



Impact of demographic and socioeconomic factors and urbanization status on postoperative outcomes following hip arthroscopy

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ABSTRACT

Introduction: Hip arthroscopy (HA) is increasingly used to treat femoroacetabular impingement (FAI) and labral tears, with growing interest in the role of socioeconomic factors on postoperative outcomes. Prior literature suggests socioeconomic deprivation may worsen patient-reported outcomes (PROMs), but findings regarding the Area Deprivation Index (ADI) and urbanization status remain inconsistent. This study aimed to evaluate the difference in PROMs after HA secondary to symptomatic FAI and hip labral tears based on the residential urbanization status, demographic variables, and Area Deprivation Index (ADI) values of patients in our single-center cohort

Methods: A single-institution retrospective review was conducted on 86 patients who underwent HA between 2014 and 2023. Patients were categorized as urban or rural based on U.S. Census data and assigned national/state ADI scores based on their residential addresses. PROMs (mHHS, HOS-ADL, HOS-Sport, NAHS) were collected via telephone survey at ≥ 1 year postoperatively. Statistical comparisons and multivariable regression analyses were used to assess the impact of demographic variables and ADI on PROMs.

Results: There were no significant differences in PROMs between urban and rural patients. However, regression analysis revealed that national ADI and age were significantly negatively correlated with all PROMs ($p < 0.05$). Older age and higher ADI independently predicted worse postoperative outcomes. Interaction effects, such as age \times BMI or age \times ADI, also negatively influenced certain PROMs. Race and surgical indication showed limited interaction effects.

Conclusion: While urbanization status did not impact outcomes, higher socioeconomic deprivation (as measured by national ADI) and increased age were associated with significantly worse PROMs after HA at 1-year follow-up. These findings suggest that neighborhood-level socioeconomic disadvantage plays a more critical role than urban-rural classification in influencing recovery. Strategies aimed at addressing social determinants of health may improve HA outcomes, particularly in socioeconomically disadvantaged populations.

1. Introduction

Hip arthroscopy (HA) has been increasingly implemented as a treatment modality for many hip pathologies, including labral tears and femoroacetabular impingement (FAI). From 2003 to 2013, there was a 7.2 times increase in HA, with a projected 13.8 times increase by 2023.¹ In response, research surrounding HA has increased. Current literature has focused on postoperative patient-reported outcome measures (PROMs) and their determinants following HA.^{2–5}

Socioeconomic status is a known predictor of postoperative outcomes. Studies have shown that patients experiencing greater levels of socioeconomic deprivation have worse outcomes after HA.⁶ These patients also often have higher rates of revision surgeries and conversion to total hip arthroplasty (THA).⁶ This may be due to a number of factors, including less access to resources such as healthcare professionals, transportation, or nutritious foods.⁷

Furthermore, patients living in rural areas, low-resource urban areas, or areas designated as health profession shortage areas (HPSA) often

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have reduced access to resources, which may have a negative effect on postoperative outcomes.^{6,8,9} There is currently a lack of literature surrounding the effect of socioeconomic determinants of health on postoperative outcomes following HA. There is also disagreement in the literature among studies evaluating the association between patients' Area Deprivation Index (ADI) values and its effect on PROMs following HA.^{10,11} Some studies argue that while patients with greater neighborhood-level socioeconomic disadvantage may have worse PROMs early on, this resolves at long-term follow-up. Other studies argue that patients with greater neighborhood-level socioeconomic disadvantage have worse PROMs throughout the postoperative period after HA.^{10–13}

The purpose of this study is to evaluate the difference in PROMs after HA secondary to symptomatic FAI and hip labral tears based on the residential urbanization status, demographic variables, and Area Deprivation Index (ADI) values of patients in our single-center cohort. We hypothesize that patients who reside in low-resource communities and have relatively higher ADI values report worse postoperative PROMs.

2. Materials and methods

Institutional Review Board approval was obtained before the conduction of this study (IRB-300012126).

