Instability Burden Across Joints: A Patient-Reported Outcomes Measurement Information System (PROMIS)-Based Comparison of Hip Dysplasia, Knee, and Shoulder Instability

Hail Turki Alharthi

Assistant professor, hip and knee arthroplasty, Orthopedic surgery and Sport Medicine Department, College of medicine, Taif University, Saudia Arabia.

hailturki394@gmail.com

Abstract

Purpose: The burden of joint instability on the patient's general health has been well recognized in the shoulder and knee but not as much in the hip. This study compares patients who have undergone corrective surgery for instability of the hip knee, and shoulder to better understand their relative impact on quality of life.

Methods: 230 instability correction procedures performed between 1-Jun-2018 and 31-Jan-2023 were included in the analysis: 62 dysplastic hips [Mean Age 31(16-47), BMI 25(18-33), ASA 2.0 (1-3) and 7 Males (11%)], 112 knees with ligamentous injuries [Mean Age 34(18-61), BMI 27(16-48), ASA 1.6(1-3) and 62 Males (55%)], and 56 unstable shoulders [Mean Age 38(18-67), BMI 27(20-37), ASA 2.0(1-3) and 39 Males (70%)]. Intra-operative surgical details including, arthroscopic treatment, as well as labral, cartilage, and bone corrections, were collected. Pre-operative and 1-year post-operative Physical and Mental PROMIS patient-reported outcome measures were also compiled.

Results: In the hip group surgeries were: periacetabular osteotomy (PAO) (71%), PAO with scope (23%), and Arthroscopy alone (6%); in the shoulder group: 61% of patients received a scope, and 39% received open surgery; in the knee group: 85% of patients received ACL surgery alone while 15 received both ACL and Meniscus treatment. All patients improved their functional score with hip instability having the worst physical outcomes pre- and postoperatively. Mean Pre-operative Physical Health PROMIS score was [Hip 40.1 (SD 6.9); Knee 48.3 (SD 7.7); Shoulder 46.6 (SD

8.0)] and 12 months post-operative was [Hip 45.2 (SD 7.6); Knee 50.4 (SD 6.2); Shoulder 48.8 (SD 7.7)].

Conclusion: Joint instability carries a significant burden on patients' both physical and mental quality of life. More importantly, instability from a bony deformity i.e. hip dysplasia is as impactful as soft tissue/ligamentous instability of the shoulder and knee. This analysis adds validity to instability as the leading pathomechanism of hip dysplasia.

Keywords: Hip, Knee, Shoulder, Instability, Dysplasia, Physical Function, Patient-Reported Outcomes Measurement.

1. Introduction

In general, hip instability is defined as an uncontrolled, non-physiological motion of the hip that results in pain with or without symptoms of hip joint unsteadiness [1]. Hip instability can cause pain and disability in many young people, especially athletes. Hip instability in adolescents and young adults is a health problem and disease caused by several factors including femoral torsion, bony coverage of the acetabulum, in addition to hip instability due to acetabulum-femoral collision and soft tissue laxity [2-4]. One of the most important factors that lead to hip instability is developmental dysplasia of the hip (DDH) [2]. DDH occurs when the acetabular coverage is generally incomplete from the superior and anterior sides, which results in the acetabulum deviating more than normal and a decrease in the lateral center edge angle (LCEA) [2].

Hip dysplasia, which results in capsular laxity and asymmetry between the femoral head and a no hemispherical or shallow acetabulum, is a common cause of non-arthritic hip discomfort in adolescents and young adults. These conditions induce relative increases in joint contact forces with a decrease in weight-bearing surface area [5,6]. DDH, in particular, is one of the several etiologic factors contributing to the diagnosis of hip instability. The incidence of DDH is relatively low based on universal screening; in the first two postnatal weeks, ultrasonography indications of DDH are seen in about 0.24% of newborns [7].

The stability of the knee joint (tri-compartmental complex), which consists of the menisci and condyles with supporting structures, depends on the support of four main ligaments the lateral collateral ligament (LCL), the medial collateral ligament (MCL), the posterior cruciate ligament (PCL), and the anterior cruciate ligament (ACL) [8,9]. In addition, the soft tissue structures (meniscus, ligaments, and muscles) support the femur, static forces, and tibia [9]. Thus, knee

instability results from an injury to one of the ligaments of the knee joint due to direct or indirect trauma such as twisting, cutting, sudden deceleration, and jumping [8]. Damage to the soft tissue structures of the knee joint as a result of a chronic or acute injury leads to laxity or what is known as knee dysplasia, which commonly appears in adolescence [10,11]. Furthermore, knee instability or dysplasia leads to knee pain that may be accompanied by imbalance, as well as degenerative changes in osteoarthritis, cartilage of the knee joint, and generalized knee weakness [12,13].

