*Review*

# Sex-Based Differences in Outcomes After Hip Arthroscopic Surgery for Femoroacetabular Impingement

## A Systematic Review

Thomas J. McCormack,*† BS, Matthew L. Vopat,† MD, Jacob Rooker,† BS, Armin Tarakemeh,† BA, Jordan Baker,† BS, Kimberly J. Templeton,† MD, Mary K. Mulcahey,‡ MD, Scott M. Mullen,† MD, John P. Schroeppel,† MD, and Bryan G. Vopat,† MD

*Investigation performed at the Medical Center of the University of Kansas, Kansas City, Kansas, USA*

**Background:** While sex-based differences in outcomes after hip arthroscopic surgery for femoroacetabular impingement syndrome (FAIS) are often recorded, no studies have been dedicated to analyzing the literature as a whole.

**Purpose:** To investigate whether sex is a predictor of outcomes in studies evaluating hip arthroscopic surgery for FAIS.

**Study Design:** Systematic review; Level of evidence, 4.

**Methods:** A systematic review was conducted following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. We searched the PubMed, Embase, Cochrane, Ovid, and PubMed Central databases for English-language studies that evaluated sex-specific outcomes in human populations. The search terms used were as follows: ("Hip Arthroscopy") AND ("Femoroacetabular Impingement" OR "FAI") AND ("Sex" OR "Gender" OR "Male" OR "Female"). Studies with evidence levels 2 through 4 were included. The studies were then screened, followed by data extraction. Modified Harris Hip Score (mHHS) outcomes and return-to-sport (RTS) rates were recorded. These were analyzed using random-effects meta-analysis. Heterogeneity was calculated using the $I^2$ statistic.

**Results:** Of 256 full-text articles screened, 48 articles were included in this analysis; of these, 14 studies (29%) concluded that female sex was a negative predictor of postoperative outcomes, while 6 studies (13%) found female sex to be positive predictor. The remaining 28 studies (58%) found no sex-based differences in postoperative outcomes. Of 7 studies (416 male and 519 female) included in the mHHS analysis, 2 studies concluded that male patients had significantly higher postoperative mHHS scores. Of 6 studies (502 male and 396 female) included in the RTS analysis, 1 study concluded that male patients had a significantly higher RTS rate.

**Conclusion:** Almost one-third of the included studies determined that female sex was a negative predictor of postoperative outcomes, 13% found female sex to be a positive predictor, and 58% found no sex-based differences. Our study illustrates an insufficiency of high-level evidence supporting sex-specific differences in outcomes after hip arthroscopic surgery, but findings indicated that the postoperative mHHS score and RTS rate may be influenced by sex.

**Keywords:** femoroacetabular impingement syndrome; sex-based outcomes; hip arthroscopic surgery

Femoroacetabular impingement syndrome (FAIS) is increasingly diagnosed and treated in patients of all age groups.[49] These bony impingements present as cam, pincer, or combined morphologies that can severely affect hip function. FAIS treatment is particularly of interest in young athletes because of its hindrance on their performance and lengthy recovery time.[6]

Over the past 3 decades, hip arthroscopic surgery has become the leading surgical treatment for FAIS. Hip arthroscopic surgery has proven to lower morbidity, decrease recovery time, and lower complication rates compared with open approaches.[4] Review articles in the literature have addressed the predictors of hip arthroscopic surgery failure as well as approaches to treatment after

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failure,[35,51] but none has reviewed the literature exclusively looking at sex-based outcomes.

Evaluating sex-based outcomes is important because we often find disparities regarding sex in medicine.[50] This exploration can also serve as a platform from which to discuss the reason for disparities to appropriately address them. Research focusing on female-specific outcomes has historically been excluded from sports science and sports medicine. Although the sports medicine literature has made great strides in generating inclusive studies, the current landscape still fails to reflect the continued increase in the popularity of female sports.[50]

More specifically, exploring outcomes regarding sex is important to understand the cause of FAIS and the response to treatment of those undergoing hip arthroscopic surgery. The literature has presented differing findings on the predictive value of sex.[11,39,40,51] While studies have found different cam- or pincer-type lesion rates, degrees of dysplasia, and alpha angles between men and women, our goal was to exclusively analyze outcomes purely through the lens of sex. This study is a systematic review of the literature regarding sex-based outcomes of hip arthroscopic surgery for FAIS.

## METHODS

### Search Strategy and Study Selection

A systematic review of the literature was performed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[32] The search was performed using PubMed, Embase, Cochrane, Ovid, and PubMed Central databases. The search terms applied were as follows: ("Hip Arthroscopy") AND ("Femoroacetabular Impingement" OR "FAI") AND ("Sex" OR "Gender" OR "Male" OR "Female"). All articles fitting the search terms up to November 15, 2021, were reviewed. Screening was performed by 2 reviewers (T.J.M. and M.L.V.). After initial screening, a consensus between the reviewers determined the final inclusion of studies. Duplicates were removed using EndNote reference management software (Clarivate). The remaining studies were then filtered using inclusion and exclusion criteria. Inclusion criteria were as follows: English language, human studies, and studies evaluating sex-specific outcomes. Exclusion criteria were as follows: animal studies, cadaveric studies, review studies/systematic reviews, commentaries, letters to the editor, studies not evaluating sex-specific outcomes, studies including other associated injuries and isolated cartilage damage (ie, associated chondroplasty and microfracture), studies including revision, and studies including open procedures (eg, periacetabular osteotomy and adjunctive femoral osteotomy). Filtering took place first through abstract and title screening and then through a full-text review.

