Sex-Based Differences in Clinical Outcomes After Arthroscopic Anterior Shoulder Stabilization

Results at 5-Year Follow-up

Mo Chen,* MD, PhD, Sijia Feng,* MD, Yuzhou Chen,* MD, PhD, Zheci Ding,* MBBS,
Yuxue Xie,[†] MD, Jiwu Chen,* MD, PhD, Yinghui Hua,* MD, PhD, Jun Chen,* MD, PhD,
Jianjun Yang,[‡§] MD, PhD, and Shiyi Chen,*[§] MD, PhD
*Investigation performed at Huashan Hospital, Fudan University, Shanghai,
People's Republic of China*

Background: The influence of patient sex on clinical outcomes after arthroscopic anterior shoulder stabilization is unclear.

Purpose: To investigate sex-based differences in clinical outcomes after arthroscopic anterior shoulder stabilization.

Study Design: Cohort study; Level of evidence, 3.

Methods: A retrospective study was conducted among 76 patients who underwent arthroscopic anterior shoulder stabilization from February 2010 to December 2017. The patients were grouped by sex. The recurrence rate of instability was compared, as were pre- and postoperative pain scores, functional outcome scores, and active range of motion (ROM). Postoperative magnetic resonance imaging (MRI) was also performed for structural assessment of the glenohumeral joint.

Results: No significant difference was found in the recurrence rate between female and male patients (13.3% vs 14.8%; $P \geq .999$; risk ratio, 1.107 [95% CI, 0.266-4.597]). Compared with male patients, female patients had a significantly lower preoperative Constant score (94.4 ± 6.4 vs 85.4 ± 11.1; $P = .002$), forward flexion (173.8° ± 10.7° vs 154.0° ± 33.8°; $P = .011$), abduction (171.0° ± 18.4° vs 142.7° ± 39.9°; $P = .001$), and external rotation (76.6° ± 21.6° vs 67.7° ± 20.4°; $P = .037$). Postoperatively, female patients had a significantly lower Simple Shoulder Test score compared with men (8.8 ± 1.9 vs 10.3 ± 1.6; $P = .005$). The mean changes from pre- to postoperative Rowe score (43.6 ± 21.4 vs 31.5 ± 19.8; $P = .044$), Constant score (9.9 ± 8.9 vs 0.8 ± 8.1; $P = .002$), forward flexion (24.0 ± 36.2 vs 4.2 ± 10.9; $P = .013$), abduction (36.0 ± 38.3 vs 7.6 ± 18.4; $P < .001$), and external rotation (19.7 ± 21.3 vs 6.7 ± 26.2; $P = .023$) in female patients were significantly higher than those in the men. There were no sex-based differences on any MRI parameter measured.

Conclusion: Female patients had a similar recurrence rate as that of male patients after arthroscopic anterior shoulder stabilization. Most postoperative clinical outcome measures showed no significant difference between the sexes. Despite worse preoperative values, more significant improvements in postoperative shoulder function and active ROM were seen in women.

Keywords: anterior shoulder instability; sex; arthroscopic shoulder stabilization; clinical outcome; recurrence

Shoulder instability has a relatively low incidence, varying between 23.12 and 23.91 per 100,000 person-years.[23] Anterior shoulder instability is the most common type, with a prevalence of 1.7% in the general population.[4,16] Men are at a particularly high risk of anterior shoulder instability, about 3 times that of women.[16] In previously reported cohort studies, the ratio of enrolled male to female patients is high, around 3.8% to 5.6%.[14,22,25] Consequently, male patients compose the majority of participants in existing studies, while female patients are underrepresented.

Given the paucity of female patients, although sex-based anatomic differences in shoulder instability are fairly investigated to some degree, studies regarding sex-related research of arthroscopic shoulder stabilization are few.[9] To our knowledge, the only prior cohort study involving the sex-based postoperative outcome differences was conducted by Kaipel et al[15]; these authors studied 36 patients (24 men, 12 women) undergoing arthroscopic shoulder stabilization and found that postoperative Constant score and shoulder stability were significantly lower in female patients.

