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# Shoulder Functional Performance Status of National Collegiate Athletic Association Swimmers

## Baseline Kerlan-Jobe Orthopedic Clinic Scores

Lucas Wymore,<sup>\*†</sup> MD, and Jan Fronek,<sup>†</sup> MD

*Investigation performed at the Department of Orthopedic Surgery, Scripps Clinic, La Jolla, California, USA*

**Background:** Shoulder trouble, described in the literature as “swimmer’s shoulder,” has been associated with competitive swimmers. The Kerlan-Jobe Orthopedic Clinic (KJOC) Shoulder and Elbow Score is a validated survey used to define functional and performance measures of the upper extremity in overhead athletes. To date, no study has investigated the baseline functional scores for swimmers actively competing in the sport.

**Purpose:** To establish a baseline score for National Collegiate Athletic Association (NCAA) swimmers actively competing in the sport.

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

**Methods:** After institutional review board approval, the KJOC Shoulder and Elbow Score was administered to 5 NCAA swim teams (N = 99 participants; 46 men, 53 women). The results on 10 specific individual questions and on the total score were calculated according to the survey’s original description. The mean scores were calculated for all participants. The Mann-Whitney *U* test was used to determine differences between sexes, years swimming, and self-reported injury status.

**Results:** The mean  $\pm$  SD baseline KJOC score (out of a possible 100) for all participants was  $79.0 \pm 18.7$ ; the mean score for men was  $81.9 \pm 15.6$  and for women  $76.6 \pm 20.8$ . The score for athletes identifying themselves as injured at baseline was  $53.9 \pm 18.8$ , compared with  $84.4 \pm 13.6$  for those not reporting as injured ( $P < .001$ ). Athletes competing  $\geq 11$  years had a mean score of  $72.0 \pm 22.1$ ; those competing  $\leq 10$  years scored  $86.4 \pm 11.4$  ( $P = .007$ ).

**Conclusion:** Baseline scores for swimmers, which were lower than expected, were lower than baseline scores seen in studies of other overhead sports athletes. The data corroborate previous studies identifying swimmers as having a high level of shoulder trouble. Further research is indicated for improving shoulder symptoms and performance in competitive swimmers.

**Keywords:** shoulder; swimming; athletic training; clinical assessment; KJOC scores

Competitive swimming has been associated with shoulder trouble among participants, with a prevalence of 41% to 90% of participants reporting shoulder pain.<sup>4,21,23</sup> The term “swimmer’s shoulder” was first used by Kennedy and Hawkins<sup>9</sup> in 1974 to describe this phenomenon.

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Several authors have attempted to explain the pathologic changes. Tendinopathy and instability are commonly thought to be the cause of shoulder pain. More uncommon causes include suprascapular nerve compression, os acromiale, and thoracic outlet syndrome, as reported in small series and case reports.<sup>2,3,6</sup> Swimmers train 18,000 to 20,000 yards per day at the elite level.<sup>10</sup> Several investigators have examined training volume as an underlying cause of swimmer’s shoulder.<sup>12,13,20</sup> Hand paddles, painful passive stretching, and heavy weights have been associated with increased risk for the development of swimmer’s shoulder.<sup>13</sup> The majority of research has focused on swimmers with painful shoulders. Few studies have investigated healthy swimmers, and many of these focused on biomechanics of the swimming strokes.<sup>5,16,17,19</sup>

The Kerlan-Jobe Orthopedic Clinic (KJOC) score was developed as a quantitative measure of function and

performance of the upper extremity in overhead athletes.<sup>1</sup> This validated score has been used previously to calculate baseline scores in asymptomatic professional pitchers.<sup>11</sup> To our knowledge, no study has attempted to define a baseline score for active collegiate swimmers.

The purpose of this study is to identify a baseline KJOC score for swimmers currently competing in the sport. We hypothesized that baseline scores in competitive swimmers will be high, similar to scores reported in the literature for athletes active in overhead sports.

## METHODS

### Study Participants

The participants in this study were from 5 National College Athletic Association (NCAA) swimming teams (99 athletes; 2 men's teams, 3 women's teams). This represents the highest level of collegiate swimming in the United States, with elite athletes training 18,000 to 20,000 yards per day<sup>10</sup> and competing usually from October until March. For this study, men's and women's teams from the same university were considered separate teams, as some universities do not offer swimming for both sexes. Both men's and women's teams were invited to participate. Eight teams from 5 universities were contacted. Two teams from 1 university declined participation because of university policy regarding participation in research projects. One team from 1 university declined because of a scheduling conflict. All stroke specialties were included. Divers were excluded from the study. For the purpose of the study, only active athletes were eligible for participation. An "active athlete" was defined as one currently swimming with his or her university team, consistent with the definition used in previous work with professional pitchers.<sup>11</sup> Postoperative athletes were included if they met the definition of "active athlete."