The selection was initially intended to only include level of evidence 1 and 2 studies, but after search criteria were applied, it became evident that we would need to include level 3 and 4 studies. This decision is reported and analyzed in the following Results and Discussion sections.

### Data Extraction

The following data were extracted from each article if reported: number of patients (subdivided by sex), age, body mass index, follow-up in months, procedures performed, surgical technique, number of athletes, level of competition, sport type, position in sport, functional outcome measures, minimal clinically important difference, lateral center-edge angle (or alpha angle), sexual activity, satisfaction, osteoarthritis progression, procedure survival time, joint space width, return-to-sport (RTS) duration, RTS percentage, return to activity, conversion to total hip arthroplasty, revision rate, and complications.

### Quality-of-Bias Assessment

A quality-of-bias assessment was conducted using the methodological index for nonrandomized studies (MINORS). This was accomplished by analyzing each study using 12 separate criteria. Each score was then tallied and categorized by its inherent risk of bias on a graded scale in which a score of 0 indicates that the item was not reported, a score of 1 denotes that the item was reported but inadequate, and a score of 2 indicates that the item was reported and adequate. The global ideal score for the MINORS criteria is 16 for noncomparative studies and 24 for comparative studies. For our assessment, scores >15 were considered good, scores from 12 to 15 were considered fair, and scores <12 were considered poor.

### Statistical Analysis

Because of the prevalence of studies that reported modified Harris Hip Score (mHHS) outcomes and RTS rates, these studies were included in a separate review. They were

*Address correspondence to Thomas J. McCormack, BS, University of Kansas, 10730 Nall Avenue, Suite 200, Overland Park, KS 66211, USA (email: t501m032@kumc.edu).
†Medical Center, University of Kansas, Kansas City, Kansas, USA.
‡School of Medicine, Tulane University, New Orleans, Louisiana, USA.
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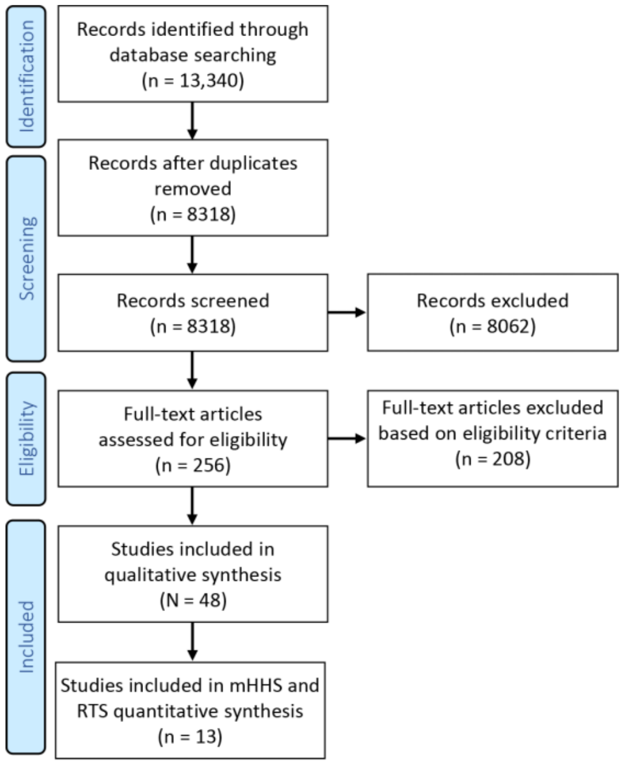


**Figure 1.** PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart of study selection.

analyzed using random-effects meta-analysis. The mean difference, along with the 95% CI, was calculated for postoperative mHHS scores. For RTS rates, the odds ratio (OR) and 95% CI were calculated. Heterogeneity was examined using the $I^2$ statistic.[23] $P < .05$ was considered significant. Heterogeneity was found to be too high for the mHHS and RTS to appropriately analyze and include. R (Version 3.6.3; R Core Team) was used for all statistical analyses. Forest plots were generated to report both mHHS and RTS results.

## RESULTS

### Characteristics of Included Studies

The literature search results can be observed in Figure 1. After search terms were applied, 13,340 articles were identified. After title and abstract screening, 256 were left for a full-text review. At the conclusion of the search, 48 studies were included in the qualitative synthesis, while a total of 13 studies were included in the mHHS[9,15,16,20,43,48,55] and RTS[13,20,46,48,53,54] analyses. Most studies (176/256 [68.8%]) were excluded during the full-text review because they lacked a sex-based comparison of functional outcomes. A summary of the 48 included studies is shown in Appendix Table A1, and a summary of study bias according to MINORS criteria is included in Appendix Table A2.

