Journal of Orthopaedic Science and Research

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Social Determinants of Health are Risk Factors for Decreased Follow Up After Spinal Fusion for Adolescent Idiopathic Scoliosis

Sarah R Bradley[1], Mathew J Gregoski[2], Ryan J Mcfadden[3], Thomas C Geiger[1], Jonathan Pire[1], Sara S Van Nortwick[1], Matthew A Dow[1], Robert F Murphy[1*]

[1]Department of Orthopaedics and Physical Medicine, Medical University of South Carolina, Charleston, SC, USA

[2]Department of Public Health Sciences, Medical University of South Carolina, Charleston, SC, USA

[3]University of South Carolina School of Medicine – Columbia, Columbia, SC, USA

***Correspondence author:** Robert F Murphy, MD, Department of Orthopaedics and Physical Medicine, Medical University of South Carolina, Charleston, SC, USA; Email: murphyr@musc.edu

Citation: Bradley SR, et al. Social Determinants of Health are Risk Factors for Decreased Follow Up After Spinal Fusion for Adolescent Idiopathic Scoliosis. J Ortho Sci Res. 2025;6(1):1-5. https://doi.org/10.46889/JOSR.2025.6102

Received Date: 10-12-2024

Accepted Date: 11-01-2025

Published Date: 18-01-2025

Abstract

Objective(s): Spinal Fusion (SF) for Adolescent Idiopathic Scoliosis (AIS) is an effective procedure for curve correction and arthrodesis. Regular patient follow-up is beneficial for clinical and radiographic surveillance and patient outcomes. This study aimed to investigate risk factors for decreased patient follow-up after SF for AIS.

Methods: AIS patients who underwent SF at a single tertiary medical center from 2017 to 2022 and were eligible for 1, 2 or 5 years follow up were retrospectively reviewed.

Results: During the 6-year study period, 215 SF were recorded, with a median age at SF of 14 years (interquartile range [IQR 3]) and 166 females (77%). Follow up completion to eligibility status for each of the three time points was as follows: 1 year 157/215 (73%), 2 years 74/154 (48%) and 5 years 10/37 (27%).

Univariate analysis demonstrated that Black patients (p=0.007) and those with public insurance (p<0.001) were significantly less likely to compete 1-year follow-up. At 2-year follow up, significant differences were only found for Black patients (p=0.042). Of the patients who qualified for 2 year follow up, median round trip driving distance was 66.64 miles (IQR 165.05); although increased driving distance did not affect completion of 2 year follow up (p=0.586).

Conclusion: In a cohort of 215 SF patients with AIS, follow up completion dropped off from 1 year (73%) to 2 year (48%) to 5 year (27%). Black patients and those with public insurance were significantly less likely to complete 1-year follow-up.

Keywords: Adolescent Idiopathic Scoliosis; Follow-Up; Social Determinants; Public Insurance

Introduction

Adolescent Idiopathic Scoliosis (AIS) is defined by a Cobb angle of >10° in the coronal plane and associated axial rotation and approximately 90% of AIS patients are 11-18 years old [1]. Surgical management for AIS, most commonly Spinal Fusion (SF), is indicated for patients with Cobb angles >50°, with the goal of limiting progression later in life, as well as correcting scoliosis to the degree that is safely possible [2-4].

Although the reported prevalence of AIS of 2-3% has remained steady over the past two decades, the rate of SFs for AIS is increasing [5-9]. Post-surgical SF patients undergo follow-up at regular intervals to detect complications, evaluate radiographs and examine clinical results. The number of visits required for post-operative care can put a burden on families. Several studies have explored social determinants of health that could serve as risk factors for outcomes in pediatric orthopedics patients [10]. Insurance status, race and social deprivation have been found to have direct links to access to care and treatment outcomes. Patients with public insurance have been found to have worse functional outcomes and lower post-treatment follow-up rates [11]. In the AIS population specifically, patients with public insurance have been found to have significantly higher rates of baseline comorbidities and larger curves at presentation [12,13]. Black patients have also been found at higher risk for presenting

with severe scoliosis or curve magnitudes requiring surgical intervention rather than non-operative management [14-16]. Although studies have explored the implications of social determinants of health on severity of disease and treatment outcomes in AIS patients, the literature is yet to address these factors as possible predictors for completion of follow up. The primary purpose of this study was to investigate patient completion of 1, 2 and 5-year follow-up after SF for AIS. Our secondary measure was to evaluate completion of follow-up as a function of curve magnitude, age, gender, race, insurance status or distance to the academic medical center. We hypothesized a lower likelihood of follow-up in patients who are publicly insured, identify as Black or must travel farther distances for care.