It is generally reported that male sex predicts a significantly higher risk of recurrent instability after nonsurgical management of traumatic primary anterior shoulder dislocation.[23,39] However, sex-based differences in recurrence rates after stabilization surgery have been controversial. Porcellini et al[29] found that recurrence rates for male and female patients were 10.1% and 2.8%, respectively (*P* = .02). Based on the pooled data from 5 previously published studies, Randelli et al[30] reported an overall recurrence rate of 15.0% (96/642) in men compared with 8.7% (20/230) in women (*P* = .02). However, women have also been found to have a higher risk of recurrence.[21] Bradley et al[5] found that female athletes were significantly more likely to undergo revision surgery after arthroscopic posterior shoulder capsulolabral repair (*P* = .001; OR = 4.47). Another study reported no difference in recurrence rates between the sexes.[30]

The purpose of this study was to investigate sex-based differences in clinical outcomes of patients who underwent arthroscopic anterior shoulder stabilization. It was hypothesized that the clinical outcomes of female patients after arthroscopic anterior shoulder stabilization would be similar to those of male patients.

METHODS

Study Design

This study was approved by the health sciences institutional review board of our hospital, and informed consent was obtained from all participants. Patients who underwent arthroscopic shoulder stabilization between February 2010 and December 2017 were retrospectively included. The study inclusion criteria were patients who were diagnosed with anterior glenohumeral instability, underwent arthroscopic Bankart repair alone or Bankart repair with remplissage, had a Bankart or ALPSA (anterior labroligamentous periosteal sleeve avulsion) lesion under arthroscopy, and had a minimum of 2 years of follow-up data.

The exclusion criteria were patients who had posterior shoulder instability or multidirectional instability, were diagnosed with a rotator cuff tear or frozen shoulder, underwent a Latarjet procedure or an open surgery, had bilateral surgery or previous surgery on either the ipsilateral or contralateral shoulder, and were diagnosed with a glenoid bone defect larger than 25% or superior labral anterior posterior (SLAP) lesion under arthroscopy.

Surgical Technique

The procedure of arthroscopic shoulder stabilization was performed by a senior surgeon (S.C.) with an assistant according to previously established methods.[27,42] All patients were under general anesthesia in the lateral decubitus position during the surgery. A diagnostic arthroscopy for Bankart lesion, ALPSA lesion, Hill-Sachs lesion, SLAP lesion, glenoid bone defect, rotator cuff tear, and other concomitant injuries through a standard posterior portal was performed. The dynamic examination of the affected arm was performed to confirm the diagnosis. Bankart lesions and ALPSA lesions were repaired by fixing the capsulolabral tissues to the glenoid rim with 2 to 5 anchors (2.9-mm Lupine; Mitek). Whether the Hill-Sachs lesion engaged with the anterior glenoid rim was examined based on a previous study.[8] Engaging Hill-Sachs lesions or Hill-Sachs lesions with a tendency to be engaged were treated with an additional remplissage procedure by implanting 1 or 2 suture anchors (4.5-mm Biocorkscrew; Arthrex). When the glenoid bone defect was less than 25% in size, no bone graft was needed.

Postoperative Rehabilitation

All patients underwent a standardized rehabilitation plan. A sling was worn on the operated arm, which was kept in 15° of abduction within 6 weeks postoperatively. Passive shoulder flexion and external rotation at 90° of abduction were initiated after 6 weeks postoperatively. Wall slides, internal rotation stretching, stretching training of abduction-external rotation at 90° of abduction, and isometric strengthening exercises were carried out after 3 months. About 6 months after surgery, the patient was evaluated by the surgeon before being allowed to return to previous activities.

Outcome Evaluations

Preoperative information and intraoperative findings were obtained from the medical records and confirmed with the patients during postoperative follow-up. Recurrence was defined as at least 1 episode of postoperative shoulder

§Address correspondence to Shiyi Chen, MD, PhD, Sports Medicine Institute, Department of Sports Medicine and Arthroscopy, Huashan Hospital, Fudan University, Shanghai 200040, People's Republic of China; or Jianjun Yang, MD, PhD, Department of Orthopaedics, Tenth People's Hospital of Tongji University, Shanghai 200072, People's Republic of China (email: shiyi_chen@fudan.edu.cn; yangjianjun0311@163.com).

*Sports Medicine Institute, Department of Sports Medicine and Arthroscopy, Huashan Hospital, Fudan University, Shanghai, People's Republic of China.

†Department of Radiology, Huashan Hospital, Fudan University, Shanghai, People's Republic of China.