2.1. Study methods and patient population

This single-institution retrospective study evaluated the medical records of 86 patients who underwent HA from 2014 to 2023. Indications for undergoing HA included: treatment of symptomatic hip labral tears or femoroacetabular impingement (FAI). Demographic data, including age, body mass index (BMI), gender, race, and surgical indication, were obtained from electronic medical records. The study population was divided into urban and rural groups based on urbanization status determined by the United States Census data.¹⁴ Home address was also used to determine each patient's state and national ADI: a validated, quantitative metric that assesses neighborhood-level socioeconomic status. This study excluded patients who (i) did not speak English, (ii) did not have a working phone number listed, (iii) had a hip arthroplasty after their initial hip arthroscopy, (iv) were under the age of 18 at follow-up, (v) resided in an area that was missing from ADI ranking, or (vi) did not have a minimum of 1-year follow up.

2.2. Study variables

Patients were contacted by phone, and questionnaires were administered to collect PROMs. These included the modified Harris Hip Score (mHHS), Hip Outcome Score-Activities of Daily Living (HOS-ADL), Hip Outcome Score-Sports (HOS-Sports), and Non-Arthritic Hip Score (NAHS). Baseline PROMs were not recorded, eliminating a comparison between pre- and postoperative PROMs. Therefore, our primary outcome was to compare postoperative PROMs for patients who underwent HA between those with varying residential urbanization status, and state and national ADI values at a minimum of 1-year follow-up. Secondary outcomes included evaluating interactions between various demographic variables and their influence on outcome scores.

2.3. Area Deprivation Index (ADI)

The area deprivation index is a validated, quantitative metric that evaluates neighborhood-level socioeconomic conditions and access to resources in a region. ADI is calculated based on four main categories: income, education, employment, and housing quality. ADI values for a given United States census block group are presented as a state decile (0–10) and national percentile (0–100). An ADI value closer to 0 indicates an affluent area with minimal deprivation, a value in the 5th decile and

50th percentile indicates an average level of deprivation, and values greater than 5 and 50 indicate higher levels of socioeconomic deprivation relative to the rest of the state and national, respectively. In this study, each patient's home address was used to calculate ADI.

2.4. Statistical analysis

A departmental statistician performed formal comparative statistics using SAS/STAT software (SAS Institute Inc, Cary, North Carolina). Statistical tests included χ^2 tests for categorical variables and t-tests as well as a multivariable logistic regression analysis for continuous variables. The threshold for statistical significance was set to 0.05.

3. Results

Patient baseline demographics were collected and assessed among the urban and rural cohorts. There were a total of 45 patients in the urban group and 41 patients in the rural group. The mean age of patients in the urban cohort was 42.9 ± 12.2 and 36.7 ± 14.7 in the rural cohort. There was no significant difference in age noted between these groups ($P = 0.22$). There was also no significant difference noted in the average follow-up ($P = 0.49$), smoking status ($P = 0.20$), and mean BMI of patients in either cohort ($P = 0.34$).

When assessing gender and race distribution, there were significantly more males in the urban group and significantly more females in the rural group ($P = 0.03$). Additionally, there were significantly more White patients in the rural group, and significantly more Asian and Black patients in the urban group ($P = 0.04$). Further information on patient demographics can be referenced in [Table 1](#).

National and state Area Deprivation Index (ADI) values were also assessed among patients in both cohorts. No significant differences were noted between state decile ADI values or national percentile ADI values between groups. The rural group had a mean ADI (national) percentile of 64.3 ± 17.7 while the urban group had a mean ADI (national) of 62.2 ± 26.2 . This finding indicates that patients in our study group on average had ADI values that were above the 60th percentile for neighborhood-level socioeconomic disadvantage regardless of urbanization status. Further information on ADI values and surgical indications can be referenced in [Table 2](#).

Postoperative patient-reported outcome measures (PROMs) were also recorded for all patients in both cohorts. There were no significant differences noted between urban and rural cohorts with respect to each of the four PROMs that were assessed. Further information on mean PROM scores can be referenced in [Table 3](#).

Linear regression models were created to assess the relationship between various patient demographic variables and PROMs. β values were included in [Table 4](#) to indicate whether each correlation was positive or negative, and interactions between variables were also assessed to evaluate the influence of demographic variables on each other and their overall effect on each PROM. All significant predictors of PROMs and specific values can be referenced in [Table 4](#).

3.1. Modified Harris Hip Score (mHHS)

Regression analysis of demographic and interaction variables in relation to the mHHS revealed that there was a significant negative correlation between mHHS and age ($P = 0.0009$). There was also a significant negative correlation between mHHS and ADI (national) ($P = 0.0008$). Additionally, interaction between age and BMI also revealed a significant negative correlation, indicating that as age and BMI increase, mHHS scores decrease ($P = 0.0002$). Lastly, interaction between BMI and ADI (national) revealed a significant negative correlation, indicating that as BMI and ADI (national) values increase, mHHS scores decrease ($P = 0.0025$).

