Socioeconomic Status Affects Postoperative Time to Union in Surgically Treated Pediatric Fracture Patients

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INTRODUCTION:

Long bone fractures account for 10-25% of all pediatric injuries. Among those fractures treated with surgery, there are many factors that can affect postoperative healing. Some of these factors are directly related to socioeconomic status (SES). This study uses median household income (MHI) and childhood opportunity index (COI) as a proxy for SES. COI quantifies and maps the quality of resources and conditions available to children based on the neighborhood in which they live. The goal of the current study is to evaluate the relationship between SES and time to union in pediatric patients with long bone fractures.

METHODS:

A retrospective review of pediatric long bone fractures between January 2010 and July 2020 at our Level I pediatric trauma center was conducted. Demographic and relevant medical data were collected. Patients were sorted into union and non-union groups. Time to union prior to and after 4 months was also examined. The zip code of each patient was collected and the MHI and COI of each zip code was identified. Groups starting at $20,000 and increasing by $10,000 were created and patients were sorted into these groups by MHI. Comparisons of the collected variables across income group and union status were conducted. Multiple regression analysis was used to determine the independent effect of each variable on time to union.

RESULTS:

Initially 1018 patients were identified. Patients with non-extremity fractures, incomplete demographic information, or who were treated without surgery were excluded. 395 patients were included in statistical analysis. Demographic information can be viewed alongside the distribution of MHI in Table 1. There was a wide distribution of long bone fractures within this sample, which can be viewed in Table 2. Demographic information and distribution of long bone fractures were stratified by union, non-union, union achieved in less than 4 months, and delayed union achieved in greater than 4 months. Data showed no significant difference in sex, race, ethnicity, and fracture location across any of these groups or across any income brackets.

As shown in Table 3, COI and MHI were significantly higher in the union group than the non-union group. Further, COI and MHI were significantly higher in the group that reached union before 4 months compared to the group that reached union after more than 4 months.

Linear and logistic regression models showed that as MHI decreases by $10,000, time to union increases by 9.6 days and as the COI decreases by 10 units, time to union increases by 6.8 days ($p < .001$). Furthermore, as the MHI decreases by $10,000, odds of union taking longer than 4 months increases by 29%, and as the COI decreases by 10 units, odds of union taking longer than 4 months increases by 19% ($p < .001$). As MHI increases by $10,000, odds of union increase by 2.6% ($p < .012$), and as COI increases by 10 units, odds of union increase by 10.7% ($p < .032$). The relationship of MHI and COI to time to fracture union is shown in Figures 1-3.

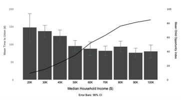
DISCUSSION AND CONCLUSION:

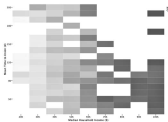
Our results from this study indicate that timely fracture union is seen more often in pediatric patients who have a higher child opportunity index and come from zip codes with higher median household incomes. In addition, this study found children with higher COI and from higher SES groups have higher odds of achieving union.

Nutrition is one potential mediator for this effect. There are a multitude of studies that link lower SES to malnutrition, vitamin D deficiency, calcium deficiency, poorer diabetes control, and poorer overall health when compared to higher SES patients. Lower SES patients also face many challenges in accessing healthcare, especially financial and transportation issues.

In conclusion, this is the first study to investigate the relationship between SES and time to union in pediatric patients. There is a significant relationship between SES and time to union in surgically treated pediatric fracture patients.

Dual Axes Plot of Mean Time to Union and Mean Child Opportunity Index with Respect to Median Household Income





Dual Axes Plot of Median Household Income and Child Opportunity Index With Respect to Union Status and Timing

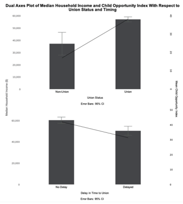


Table 1

Demographics

		Mean (SD)
Median income		56629 (20716)
Child Opportunity Index		38 (24)
Time to Union		104 (65)
Follow-up Time		228 (239)
Age (y)		11.41 (2.92)
BMI		23.26 (8.54)
		N (%)
Female		173 (44)
Male		222 (56)
Black		12 (3.0)
White		383 (97)
Hispanic		201 (51)
Non-Hispanic		194 (49)
Non-Union		8 (2)
Union		387 (98)
Categorical Median Income ($)	20,000	12 (3)
	30,000	84 (21.6)
	40,000	78 (20.1)
	50,000	73 (18.8)
	60,000	63 (16.2)
	70,000	31 (8)
	80,000	15 (3.9)
	90,000	8 (2.1)
	100,000	25 (6.3)

Table 1: BMI, Body Mass Index; y, years; SD, Standard Deviation; N, count; %, proportion reported as a percentage; $, US Dollars.

