Sociodemographic Factors Associated With Decreased Compliance to Prescribed Rehabilitation After Surgical Treatment of Knee Injuries in Pediatric Patients

Allan K. Metz,*[†] BS, Tami Hart-Johnson,[†] MS, R. Alexander Blackwood,[†‡] MD, PhD, and Eileen A. Crawford,*[§] MD

Investigation performed at Department of Orthopaedic Surgery, University of Michigan, Ann Arbor, Michigan, USA

Background: Rehabilitation is an important component of care in postsurgical knee patients, especially as it pertains to return to preinjury activity level. Despite the established significance of rehabilitation in improving outcomes after certain surgical procedures, there is a lack of investigation into compliance rates and factors that affect compliance in pediatric patients.

Purpose/Hypothesis: The purpose of this study was to evaluate sociodemographic factors associated with noncompliance in pediatric patients after knee surgery to characterize health disparities in this population. Our hypothesis was that certain sociodemographic factors would be associated with decreased compliance.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: A retrospective review of medical records was used to gather data on compliance rate, demographics, and socioeconomic factors for pediatric patients undergoing rehabilitation after knee surgery. Compliance rate was determined by counting the total scheduled appointments, cancellations, and no-shows (defined as visits for which patients did not show up and did not provide notification of cancellation). Various types of knee injuries were included in this study. Data were evaluated using bivariate analyses in addition to hierarchical linear and binary logistic regression to assess for associations between sociodemographic factors and compliance rate.

Results: Our total sample size was 186 patients. When compared with patients from non–single-parent households, patients from single-parent households were found to have a lower rate of physical therapy compliance (72.2% vs 80.1%; $P < .001$), were less likely to reach the 85% compliance threshold (9.1% vs 42.4%; $P < .001$), and had an increased amount of cancellations and no-shows (16.7 vs 11.7 visits; $P = .02$). Although a small sample size, Hispanic/Latino patients were shown to have a lower achievement of the 85% compliance threshold compared with non-Hispanic/Latino patients (0% vs 38.2%; $P = .04$). Increased distance from the rehabilitation clinic was associated with lower achievement of the 85% compliance threshold ($P = .033$).

Conclusion: Overall, there were several significant demographic and socioeconomic variables associated with rehabilitation compliance, specifically single-parent status, distance to rehabilitation clinic, and ethnicity. These results suggest potential predictors of decreased compliance that warrant prospective investigation.

Keywords: compliance; health disparities; knee injury; pediatrics; rehabilitation; sports medicine

Knee injuries are a common occurrence in pediatric orthopaedic care,[2,20] with surgical management of these injuries being a potentially stressful process for patients and their families. The incidence and severity of knee injuries in young athletes have been increasing in recent decades with the rise of intense, year-round athletic participation.[4,11,13,14,28] Many patients additionally express an interest to return to sporting activities after injury,[5,16,18,22] which can lead to a heightened risk of reinjury.[9,16] Compliance with rehabilitation is paramount in the care of these patients but can be difficult for patients to achieve because of a variety of factors, including pain associated with rehabilitation,[6] increased total length of rehabilitation periods in pediatric patients,[16] and concomitant injuries leading to more complex care.[22] Compliance to rehabilitation allows patients to improve their chances to return to normal knee functioning[8,12] and mitigates the risk of recurrent knee injuries,[16] while lack of compliance is associated with negative postsurgical outcomes.[8]

Despite the importance of rehabilitation compliance in helping patients recover, there is a lack of research in this pediatric population regarding compliance rates. Established research on rehabilitation compliance rates in adults for frozen shoulder syndrome[7] and osteoarthritis[27] highlights deficits in rehabilitation compliance, which likely can be extended to the pediatric population. Many factors may contribute to an individual's level of compliance with prescribed rehabilitation, including sociodemographic factors that make attending the visits challenging. If certain sociodemographic factors have a significant impact on rehabilitation compliance, they may be a source of health disparities of which providers are not currently aware.