Shoulder instability is caused due to abnormal movements of the joint as a result of damage to the dynamic stabilizer [14]. It is also caused by a range of disorders overlapping that may lead to complete dislocation of the shoulder joint and may progress to uncontrolled and excessive movement of the humeral head [15]. Shoulder instability can lead to shoulder laxity and is the result of excessive shoulder joint movement, shoulder instability is also accompanied by symptoms including pain, paresthesia, discomfort, fatigue, and anxiety [15]. Shoulder instability is most prevalent in adolescents, especially young males over the age of 16 year and also females over the age of 70 year [14].

Pain resulting from joint instability, including the hip, knee and shoulder, greatly affects patients' daily activities, causing them to suffer in social relationships, work or entertainment, and consequently affecting their quality of life (QOL) [16-19]. Therefore, it was necessary to determine the impact of hip, knee and shoulder instability on QOL before and after surgery and the necessary treatments. The Patient-Reported Outcomes Measurement Information System (PROMIS) is a tool developed by the National Institutes of Health to assess several health domains including well-being and function in the physical, mental, and social health domains, as well as the severity and interference of pain and fatigue [20,21]. PROMIS has been used for brief and accurate assessment and comparison across multiple conditions or population groups, as well as for screening of disability and rehabilitation, and to facilitate communication between patients and physicians [22]. Many studies have demonstrated the efficacy and effectiveness of PROMIS as an indicator for reporting patient outcomes related to different orthopedic surgery procedures [23-25]. Furthermore, the impact of joint instability on QOL has been relatively well documented using the most widely used and proven joint-specific scales PROMIS. In addition, joint instability affects the general health of individuals and QOL, which can also be measured through PROMIS. This measure assesses not only physical distress but also mental, social, and emotional distress [26].This is of great importance since clinical indicators such as laboratory tests and X-rays may

not be very relevant to how individuals with chronic diseases live their daily lives. The burden of joint instability on overall patient health has been well recognized in the shoulder and knee but not to the same extent in the hip. Therefore, the purpose of our current study was to investigate and comparative among patients who underwent corrective surgery for hip, knee, and shoulder instability to better understand their relative impact on QOL.

2. Materials and Methods

2.1 Study Design and Participants

Inclusion criteria for this study included patients diagnosed with shoulder instability, knee dysplasia, and hip dysplasia from 1 February 2023 to 30 September 2023. There was a total of 512 shoulder, knee, and hip corrections performed. Patients who completed a minimum of 1-year post-operative follow-up were included in the analysis; 62 dysplastic hips, 112 knees with ligamentous injuries, and 56 unstable shoulders (Table 1). The ages of the participating patients ranged from 16 to 67 years.

Table 1: PROMIS scores retrieve during retrospective chart review.

	Shoulder Instability		Knee Ligament		Hip Dysplasia		Total
	(n)	%	(n)	%	(n)	%	(n)
Pre-op	143	100	283	100	86	100	512
3-months	62	43	119	42	59	69	240
>1 year	56	39	112	40	63	73	231

Inclusion criteria for this study included patients diagnosed with shoulder instability, knee dysplasia, and hip dysplasia from 1 February 2023 to 30 September 2023, while exclusion criteria included patients lost to follow-up. Finally, the study objectives were explained to the participating patients by the principal investigator and their informed consent to participate was obtained. Approval for the application of this study protocol was obtained from the hospital's ethics committee. This study is designed as a retrospective review of stability correction procedures using an orthopedic research database from our local institution between 1 June 2018 and 31 January 2023. Patients diagnosed with shoulder instability, knee ligament injuries, and hip dysplasia within this period are included. Only patients who complete a minimum of 1-year postoperative follow-up are considered for final analysis. Patients lost to follow-up are excluded. Ethical approval is obtained from the hospital ethics committee, and all patient data are handled according to institutional privacy and confidentiality guidelines.

2.2 Privacy and Confidentiality

All personal health information will be treated confidentially concerning its collection, use, and disclosure. Participant names or potentially identifying personal health information will not leave the institution. A master list that links participant identifiers to their unique participant number will be maintained and stored separately from all other study records according to local institutional policies. Patient-specific identifiers will be recorded on the study master list only and will not be incorporated into the final data set. To enable regulatory audits, the Lead Qualified Investigator will have the responsibility to retain study-related documents according to regulations. All study records will be kept for 10 years minimum. After 10 years, records will be destroyed under local institutional policies.