Table 1
Patient baseline demographics.

	Total	Average Age (Yrs)	Gender		Race			Average BMI ¹ (kg/m ²)	Smoking Status		Average Follow-up (Months)
			Male	Female	Black	White	Asian		Yes	No	
Urban	45	42.9 ± 12.2	23	22	12	31	2	28.1 ± 6.2	11	34	42.9 ± 33.5
Rural	41	36.7 ± 14.7	13	28	4	36	0	27.9 ± 7.2	10	31	38.2 ± 28.3
P-Values	–	0.22	0.03		0.04			0.34	0.20		0.49

BMI, Body Mass Index.

Table 2
Average area deprivation index & surgical indication.

	Average ADI (State)	Average (National)	Surgical Indication	
			FAI	Labral Tear
Urban	4.4 ± 3.0	62.2 ± 26.2	27	18
Rural	4.2 ± 2.2	64.3 ± 17.7	30	11
P-Values	0.69	0.67	–	–

ADI, Area Deprivation Index; FAI, Femeroacetabular Impingement.

Table 3
Urban vs. Rural patient reported outcome measures (PROMs).

	Mean mHHS	Mean HOS-ADL	Mean HOS-Sport	Mean NAHS
Urban	64.2 ± 19.3	72.8 ± 22.5	62.0 ± 30.1	73.3 ± 21.8
Rural	66.7 ± 17.6	74.5 ± 20.3	64.4 ± 31.1	74.9 ± 21.7
P-Values	0.57	0.51	0.83	0.99

mHHS, Modified Harris Hip Score; HOS-ADL, Hip Outcome Score-Activities of Daily Living; HOS-Sport, Hip Outcome Score-Sport; NAHS, Non Arthritic Hip Score.

Table 4
Summary of significant predictors in regression models.

PROMs	Variables Assessed	P-Values	β Values
mHHS	Age	0.0009	–0.45
	ADI (National)	0.0008	–0.28
	Age ^a BMI	0.0002	–0.02
	BMI ^a ADI (National)	0.0025	–0.02
HOS-ADL	Age	0.0002	–0.58
	ADI (National)	0.0051	–0.27
	Age ^a Race (Black)	<0.0001	–1.59
	Age ^a Race (White)	0.0025	–0.46
	ADI (National) ^a Race (White)	0.0087	–0.54
HOS-Sport	Age	0.0002	–0.84
	ADI (National)	0.009	–0.36
	Age ^a ADI (National)	0.0022	–0.02
	Age ^a Surgical Indication	0.076	–0.20
NAHS	Age	0.0009	–0.56
	ADI (National)	0.023	–0.23
	Age ^a ADI (National)	<0.0001	–0.01

^a Denotes Interaction Between Two Variables; PROMs, Patient Reported Outcome Measures; mHHS, Modified Harris Hip Score; HOS-ADL, Hip Outcome Score – Activities of Daily Living; HOS-Sport, Hip Outcome Score-Sport; NAHS, Non Arthritic Hip Score.

3.2. Hip Outcomes Score-activities of Daily Living (HOS-ADL)

Regression analysis of demographic and interaction variables in relation to the HOS-ADL scores revealed that there was a significant negative correlation between age and HOS-ADL scores (P = 0.0051). Furthermore, there was also a significant negative correlation between ADI (national) and HOS-ADL scores (P = 0.009). Additionally, interaction between age and race (black) demonstrated a significant negative correlation (P = < 0.0001), and the interaction between age and race (white) also demonstrated a significant negative correlation (P = 0.0025). These findings indicate that older patients identifying with the two aforementioned races had worse HOS-ADL scores. Lastly, there was

also significant negative correlation between the interaction of ADI (national) and race (white), indicating that white patients with higher ADI (national) values demonstrated lower HOS-ADL scores.

3.3. Hip Outcome Score-Sport (HOS-sport)

Regression analysis of demographic and interaction variables in relation to HOS-Sport outcome scores revealed that there was a significant negative correlation with age (P = 0.0002) and ADI (national) (P = 0.009). Additionally, the interaction between age and ADI (national) also revealed a significant negative correlation (P = 0.0022), indicating that older patients with higher ADI (national) values had worse HOS-Sport outcome scores. Lastly, the interaction between age and surgical indication also revealed a significant negative correlation with HOS-Sport values. This finding indicated that older patients treated for FAI had worse HOS-Sport scores.