The aim of this study was to investigate the association of sociodemographic factors with compliance to rehabilitation after surgical treatment of knee injuries in pediatric patients to evaluate potential predictors of noncompliance that create these disparities. We hoped to identify potential health disparities in this group that would inform future research and interventions centered on increasing compliance in this population and develop a set of predictors clinicians can refer to when evaluating a patient's risk for reduced compliance. Our hypothesis was that individuals with government insurance, an increased distance between residence and rehabilitation clinic, larger family size, and single-parent family status will have decreased rates of rehabilitation compliance. We also hypothesized that patients aged 16 years and older will have a higher compliance with rehabilitation.

METHODS

Data Collection

This study was a retrospective medical-record review conducted at The University of Michigan (Ann Arbor, MI). Owing to the retrospective nature of this study, which solely involved patient information available in the study institution's electronic health record (EHR), institutional review board exemption was granted. Patients who had undergone surgery for a knee injury from January 1, 2015, to December 31, 2018, and had rehabilitation within the health system on an outpatient basis through January 1, 2020, were reviewed for inclusion in this study. They were excluded if older than 18 years at the time of surgery or had a prior knee surgery. Injuries to the anterior and posterior cruciate ligaments, medial and lateral collateral ligaments, medial and lateral menisci, medial patellofemoral ligament, and tibial eminence were included in this study.

Information was gathered on study participants by using the EHR and Data Direct, a component of the institutional EHR that allows for deidentified data extraction. This allowed for acquisition of patient information such as appointments scheduled, reason for cancellation, compliance with scheduled appointments, and sociodemographic variables, including age, sex, race, ethnicity, religious affiliation, preferred language, injury type, family size, single-parent household, stability of residence during treatment, distance to rehabilitation location, and insurance type. Race was indicated with a categorical variable that included Black, Asian, White, and other for descriptive purposes, described in a similar fashion to Huang and Hanauer.[15] Ethnicity as provided on the EHR was defined as Hispanic/Latino and non-Hispanic/Latino. For multivariate analysis, non-Hispanic White versus all other (Black, Asian, or other) was used because of the small cell size for various racial groups. Religious affiliation and preferred language were categorized as either religiously affiliated or not religiously affiliated, and preferred language was defined as English or other.[15] Injury was categorized as 1 or a combination of the aforementioned injuries.

Family size and single-parent household status were determined by provider notes, with family size including all individuals reported living in the patient's residence. Stability of residence and distance to rehabilitation location were determined from patient-reported addresses. Distance from residence to rehabilitation site was calculated using Google Maps. When individuals reported more than 1 residence during rehabilitation, the average distance between the rehabilitation site and listed addresses was calculated and included in the analysis. If the patient listed a single residence during treatment, we considered it a stable residence; if 2 or more residences were listed during treatment, it was considered an unstable residence.[23] Insurance type was classified as government insurance (ie, Medicaid) or private insurance.[23]

Rehabilitation was defined as physical therapy undertaken in the postoperative period. Duration of rehabilitation varied based on the surgery performed and each patient's progress, but in general was expected to fall in the range of 12 to 78 visits (2 to 3 times per week for 6 weeks to 6 months). Compliance with prescribed rehabilitation was determined by recording the number of appointments scheduled and the outcomes of those appointments. Rehabilitation visits completed, visits canceled by the patient, and no-shows (defined as visits for which patients did not show up and did not provide notification of cancellation) were considered in the analysis. These 3 scenarios composed the total number of visits scheduled, and the compliance percentage was calculated from these values.

Canceled visits were defined as any appointment the patient or patient's family called to cancel. Visits canceled by the health care team were not considered. An

§Address correspondence to Eileen A. Crawford, MD, 4008 Ave Maria Drive, Lobby A Suite 1000, Ann Arbor, MI 48106, USA (ceileen@med.umich.edu).
*Department of Orthopaedic Surgery, University of Michigan, Ann Arbor, Michigan, USA.
†Office of Health Equity and Inclusion, University of Michigan, Ann Arbor, Michigan, USA.
‡Department of Pediatrics, University of Michigan, Ann Arbor, Michigan, USA.

