyses were conducted where multiple continuous dependent variables were combined into a weighted linear composite variable. Specifically, 1) median income and poverty level, 2) percentage of White, Black and Asian, and 3) high school and some college education (by geographic location) were combined into three dependent variables in the analyses with regard to the independent variables of tumor diagnosis (12 conditions) and operative intervention (2 conditions).

Results

Table 1 presents the descriptive data (frequencies, means and standard deviations) for our dependent variables (ethnicity plus median income, poverty, race, and education per geographic location) by our independent variables (tumor diagnosis and operative intervention). (Table 2) presents results of our inferential tests of differences regarding our dependent variables by independent variables: specifically, effect sizes (*r*) and probability levels (*p*). The results indicate no statistically significant differences at the .05 level (two-tailed) on diagnosis and intervention for the social and economic variables. The effect sizes (or strength of difference) are all small (Cohen, 1988).

Discussion

This study utilized one of the largest detailed databases dedicated to benign bone lesions in the United States to elucidate the potential presence of racial and socioeconomic biases in the care provided

Table 1: Frequencies (#), means (M) and standard deviations (SD) for socioeconomic variables by diagnosis and intervention.

	Ethnicity (Hispanic)		Median Income	Poverty Percent	Race Percent			Education High School (HS)	
	Hispanic	Non-Hispanic	M (SD)	M (SD)	White M (SD)	Black M (SD)	Asian M (SD)	HS M (SD)	HS+ M (SD)
Diagnosis									
Aneurysmal Bone Cyst (ABC)	2	19	94,418.33 (20,156.53)	8.46 (3.91)	60.82 (16.92)	14.84 (8.66)	15.52 (8.79)	88.35 (4.75)	42.72 (11.53)
Chondroblastoma	2	5	9,686.79 (37,729.94)	8.53 (3.91)	56.42 (14.18)	15.21 (8.81)	23.64 (8.99)	86.82 (6.51)	40.37 (15.68)
Chondromyxoid Fibroma (CMF)	0	2	85,029.50 (18,386.90)	6.60 (5.23)	70.10 (32.24)	10.85 (13.93)	15.05 (17.32)	89.50 (9.76)	36.55 (4.31)
Chondrosarcoma	1	2	102,643.25 (40,169.97)	7.03 (3.86)	60.60 (15.75)	11.75 (10.52)	21.85 (6.67)	88.57 (7.16)	43.93 (15.86)
Enchondroma	7	68	102,265.28 (30,231.95)	7.54 (4.12)	64.99 (22.07)	13.48 (11.95)	12.96 (11.13)	88.71 (6.30)	41.16 (14.61)
Fibrous Dysplasia (FD)	1	7	101,851.90 (35,139.05)	9.82 (6.86)	58.86 (17.85)	15.53 (13.21)	14.74 (10.21)	85.35 (9.47)	43.51 (18.08)
Giant Cell Tumor of Bone (GCT)	5	25	94,115.15 (32,576.86)	8.26 (3.26)	58.80 (17.30)	13.75 (9.08)	21.49 (11.01)	87.09 (5.71)	40.32 (10.35)
Nonossifying Fibroma (NOF)	4	16	107,439.40 (28,235.58)	7.18 (3.03)	65.30 (21.37)	12.40 (12.59)	13.24 (11.46)	89.64 (6.24)	43.59 (13.75)
Osteochondroma	43	214	101,055.94 (29,606.60)	7.62 (3.88)	62.91 (19.97)	13.92 (12.05)	14.46 (10.71)	88.17 (6.61)	41.77 (12.18)
Osteoid Osteoma	3	41	96,324.89 (23,778.55)	7.76 (3.89)	64.56 (20.85)	13.11 (12.50)	14.98 (10.76)	88.27 (6.63)	41.20 (11.09)
Solitary Bone Cyst (SBC)	11	39	109,428.26 (31,802.23)	6.79 (3.44)	66.07 (20.17)	11.51 (12.07)	13.31 (11.49)	89.36 (6.68)	41.97 (13.99)
Other	4	26	97,500.43 (28,529.48)	8.05 (3.76)	63.84 (19.24)	13.23 (10.59)	16.21 (11.17)	87.64 (6.56)	39.40 (10.05)
Intervention									
Operative	60	324	99,897.74 (29,080.20)	7.71 (3.89)	63.02 (20.02)	13.74 (11.81)	14.89 (11.01)	88.10 (6.55)	41.24 (12.16)
Nonoperative	23	135	103,117.53 (30,299.61)	7.51 (3.80)	64.16 (19.96)	13.03 (11.46)	14.64 (10.81)	88.70 (6.37)	42.46 (13.53)

Table 2: Cross tabulations and multivariate tests of differences for socioeconomic variables by diagnosis and intervention: Effect sizes (ES) and probability levels for statistical significance (p).

	Ethnicity	Income/Poverty	Race Percent	Education Level
	(Hispanic)	by Geography	By Geography	By Geography
	ES (p)	ES (p)	ES (p)	ES (p)
Diagnosis	.173 (.567)	.138 (.250)	.138 (.240)	.014 (.675)
Intervention	.035 (.660)	.055 (.374)	.032 (.992)	.045 (.496)

to patients within our suburban New York healthcare system. We investigated the relationship between patients' race/ethnicity, socioeconomic status (median income), level of education and tumor prevalence/management. Statistical analyses concluded that there were no significant differences between prevalence of benign bone lesions and therapeutic management in patients of different racial and economic backgrounds. This cohort is likely representative of other suburban cities in the United States where treatment trends should be similar, however further studies on a national level are recommended to make an objective assessment. During a time where health disparities are being uncovered across multiple areas of healthcare, it is uplifting to see that our data indicate that care is delivered equally in the realm of benign bone tumors within this large NY based hospital system.