The 48 studies comprised 11,698 hips, with 6066 being male (51.9%) and 5632 being female (48.1%). A wide range in patient characteristics was seen among the studies. For example, patient ages ranged from 10 to 76 years. There were 1185 athletes; however, only 898 (75.8%) were able to be stratified by sex: 502 male (55.9%) and 396 female (44.1%). The studies that categorized athletes by sex reported the following sports for their participants: hockey, football, baseball, softball, soccer, track, water polo, triathlon, lacrosse, tennis, gymnastics, basketball, running, dancing, golf, volleyball, swimming, rowing/crew, rugby, fencing, field hockey, bobsled, weight lifting, wrestling, and high-intensity interval training.

A wide range of outcome measures was used in the studies. The following are functional outcomes that were subdivided by sex in ≥2 studies: Hip Outcome Score–Activities of Daily Living (HOS-ADL),[2,3,8,9,15,16,25,27,31] Hip Outcome Score–Sports Specific,[2,3,8,9,16,20,27,31] mHHS,[§] 12-item international Hip Outcome Tool,[27,33,41,47] 33-item international Hip Outcome Tool,[5,25,48] EuroQol–5 Dimensions,[26,33,47] and visual analog scale for pain or satisfaction.[2,3,8,20,33,47] Overall, 14 studies in the qualitative analysis indicated that female sex, according to various measures, was a negative predictor of outcomes after hip arthroscopic surgery for FAIS.[‖] In comparison, 6 studies found that female sex was a positive predictor of outcomes.[2,7,9,15,31,45] The remaining 28 studies either concluded that sex did not significantly affect outcomes or that there were not enough data to support this claim.

### Analysis of mHHS and RTS

The 7 studies[9,15,16,20,43,48,55] included in the mHHS analysis comprised 416 male and 519 female patients. Because of heterogeneity of the data ($I^2 = 51\%$), these outcomes could not be pooled. There were 2 studies that found male patients to have a significant increase in the mHHS score compared with female patients postoperatively.[16,43] The remaining studies found the difference to be nonsignificant. A forest plot presenting mHHS outcomes is seen in Figure 2. The 6 studies[13,20,46,48,53,54] included in the RTS analysis comprised 502 male and 396 female patients. As with the mHHS analysis, heterogeneity was too high ($I^2 = 71\%$) to pool the outcomes. One study found male patients to have a higher RTS rate.[53] The remaining studies found the difference to be nonsignificant. A forest plot presenting RTS outcomes is shown in Figure 3.

## DISCUSSION

The major findings of our study are that when observing different outcomes, both male and female sexes were found to be a positive or negative predictor of success after hip arthroscopic surgery for FAIS. With 14 of the 48 studies included in the systematic review concluding female sex as a negative predictor, it could be determined that sex may play a role in postoperative outcomes. While some articles in the qualitative review suggested female sex as a negative

[§]References 2, 3, 8, 9, 16, 20, 27, 30, 31, 34, 43, 48, 55, 56.
[‖]References 3, 12, 14, 16, 19, 21, 26, 28, 30, 43, 52, 53, 57, 59.

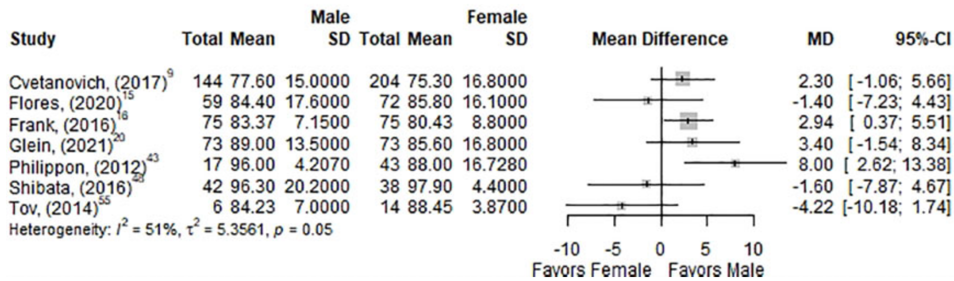


**Figure 2.** Forest plot for modified Harris Hip Score outcomes by sex (7 studies[9,15,16,21,43,48,55]). MD, mean difference.

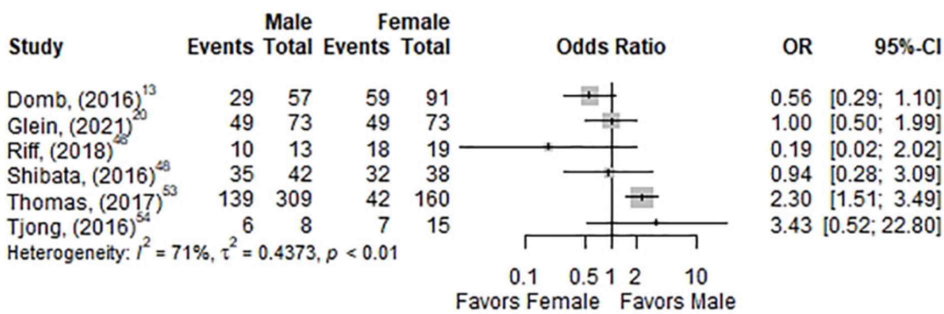


**Figure 3.** Forest plot for return-to-sport outcomes by sex (6 studies[13,20,46,48,53,54])

predictor, 58% of the included studies could not find a statistical difference in the 2 sexes regarding outcomes. These results were somewhat limited by the insufficient literature and heterogeneity of the data, highlighted by the fact that approximately 70% of the studies had a level of evidence of $\geq$3. Also, this is emphasized by the $I^2$ values from the mHHS (51%) and RTS (71%) analyses.