TABLE 1
Study Population Descriptives and Visit Compliance Data
(N = 186 Participants)[a]

Variable	Total Value
Age, y	15.3 ± 2.0
Age ≥16 y	98 (52.7)
Sex, male	72 (39.2)
Language, American English	183 (98.4)
Race	
Non-Hispanic White	149 (80.1)
Black	26 (14.0)
Asian	4 (2.1)
Hispanic/Latino	7 (3.8)
Other	7 (3.8)
Religiously affiliated	112 (60.2)
Family size	3.7 ± 1.2
Single-parent family	33 (17.7)
Insurance type, government	34 (18.3)
Number of appointments scheduled	59.9 ± 32.7
Number of appointments attended	44.7 ± 25.2
Cancellations	9.8 ± 9.2
No-shows	2.6 ± 4.0
Compliance rate, %	78.9 ± 11.9
≥85% compliant	69 (37.1)

[a]Data are presented as n (%) or mean ± SD.

85% threshold was set for analysis of the data with hierarchical linear and binary logistic regression. As there is little research into rehabilitation compliance, especially in pediatric patients, this threshold was chosen by us to allow for regression analysis of the study patients. A study on compliance with physical therapy in patients with frozen shoulder demonstrated that even the control group who received no mobile phone reminders to complete their exercises achieved compliance of 85%. The intervention group had significantly higher compliance at 97% and had better range of motion at the completion of the study.[7]

Statistical Analysis

Analysis of variance (ANOVA) was used to evaluate the relationships between variables and compliance to rehabilitation percentage. Hierarchical linear regression was conducted with compliance to rehabilitation percentage and evaluated with a stepwise addition of independent variables to produce a 3-block model. Demographic variables such as age (years, continuous), sex (male = 1), and race (white = 0, other = 1) were included in the first block. The second block consisted of sociodemographic variables such as religious affiliation (religiously affiliated = 1), family size (number of individuals, continuous), and single-parent household (yes = 1). The third block included socioeconomic predictors of distance to rehabilitation (miles, continuous), stability of residence (unstable residence = 1), and insurance type (government insurance = 1).

Hierarchical binary logistic regression was conducted in a 3-block model to control confounding variables and identify predictors of noncompliance to rehabilitation for patients.
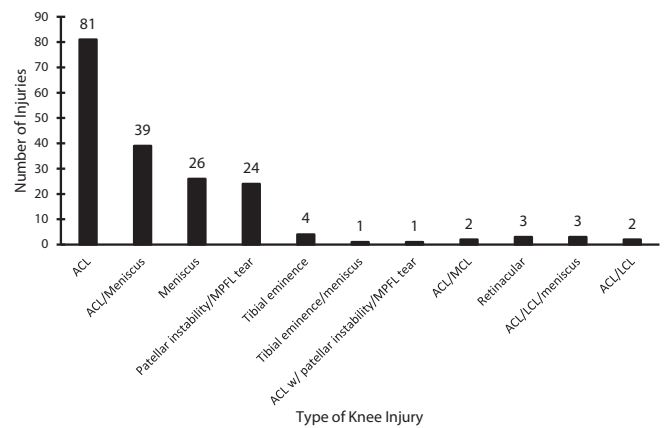

Figure 1. Distribution of injuries in study participants. Our study population showed a predominance of ACL and meniscus injuries, in addition to a significant amount of MPFL injuries. ACL, anterior cruciate ligament; LCL, lateral collateral ligament; MCL, medial collateral ligament; MPFL, medial patellofemoral ligament.

Rehabilitation compliance for this model was placed at 85% (≥85% = 1; <85% = 0). Variables were added in a stepwise fashion identical to the logistic regression for the 3 blocks (demographics, sociodemographics, and socioeconomic status). All analyses were carried out using the Statistical Package for Social Sciences 25 (SPSS Inc), with $P < .05$ as the threshold for significance.

RESULTS

Study Population Description

After the study selection process, 186 patients were included in the analysis, the demographic characteristics of which are presented in Table 1.

The study population was largely non-Hispanic White (80.1%) and American English–speaking (98.4%). Data regarding family size and dynamic are also listed in Table 1. Data on rehabilitation visits and compliance (Table 1) showed that patients were scheduled for 59.9 ± 32.7 appointments, attending an average of 44.7 ± 25.2 of those appointments. Patients canceled 9.8 ± 9.2 appointments on average, along with 2.6 ± 4.0 instances of no-shows during their rehabilitation period. The overall compliance rate was found to be 78.9% ± 11.9%, with 37.1% of the patient population achieving the 85% compliance threshold.