‡Department of Orthopaedics, Tenth People's Hospital of Tongji University, Shanghai, People's Republic of China.

M.C. and S.F. contributed equally to this work.

TABLE 1
Patient Characteristics[a]

	Female (n = 15)	Male (n = 61)	P Value
Age at surgery, y	28.9 ± 9.1	25.9 ± 6.3	.257
Age at initial instability, y	22.7 ± 6.9	21.2 ± 4.7	.508
Follow-up time, mo	54.6 ± 19.5	67.4 ± 30.8	.190
Preoperative dislocations	7.0 ± 3.5	6.6 ± 3.6	.565
Duration of symptoms, mo	77.0 ± 86.6	57.8 ± 55.5	.760
Dominant arm affected	10 (66.7)	34 (55.7)	.442
Cause of initial shoulder instability			.091
Sports	6 (40.0)	39 (63.9)	
Nonsports	9 (60.0)	22 (36.1)	
Contact sports	2 (13.3)	39 (63.9)	.001

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

TABLE 2
Intraoperative Findings[a]

	Female (n = 15)	Male (n = 61)	P Value
Repair technique			.387
Bankart repair alone	9 (60.0)	29 (47.5)	
Bankart repair with remplissage	6 (40.0)	32 (52.5)	
Bankart lesion	7 (46.7)	35 (57.4)	.455
ALPSA lesion	8 (53.3)	26 (42.6)	.455
Hill-Sachs lesion	10 (66.7)	45 (73.8)	.581
Glenoid bone defect <25%	1 (6.7)	11 (18.0)	.492

[a]Data are presented as n (%). ALPSA, anterior labroligamentous periosteal sleeve avulsion.

dislocation or subluxation. Preoperative evaluations included the visual analog scale (VAS) score for pain; Rowe score;[32] Constant score;[10] and active range of motion (ROM), including forward flexion, abduction, external rotation at 90° of abduction, and internal rotation. In addition to preoperative functional scores and ROM, postoperative evaluations were supplemented with the American Shoulder and Elbow Surgeons (ASES) score,[20] Simple Shoulder Test (SST) score,[3] Oxford Shoulder Instability Score (OSIS),[12] Single Assessment Numeric Evaluation (SANE) score,[40] and recurrence rate.

Magnetic Resonance Imaging Assessment

Magnetic resonance imaging (MRI) assessments were completed by a surgeon (M.C.) and an experienced radiologist (Y.X.), both of whom were blinded to the patient grouping. The operated shoulder was assessed postoperatively using a 3.0-T machine (Magnetom Verio; Siemens) equipped with an 8-channel shoulder coil. The sequences mainly included T1, T2, proton density, fat suppression, and water excitation. The cartilage was evaluated using axial 3-dimensional proton-density sequences with fat suppression and water excitation.[13] According to the method of Yoo et al,[43] the parameters measured on axial images were anterior labrum glenoid height index (LGHI) and anterior labral slope, while inferior LGHI and inferior labral slope were measured on coronal images. Cartilage thickness on the humeral head side and the glenoid side were measured from 3 consecutive axial planes around the largest diameter of the humeral head: anterior, middle, and posterior.

Statistical Analysis

The sample-size estimation was performed before patient involvement. The recurrence rate was selected as the endpoint. The recurrence rate of male and female patients was respectively based on the reports of van der Linde et al[37] and Balg and Boileau.[2] The α level was set at .05, the statistical power was 0.8, and the distribution ratio was 4 between reported epidemiological studies[16,28] and enrollment in the previous cohort studies.[7,11,16,17] The calculation

indicated that at least 36 male patients and 9 female patients were needed to detect a significant difference.

Continuous variables, presented as mean ± SD, were analyzed with a Mann-Whiney U test, and categorical variables, presented as n (%), were compared using Pearson chi-square tests and continuity correction in the chi-square test. The risk ratio of recurrence was calculated. SPSS Statistics 26 (IBM) and STATA 16.0 (StataCorp) software were used to conduct statistical analyses. $P <.05$ was considered statistically significant.

RESULTS

A total of 108 patients met the inclusion criteria, and 76 (70.4%) patients were available for the final follow-up. Of these, 61 patients were male and 15 patients were female. The mean follow-up time of the 76 patients was 64.9 ± 29.3 months (range, 29-123 months).