The greatest factor contributing to this high heterogeneity was the lack of randomization throughout the studies. In our assessment of the risk of bias using the MINORS criteria, only 3 comparative studies were given an adequate rating for the baseline equivalence of groups: Domb et al[13], Hatakeyama et al[22], and Randelli et al.[44] Because of this lack of randomization, pooling the data for analysis was not reliable.

Interestingly, 2 studies highlighted the finding that female patients aged $\geq$45 years fared worse after surgery than their male counterparts.[3,16] Beck et al[3] stratified their study cohort by age and sex and determined that female patients aged $\geq$45 years scored consistently lower than every other sex/age group on the HOS-ADL, HOS-SS, and mHHS while also having the highest pain score. Similarly, Frank et al[16] categorized their study population by sex and age, also finding that female patients aged >45 years scored significantly lower than all other groups when looking at the same outcomes as Beck et al.[3] That study noted that in the age group <45 years, female patients fared as well as male patients in terms of functional outcome scores. Throughout the literature, age was often presented as a negative predictor of outcomes for both male and female patients.[2,16,59]

There are 2 previous systematic reviews worth noting: Minkara et al[39] and Sogbein et al[51] both touched on sex as a predictor of outcomes after hip arthroscopic surgery. Minkara et al mentioned male sex to be associated with higher postoperative mHHS scores as well as a higher risk of labral tears and acetabular chondromalacia. That study contrasted these results to female sex, which they linked to less severe cam-type deformities but also a higher risk of persistent pain after surgery, requiring second-look hip arthroscopic surgery. Overall, Minkara et al claimed that their review is consistent with the notion that female sex is a risk factor associated with hip arthroscopic surgery. Sogbein et al also mentioned an array of studies linking negative outcomes to female sex, but they found men to be more likely to undergo subsequent total hip arthroplasty than women (44% vs 20%, respectively; $P = .002$). While we recognize some of the same mixed results of these 2 reviews, it is also important to acknowledge that these reviews were analyzing outcomes in relation to many factors, not only sex. We believe that our sex specific–based analysis shows a more heterogeneous picture than some of their more anecdotal claims.

It is important to discuss the studies that found female sex to be a positive predictor of outcomes.[7,9,28,44] Carton and Filan[7] found that for the 36-item Short Form Health Survey (SF-36), which reviews quality-of-life measures, female sex was a significant clinical predictor of achieving the minimal clinically important difference (OR, 0.121 [95% CI, 0.026-0.568]; $P = .007$). Carton and Filan was the only study that used the SF-36. Cvetanovich et al[9] presented in their results that female patients in the borderline dysplastic group had greater improvements in both HOS-ADL ($P = .05$) and mHHS ($P = .005$) scores compared with their male counterparts in the borderline dysplastic group. Levy et al[31] discovered in their case series that in those who identified as recreational or competitive runners, female patients had a greater improvement in HOS-ADL scores compared with male runners (28.8 ± 17.5 vs 13.8 ± 10.5, respectively; $P = .001$). Last, Rhon et al,[45] who included 1870 participants, found that male sex was a predictor of osteoarthritis within 2 years of hip arthroscopic surgery for FAIS (OR, 1.31 [95% CI, 1.04-1.65]). While more articles suggested male sex as a positive predictor of outcomes, it is worth acknowledging the differing results in these studies.

Some studies stood alone because of their exploration of unique outcomes. Kunze et al[27] focused on the sleep quality of patients after surgery. They found no difference in the mean Pittsburgh Sleep Quality Index at any point after surgery between the sexes. Data were collected at 3, 6, 12, and 24 months postoperatively. Lee et al[30] aimed to compare sexual functional outcomes between male and female patients. Their study found that female patients returned to sexual activity later (34.8 ± 23.2 vs 21.0 ± 10.7 days, respectively; $P < .0001$), more male patients reported an increase in sexual activity postoperatively (61.9% vs 38.1%, respectively; $P < .0001$), and female patients reported more alterations in sexual positioning (82.3% vs 17.7%, respectively; $P < .0001$). Thomas et al[53] were unique in that they calculated the rate of return to duty in a military population as opposed to RTS, which was frequently examined in other articles. In a case series of 469 participants, Thomas et al found that 45% of men were able to return to duty, while only 26% of women were able to do the same ($P < .0001$). Finally, Brown-Taylor et al[5] described sagittal- and frontal-plane gait mechanics postoperatively. This provided physicians with insight on sex-specific gait impairments that can affect outcomes. While these studies started interesting conversations on hip arthroscopic surgery and FAIS, it is clear that there is a need for more standardized measures to reach proper conclusions.

### Limitations

There are several limitations to this study, including the lack of control for other associated surgical procedures, such as labral repair or debridement. While there is a plethora of data regarding outcomes after hip arthroscopic surgery for FAIS, relatively few studies aimed to compare sex-based differences. Therefore, the data that can be extracted from the literature are quite heterogeneous and lack a clear functional outcome standard to be applied. A small portion of the studies included in the review did not provide raw data regarding sex-based outcomes, simply reporting that there was no significant difference between the 2. This lack of transparency could introduce a number of biases. Also, some of the studies included had relatively small sample sizes, which could lead to selection bias.