Anterior cruciate ligament (ACL) and meniscus injuries made up most of the injuries, with 67.7% having ACL involvement, 37.1% having meniscus involvement, and 22.5% having concomitant ACL and meniscus injuries. Overall injury frequencies are shown in Figure 1.

Analysis of Compliance Rate

ANOVA evaluation (Table 2) revealed significant findings regarding the total number of appointments scheduled

TABLE 2
Bivariate Analysis of Compliance to Visits[a]

Variable	Cancellations and No-shows	Cancellations	No-shows	Percentage Attended	Percentage With ≥85% Compliance
Age ≥16 y					
Yes (n = 98)	12.6 ± 10.6	10.0 ± 8.8	2.6 ± 3.6	78.8 ± 11.6	32.7 ± 47.1
No (n = 88)	12.4 ± 11.5	9.7 ± 9.7	2.6 ± 4.5	78.9 ± 12.5	42.5 ± 50.0
P	.88	.81	.96	.96	.19
Sex					
Female (n = 113)	13.0 ± 10.7	10.7 ± 9.8	2.2 ± 3.0	80.6 ± 10.7	39.1 ± 49.2
Male (n = 73)	11.8 ± 11.5	8.6 ± 8.3	3.2 ± 5.2	79.6 ± 13.2	36.4 ± 48.7
P	.47	.14	.10	.76	.23
NHW vs all other					
NHW (n = 147)	12.8 ± 11.1	10.4 ± 9.1	2.2 ± 3.9	78.9 ± 11.9	39.5 ± 49.0
All other (n = 39)	11.5 ± 10.8	7.6 ± 9.7	3.9 ± 4.3	78.4 ± 12.4	28.2 ± 45.6
P	.52	.09	**.03**	.78	.20
Ethnicity					
Non-Hispanic/Latino (n = 178)	12.3 ± 10.6	9.7 ± 8.8	2.6 ± 4.1	78.9 ± 12.0	38.2 ± 48.7
Hispanic/Latino (n = 7)	18.7 ± 18.1	16.3 ± 17.2	2.3 ± 2.6	74.5 ± 8.6	.0 ± .0
P	.13	.06	.84	.34	**.04**
Religiously affiliated					
Yes (n = 102)	12.5 ± 10.7	9.5 ± 8.8	2.8 ± 4.4	78.6 ± 12.0	34.3 ± 47.7
No (n = 74)	12.3 ± 11.7	10.0 ± 9.9	2.2 ± 3.6	79.2 ± 12.4	41.9 ± 49.7
P	.64	.58	.74	.63	.42
Single-parent residence					
Yes (n = 33)	16.7 ± 13.7	11.8 ± 9.8	4.9 ± 6.4	72.2 ± 12.2	9.1 ± 29.2
No (n = 151)	11.7 ± 10.1	9.5 ± 9.1	2.1 ± 3.1	80.1 ± 11.4	42.4 ± 49.6
P	**.02**	.213	**<.001**	**<.001**	**<.001**
Insurance type					
Private (n = 151)	13.2 ± 11.7	10.7 ± 9.9	2.4 ± 4.1	79.5 ± 11.9	40.4 ± 49.2
Government (n = 34)	9.5 ± 6.3	6.2 ± 4.5	3.3 ± 3.9	76.4 ± 12.1	23.5 ± 43.1
P	.08	**.01**	.262	.169	.07

[a]Data are presented as mean ± SD. Bold P values indicate statistically significant differences between variables (P < .05). NHW, non-Hispanic White.

and the instances of cancellations and no-shows. Participants with a single-parent family dynamic were less likely to achieve 85% compliance (P < .001), and they had a lower overall percentage of visits attended (P < .001). These patients also had significantly more cancellations and no-shows (P = .02), driven primarily by an increase in no-shows (P < .001). Hispanic/Latino patients were found to have a lower achievement of the 85% threshold than non-Hispanic/Latino patients (P = .04). Non-Hispanic White patients had less no-shows than their counterparts (P = .03).

Hierarchical binary logistic regression analyses also revealed significant findings in our study population (Table 3). These findings showed that patients with a single-parent dynamic had a lower achievement of the 85% adherence threshold.