Materials and Methods

Following Institutional Review Board approval, a retrospective chart review was performed to identify patients who underwent SF at a multi-surgeon academic health center in the United States of America between January of 2017 and November of 2022. Subjects included those 21-years and younger diagnosed with AIS and treated with SF (associated CPT codes: 22802, 22804). Neuromuscular, congenital and syndromic patients were excluded, as well as those with non-fusion procedures.

Chart review included demographic data, patient home address, SF approach (anterior versus posterior) and attendance at institutional follow-up intervals of 2 weeks, 6 weeks, 3 months, 6 months, 1 year, 2 years and 5 years. Driving distance from each subjects' home address to the institution was calculated using Google Maps [17]. Area Deprivation Index (a mapping tool that scores socioeconomic conditions of neighborhoods, with a higher score reflecting greater disadvantage) was determined for each subject using Neighborhood Atlas [18].

Statistical analyses were completed using SPSS version 28 (IBM corporation, Armonk, NY). All data was analyzed to examine dispersion and normality. Medians and Interquartile Ranges (IQR) were calculated for all continuous variables; frequencies and percentages for all categorical variables. Based on Kolmogorov-Smirnov normality tests results, variables with continuous outcomes (e.g. Deprivation Indices, Age at Index, Driving Distance) were assessed using Independent-Samples Mann-Whitney U Test across groups (i.e. 1-year follow up completion vs non-completion). Categorical variables (e.g. Race, Gender, Insurance Type) were assessed using X^2s or Fishers Exact test as appropriate. Between group counts and percentages are presented.

A total of seven patient covariates (i.e. Gender, Race, Insurance, Age, State ADI, National ADI and Round-trip driving distance) were screened for significance with both one year and two year follow up completion/|non-completion using univariate logistic regression models to ensure individual covariates had adequate statistical power for inclusion. Following univariate logistic regression models, multivariable logistic models were completed including any covariates with a univariate p-value ≤0.10 was entered into a multivariable logistic regression model. Logistic regression results are presented as OR with corresponding p values. P-values ≤0.05 were considered statistically significant.

Results

During the 6-year study period, 215 AIS patients treated with SF qualified for 1 year follow up. The median age at surgery was 14.5 years (IQR 3) and most participants were females (166, 77%). Most patients (214, 99%) had a posterior only procedure with one having a combined anterior/posterior fusion. A subset of 154 patients qualified for 2 year follow up with the median age at surgery 14 years (IQR 3). Follow up completion to eligibility status for each of the three time points was as follows: 1 year 157/215 (73%), 2 years 74/154 (48%) and 5 years 10/37 (27%). Please see Fig. 1.

Patients who self-identified as Black were less likely to complete 1-year (p=0.007) and 2-year follow up (p=0.042) when compared to those who identified as White, Hispanic or Other (Table 1). Patients with public insurance were also less likely to complete 1-year follow up when compared to those with private insurance (p<0.001). In the multivariate regression model including both race and insurance, only insurance remained significant (p = .007). At 2-years, patients with public insurance (p=0.306) and black race (p = 0.042), had lower rates of follow up completion, though only race was significant. In the 5-year follow up cohort there was no significant difference in follow up completion when comparing race or insurance type. There was no significant association between follow up completion and clinical characteristics such as age at index surgery and gender, at 1 year, 2 year or 5 year follow up.