## CONCLUSION

While many studies found no difference or conclusive evidence when comparing sex-based outcomes after hip arthroscopic surgery, almost one-third of the included studies determined that female sex was a negative predictor of postoperative outcomes. In 13% of the included literature, female sex was determined to be a positive predictor. This study illustrates an insufficiency of high-level evidence evaluating sex-based outcomes after hip arthroscopic surgery but also shows the beginning of our understanding of sex-specific medicine. Further literature with more standardized measures is needed to evaluate the difference in postoperative outcomes in terms of sex.

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# APPENDIX

## APPENDIX TABLE A1
Characteristics of Included Studies[a]

| Lead Author (Year) | Study Design (LOE) | No. of Hips (M/F) | Mean Age, y | Mean Follow-up[b] | Outcomes |
|---|---|---|---|---|---|
| Adib[1] (2018) | Retrospective cohort (3) | 252 (94/158) | 22 | 6 wk, 3 mo, 1 y, then yearly | Postoperative iliopsoas tendinitis in 17 M patients (18% [95% CI, 12%-27%]) and 43 F patients (27% [95% CI, 21%-35%]); no patient-specific risk factors found |
| Beck[2] (2021) | Case-control (3) | 150 (75/75) | 37.4 ± 14.1 | 62.7 ± 5.5 | Although F patients had slightly higher scores, difference was not significant; however, F patients reached MCID for HOS-SS (58.0% vs 48.3%, respectively; $P = .008$) and mHHS (75.4% vs 54.0%, respectively; $P = .012$) at higher rates than M patients |
| Beck[3] (2019) | Retrospective comparative (3) | 108 (54/54) | 40.9 ± 13.1 | 32.9 ± 9.3 | F patients aged ≥45 y had lowest HOS-ADL, HOS-SS, and mHHS scores; same group had highest pain score (29.9 ± 28.3; $P < .001$) |
| Brown-Taylor[5] (2020) | Cross-sectional case-control (3) | 25 (8/17) | F: 36 ± 11<br>M: 36 ± 8 | F: 2.63 ± 1.50 y<br>M: 2.16 ± 1.10 y | No sex-based difference in iHOT-33 scores ($P \geq .44$) or gait speed ($P = .15$) |
| Carton[7] (2020) | Cohort (2) | 576 (553/23) | 25.9 ± 5.7 | 28.8 ± 8.4 | F sex was significant clinical predictor of achieving MCID on SF-36 (OR, 0.121 [95% CI, 0.026-0.568]; $P = .007$) |
| Chahla[8] (2019) | Cohort (3) | 600 (387/213) | 33.5 ± 12.3 | 2 y | On multivariate analysis, sex was not significant factor for HOS-ADL (β = –0.1 [95% CI, –3.2 to 2.9]; $P = .172$), HOS-SS (β = –1.63 [95% CI, –0.33 to 0.04]; $P = .117$), mHHS (β = 1.1 [95% CI, –2.2 to 4.4]; $P = .512$), and VAS for satisfaction (β = –0.43 [95% CI, –0.63 to 9.21]; $P = .88$) |
| Cvetanovich[9] (2017) | Cohort (3) | 348 (144/204) | Borderline dysplastic: 31.5 ± 11.8<br>Normal coverage: 32.9 ± 12.0 | 31.2 ± 7.2 | In borderline dysplastic group, F patients had greater improvements than M patients on HOS-ADL (25.9 ± 16.3 vs 10.8 ± 18.5, respectively; $P = .05$) and mHHS (27.9 ± 12.9 vs 8.1 ± 19.0, respectively; $P = .005$); there were no differences for HOS-SS (27.4 ± 27.0 vs 15.1 ± 27.6, respectively; $P = .31$) |
| Cvetanovich[10] (2018) | Case series (4) | 37 (11/26) | 17.0 ± 1.4 | 28.3 ± 6.2 | No statistical differences in outcomes based on sex (HOS-ADL, HOS-SS, mHHS) |
| Domb[12] (2021) | Case-control (3) | 745 (260/485) | 36.0 | 62.0 | M patients were approximately half as likely to convert to THA than F patients ($P = .001$) |
| Domb[13] (2016) | Cohort (2) | 148 (57/91) | RTS: 30.7<br>No RTS: 30.4 | 25.2 | No sex-based difference was found in whether patients returned to sport |
| Faccioni[14] (2019) | Cross-sectional (4) | 126 (67/59) | 33.56 ± 7.40 | | M patients had higher NAHS functional scores than F patients (65.6 ± 19.6 vs 49.3 ± 21.6, respectively; $P < .001$) and greater proportion of deep chondral lesions (n = 23 [34.3%] vs n = 2 [3.4%], respectively; $P = .001$) |
| Flores[15] (2020) | Cohort (2) | 131 (59/72) | F: 34.2 ± 9.5<br>M: 35.8 ± 10.3 | 2 y | All patient-reported outcome scores showed statistically significant improvement in both sexes except for SF-12 MCS scores in M patients ($P = .581$); MCID for HOOS-ADL was met by more F patients than M patients (79.2% vs 62.7%, respectively; $P = .037$); no sex-based differences were noted in PASS for mHHS or MCID for mHHS, HOOS–Symptoms, HOOS–Pain, HOOS–Sports, or HOOS-QoL |
| Frank[16] (2016) | Prognostic (2) | 150 (75/75) | 37.90 ± 12.83 | 33.64 ± 5.70 | M patients aged >45 y scored significantly better than F patients aged >45 y on HOS-SS ($P = .024$) and mHHS ($P = .042$) |
| Frank[17] (2018) | Case series (4) | 26 (10/16) | 31.3 ± 7.2 | 2 y | Ability to return to higher level of performance was not associated with sex ($P = .62$) |
| Gao[18] (2019) | Retrospective cohort (3) | 242 (140/102) | 36.2 ± 9.5 | 22.88 ± 11.74 | No sex-based differences were found between those with vs without HO |
| Gicquel[19] (2014) | Cohort (4) | 51 (19/32) | 31 | 55.2 | In those classified with Tönnis 0 preoperatively, only factor significantly associated with dissatisfaction was F sex ($P = .002$) |