Distance to Physical Therapy and Stability of Residence Analysis

Distance to physical therapy site and stability of residence were variables that were also evaluated in this study; however, owing to limitations with the EHR at our institution, we were unable to assess these variables

TABLE 3
Hierarchical Binary Logistic Regression: Predictors of Achieving 85% Adherence to Rehabilitation[a]

Variable	R^2	Odds Ratio	P	β (SE)
Block 1: demographics	.040	—	.153	—
Sex, male	—	1.446	.225	.369 (.324)
Race, all other	—	.550	.145	−.597 (.410)
Age ≥16 y	—	.679	.225	−.388 (.319)
Block 2: sociodemographics	.163	—	**<.001**	—
Religiously affiliated	—	.667	.206	−.405 (.320)
Family size	—	.844	.310	−.169 (.167)
Single-parent household	—	.109	**.001**	−2.216 (.674)
Block 3: socioeconomic status	.179	—	.121	—
Government insurance	—	.467	.130	−.761 (.503)
Final model	—	—	**<.001**	—
Sex, male	—	1.619	.164	.482 (.346)
Race, all other	—	.741	.498	−.300 (.442)
Age ≥16 y	—	.604	.146	−.504 (.347)
Religiously affiliated	—	.612	.135	−.491 (.329)
Family size	—	.862	.376	−.149 (.168)
Single-parent household	—	.113	**.001**	−2.181 (.681)
Government insurance	—	.467	.130	−.761 (.503)

[a]Bold P values indicate statistical significance (P < .05).

TABLE 4
Hierarchical Linear Regression: Predictors
of Rehabilitation Appointment Adherence[a]

Variable	R^2_Δ	F	β	P
Block 1: demographics	.008	.248	—	**<.001**
Sex, male	—	—	−.031	.766
Race, all other	—	—	.038	.720
Age ≥16 y	—	—	−.075	.474
Block 2: sociodemographics	.033	1.012	—	**<.001**
Religiously affiliated	—	—	−.160	.134
Single-parent residence	—	—	−.077	.496
Family size	—	—	−.060	.600
Block 3: socioeconomic status	.067	2.170	—	**<.001**
Distance to rehabilitation	—	—	−.225	**.033**
Unstable housing	—	—	−.121	.259
Government insurance	—	—	−.019	.862
Final model	—	—	—	**<.001**
Sex, male	—	—	−.019	.857
Race, all other	—	—	.078	.457
Age ≥16 y	—	—	−.069	.520
Religiously affiliated	—	—	−.152	.149
Single-parent residence	—	—	−.117	.303
Family size	—	—	−.104	.362
Distance to rehabilitation	—	—	−.225	**.033**
Unstable housing	—	—	−.121	.259
Government insurance	—	—	−.019	.862

[a]Bold P values indicate statistical significance ($P < .05$).

for each participant in our study population. Therefore, this analysis was conducted on a subset of our study sample, totaling 96 patients with demographic characteristics similar to the full study population. Our linear regression showed a significant association between percentage of rehabilitation attended and the distance to rehabilitation location when added in block 3 ($P = .03$), listed in Table 4.

DISCUSSION

Overall, our analysis revealed significant associations with several sociodemographic factors and compliance with prescribed rehabilitation for knee injuries in our study population. Single-parent families were found to have a lower achievement of the 85% compliance threshold, a lower overall compliance percentage with rehabilitation, and an increase in cancellations and no-shows. In addition, an increased distance between residence and rehabilitation clinic and individuals identifying as Hispanic/Latino were associated with lower achievement of the 85% compliance threshold. Notably, government insurance status, increased family size, and age 16 years and older were not associated with decreased compliance in our study group.

Some of the most striking findings in our analysis were regarding associations with single-parent family status, specifically the findings of decreased overall compliance and decreased attainment of our established compliance threshold. Prior studies have highlighted similar results with decreased compliance to prescribed treatment of patients with this family dynamic, such as higher rates of rescheduling and missing clinic appointments in an asthma clinical trial[26] and noncompliance to pharmacological therapy in transplant patients.[17,25] Although these studies were not focused on rehabilitation, they do suggest difficulties with single-parent families in complying with health care appointments, potentially from difficulties associated with single parents needing to coordinate conflicting responsibilities between themselves and their children. As single-parent status was associated with decreased compliance in our study population in a similar way to increased distance from rehabilitation site, we believe this may be a potential intervention opportunity for nurse navigators and social workers to help increase compliance. Although further investigation is needed into the exact cause of decreased compliance in these patients, transportation programs, expanded hours of rehabilitation sites, and increased proximity to facilities may help mitigate lack of compliance. If follow-up and rehabilitation visits occur in or near the same facilities, consolidating these visits into the same day may also help increase patient compliance in both these areas.