2.3 Study Instruments and Procedures

Patients participating in this study were evaluated through the data and information obtained from patient records charts and instruments on which the study relied. Data and clinical and general information were collected by the first questionnaire which includes questions related to data on the important and basic sociodemographic characteristics and surgery details of the participants (gender, age, marital status, body mass index (BMI), American Society of Anesthesiologist (ASA), date of the surgery, side of surgery, and cartilage damage). Also, intra-operative surgical details including, arthroscopic treatment, as well as labral, cartilage, and bone corrections, were collected. Intra-operative surgical details collected included: Arthroscopic treatment, labral, cartilage, and bone corrections, were collected. The comparison between surgical conditions and QOL for patients was measured by the second questionnaire PROMIS Global scale, which was developed and tested for its validity and reliability and its implementation of the reports preparation system for collecting and measuring important clinical results [27]. PROMIS's questionnaire consists of 10 items for five basic domains (physical function, pain, fatigue, emotional distress, and social health) [27,28]. Each question in this questionnaire contains a scale of a component of five points which ranges from 1 (poor) to 5 (excellent) [24]. PROMIS questionnaire is easy to use in the clinical environment, as it does not take a long time to complete it only from 2 to 5 minutes. Pre-operative and 1-year post-operative physical and mental PROMIS measures were compiled.

2.4 Statistical Data Analysis

All statistical analyses, tests, data entry, and coding were performed using SPSS version 24 (IBM, USA). Scoidemographic characteristics data were analyzed using descriptive statistics and variables were reported by frequency and percentage. Continuous study sample variables were reported by means and standard deviations (SD). Quantitative data will be summarized using mean and standard deviation or median with IQR according to the shape of the distribution. Patient QOL domain data were obtained from PROMIS Global instruments and principal components analysis was performed statistically.

3. Results

In our current study, 230 patients who underwent instability correction procedures hip, knee, and shoulder were included, 47% were male and 53% were female. From Table 1, the analysis results showed that 62 patients had hip dysplasia (7 males (11%) and the rest were females, with mean age 31 (16-47), BMI 25 (18-33), ASA 2.0 (1-3), and 24% had cartilage damage). Also, among the participants, 112 patients had knee ligament injuries (62 males (55%) and the rest were females, mean age 34 (18-61), BMI 27 (16-48), ASA 1.6 (1-3), and 38% had cartilage damage). While 56 patients had unstable shoulders (39 males (70%) and the rest females, mean age 38 (18-67), BMI 27 (20-37), ASA 2.0 (1-3), and 66% had cartilage damage) as shown in Table 2.

Table 2: Demographic data reporting patients' BMI, ASA status and their average age at the time of surgery.

	Knee (n=112)	Hip (n=62)	Shoulder (n=56)
Female n (%)	50 (45%)	55 (89%)	17 (30%)
Male n (%)	62 (55%)	7 (11%)	39 (70%)
Mean BMI ± SD (kg/m^2)	27 ± 5.5	25 ± 4.0	27 ± 4.4
Mean ASA ± SD	1.6 ± 0.6	2 ± 0.6	2 ± 0.7
Mean Age ± SD	34 ± 10.5	31 ± 8.2	38 ± 13.3

SD=Standard deviation, ASA=American Society of Anesthesiologists, BMI=Body mass index (BMI) k/m^2

Results regarding the details of surgical procedures that participants underwent showed that they underwent a variety of surgical procedures. The hip patients underwent the following surgical procedures: (71%) underwent PAO, (23%) PAO with arthroscopy, (6%) arthroscopy alone, (5%) debridement, (6%) labral repair, and (10%) debridement with repair (Table 3). Of the

shoulder patients, (61%) received arthroscopy surgery, (39%) received open surgery. Regarding the knee patients who underwent other surgical procedures, which are (94%) all ACL surgery, (85%) underwent ACL surgery alone, and (15%) received both ACL and meniscus treatment (Table 3).

Table 3: Surgical procedure performed to correct hip dysplasia, knee and shoulder instability.

Hip (n=62)		**Shoulder (n=56)**		**Knee (n=112)**	
PAO Alone	44 (71%)	Arthroscopy	34 (61%)	All ACL	105 (94%)
Arthroscopy Alone	4 (6%)	Open Surgery with Latarjet	6 (11%)	ACL + Meniscus	17 (15%)
PAO + Arthroscopy	14 (23%)	Open without Latarjet	7 (13%)	ACL Alone	95 (85%)
Debridement	3 (5%)	Debridement	9 (16%)		
Labral Repair	4 (6%)	Labral Repair	8 (14%)		
Debridement + Repair	6 (10%)				

PAO=Periacetabular Osteotomy, ACL= Anterior Cruciate Ligament

Cartilage damage was found in 13 Hip patients (21%), 41 of Knee patients (37%), and 34 of shoulder patients (61%) (Figure 1).