*(continued)*

APPENDIX TABLE A1 (continued)

| Lead Author (Year) | Study Design (LOE) | No. of Hips (M/F) | Mean Age, y | Mean Follow-up[b] | Outcomes |
|---|---|---|---|---|---|
| Glein[20] (2021) | Cohort (3) | 146 (73/73) | F: 25.6 ± 8.9<br>M: 26.4 ± 8.6 | F: 65.1 ± 27.9<br>M: 59.9 ± 30.6 | At 2-y follow-up, there was no difference on any outcome measure between M and F patients: mHHS ($P = .490$), NAHS ($P = .479$), HOS-SS ($P = .815$), VAS ($P = .677$), and satisfaction ($P = .239$); RTS rate was comparable between F and M groups ($P > .999$) |
| Hassebrock[21] (2020) | Cohort (3) | 50 (32/18) | Accelerated surgery: 22<br>Standard surgery: 19 | 2 y | M patients had higher rate of return to play compared with F patients ($P = .03$); M sex ($P = .09$) and BMI ($P = .08$) were not positive prognostic factors for RTS at same/higher level |
| Hatakeyama[22] (2017) | Case-control (3) | 45 (15/30) | 31.4 | 42.5 | No significant difference in sex between success and failure groups ($P = .070$) |
| Ibrahim[24] (2018) | Retrospective cohort (3) | 88 (57/31) | 31 | 32.4 | No demographic factor (age, sex, side, BMI) was found to be significantly associated with changes in HOOS score |
| Joseph[25] (2015) | Cohort (2) | 229 (73/156) | 31.6 ± 10.8 | 3, 6, 12, 24 | Main effect of sex was not statistically significant for HOS-ADL ($P = .14$) or iHOT-33 ($P = .07$); post hoc $t$ tests showed that F patients reported poorer hip function than M patients before surgery ($P \leq .003$) on HOS-ADL (mean ± SEM, 60.5 ± 1.3 vs 67.4 ± 1.9, respectively) and iHOT-33 (mean ± SEM, 30.9 ± 1.3 vs 38.0 ± 1.9, respectively); neither HOS-ADL ($P \geq .2$) nor iHOT-33 ($P \geq .13$) scores were different between sexes at any other time point |
| Kaldau[26] (2018) | Cohort (2) | 84 (45/39) | 40.4 ± 11.0 | 82.9 | No sex-based difference for conversion to THA was observed; M sex was positive predictor for HSAS scores ($P = .04$) |
| Kunze[27] (2019) | Case series (4) | 52 (19/33) | 37.8 ± 1.9 | 3, 6, 12, 24 | No sex-based difference in mean PSQI score at any time point; no differences in postoperative mHHS, HOS-ADL, HOS-SS, and iHOT-12 scores or extent to which patients believed that their hip pain affected their sleep |
| Larson[28] (2016) | Case series (4) | 1615 (810/805) | 30.5 | 18.7 | Significantly higher rate of complications for F patients than M patients (10.0% vs 6.7%, respectively; $P = .017$) |
| Laurito[29] (2021) | Retrospective cohort (2) | 230 (157/73) | F: 43<br>M: 39 | 17 | No influence of sex on HHS scores ($P = .304$) |
| Lee[30] (2015) | Case series (4) | 131 (56/75) | 35.2 ± 11.6 | 21.0 ± 5.4 | F patients resumed sexual activity later than M patients (34.8 ± 23.2 vs 21.0 ± 10.7 d, respectively; $P < .0001$); more M patients reported increase in sexual activity than F patients (61.9% vs 38.1%, respectively; $P < .0001$); more F patients reported alterations in sexual positioning than M patients (82.3% vs 17.7%, respectively; $P < .0001$) |
| Levy[31] (2016) | Case series (4) | 51 (22/29) | 26.3 ± 7.8 | 2 y | More improvement in HOS-ADL scores in F patients than M patients (28.8 ± 17.5 vs 13.8 ± 10.5, respectively; $P = .001$); no significant sex-related differences in 2-y HOS-ADL scores (93.6 ± 6.3 vs 91.5 ± 14.1, respectively; $P = .51$); preoperative or 2-y postoperative HOS-SS and mHHS scores were not significantly different between sexes |
| Maempel[33] (2018) | Case series (4) | 88 (39/49) | 31.73 | 24.3 | Sex was not predictive of postoperative iHOT-12, EQ-5D index, or EQ-5D VAS scores ($P \geq .49$) or patient satisfaction ($P = .86$) |
| Maerz[34] (2021) | Cohort (2) | 621 (269/352) | F: 29.9 ± 12.1<br>M: 29.8 ± 11.6 | F: 4.1 ± 2.3 y<br>M: 4.5 ± 2.5 y | Greater proportion of F hips achieved MCID for mHHS, but M hips were more likely to meet PASS; sex was not identified as independent predictor of any outcome |
| Martinez[37] (2019) | Prospective cohort (2) | 110 (67/43) | 36.0 ± 7.5 | 24 h, 3 wk, 6 wk, 3 mo, 6 mo | Perineal neurapraxia 24 h after HA: 40 M (59.7%) and 25 F (58.1%); lateral cutaneous femoral nerve neurapraxia 24 h after HA: 8 M (11.9%) and 7 F (16.3%) |
| Martínez[36] (2015) | Cohort (3) | 179 (63/116) | Failure: 39.00<br>Success: 43.92 | 23.83 ± 9.80 | Revision surgery in 5 F and 2 M patients |
| Matsuda[38] (2016) | Cohort (2) | 150 (72/78) | 40.3 ± 13.4 | 3, 12, 24 | Bivariate analysis of M sex vs change in NAHS score from baseline to 24 mo ($r = 0.02$; $P = .82$); Wilcoxon/Kruskal-Wallis testing ($P = .81$) |
| Öhlin[41] (2017) | Cohort (2) | 198 (122/76) | 41.0 ± 12.1 | 2 y | Sex was not significant factor for iHOT-12 scores ($r = –0.106$; $P = .137$) |
| Perets[42] (2018) | Case series (4) | 94 (42/52) | 55.2 ± 3.8 | 70.1 | Sex vs THA (risk ratio, 1.24 [95% CI, 0.64-2.38]; $P = .521$) |
| Philippon[43] (2012) | Case series (4) | 60 (17/43) | 15 | 2 y | At follow-up, sex was only factor associated with mHHS scores (96 for M vs 88 for F; $P = .018$); all 8 second-look surgical procedures were on F patients |
| Randelli[44] (2010) | Retrospective cohort (3) | 300 (180/120) | 37.4 | 17.9 | There were 4 M and 1 F patients who presented with HO (overall prevalence, 1.6% [95% CI, 0.2%-3.0%]) |
| Rhon[45] (2019) | Cohort (2) | 1870 (1037/833) | 32.24 ± 8.09 | ≤2 y | M sex was predictor of osteoarthritis at 24 mo after surgery (OR, 1.305 [95% CI, 1.035-1.645]; $P = .025$) |
| Riff[46] (2018) | Case series (4) | 32 (13/19) | 34.7 ± 6.9 | 2 y | No difference in rate of return to high-intensity interval training between M and F patients (77% vs 95%, respectively; $P = .27$) |
| Robinson[47] (2020) | Retrospective cohort (3) | 171 (70/101) | 29 | 24.3 | No sex-based difference between those who were satisfied (52 F vs 38 M) and those who were not (24 F vs 7 M) ($P = .051$) |