Benign bone tumors are neoplastic processes that most often affect the pediatric population. For this reason, very limited data exists analyzing the relationship between social determinants of health and the prevalence/management of benign bone lesions. However, studies have investigated this relationship in osseous malignancies [12]. In the setting of craniomaxillofacial benign lesions, a study by Philips et al. reported that minority and lower socioeconomic group status is associated with poorer surgical outcomes and increased postoperative complications such as increased length of stay, morbidity, and mortality. Although our analyses did not include craniomaxillofacial lesions it is important to determine any potential biases that may increase the likelihood of minority patients receiving suboptimal care and increased suffering.

In a systematic review of literature analyzing the influence of race and ethnicity on complications and mortality after orthopedic surgery, Schoenfeld et al. concluded that patients from minority racial and ethnic populations had an increased mortality and rate of complications following spinal or joint replacement procedures [13]. This review, which included 33 published studies, highlights the importance of understanding the patterns of surgical management with regard to benign bone lesions. Surgeons must understand the racial and ethnic factors involved when determining the clinical course for benign bone lesions as surgical management may lead to increased postoperative complications and increased morbidity.

In 2018 Deb et al. reported that white patients were significantly more likely to receive surgery for primary osseous neoplasms and that nonwhite patient treatment was associated with shorter survival times [14]. A key difference to be noted however between the management of malignant and benign bone lesions is that surgical resection and adjuvant therapy are often necessary for survival with malignant lesions. In benign bone lesions multiple factors including surgeons' preference and patient symptoms can determine if surgical management is required for treatment. The decreased surgical rate of nonwhite patients in the setting of aggressive spinal neoplasms is important for understanding the potential barriers to performing surgical management of non-

malignant osseous neoplasms. If minority patients are less willing to undergo surgery due to fear of increased postoperative complications or increased hospital length of stay, they may not be receiving adequate treatment even if their rate of non-surgical management is equal to that of their white counterparts.

In 2015 Lavernia et al. analyzed if Black patients have more severe or frequent preoperative pain, and if there was a difference in well-being between black patients and white patients after knee arthroplasty. They determined that black patients had more severe preoperative pain intensity and worse well-being scores when compared to their white counterparts. Additionally, they found that postoperative pain intensity was higher in black patients. These findings emphasize the disparity between a minority population and white patients, and highlight the differences between preoperative pain evaluations across race, which is a key indicator for the surgical management of benign bone lesions [15].

Due to the complex nature of determining the appropriate treatment of benign bone lesions there is an increased risk of implicit racial bias when caring for patients. Implicit racial bias in pediatric orthopedic surgery has been documented throughout the current literature [16]. Dodwell et al. determined that an association existed between implant removal following pediatric femoral fractures and higher socioeconomic status and white race. This finding implies that racial bias impacts surgical management decisions. Guzek et al. surveyed 415 pediatric orthopedic surgeons using a child-race implicit association test to determine if implicit bias existed and how this affected clinical decision making [17]. Their findings concluded that although a pro-white implicit racial bias existed in their cohort it did not impact clinical decision making. Our own analysis of benign bone lesion patients showed equal dispersion of surgical management amongst different socioeconomic and racial statuses.

A noteworthy consideration of our analyses is that race and socioeconomic status were indirectly assessed via zip code due to lack of this data point in the available electronic medical record. Still, we believe the US Census Bureau demographic data functions as a valid, reputable corollary. Additionally, although we believe our suburban New York population to be diverse and representative of the national population, our study was limited to one geographic region which limits the generalizability of our findings. Another limitation is the lack of assessment of the lesional metabolic activity and how that variable informed management. Osteochondromas, which constituted the largest number of benign bone lesions in our database, are generally treated conservatively with management consisting of observation of the lesion every three to six months. Complicated or symptomatic lesions are treated with marginal excision which is often determined by the surgeon based on patient reported symptomatology [18]. This is important because current literature suggests that minorities are more likely to have underreported pain intensity and receive less adequate treatment for acute and chronic pain [19]. Further analysis is required to determine if a relationship exists between patient presentation, lesional metabolic activity and certain racial and economic groups. Lastly, our study lacked patient follow-up and outcome data. Future efforts should be focused on determining if patient outcomes in both surgically treated and non-surgically treated cohorts were comparable and whether or not patient satisfaction was consistent among all races and socioeconomic classes.

The results of the current study revealed non-preferential management in the treatment of benign bone tumors based on race and socioeconomic status. This finding contrasts with previous reports

demonstrating disparities between patient race and surgical rates in primary osseous neoplasms. Our analysis concluded that no racial or socioeconomic factors were associated with increased incidence of peripheral bone lesions or of a particular mode of treatment. This finding within our suburban New York healthcare system indicates that physicians are taking a positive step forward in creating a more fair and equitable healthcare system. Future efforts should be directed at analyzing long-term treatment outcomes with respect to patient race and socioeconomic status in benign bone lesions [20]. In addition, larger similar studies should be performed in other geographic zones and at a national level to increase the validity and applicability of these findings. Continued discussion of diversity, equity and inclusion (DEI) in healthcare, along with in-depth analyses on medical disparity such as this one will help bridge the gap toward equal healthcare.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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