Linear regression analyses showed that increased distance from rehabilitation location coincided with decreased overall compliance rate with physical therapy, although it should be acknowledged that this analysis was not conducted on the full study population. Other studies have demonstrated similar findings of the inverse relationship between distance and compliance, including a decrease in return visits to a stroke clinical trial[21] and a decrease in adherence to rehabilitation following distal radius surgery.[14] Although these studies were not solely focused on rehabilitation, they highlight the burden that increased distance from medical facilities to patients' residence places on compliance rates in multiple aspects of health care. Although this finding was not necessarily surprising, it underscores the importance of establishing open communication with patients to locate a rehabilitation facility that best suits their needs, even if that facility is outside of the clinician's health system or practice. It is unclear whether this finding was exclusively secondary to the increase in distance, or if there was a component of lack of consistent transportation that may also have contributed to this finding. Transportation assistance programs for patients would likely be useful in this population, regardless of whether the driving factor is distance or a lack of transportation. This may be another opportunity for nurse navigators and social workers to assist on a patient-by-patient basis in clinic.

Regarding the potential issue of transportation, it is worth noting that patients 16 years and older did not have an increased or decreased rate of rehabilitation compliance compared with those younger than 16 years in the bivariate analysis. It was initially expected that the first group would have a higher rate of compliance, as 16 years is the age at which residents of Michigan can drive without supervision. The lack of difference may be a result of parents still playing an active role in their children's health care, a lack of vehicles in the home, or simply a lack of having a driver's

license, as this variable was not explicitly examined in this study. Knee injuries may also have limited the driving ability of some of the study participants.

Family size was also not found to have a significant association with compliance to rehabilitation. Larger family size was expected to have a negative impact on compliance owing to competing interests of multiple family members, specifically in situations where families have multiple pediatric-aged members. One theoretical explanation is that that these families instead are composed of more adult-aged individuals, rather than younger individuals. This may have helped patients attend their rehabilitation appointments by having more family members capable of assisting patients in attending these appointments, offsetting any negative effect of larger family size. A study evaluating the effects of family cohesiveness found that more cohesive families had increased patient compliance to medical treatment.[10] Although large families are not necessarily cohesive, families with multiple older adolescent or adult members who can support a child's compliance may help maintain good compliance, just as single-parent households struggle more with maintaining compliance.

Participants of Hispanic/Latino ethnicity were found to have a lower achievement of the 85% compliance threshold. While this finding was statistically significant, it is worth taking into consideration the small sample size of this population and potential lack of generalizability to larger populations, given this small sample size in our study population.

Individuals with government insurance were initially hypothesized to have a decreased compliance with rehabilitation. This variable was initially selected to be representative of socioeconomic status because of a lack of ability to acquire financial information on study patients; however, this observed lack of effect may be representative of all members of the study population having insurance coverage. Although having insurance coverage was not part of the inclusion criteria for our study, all members of our study had insurance coverage. It is possible a more appropriate evaluation of this variable in future studies would be to examine the relationship with rehabilitation compliance and lack of insurance coverage, or the relationship between rehabilitation compliance and co-pay amounts for rehabilitation visits.

Only 37.1% of our study population reached the 85% threshold established for analysis, which is a lower achievement level than we anticipated. We believe this underscores the difficulty that patients have with compliance to rehabilitation and raises the need for further characterization of patient needs in terms of support to increase compliance to rehabilitation. In a perfect scenario, patients would have 100% compliance with their rehabilitation and other health care appointments to maximize positive outcomes and reduce health care waste, but this is obviously not a realistic expectation of patients. The 85% compliance threshold was agreed to reflect the importance of rehabilitation compliance, especially as it concerns return to sport in the pediatric population, in addition to allowing for regression analysis of our results. The lack of consistent achievement of this threshold across the study population

suggests the need for further characterization and potential intervention to increase compliance rates with rehabilitation.