*(continued)*

APPENDIX TABLE A1 (continued)

| Lead Author (Year) | Study Design (LOE) | No. of Hips (M/F) | Mean Age, y | Mean Follow-up[b] | Outcomes |
|---|---|---|---|---|---|
| Shibata[48] (2017) | Cohort (3) | 80 (42/38) | 21.1 ± 2.9 | 18.9 ± 12.8 | Approximately 84% of F and 83% of M elite-level competitive athletes were able to return to same level of competitive sports (8.3 ± 3.0 vs 8.8 ± 2.9 mo, respectively) |
| Stephan[52] (2018) | Cohort (2) | 203 (89/114) | 40 | 1 y | F patients had lower chance of successful outcome compared to M patients (OR, 0.37 [95% CI, 0.17-0.83]; $P = .02$) |
| Thomas[53] (2017) | Case series (4) | 469 (309/160) | 29 | 30 | F sex correlated with presence of pelvic pain, psoas tenotomy, and Axis I diagnoses ($r = 0.40$, 0.30, and 0.22, respectively; $P < .0001$); 45% of M patients returned to duty vs 26% of F patients; F sex had OR of 0.44 (95% CI, 0.38-0.52) for failure to return to active duty ($P < .0001$) |
| Tjong[54] (2016) | Case series (4) | 23 (8/15) | RTS: 44.0<br>No RTS: 43.7 | RTS: 31.79<br>No RTS: 34.91 | RTS was noted in 5 M (63%) and 7 F (47%) patients |
| Tov[55] (2014) | Case series (4) | 20 (6/14) | 58 | 22 | No sex-based difference for mHHS ($P = .013$), HOS ($P = .024$), or functional evaluation ($P = .032$) |
| Van der Valk[56] (2022) | Cohort (2) | 91 (31/60) | 35.2 ± 1.8 | 3.50 ± 0.17 y | No sex-based difference in conversion to THA ($P = .216$) or WOMAC ($P = .98$) or mHHS ($P = .568$) scores |
| Wolfson[57] (2019) | Case series (4) | 340 (123/217) | 40.2 ± 13.1 | 50 | M patients were more likely than F patients to reach MCID at 3 mo (OR, 4.7 [95% CI, 1.7-12.8]; $P = .003$) and 6 mo (OR, 4.2 [95% CI, 1.2-14.5]; $P = .02$) and were more likely to exceed PASS at 3 mo (OR, 2.0 [95% CI, 1.1-3.9]; $P = .03$), 6 mo (OR, 2.0 [95% CI, 1.0-3.8]; $P = .04$), 1 y (OR, 3.0 [95% CI, 1.6-5.7]; $P < .001$), and 2 y (OR, 2.3 [95% CI, 1.3-4.3]; $P = .01$) |
| Yang[58] (2021) | Case series (4) | 51 (24/27) | 36.5 ± 5.6 | 26.6 ± 0.5 | No difference between sex and gluteus maximus ($P = .011$) or gluteus minimus ($P = .218$) cross-sectional area postoperatively |
| Zimmerer[59] (2021) | Retrospective comparative (3) | 112 (71/41) | Tönnis ≤1: 43.0 ± 13.0<br>Tönnis >1: 44.1 ± 11.6 | 11.0 ± 0.8 y | F sex (hazard ratio, 1.97 [95% CI, 1.72-2.38]; $P < .001$) was independently associated with lower hip survival rates |