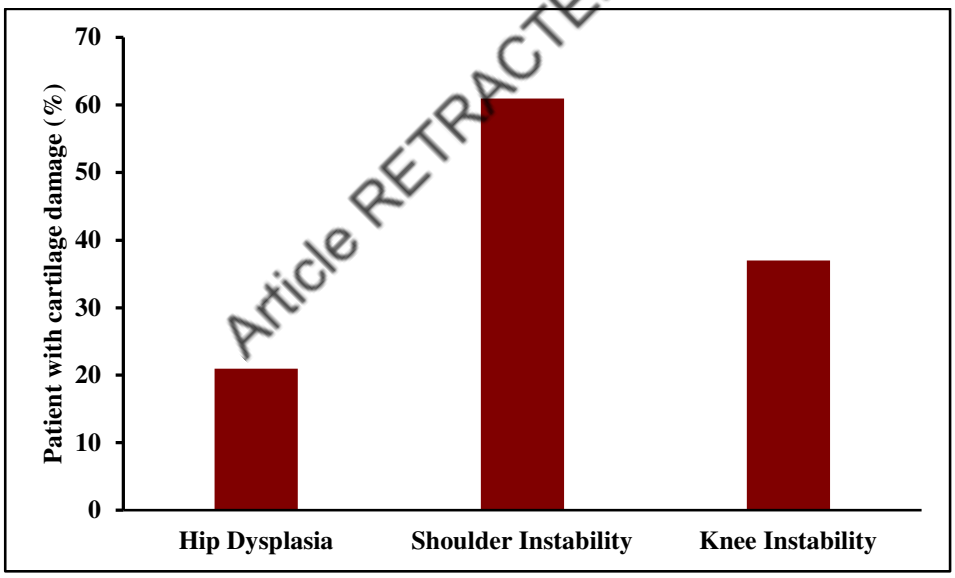

Figure 1: Percentage of cartilage damage found in Hip, Shoulder, and Knee Instability.

The results showed that all patients exhibited improvements in their PROMIS Global score and mental and physical score, with knee and shoulder instability patients improving more than hip

instability patients who showed worse physical outcomes before and after surgery. Overall, the mean pre-operative Physical Health PROMIS scores were (Hip 40.1 (SD 6.9); Knee 48.3 (SD 7.7); Shoulder 46.6 (SD 8.0)) and 12 months post-operative Physical Health PROMIS scores were (Hip 45.2 (SD 7.6); Knee 50.4 (SD 6.2); Shoulder 48.8 (SD 7.7)) as shown in Table 4.

Table 4: Pre-operative and 1-year Post-operative PROMIS Global, Mental and Physical score.

	Hip (n=62)	**Shoulder (n=56)**	**Knee (n=112)**
Pre-Op Global Score (SD)	30 (6.7)	37 (7.0)	37.8 (6.1)
Post-Op Global Score (SD)	33.2 (6.8)	37 (6.7)	38.7 (6.5)
Pre-Op Mental (SD)	38.8 (8.5)	48.1 (10.3)	48.3 (7.7)
Post-Op Mental (SD)	41.6 (9.3)	47.5 (10.0)	51.2 (6.8)
Pre-Op Physical (SD)	40.1 (6.9)	46.6 (8.0)	48.6 (8.9)
Post-Op Physical (SD)	45.3 (7.6)	48.8 (7.7)	48.6 (9.5)

SD=Standard deviation, OP= Operative

The result of comparing pre-operative and post-operative Physical Health PROMIS scores found in Hip, Shoulder, and Knee Instability were shown in Figure 2.