Overall, significant associations between reduced rehabilitation compliance and patient-specific sociodemographic and economic factors were identified, including single-parent status, distance to rehabilitation site, and ethnicity. Our study provides insight into health disparities in this population and potential predictors that can be utilized to assess a patient's risk for reduced compliance, also prompting the need for further research and characterization of this population to determine how best to intervene to increase compliance with rehabilitation. These patient factors should be taken into consideration when establishing rehabilitation regimens with patients to ensure adequate support and patient resources to promote rehabilitation compliance, as this is important in improving surgical outcomes. Identification of these potential predictors in patients can prompt and inform conversations between providers and patients concerning the importance of rehabilitation compliance and can direct patients toward available resources when appropriate. Future investigation should focus on confirming the causes of the identified discrepancies in rehabilitation compliance, then developing methods to decrease these disparities across the patient population. Prior studies in other patient populations have found that patient motivation can increase rehabilitation compliance,[6] with preoperative educational classes[19] and reminder[1,3,7,24] services displaying similar effects of increasing compliance in various clinical settings.

Limitations

In addition to biases resulting from retrospectively reviewing electronic medical records, there are other limitations of this study that warrant consideration. First, data were collected from a single health system in the midwestern United States and may not be generalizable to other locations. The average distance calculated from all residences to the rehabilitation site may not accurately represent the average distance being driven to rehabilitation appointments by patients during treatment, as it was unclear when residence changes occurred during patients' care. We were also unable to collect information on household stability and distance to physical therapy site on all patients because of limitations with our institution's EHR. Our study population was also a largely White, non-Hispanic/Latino group of patients, highlighting the need for further evaluation to fully understand potential racial and ethnic disparities in care. A larger sample size is warranted to further characterize the trends found in this study and produce results that are more generalizable to larger populations. In addition, despite our identified associations, we are unable to assess the root cause of decreased rehabilitation compliance. Future studies should include a prospective survey evaluation to help identify patient-identified barriers of decreased compliance.

CONCLUSION

Overall, our study was able to identify various associations between demographic and socioeconomic variables and decreased rehabilitation compliance. Individuals from single-parent families, an increased distance between residence and rehabilitation clinic, and individuals of Hispanic/Latino ethnicity were associated with decreased rehabilitation compliance. No significant association was found between decreased rehabilitation compliance and government insurance, increased family size, or age 16 years or older. Future studies should be prospective in nature and seek to identify patient-reported barriers to compliance.