[a]BMI, body mass index; EQ-5D, EuroQol–5 Dimensions; F, female; HA, hip arthroscopic surgery; HHS, Harris Hip Score; HO, heterotopic ossification; HOOS-ADL, Hip disability and Osteoarthritis Outcome Score–Activities of Daily Living; HOOS-QoL, Hip disability and Osteoarthritis Outcome Score–Quality of Life; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Specific; HSAS, Hip Sports Activity Scale; iHOT-12, 12-item international Hip Outcome Tool; iHOT-33, 33-item international Hip Outcome Tool; LOE, level of evidence; M, male; MCID, minimal clinically important difference; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; OR, odds ratio; PASS, Patient Acceptable Symptom State; PSQI, Pittsburgh Sleep Quality Index; RTS, return to sport; SF-12 MCS, 12-item Short Form Health Survey Mental Component Summary; SF-36, 36-item Short Form Health Survey; THA, total hip arthroplasty; VAS, visual analog scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

[b]Follow-up is shown in months unless otherwise indicated.

APPENDIX TABLE A2
Risk-of-Bias Assessment Scores[a]

| | MINORS Criteria | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lead Author (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total[b] |
| Adib[1] (2018) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Beck[2] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |
| Beck[3] (2019) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Brown-Taylor[5] (2020) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |
| Carton[7] (2020) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Chahla[8] (2019) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Cvetanovich[9] (2017) | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 10 |
| Cvetanovich[10] (2018) | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 10 |
| Domb[12] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |
| Domb[13] (2016) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 0 | 17 |
| Faccioni[14] (2019) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 13 |
| Flores[15] (2020) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |
| Frank[16] (2016) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 13 |
| Frank[17] (2018) | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Gao[18] (2019) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Gicquel[19] (2014) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 14 |
| Glein[20] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |

*(continued)*

APPENDIX TABLE A2 (continued)

| | MINORS Criteria | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lead Author (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total[b] |
| Hassebrock[21] (2020) | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 15 |
| Hatakeyama[22] (2017) | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 19 |
| Ibrahim[24] (2018) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Joseph[25] (2015) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 14 |
| Kaldau[26] (2018) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Kunze[27] (2019) | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Larson[28] (2016) | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 11 |
| Laurito[29] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 13 |
| Lee[30] (2015) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Levy[31] (2016) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 12 |
| Maempel[33] (2018) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 12 |
| Maerz[34] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Martinez[37] (2019) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 14 |
| Martínez[36] (2015) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 14 |
| Matsuda[38] (2016) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 13 |
| Öhlin[41] (2017) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 13 |
| Perets[42] (2018) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 14 |
| Philippon[43] (2012) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 14 |
| Randelli[44] (2010) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 23 |
| Rhon[45] (2019) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 14 |
| Riff[46] (2018) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Robinson[47] (2020) | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 13 |
| Shibata[48] (2017) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 13 |
| Stephan[52] (2018) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Thomas[53] (2017) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 14 |
| Tjong[54] (2016) | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 12 |
| Tov[55] (2014) | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 11 |
| Van der Valk[56] (2022) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 13 |
| Wolfson[57] (2019) | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 14 |
| Yang[58] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |
| Zimmerer[59] (2021) | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 15 |

[a]Bias was assessed based on the following 12 criteria: (1) clearly stated aim, (2) inclusion of consecutive patients, (3) prospective collection of data, (4) endpoints appropriate to the aim of the study, (5) unbiased assessment of the study endpoint, (6) follow-up period appropriate to the study aim, (7) loss to follow up <5%, and (8) prospective calculation of the study size. The following additional criteria were for comparative studies: (9) adequate control group, (10) contemporary groups, (11) baseline equivalence of groups, and (12) adequate statistical analyses. Each criterion was graded as 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). MINORS, methodological index for non-randomized studies.

[b]Scoring: green = good (>15), yellow = fair (12-15), and red = poor (<12).