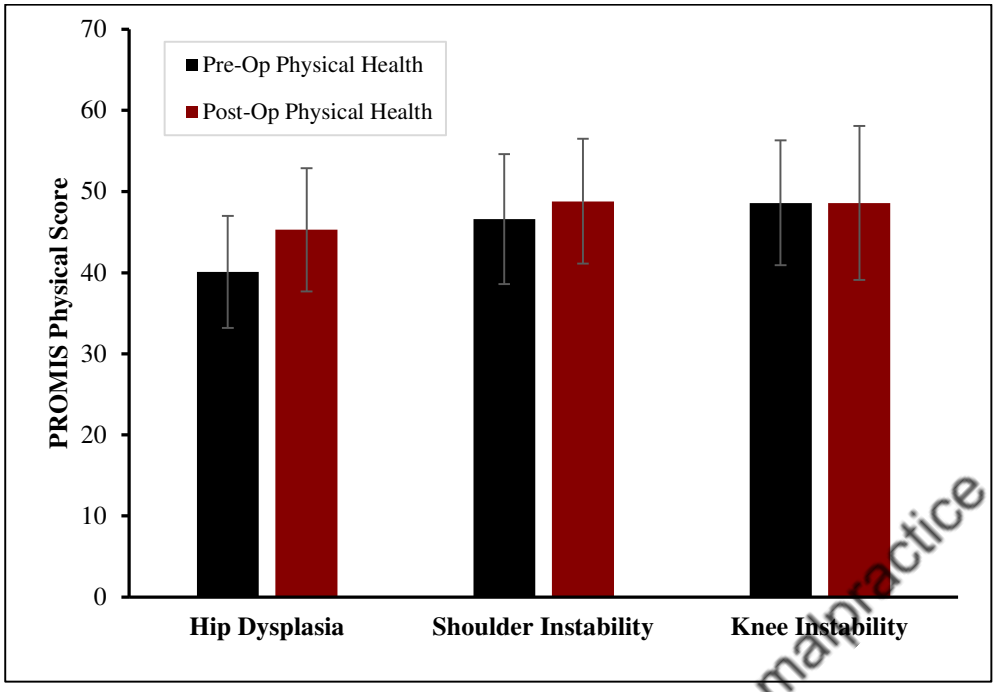

Figure 2: Comparing pre-operative and post-operative Physical Health PROMIS scores found in Hip, Shoulder, and Knee Instability.

Limitation

A limitation of this study is the comparison of different pathologies, including hip dysplasia, knee ligament injuries, and shoulder instability, which involve different surgical procedures, recovery periods, and clinical outcomes. These differences may influence PROMIS scores and create potential bias when directly comparing patient-reported outcomes between groups. Another limitation is the retrospective study design, which depends on previously recorded clinical data and may be affected by incomplete documentation or missing follow-up information. This may influence the accuracy of PROMIS score comparisons and the overall interpretation of postoperative patient outcomes.

4. Discussion

In the current study, we found that there was a clear difference between the three patient groups, as the results showed that most of the hip dysplasia patients were female and younger than the knee and shoulder instability groups. Although the patients were from Canada and lived in a good standard of living and health care. This result may be explained by the fact that female patients are more likely to have arthritis, which can lead to many joint instability problems, and also be the result of several environmental, genetic, and mechanical factors [2,29]. In addition, results of the

ASA classification tool, which assesses the health status of patients before and after surgery, indicated that patients with hip dysplasia and shoulder instability had higher mean ASA scores than patients with knee ligament injuries. The mean ASA score was less than 3 for the three groups, indicating that patients had improved postoperative health status and QOL and complications and risks were less [30].

Regarding the details of surgical procedures for patients, there was variation, which is normal since our study included three groups with three types of joint instability. To evaluate the burden of disease using PROMIS on the health, physical status, and QOL of patients, it must be noted that different surgical procedures between groups may directly affect the results. Accordingly, several studies have reported that different surgical procedures for joint instability have an impact on the health of patients after surgery [31,32]. In our study, we implemented the PROMIS scale, which has demonstrated reliability and acceptability in surgical fields. It was used to obtain information on assessing health status and physical function in patients. This scale has been widely used for comparison between groups and to determine burden in patient populations with hip and knee conditions, meniscal repair, and ACL reconstruction [24,33].

The results related to the participant's responses to the PROMIS questionnaire revealed that the total mean scores of Physical Health PROMIS scores for the three groups before and after surgery were less than 60. Also, the total mean score for the hip dysplasia group before and after surgery was lower compared to the total mean score for the knee ligament and shoulder instability. These results indicate that the participating patients reported a significant improvement in their physical performance and function as well as their QOL after a period of three months to two years. In addition, there were differences between groups in physical, mental health, and Physical Health PROMIS, possibly because patients with hip dysplasia report different symptoms before and after surgery than those with knee or shoulder instability as shown in Table 4 and Figure 2. These results regarding the comparison of patients' responses to assess the burden of disease between groups are consistent with many previous studies that have confirmed the possibility of using PROMIS to compare groups in terms of determining the impact of disease on physical performance and health in general [34-37]. Furthermore, these results indicate the effectiveness and success of the PROMIS Global scale in assessing the physical and mental health of patients. This result is consistent with the results of a study conducted by Morgan et al., which confirmed the existence of high correlations between PROMIS and a range of joint diseases, including

shoulder and hand instability, and that the PROMIS scale r esponds to any changes or declines in physical function that affects patients' QOL [38]. The higher prevalence of hip dysplasia among female patients should be explained using stronger clinical evidence rather than assumptions related to arthritis alone. Relevant literature on anatomical, hormonal, and genetic factors should be included to avoid interpretive bias. Different surgical procedures across hip dysplasia, knee ligament injuries, and shoulder instability may directly influence PROMIS outcomes. This variation should be clearly acknowledged as a methodological limitation because postoperative recovery and patient-reported outcomes differ according to procedure type.