Patients who qualified for 1 year follow up drove a median estimated round-trip distance of 91.1 miles (IQR 163.7 miles) from the patient's home address to the hospital. The median national ADI was 55 (IQR 47) and the median state ADI was 4.0 (IQR 5). Patients who went on to qualify for 2 year follow up drove a median round trip distance of 66.64 miles to the medical center (IQR 165.05 miles). The median national ADI of this subset of patients was 53 (IQR 42) and state ADI was 3.0 (IQR 4). These geographic variables did not show significant association with follow up completion at any time point.

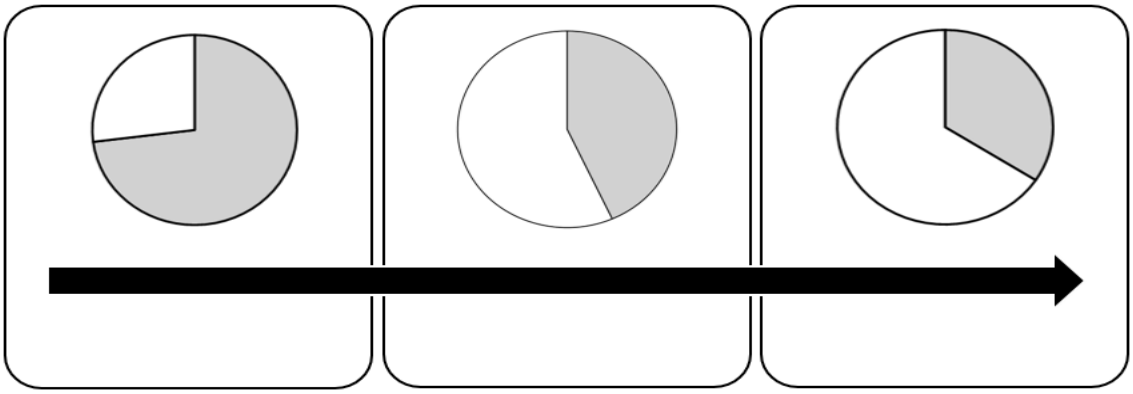

Figure 1: Percentage of completion of follow up at 1, 2 and 5 year time points.

	1 Year Follow Up (N=215)		**2 Year Follow Up (N=154)**	
	Incomplete (N=57)	Univariate *OR [95%CI] p-value*	Incomplete (N=80)	Univariate *OR [95%CI] p-value*
Gender, n (%)				
Female	40 (70)	*Reference*	63 (79)	*Reference*
Male	17 (30)	(1.673) [0.842-3.328] *p = .142*	17 (21)	(0.978) [0.453-2.113] *p = .955*
Race, n (%)				
White	22 (39)	*Reference*	40 (50)	*Reference*
Black	30 (53)	(0.413) [0.217-0.785] ***p = .007***	39 (49)	(0.502) [0.258-0.977] ***p = .042***
Hispanic	2 (3)	(0.522) [0.104-3.149] *p = .522*	0 (0)	($1.04x10^7$) [0.000] *p = .999*
Other	3 (5)	(0.229) [0.043-1.213] *p = .083*	1 (1)	(0.851) [0.052-14.047] *p = .910*
Insurance*, n (%)				
Private	18 (32)	*Reference*	41 (51)	*Reference*
Public	38 (67)	*(0.309) [0.162-0.590* ***p<.001***	37 (46)	(0.714) [0.375-1.360] p=.306
Clinical Characteristics, Median (IQR)				
Age at Index Surgery	14 (3)	(0.959) [0.833-1.104] *p = .558*	14 (3)	(1.008) [0.864-1.177] *p = .914*
Geographic Data, Median (IQR)				
State ADI	3.5 (4)	(0.958) [0.864-1.063] *p = .418*	3 (4)	(0.957) [0.856-1.07] *p = .443*
National ADI	54.5 (43)	(0.996) [0.984-1.007] *p = .464*	54 (42)	(0.996) [0.984-1.008] *p = .523*

Round-Trip Driving Distance	103.77 (175.29)	(1.002) [0.999-1.006] *p = .174*	66.06 (177.65)	(0.999) [0.996-1.002] *p = .586*
*Excluded self-pay. 1 year follow up N= 213. 2 year follow up N= 152				

Table 1: Clinical and demographic variables as risk factors for completion of 1 and 2 year follow up.