3.4. Non Arthritic Hip Score (NAHS)

Regression analysis of demographic and interaction variables in relation to NAHS outcome scores revealed a significant negative correlation between NAHS and age (P = 0.0009) as well as NAHS and ADI (national) (P = 0.023). Additionally, interaction between age and ADI (national) revealed a significant negative correlation with NAHS, indicating that older patients with higher ADI (national) values had lower NAHS outcome scores.

4. Discussion

The most important finding in this study was that patient-reported outcomes after hip arthroscopy were inversely correlated with age and ADI (national) values, indicating that as patient age and neighborhood-level socioeconomic deprivation increases, PROMs (mHHS, HOS-ADL, HOS-Sports, NAHS) worsen at 1-year follow-up. Additionally, there were no significant differences in outcomes between patients in the urban and rural cohorts. This supports the initial hypothesis as those with higher ADI (national) values demonstrated worse outcome scores irrespective of urbanization status based on United States census data.¹⁴

Of the total United States population, over 265 million Americans live in urban areas, over 66 million live in rural areas, and over 77 million live in areas designated as health profession shortage areas (HPSA).^{14,15} It is important to identify how social determinants of health play a role in affecting postoperative outcomes in patients after HA so that targeted interventions may be put in place to help patients achieve better postoperative recovery. While it may not matter whether patients live in urban or rural areas, a key factor that contributes to worsening PROMs after HA at 1-year follow-up is likely due to a lack of resource availability and increased neighborhood-level socioeconomic disadvantage.

Interactions between demographic variables and each individual outcome score also revealed a negative correlation. Specifically, between age and BMI, BMI and ADI (national), age and race (Black), age and race (White), ADI (national) and race (White), and age and surgical indication. Therefore, patients who reported worse postoperative outcomes were older with higher BMIs, had high BMIs that were more disadvantaged, were older black and white patients, were white patients

that lived in relatively higher ADI areas, and older patients with FAI. Prior studies have reported significant racial disparities when evaluating PROMs at follow-up for various procedures including rotator cuff repair, however, no study has looked at the interaction of race and socioeconomic status and its influence on PROMs after HA.¹⁶

While our study findings are consistent with those of a similar study by Kazi et al., they also contrast findings of studies such as Lee et al. and Cruse et al. that both indicate no significant correlation between ADI and PROMs after HA, therefore suggesting a disconnect in the current literature.^{6,10,11,17}

The cohort study by Lee et al. revealed that while patients with higher ADI (national) values had worse preoperative PROMs, these differences were no longer present at 1-year follow-up and both cohorts achieved similar rates of the minimal clinically important difference (MCID) and the Patient Acceptable Symptom State (PASS) for each PROM score. However, on further evaluation of this study, it is noted that the ADI (low) cohort had a mean of 5.8 ± 3.0 and the ADI (high) cohort had a mean of 28.0 ± 14.5 . The distribution of the patient population in this study was skewed with a majority of patients in both cohorts existing far below the 50th percentile of ADI (national) values, indicating that these patients were, on average, less disadvantaged at the neighborhood-level than those in our study cohort. In our study population, however, mean ADI (national) values were above the 60th percentile in both the urban and rural cohorts. This finding questions the previous work's external validity and generalizability as the reported conclusions and associations may be inapplicable to a higher ADI population like our study has shown. Additionally, this highlights the importance of multiple cohort studies being done on this topic to gain a better understanding of postoperative outcomes in varying patient populations across the United States.

The Patient Acceptable Symptom State (PASS) is an absolute value that delineates between when a patient feels well and unwell.¹⁸ Unlike the MCID, which is a difference that must be achieved to consider significant improvement, PASS is a threshold beyond which patients report feeling better with respect to each relevant patient-reported outcome measure.^{18,19} A study by Chahal et al. first established a PASS threshold for the mHHS, HOS-ADL, and HOS-Sport PROMs. These thresholds were determined to be 74 (mHHS), 87 (HOS-ADL), and 75 (HOS-Sports).¹² An additional study also established a PASS threshold for NAHS (81.9–85.6).²⁰ The mean scores for both urban and rural cohorts across all 4 PROMs in our study were below PASS thresholds, indicating that on average patients in our study had poor postoperative outcomes.