Finally, the results of our study emphasize the importance of using the PROMIS Global system to obtain information from orthopedic patients, as it can be easily used to determine the burden of disease on the health and physical status of patients. This may help physicians monitor the health status of patients with joint instability after surgery and also assess the improvement in physical function, QOL, and changes related to surgical interventions that occur over time. Furthermore, by comparing the results of three participating groups, we were able to find significant improvements in physical function, health status, and quality of life. This may be a result of the great attention and follow-up that patients with hip, knee, and shoulder instability receive from their supervising physicians even after two years of follow-up. The discussion should emphasize that PROMIS is useful for comparing patient-reported health outcomes, but interpretation must consider differences in pathology severity, treatment approach, and rehabilitation duration to ensure accurate comparison between the three orthopedic patient groups.

5. Conclusion

This study concluded that joint instability carries a significant burden on patients' both physical and mental QOL. More importantly, instability from a bony deformity i.e. hip dysplasia is as impactful as soft tissue/ligamentous instability of the shoulder and knee. This analysis adds validity to instability as the leading pathomechanism of hip dysplasia. Additionally, joint instability is a significant burden on patients and affects their overall QOL. This was demonstrated by assessing the physical and health status using the PROMIS Global system, which has proven effective in identifying the status of patients with joint instability before and after surgery. Despite the good results obtained, there is an urgent need for further future studies to identify factors that affect patients' QOL after surgery and to use multiple measures to compare results and correlations

between these measures. This provides results that may help physicians and health care professionals, especially orthopedic clinics, in improving surgical and treatment procedures.

References

1. Kalisvaart, M. M., & Safran, M. R. (2015). Microinstability of the hip—it does exist: etiology, diagnosis and treatment. *Journal of hip preservation surgery*, *2*(2), 123-135. https://doi.org/10.1093%2Fjhps%2Fhnv017
2. Kraeutler, M. J., Garabekyan, T., Pascual-Garrido, C., & Mei-Dan, O. (2016). Hip instability: a review of hip dysplasia and other contributing factors. *Muscles, ligaments and tendons journal*, *6*(3), 343. https://doi.org/10.11138%2Fmltj%2F2016.6.3.343
3. Canham, C. D., Yen, Y. M., & Giordano, B. D. (2016). Does femoroacetabular impingement cause hip instability? A systematic review. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *32*(1), 203-208. https://doi.org/10.1016/j.arthro.2015.07.021
4. Larson, C. M., Stone, R. M., Grossi, E. F., Giveans, M. R., & Cornelsen, G. D. (2015). Ehlers-Danlos syndrome: arthroscopic management for extreme soft-tissue hip instability. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *31*(12), 2287-2294. https://doi.org/10.1016/j.arthro.2015.06.005
5. Ganz, R., Leunig, M., Leunig-Ganz, K., & Harris, W. H. (2008). The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clinical Orthopaedics and Related Research®*, *466*(2), 264-272. https://doi.org/10.1007%2Fs11999-007-0060-z
6. Pompe, B., Daniel, M., Sochor, M., Kralj-Iglič, V., & Iglič, A. (2003). Gradient of contact stress in normal and dysplastic human hips. *Medical Engineering & Physics*, *25*(5), 379-385. https://doi.org/10.1016/S1350-4533(03)00014-6
7. Kolb, A., Schweiger, N., Mailath-Pokorny, M., Kaider, A., Hobusch, G., Chiari, C., & Windhager, R. (2016). Low incidence of early developmental dysplasia of the hip in universal ultrasonographic screening of newborns: analysis and evaluation of risk factors. *International orthopaedics*, *40*, 123-127. https://doi.org/10.1007/s00264-015-2799-2
8. Kakarlapudi, T. K., & Bickerstaff, D. R. (2000). Knee instability: isolated and complex. *British Journal of Sports Medicine*, *34*(5), 395-400. https://doi.org/10.1136%2Fewjm.174.4.266
9. Hauser, R. A., Steilen-Matias, D., Lackner, J. B., Rawlings, B. R., Mann, J., Grogan, T., & Phillips, A. (2023). Ligamentous knee joint instability: Association with chronic conditions of the knee and treatment with prolotherapy. *The Open Pain Journal*, *16*(1). http://dx.doi.org/10.2174/0118763863267142231023052404
10. Hasegawa, A., Otsuki, S., Pauli, C., Miyaki, S., Patil, S., Steklov, N., ... & Lotz, M. K. (2012). Anterior cruciate ligament changes in the human knee joint in aging and osteoarthritis. *Arthritis & Rheumatism*, *64*(3), 696-704. https://doi.org/10.1002%2Fart.33417
11. Moya-Angeler, J., Jiménez-Soto, C., Maestre-Cano, D., de la Torre-Conde, C., Sánchez-Jimenez, R. M., Serrano-García, C., ... & León-Muñoz, V. J. (2023). Early Identification and Treatment of Trochlear Knee Dysplasia. *Journal of Personalized Medicine*, *13*(5), 796. https://doi.org/10.3390%2Fjpm13050796