Patient Characteristics and Intraoperative Findings

Patient characteristics are reported in Table 1. The 2 groups did not differ significantly in characteristics, except for less contact sports participation in women (13.3% vs 63.9%; P = .001). No postoperative complications were reported. No significant differences were found between the 2 groups in terms of operative technique and intraoperative findings (Table 2).

Results of Outcome Evaluations

The pre- and postoperative shoulder function scores and active ROMs are shown in Table 3. Compared with male patients, female patients had a significantly lower preoperative Constant score (94.4 ± 6.4 vs 85.4 ± 11.1; P = .002), forward flexion (173.8° ± 10.7° vs 154.0° ± 33.8°; P = .011), abduction (171.0° ± 18.4° vs 142.7° ± 39.9°; P = .001), and external rotation (76.6° ± 21.6° vs 67.7° ± 20.4°; P = .037). Postoperatively, female patients had a significantly lower SST score compared with men (8.8 ± 1.9 vs 10.3 ± 1.6; P = .005), but the difference was less than the minimal clinically important difference (MCID) for the SST score after shoulder arthroplasty (2.4 points).[34] The recurrence rate

TABLE 3
Clinical Outcomes[a]

	Preoperative			Postoperative		
	Female (n = 15)	Male (n = 61)	P Value	Female (n = 15)	Male (n = 61)	P Value
VAS pain score	2.7 ± 3.5	1.1 ± 2.2	.065	1.1 ± 1.9	0.8 ± 1.5	.452
Functional scores						
Rowe	41.8 ± 28.3	56.8 ± 16.1	.136	85.4 ± 17.9	88.3 ± 14.2	.967
Constant	85.4 ± 11.1	94.4 ± 6.4	**.002**	95.3 ± 5.0	95.2 ± 5.9	.994
ASES	—	—	—	89.8 ± 13.7	92.6 ± 10.4	.319
SST	—	—	—	8.8 ± 1.9	10.3 ± 1.6	**.005**
OSIS	—	—	—	38.6 ± 8.0	39.1 ± 8.0	.862
SANE	—	—	—	84.5 ± 14.6	85.6 ± 13.5	.774
Active ROM, deg						
Forward flexion	154.0 ± 33.8	173.8 ± 10.7	**.011**	178.0 ± 7.7	177.8 ± 9.5	.988
Abduction	142.7 ± 39.9	171.0 ± 18.4	**.001**	178.7 ± 5.2	178.3 ± 8.7	.824
External rotation	67.7 ± 20.4	76.6 ± 21.6	**.037**	87.3 ± 5.9	82.9 ± 11.2	.121
Internal rotation, vertebra	T10 ± 5	T8 ± 3	.128	T8 ± 3	T9 ± 3	.434
Recurrence	—	—	—	2 (13.3)	9 (14.8)	≥.999
Resumed activities of daily living	—	—	—	15 (100)	61 (100)	—

[a]Data are presented as mean ± SD or n (%). Bolded *P* values indicate statistically significant difference between sexes. Dashes indicate that the data was not collected in the study. ASES, American Shoulder and Elbow Surgeons; OSIS, Oxford Shoulder Instability Score; ROM, range of motion; SANE, Single Assessment Numeric Evaluation; SST, Simple Shoulder Test; T, thoracic; VAS, visual analog scale.

TABLE 4
Mean Changes From Preoperative to Postoperative
Evaluation[a]

	Female (n = 15)	Male (n = 61)	P Value
VAS pain[b]	−1.6 ± 3.5	−0.3 ± 2.4	.309
Rowe	43.6 ± 21.4	31.5 ± 19.8	**.044**
Constant	9.9 ± 8.9	0.8 ± 8.1	**.002**
Forward flexion	24.0 ± 36.2	4.2 ± 10.9	**.013**
Abduction	36.0 ± 38.3	7.6 ± 18.4	**<.001**
External rotation	19.7 ± 21.3	6.7 ± 26.2	**.023**
Internal rotation[b]	−1T ± 6	0T ± 4	.426

[a]Data are presented as mean ± SD. Bolded *P* values indicate statistically significant difference between sexes. VAS, visual analog scale.