Table 2

Fracture Frequencies and Respective OTA Classifications

		N (%)	**OTA Classifications**
Fractured Bone	Ankle	10 (2.5%)	15.2, 44C2.2u, 76.1B, 81
	Femur	101 (25.6%)	31A, 31A1, 31A2, 31B3, 31C, 31C1, 32-C3, 32A, 32A1, 32A1b, 32A2, 32A2b, 32A2c, 32A3, 32A3a, 32A3b, 32B3, 32B3b, 32C2, 32C3, 32C3k, 33A2, 33A2.2, 33A2.3, 33A3, 33A3.2, 33B1, 33C1, 41C, 42A, 61A, 32A, 32A2
	Fibula	20 (5.1%)	43B2.2/4F3, 44B2/4F3, 44C2, 4F2A, 4F2Aa, 4F2Ac, 4F2B, 4F3, 4F3B
	Humerus	82 (20.8%)	11A2, 11A2.1, 11B1, 11C1, 12A, 12A1, 12A3, 12C3, 13A, 13A1, 13A1.1, 13A1.2, 13A2.3, 13A3.2, 13B1, 13B2, 13C, 13C1, 13C2, 2R3C1, 33B1
	Metacarpal	13 (3.3%)	77.1, 77.1.2, 77.3.2, 77.3.2A, 77.4, 77.4.1, 77.5.1, 77.5.2, 78.5
	Phalanx	22 (5.6%)	19.8, 77.1, 77.4, 78, 78.1, 78.1.1.2, 78.2, 78.2.1, 78.2.2, 78.3.1, 78.4.1, 78.4.3, 78.5, 78.5.1, 78.5.1.1A, 78.5.1.2C, 78.5.1.3, 88.1.2.1
	Radius	51 (12.9%)	2R1A, 2R1C1, 2R2A, 2R2A1a, 2R2A2, 2R2A3, 2R3A, 2R3A2, 2R3A2.1, 2R3B1, 2R3B2, 2R3C, 2R3C1, 2R3C2.1, 2U2C3
	Tibia	59 (14.9%)	41A, 41A1, 41A1.2, 41A2.2, 41B1.1, 41C1, 41C1.1, 42, 42A, 42A/43A1, 42A/4F3, 42A1, 42A2, 42A3, 42A3b, 42C2, 43A, 43A1, 43A1.3, 43A2, 43A2.1, 43B1, 43B1.1, 43B2.2, 43B2.3, 43B3, 43C1, 44B2, 44B3
	Ulna	37 (9.4%	2R2A/2U2A, 2U, 2U1, 2U1B1, 2U2A, 2U2A2, 2U2A2a, 2U2A2b, 2U2A3, 2U2B3, 2U2C, 2U3, 2U3A2, 2U3A2.3, 2U3B

Table 2: N, count; %, proportion reported as a percentage; OTA, Orthopaedic Trauma Association.

Table 3

Child Opportunity Index, Median Income, BMI, and Age with Respect to Union, Non-Union, and Union Time Less Than or Greater Than 4 Months

	Child Opportunity Index	Median income	BMI	Age
	Mean (SD)			
Non-Union	**17 (15)**	**37119 (11160)**	24.72 (2.43)	13.26 (2.92)
Union	**38 (24)**	**57039 (20682)**	23.24 (8.61)	12.46 (2.92)
Less Than 4 Mo	**42 (25)**	**60233 (21184)**	22.98 (9.83)	11.14 (2.88)
Greater Than 4 Mo	**31 (23)**	**50270 (18640)**	24.03 (6.17)	12.02 (2.81)

Table 3: SD, Standard Deviation; $, US Dollars, Mo, months. Significant values are bolded (P < .001)