Discussion

Although not standardized, regular follow-up after SF for AIS is recommended for evaluation of clinical outcomes, radiographic assessment, implant integrity and arthrodesis and monitoring of complications [19,20]. In this retrospective cohort, only 48% of patients completed 2-year follow up. Additionally, univariate analysis found Black patients significantly less likely to complete 1-year and 2-year follow-up and publicly insured patients significantly less likely to complete 1-year follow up when compared to others. A 2022 retrospective review by Hubbard, et al., revealed race and estimated income were most predictive of follow-up completion in pediatric supracondylar humerus fractures following operative treatment [21]. African American patients were four times more likely to miss two or more appointments and patients with an estimated family income < $50,000 were two times more likely. When looking at all pediatric orthopedic clinic patients, Robaina, et al., found insurance status to be the best predictor for attendance at appointments, with private insurance holders having the lowest no-show rate [22]. Tartarilla, et al., observed similar outcomes in pediatric orthopedics patients, with increased odds of missed care opportunities in Black and Hispanic patients when compared to White patients and publicly insured when compared to private insurance holders [23].

Access to pediatric orthopedic surgeons can be challenging. In a review of pediatric surgical specialties, Mayer, et al., reported that in 2009, in the United States, the mean distance to the nearest pediatric orthopedist was 40.0 miles, with more than 82% of the pediatric patients living within 80 miles of pediatric orthopedic care [24]. Greater travel distance puts a burden on families, especially those multiple post-operative visits needed for surveillance. However, our study did not find a significant correlation between distance traveled and follow up completion. Wiebe, et al., found pediatric general surgery patients living farther from the hospital still attended an equivalent rate of follow-ups when offered one [25]. Another study in the pediatric general surgery population identified perceived cost and distance traveled as only weakly associated with a greater willingness to substitute a clinic visit with telemedicine [26].

Our study is not without limitation. This is a retrospective study, which by design could have led us to unintentionally exclude patients. There are factors representing potential inaccuracies in our reported estimated driving distances. For example, patients may have moved during the study period without updating their address in the medical record. Since our institutional follow-up protocol after SF is not standardized, it is difficult to generalize our single center findings to other centers where follow-up intervals likely differ. Additionally, our study period included the years of the COVID pandemic, which may have affected follow up rates. Finally, it must be acknowledged that this cohort is from the United States of America. This cohort may not be appliable to other countries or locations. Additionally, some other countries do not collect racial demographic data, so similar analyses may not be able to be conducted elsewhere.

Conclusion

In conclusion, this study found attendance at 2-year follow-ups after SF for AIS was only 48%. Black patients were less likely to attend 1-year and 2-year follow up and publicly insured patients were less likely to attend 1-year follow up. The results of this study give us insight to patients at risk for missing post-operative follow-up encounters and highlight the importance of continued efforts to identify social determinants of health leading to care disparities.

Conflict of Interests

The authors declare that they have no conflict of interest in this paper.

References

1. Negrini S, Donzelli S, Aulisa AG. SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. Scoliosis and Spinal Disorders. 2018;13(1).
2. Janicki JA, Alman B. Scoliosis: Review of diagnosis and treatment. Paediatrics and Child Health. 2008;12(9):771-6.
3. Addai D, Zarkos J, Bowey AJ. Current concepts in the diagnosis and management of adolescent idiopathic scoliosis. Child's Nervous System. 2020;36(6):1111-9.