12. Zlotnicki, J. P., Naendrup, J. H., Ferrer, G. A., & Debski, R. E. (2016). Basic biomechanic principles of knee instability. *Current reviews in musculoskeletal medicine*, *9*, 114-122. https://doi.org/10.1007%2Fs12178-016-9329-8
13. Lin, W., Kang, H., Niu, Y., Niu, J., Fan, C., Feng, X., & Wang, F. (2022). Cartilage degeneration is associated with activation of the PI3K/AKT signaling pathway in a growing rat experimental model of developmental trochlear dysplasia. *Journal of Advanced Research*, *35*, 109-116. https://doi.org/10.1016/j.jare.2021.04.006
14. Nkosi, C. S., & Chauke, N. Z. (2023). Quality of life following an open Latarjet-Bristow procedure in a general population with recurrent anterior shoulder instability. *JSES international*, *7*(2), 201-205. https://doi.org/10.1016/j.jseint.2022.12.003
15. Fernández-Matías, R., Lluch-Girbés, E., Bateman, M., & Requejo-Salinas, N. (2024). Assessing the use of the frequency, etiology, direction, and severity classification system for shoulder instability in physical therapy research–A scoping review. *Physical Therapy in Sport*. https://doi.org/10.1016/j.ptsp.2024.01.010
16. Araujo, I. L. A., Castro, M. C., Daltro, C., & Matos, M. A. (2016). Quality of life and functional independence in patients with osteoarthritis of the knee. *Knee surgery & related research*, *28*(3), 219. https://doi.org/10.5792%2Fksrr.2016.28.3.219
17. Cecchi, F., Mannoni, A., Molino-Lova, R., Ceppatelli, S., Benvenuti, E., Bandinelli, S., ... & Ferrucci, L. (2008). Epidemiology of hip and knee pain in a community based sample of Italian persons aged 65 and older. *Osteoarthritis and Cartilage*, *16*(9), 1039-1046. https://doi.org/10.1016/j.joca.2008.01.008
18. Dominick, K. L., Ahern, F. M., Gold, C. H., & Heller, D. A. (2004). Health-related quality of life among older adults with arthritis. *Health and Quality of life Outcomes*, *2*, 1-8. https://doi.org/10.1186/1477-7525-2-5
19. Mili, F., Helmick, C. G., & Moriarty, D. G. (2003). Health related quality of life among adults reporting arthritis: analysis of data from the Behavioral Risk Factor Surveillance System, US, 1996-99. *The Journal of rheumatology*, *30*(1), 160-166.
20. Hajewski, C. J., Baron, J. E., Glass, N. A., Duchman, K. R., Bollier, M., Wolf, B. R., & Westermann, R. W. (2020). Performance of the patient-reported outcome measurement information system in patients with patellofemoral instability. *Orthopaedic journal of sports medicine*, *8*(4), 2325967120915540. https://doi.org/10.1177%2F2325967120915540
21. Hays, R. D., Schalet, B. D., Spritzer, K. L., & Cella, D. (2017). Two-item PROMIS® global physical and mental health scales. *Journal of patient-reported outcomes*, *1*, 1-5. https://doi.org/10.1186/s41687-017-0003-8
22. Rafiq, R. B., Yount, S., Jerousek, S., Roth, E. J., Cella, D., Albert, M. V., & Heinemann, A. W. (2023). Feasibility of PROMIS using computerized adaptive testing during inpatient rehabilitation. *Journal of patient-reported outcomes*, *7*(1), 44. https://doi.org/10.1186%2Fs41687-023-00567-x
23. Bernstein, D. N., Houck, J. R., & Hammert, W. C. (2019). A comparison of PROMIS UE versus PF: correlation to PROMIS PI and depression, ceiling and floor effects, and time to completion. *The Journal of Hand Surgery*, *44*(10), 901-e1. https://doi.org/10.1016/j.jhsa.2018.12.006
24. Gulledge, C. M., Smith, D. G., Ziedas, A., Muh, S. J., Moutzouros, V., & Makhni, E. C. (2019). Floor and ceiling effects, time to completion, and question burden of PROMIS CAT domains