REFERENCES

1. Abaza H, Marschollek M. SMS education for the promotion of diabetes self-management in low & middle income countries: a pilot randomized controlled trial in Egypt. *BMC Public Health*. 2017;17(1):962.
2. Adirim T, Cheng T. Overview of injuries in the young athlete. *Sports Med*. 2003;33(1):75-81.
3. Arora S, Peters AL, Agy C, Menchine M. A mobile health intervention for inner city patients with poorly controlled diabetes: proof-of-concept of the TExT-MED program. *Diabetes Technol Ther*. 2012;14(6):492-496.
4. Bates NA, McPherson AL, Rao MB, Myer GD, Hewett TE. Characteristics of inpatient anterior cruciate ligament reconstructions and concomitant injuries. *Knee Surg Sports Traumatol Arthrosc*. 2016;24(9):2778-2786.
5. Brelin AM, Rue JP. Return to play following meniscus surgery. *Clin Sports Med*. 2016;35(4):669-678.
6. Chan DK, Lonsdale C, Ho PY, Yung PS, Chan KM. Patient motivation and adherence to postsurgery rehabilitation exercise recommendations: the influence of physiotherapists' autonomy-supportive behaviors. *Arch Phys Med Rehabil*. 2009;90(12):1977-1982.
7. Chen HC, Chuang TY, Lin PC, Lin YK, Chuang YH. Effects of messages delivered by mobile phone on increasing compliance with shoulder exercises among patients with a frozen shoulder. *J Nurs Scholarsh*. 2017;49(4):429-437.
8. DeFrancesco CJ, Storey EP, Shea KG, Kocher MS, Ganley TJ. Challenges in the management of anterior cruciate ligament ruptures in skeletally immature patients. *J Am Acad Orthop Surg*. 2018;26(3):e50-e61.
9. Dekker TJ, Godin JA, Dale KM, Garrett WE, Taylor DC, Riboh JC. Return to sport after pediatric anterior cruciate ligament reconstruction and its effect on subsequent anterior cruciate ligament injury. *J Bone Joint Surg Am*. 2017;99(11):897-904.
10. DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. *Health Psychol*. 2004;23(2):207-218.
11. Finlayson C. Knee injuries in the young athlete. *Pediatr Ann*. 2014;43(12): e282-e290.
12. Han F, Banerjee A, Shen L, Krishna L. Increased compliance with supervised rehabilitation improves functional outcome and return to sport after anterior cruciate ligament reconstruction in recreational athletes. *Orthop J Sports Med*. 2015;3(12):2325967115620770.
13. Herzog MM, Marshall SW, Lund JL, Pate V, Mack CD, Spang JT. Trends in incidence of ACL reconstruction and concomitant procedures among commercially insured individuals in the United States, 2002-2014. *Sports Health*. 2018;10(6):523-531.
14. Hickey S, Rodgers J, Wollstein R. Barriers to adherence with postoperative hand therapy following surgery for fracture of the distal radius. *J Hand Microsurg*. 2015;7(1):55-60.
15. Huang Y-L, Hanauer DA. Time dependent patient no-show predictive modelling development. *Int J Health Care Qual Assur*. 2016;29(4):475-488.
16. Kay J, Memon M, Marx RG, Peterson D, Simunovic N, Ayeni OR. Over 90% of children and adolescents return to sport after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc*. 2018;26(4):1019-1036.
17. Killian MO, Schuman DL, Mayersohn GS, Triplett KN. Psychosocial predictors of medication non-adherence in pediatric organ transplantation: a systematic review. *Pediatr Transplant*. 2018;22(4):e13188.
18. Kim C, Chasse PM, Taylor DC. Return to play after medial collateral ligament injury. *Clin Sports Med*. 2016;35(4):679-696.
19. Kim K, Chin G, Moore T, Schwarzkopf R. Does a preoperative educational class increase patient compliance. *Geriatr Orthop Surg Rehabil*. 2015;6(3):153-156.
20. Kraus T, Svehlik M, Singer G, Schalamon J, Zwick E, Linhart W. The epidemiology of knee injuries in children and adolescents. *Arch Orthop Trauma Surg*. 2012;132(6):773-779.
21. Leira EC, Viscoli CM, Polgreen LA, Gorman M, Kernan WN, on behalf of the ITI. Distance from home to research center: a barrier to in-person visits but not treatment adherence in a stroke trial. *Neuroepidemiology*. 2018;50(3-4):137-143.
22. Logan CA, O'Brien LT, LaPrade RF. Post operative rehabilitation of grade III medial collateral ligament injuries- evidence based rehabilitation and return to play. *Int J Sports Phys Ther*. 2016;11(7):1177-1190.
23. Lynn JV, Ranganathan K, Bageris MH, Hart-Johnson T, Buchman SR, Blackwood RA. Sociodemographic predictors of missed appointments among patients with cleft lip and palate. *Cleft Palate Craniofac J*. 2018;55(10):1440-1446.
24. Schweier R, Romppel M, Richter C, Grande G. Dissemination strategies and adherence predictors for web-based interventions-how efficient are patient education sessions and email reminders? *Health Educ Res*. 2016;31(3):384-394.
25. Shemesh E, Duncan S, Anand R, et al. Trajectory of adherence behavior in pediatric and adolescent liver transplant recipients: the medication adherence in children who had a liver transplant cohort. *Liver Transpl*. 2018;24(1):80-88.
26. Spicher M, Bollers N, Chinn T, et al. Adherence in single-parent households in a long-term asthma clinical trial. *Pediatr Nurs*. 2012;38(4):207-238.
27. Tuakli-Wosornu YA, Selzer F, Losina E, Katz JN. Predictors of exercise adherence in patients with meniscal tear and osteoarthritis. *Arch Phys Med Rehabil*. 2016;97(11):1945-1952.
28. Werner BC, Yang S, Looney AM, Gwathmey FW Jr. Trends in pediatric and adolescent anterior cruciate ligament injury and reconstruction. *J Pediatr Orthop*. 2016;36:447-452.