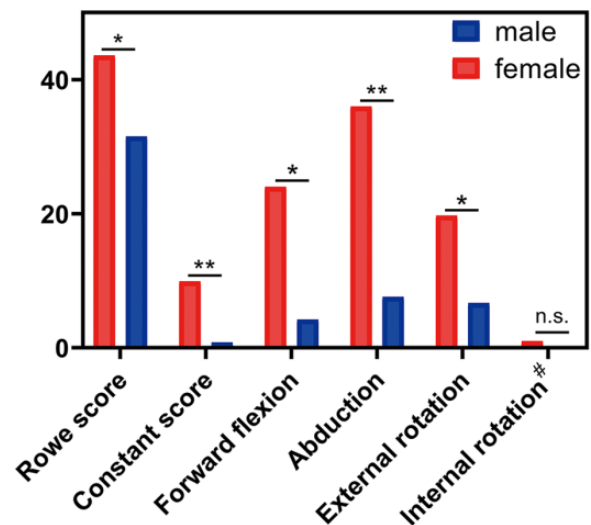[b]A negative difference indicated improvement after surgery in these evaluations.

Figure 1. Mean pre- to postoperative changes in outcomes between the sexes. *P < .05; **P < .01; n.s., not significant. #Absolute values were used in place of negative numbers.

was not significantly different between female and male patients (13.3% vs 14.8%; *P* ≥ .999; risk ratio, 1.107 [95% CI, 0.266-4.597]). All patients were able to resume activities of daily living postoperatively.

The pre- to postoperative changes in outcomes are shown in Table 4. Both groups had significant postoperative improvements in VAS, Rowe, and Constant scores as well as active ROM, with the exception of internal rotation in the male patients. The mean changes in outcomes were all higher in women compared with men (Figure 1). The improvement in female patients was significantly greater than in male patients regarding the Rowe score (43.6 ± 21.4 vs 31.5 ± 19.8; *P* = .044), the Constant score (9.9 ± 8.9 vs 0.8 ± 8.1; *P* = .002), forward flexion (24.0 ±

36.2 vs 4.2 ± 10.9; *P* = .013), abduction (36.0 ± 38.3 vs 7.6 ± 18.4; *P* < .001), and external rotation (19.7 ± 21.3 vs 6.7 ± 26.2; *P* = .023). For the Rowe score, this difference in improvement (12.1 points) between the sexes was greater than the reported MCID of 9.7 points.[26] The MCID for the Constant score has not been evaluated for arthroscopic shoulder stabilization but has been reported as 8 points for reverse shoulder arthroplasty.[36] The difference in improvement of Constant score between the sexes was 9.1 points in the current study.

TABLE 5
MRI Assessments[a]

	Female (n = 11)	Male (n = 37)	P Value
Labrum			
Anterior LGHI	3.2 ± 0.6	3.2 ± 0.7	.755
Inferior LGHI	2.7 ± 0.6	2.7 ± 0.6	.893
Anterior labral slope, deg	27.6 ± 3.8	26.5 ± 2.8	.137
Inferior labral slope, deg	25.2 ± 1.7	26.1 ± 2.6	.220
Cartilage			
Thickness (humeral head side), mm			
Anterior	1.4 ± 0.2	1.4 ± 0.1	.719
Middle	1.3 ± 0.1	1.3 ± 0.2	.628
Posterior	1.4 ± 0.1	1.4 ± 0.2	.793
Thickness (glenoid side), mm			
Anterior	1.3 ± 0.2	1.4 ± 0.1	.067
Middle	1.3 ± 0.1	1.3 ± 0.2	.966
Posterior	1.3 ± 0.1	1.4 ± 0.2	.192

[a]Data are presented as mean ± SD. LGHI, labrum glenoid height index; MRI, magnetic resonance imaging.

Results of MRI Assessment

Of the 76 study patients, 48 (63.2%; 11 women and 37 men) were willing to undergo a postoperative MRI. Results indicated that there were no statistically significant differences between the sexes on any of the MRI parameters measured (Table 5).

DISCUSSION

To our knowledge, this was the first study that compared pre- and postoperative shoulder function and active ROM between 2 sexes to evaluate sex-based differences in clinical outcomes of arthroscopic anterior shoulder stabilization. This study serially evaluated the clinical outcomes after arthroscopic anterior shoulder stabilization and analyzed the sex-based differences in them. The most important finding was that most clinical outcomes of women were no worse than those of men and that women had even greater improvements in shoulder function scores and active ROM.