Our study uncovers the discrepancies in patient-reported outcomes after hip arthroscopy based on multiple demographic variables such as urbanization status, race, age, BMI, and ADI, showing negative correlations between numerous variables and each associated patient reported outcome score. However, this study is unable to explicitly uncover why many of these negative correlations exist between demographic variables and PROMs. One such reason could be that those with lower socioeconomic status have reduced access to services that are associated with outcomes. This may mean that physical therapy was harder to access or postoperative visits were difficult to travel to which has been directly tied to outcomes after HA.²¹ Another reason may be that the barriers to care did not allow these patients to seek care early in the pathologic process. This may be due to factors such as insurance type. Patients from higher ADI areas are more likely to rely on government-provided insurance.²² There is evidence that patients with government-provided insurance have significantly longer wait times for orthopaedic procedures than those commercially insured.²³ This delay may result in the progression of a patient's pathology to the point where HA is less effective than if it were treated earlier. Therefore, targeted interventions to assist patients prone to worse outcomes may be useful in helping them to achieve more favorable postoperative recovery.

4.1. Limitations

This study is not without limitations. The largest limitation of this study is the lack of pre-operative outcomes, which did not allow us to assess the change in PROMs from pre-to post-op or to evaluate the MCID in our study cohort. Another limitation is that this study did not examine the effect that gender may have on hip arthroscopy PROMs, aside from evaluating distribution of gender across groups. However, sex has been proven to not affect PROMs after hip arthroscopy so there was likely no need to further evaluate this effect.⁴ Additionally, the sample size of patients in both the urban and rural cohorts was relatively small. A larger cohort may have revealed additional findings. Lastly, while ADI is a helpful tool to assess socioeconomic deprivation, it is unable to evaluate additional social determinants of health such as access to transportation, access to nutritious foods, and health literacy. However, it is difficult to quantify many of these variables, and ADI is the best surrogate for this that we can quantify and use for research purposes.²⁴ Other limitations are those inherent to any retrospective studies and include selection bias, unknown confounders, and survivorship bias. However, these would likely affect both comparison groups equally, and should therefore not change outcomes.

5. Conclusion

While urbanization status did not impact outcomes, higher socioeconomic deprivation (as measured by national ADI) and increased age were associated with significantly worse PROMs after HA at 1-year follow-up. These findings suggest that neighborhood-level socioeconomic disadvantage plays a more critical role than urban-rural classification in influencing recovery. Strategies aimed at addressing social determinants of health may improve HA outcomes, particularly in socioeconomically disadvantaged populations.

Consent

Institutional review board approval was obtained for this retrospective study, which used previously collected data. Therefore, no patient consent was required.

Authorship statement

Dev Dayal: 1) Conceptualization, 2) Methodology, 3) Formal Analysis, 4) Investigation, 5) Data Curation, 6) Writing-original draft; **Maxwell Harrell:** 1) Methodology, 2) Validation, 3) Resources, 4) Writing-editing and reviewing; **Clay Rahaman:** 1) Formal Analysis, 2) Investigation, 3) Data Curation, 4) Writing-editing and reviewing; **Caleb Berta:** 1) Validation, 2) Investigation, 3) Data Curation, 4) Writing-editing and reviewing; **Joe Dekle:** 1) Validation, 2) Investigation, 3) Data Curation; **Henry Bonner:** 1) Validation, 2) Investigation, 3) Data Curation; **Jeffrey Krout:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing; **Eugene Brabston:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing; **Walter Smith:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing; **Thomas Evely:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing; **Amit Momaya:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing; **Aaron Casp:** 1) Resources, 2) Supervision, 3) Project administration, 4) Writing-editing and reviewing.

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Declaration of competing interest

The following authors have the stated interests, all others have none to disclose: **Eugene Brabston**: EBSCO-Editorial or Governing board, Link Orthopaedics-Paid consultant, Orthopaedic Design NA-Paid consultant; **Walter Smith**: Enovis: Paid Consultant. **Amit Momaya**: CONMED Corporation- Other Professional Activities, Arthroscopy-Editorial Board; **Aaron Casp**: American Orthopaedic Society for Sports Medicine-Board or committee member, Arthrex, Inc-Paid consultant.

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