among shoulder and knee patients undergoing nonoperative and operative treatment. *JBJS Open Access*, *4*(4), e0015. https://doi.org/10.2106/JBJS.OA.19.00015
25. Anthony, C. A., Glass, N. A., Hancock, K., Bollier, M., Wolf, B. R., & Hettrich, C. M. (2017). Performance of PROMIS instruments in patients with shoulder instability. *The American journal of sports medicine*, *45*(2), 449-453. https://doi.org/10.1177/0363546516668304
26. Shigley, C., & Green, A. (2022). Shoulder conditions and health related quality of life and utility: a current concepts review. *JSES international*, *6*(1), 167-174. https://doi.org/10.1016/j.jseint.2021.10.006
27. Hays, R. D., Schalet, B. D., Spritzer, K. L., & Cella, D. (2017). Two-item PROMIS® global physical and mental health scales. *Journal of patient-reported outcomes*, *1*, 1-5. https://doi.org/10.1186/s41687-017-0003-8
28. Cella, D., Riley, W., Stone, A., Rothrock, N., Reeve, B., Yount, S., ... & PROMIS Cooperative Group. (2010). The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *Journal of clinical epidemiology*, *63*(11), 1179-1194. https://doi.org/10.1016/j.jclinepi.2010.04.011
29. Kotlarsky, P., Haber, R., Bialik, V., & Eidelman, M. (2015). Developmental dysplasia of the hip: What has changed in the last 20 years?. *World journal of orthopedics*, *6*(11), 886. https://doi.org/10.5312%2Fwjo.v6.i11.886
30. Schaeffer, J. F., Scott, D. J., Godin, J. A., Attarian, D. E., Wellman, S. S., & Mather III, R. C. (2015). The association of ASA class on total knee and total hip arthroplasty readmission rates in an academic hospital. *The Journal of arthroplasty*, *30*(5), 723-727. http://dx.doi.org/10.1016/j.arth.2014.12.014
31. Wilkin, G. P., Poitras, S., Clohisy, J., Belzile, E., Zaltz, I., Grammatopoulos, G., ... & Beaulé, P. E. (2020). Periacetabular osteotomy with or without arthroscopic management in patients with hip dysplasia: study protocol for a multicenter randomized controlled trial. *Trials*, *21*, 1-12. https://doi.org/10.1186/s13063-020-04592-9
32. Ruzbarsky, J. J., Comfort, S. M., Rutledge, J. C., Shelton, T. J., Day, H. K., Dornan, G. J., ... & Philippon, M. J. (2024). Improved functional outcomes of combined hip arthroscopy and periacetabular osteotomy at minimum 2-year follow-up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *40*(2), 352-358. https://doi.org/10.1016/j.arthro.2023.06.034
33. Sheean, A. J., Schmitz, M. R., Ward, C. L., Barrow, A. E., Tennent, D. J., Roach, C. J., ... & Wilken, J. M. (2017). Assessment of disability related to femoroacetabular impingement syndrome by use of the Patient-Reported Outcome Measure Information System (PROMIS) and objective measures of physical performance. *The American journal of sports medicine*, *45*(11), 2476-2482. https://doi.org/10.1177/0363546517708793
34. Hancock, K. J., Glass, N., Anthony, C. A., Wolf, B. R., Hettrich, C. M., Albright, J., ... & Amendola, A. (2019). PROMIS: a valid and efficient outcomes instrument for patients with ACL tears. *Knee Surgery, Sports Traumatology, Arthroscopy*, *27*, 100-104. https://doi.org/10.1007/s00167-018-5034-z
35. Robins, R. J., Anderson, M. B., Zhang, Y., Presson, A. P., Burks, R. T., & Greis, P. E. (2017). Convergent validity of the patient-reported outcomes measurement information system's physical function computerized adaptive test for the knee and shoulder injury sports medicine patient

population. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *33*(3), 608-616. https://doi.org/10.1177/2325967115S00147
36. Scott, E. J., Westermann, R., Glass, N. A., Hettrich, C., Wolf, B. R., & Bollier, M. J. (2018). Performance of the PROMIS in patients after anterior cruciate ligament reconstruction. *Orthopaedic journal of sports medicine*, *6*(5), 2325967118774509. https://doi.org/10.1177/2325967118774509
37. Kollmorgen, R. C., Hutyra, C. A., Green, C., Lewis, B., Olson, S. A., & Mather III, R. C. (2019). Relationship between PROMIS computer adaptive tests and legacy hip measures among patients presenting to a tertiary care hip preservation center. *The American journal of sports medicine*, *47*(4), 876-884. https://doi.org/10.1177/0363546518825252
38. Morgan, J. H., Kallen, M. A., Okike, K., Lee, O. C., & Vrahas, M. S. (2015). PROMIS physical function computer adaptive test compared with other upper extremity outcome measures in the evaluation of proximal humerus fractures in patients older than 60 years. *Journal of orthopaedic trauma*, *29*(6), 257-263. https://doi.org/10.1097/BOT.0000000000000280