Three factors—physiological, psychological, and social—may be related to the present findings. In terms of physiological factors, the reported anatomic difference between male and female glenohumeral joints lies in the glenoid anatomy and humeral head size but not in joint laxity and glenohumeral relationships.[19,33,38] The glenoid of women is smaller, taller, and thinner than that of men. The oval-shaped glenoid makes women more prone to shoulder instability, especially multidirectional shoulder instability.[9,41] Based on the MRI assessments in this study, there was no difference in the labrum and cartilage thickness between the sexes. It was suggested that structural similarities might not affect the clinical outcomes, including the recurrence rate of women.

In terms of psychological factors, women might be more sensitive to pain and apprehensiveness about the disease. In this study, postoperative SST scores of the female patients were significantly lower than those of the male patients, although other postoperative functional scores and active ROM of the female patients were similar to or higher than those of the male patients. This might be because the SST score consists of 12 yes or no questions about whether the patient can perform activities of daily living, which are supposed to be answered by the patients. Lacking testing data with sufficient measurement properties, this score mainly focuses on the subjective feelings of the patients.[1] However, the subjective satisfaction of female patients with shoulder instability or other shoulder diseases has been reported to be insufficient compared with male patients. Largacha et al[18] conducted a study reporting 2674 patients having 1 of the 16 most prevalent shoulder diagnoses. The results showed that sex had a differential effect on the self-assessments, in which female patients tended to identify greater deficits in comfort and the SST score than male patients. A deficit in comfort was also found in female patients undergoing rotator cuff decompression or rotator cuff repair. Razmjou et al[31] found that female candidates for rotator cuff—related surgeries reported more frustration and depression because of the shoulder as well as more anxiety about the effect of their shoulder's condition on their occupation.

Notably, the preoperative Constant score of women was lower than that of men in this study. According to the literature, certain shoulder functional scores can be biased by sex, such as the Constant score. Brinker et al[6] investigated 120 healthy collegiate or recreational athletes and found that men had significantly higher Constant scores than women, primarily because of the strength subscale. In contrast, the pre-1994 ASES score and OSIS had mostly negligible variance attributable to sex.[6] Therefore, it was suggested that examiners should adopt the Constant score with caution when evaluating patients of different sexes, as women might be underestimated because of their inferior physical strength. Furthermore, the present results gave a hint that the change in Constant score from preoperatively to postoperatively, rather than absolute value, might be more precise for analyzing the difference in therapeutic efficacy of arthroscopic stabilization between sexes.

In terms of social factors, women's activity intensity is lower than that of men in both daily life and sports, regardless of professional athletes. For preferred sports, women are less likely to engage in contact sports than men. Meanwhile, men are larger, so involvement in contact sports results in higher forces to the shoulder. As in this study, the contact sports participation rate of women was significantly lower than that of men (P = .001). Low postoperative activity intensity and rare participation in contact sports result in a lower risk of recurrence.[24,35]

Based on this study, advice for future sex-related investigation regarding shoulder function after arthroscopic stabilization can be offered. First and foremost, the shoulder functional scores that are less affected by sex, such as the Rowe score, ASES score, and OSIS, are recommended to reduce bias. Besides, more attention should be paid to the postoperative recovery of shoulder function and active ROM in male patients, as they might not get the desired improvements in shoulder function and active ROM

compared with female patients. Last but not least, physiological, psychological, and social factors should all be taken into consideration when counseling patients before and after surgery to ensure suitable treatment and rehabilitation based on the sex difference in clinical outcomes.

There were some limitations in the current study. First, biases and inaccuracies associated with retrospective studies could not be avoided. Second, like other shoulder instability cohort studies, the rate of female patients enrolled was lower than that reported in epidemiology studies. As a result, the number of female patients was relatively small. Further study with a larger sample size for female patients in the general population is needed. Third, the lack of preoperative ASES score, SST score, OSIS, and SANE score made a more detailed comparison of pre- and postoperative shoulder function impossible.

CONCLUSION

Women have similar recurrence rates to men after anterior shoulder stabilization. Most postoperative clinical outcome measures showed no significant difference. Despite worse preoperative values, women showed significantly greater improvements in postoperative shoulder function and active ROM compared with men.

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