4. Beauchamp EC, Anderson RCE, Vitale MG. Modern surgical management of early onset and adolescent idiopathic scoliosis. Neurosurg. 2019;84(2):291-304.
5. Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. Journal of Children's Orthopaedics. 2013;7(1):3-9.
6. Hresko MT. Idiopathic Scoliosis in Adolescents. The New England journal of medicine. 2013;368(9):834-41.
7. Theologis AA, Sing DC, Chekeni F, Diab M. National trends in the surgical management of adolescent idiopathic scoliosis: analysis of a national estimate of 60,108 children from the national inpatient sample over a 13-year time period in the United States. Spine Deformity. 2017;5(1):56-65.
8. Vigneswaran HT, Grabel ZJ, Eberson CP, Palumbo MA, Daniels AH. Surgical treatment of adolescent idiopathic scoliosis in the United States from 1997 to 2012: an analysis of 20, 346 patients. Journal of Neurosurgery: Pediatrics. 2015;16(3):322-8.
9. Cho SKMD, Lenke LGMD, Bridwell KHMD, Kim YJ. Recent trends in surgical management of adolescent idiopathic scoliosis: a review of 17,412 cases from the scoliosis research society database 2001-2008. The spine journal. 2013;13(9):S122.
10. Sborov KD, Haruno LS, Raszka S, Poon SC. Racial and ethnic disparities in pediatric musculoskeletal care. Current Reviews in Musculoskeletal Medicine. 2023;16(10):488-92.
11. Arant KR, Modest JM, Gil JA, Cruz AI, Jr. What's new in pediatric orthopaedic health care disparities? J Pediatr Orthop. 2022;42(9):e954-9.
12. Moore HG, Patibandla SD, McClung AM. Do children with medicaid insurance have increased revision rates 5 years after posterior spinal fusions? J Pediatr Orthop. 2023.
13. Russell T, Dharia A, Folsom R. Healthcare disparities in adolescent idiopathic scoliosis: the impact of socioeconomic factors on Cobb angle. Spine Deformity. 2020-08-01 2020;8(4):605-11.
14. Heffernan MJ, Younis M, Song B. Disparities in pediatric scoliosis: the impact of race and insurance type on access to nonoperative treatment for adolescent idiopathic scoliosis. J Pediatr Orthop. 2022;42(8):427-31.
15. Zavatsky JM, Peters AJ, Nahvi FA. Disease severity and treatment in adolescent idiopathic scoliosis: the impact of race and economic status. Spine J. 2015;15(5):939-43.
16. Erkkila IP, Reynolds CA, Weissman JP. Factors associated with presentation of severe adolescent idiopathic scoliosis. J Pediatric Orthopaedic Society of North America. 2023;5(3).
17. Google. Google maps distance calculator. 2023.
18. PhD AKM. Area Deprivation Index. University of Wisconsin School of Medicine and Public Health. 2023.
19. Ahmed SI, Bastrom TP, Yaszay B, Newton PO. 5-year reoperation risk and causes for revision after idiopathic scoliosis surgery. Spine (Philadelphia, Pa 1976). 2017;42(13):999-1005.
20. Hariharan AR, Shah SA, Petfield J. Complications following surgical treatment of adolescent idiopathic scoliosis: a 10-year prospective follow-up study. Spine Deformity. 2022;10(5):1097-105.
21. Hubbard EW, Rathjen KE, Elliott M, Wimberly RL, Riccio AI. Predictors of appointment adherence following operative treatment of pediatric supracondylar humerus fractures: which patients are not following up? Journal of pediatric orthopaedics B. 2022;31(1):25-30.
22. Robaina JA, Bastrom TP, Richardson AC, Edmonds EW. Predicting no-shows in paediatric orthopaedic clinics. BMJ Health & Care Informatics. 2020;27(1):e100047.
23. Tartarilla AB, Tennermann N, Melvin P, Ward VL, Bauer AS. Sociodemographic missed-care predictors for pediatric orthopaedic telemedicine during COVID-19. J Pediatr Orthop. 2022;42(6):e688-95.
24. Mayer ML, Beil HA, von Allmen D. Distance to care and relative supply among pediatric surgical subspecialties. J Pediatr Surg. 2009;44(3):483-95.
25. Wiebe ME, Shawyer AC. Impact of distance on postoperative follow-up in patients of pediatric surgery: a retrospective review. World Journal of Pediatric Surgery. 2020;3(4):e000195.
26. Bator EX, Gleason JM, Lorenzo AJ. The burden of attending a pediatric surgical clinic and family preferences toward telemedicine. J Pediatric Surgery. 2015;50(10):1776-82.