### Study Procedures

An introduction letter was sent to the coaching staff of collegiate swim teams in the NCAA detailing the study and inviting their athletes to participate. Appointments were made during a team practice early in the fall of the 2013 swimming season for data collection to ensure that the time in the season was consistent. A member of the research team (L.W.) administered the survey in person and was available to answer study-related questions. All participation was voluntary; no athletes declined participation. The study protocol was reviewed by our institutional review board and was granted exempt status.

A letter was provided to participants detailing the study. After consent, the KJOC Shoulder and Elbow Score survey was given to all participants. The survey took approximately 10 minutes to complete. The survey includes demographic questions and items specific to performance of the shoulder. Participants were instructed to complete the survey with their current condition; no

identifying information was collected. After completion, the scores were calculated according to the original description,<sup>16</sup> and participants were given a deidentified study ID number. The scores and demographic information were entered into a database for analysis.

### Study Measures

The KJOC score is a 10-item score developed to quantify function of the upper extremity in overhead athletes. The 10 items are divided into two 5-item sections: function and performance. Each item is followed by a 10-cm line, and athletes are asked to mark their response in the style of a visual analog scale. Higher scores represent better function. Individual questions are scored in centimeters from 0 to 10, with 10 being the highest score. The individual scores are added for a total score from 0 to 100, with 100 being a perfect score.

### Statistical Analysis

Descriptive analysis was used to define the means of the group. Because the data were not normally distributed, further analysis using Mann-Whitney *U* test and Wilcoxon signed rank test was used to examine between groups by sex and demographic information. We compared groups based on injury status and years swimming.

## RESULTS

The mean age of the respondents was 19.4 years (range, 17-23 years; SD,  $\pm 1.3$  years). Four of the 99 surveys were returned incomplete and were excluded from final analysis for total score and group comparisons. Their responses to individual questions were included. Eighty-one swimmers responded they were not currently injured, 18 that they were currently injured. Sixty-seven athletes stated that they were competing without arm trouble, 28 said that they were competing with arm trouble, 1 was not competing because of arm trouble, and 3 did not respond. Those identifying themselves as injured also stated they were competing with arm trouble. The athlete who responded as not competing because of arm trouble was excluded, as the respondent did not meet the definition of an active athlete. Thirty-seven swimmers responded that they had been competing  $\leq 10$  years, 44 responded  $\geq 11$  years, and 18 did not respond to this question. The results are summarized in Table 1.

The KJOC score (mean  $\pm$  SD) of all athletes surveyed was  $79.0 \pm 18.7$ ; the score was  $81.9 \pm 15.6$  for male swimmers and  $76.6 \pm 20.8$  for female swimmers. This difference was not significant ( $P = .357$ ). Swimmers classifying themselves as injured had a significantly lower score ( $53.9 \pm 18.8$ ) compared with those stating they were not currently injured ( $84.4 \pm 84.4$ ;  $P < .001$ ). The mean scores for swimmers competing without arm trouble was significantly higher ( $85.9 \pm 12.8$ ) compared with swimmers competing

TABLE 1  
Summary of Results<sup>a</sup>

Characteristic	n (%)	KJOC Score, mean $\pm$ SD	P Value
Sex			.357
Male	46 (46.4)	81.9 $\pm$ 15.6	
Female	53 (53.6)	76.6 $\pm$ 20.8	
Injury status			<.001
Currently injured	18 (18.2)	53.9 $\pm$ 18.8	
Not currently injured	81 (81.8)	84.43 $\pm$ 13.6	
Arm trouble			<.001
Competing with arm trouble	28 (29.5)	60.0 $\pm$ 18.9	
Competing without arm trouble	67 (70.5)	85.9 $\pm$ 12.8	
Years competing			.007
$\leq 10$	37 (45.7)	86.4 $\pm$ 11.4	
$\geq 11$	44 (54.3)	72.0 $\pm$ 22.1	
Age, y			.132
$\leq 19$	55	81.8 $\pm$ 17.2	
$> 19$	44	75.6 $\pm$ 20.2	
Overall score	99 (100)	79.0 $\pm$ 18.7	

<sup>a</sup>KJOC, Kerlan-Jobe Orthopedic Clinic.

TABLE 2  
Results for Each KJOC Question<sup>a</sup>

Question	Mean $\pm$ SD	Range	95% CI
How difficult is it for you to get loose or warm before competition or practice?	6.46 $\pm$ 2.75	0.9-10	5.91-7.01
How much pain do you experience in your shoulder?	7.18 $\pm$ 2.76	0-10	6.63-7.73
How much weakness and/or fatigue (ie, loss of strength) do you experience in your shoulder?	7.06 $\pm$ 2.56	0-10	6.55-7.57
How unstable does your shoulder feel during competition?	8.06 $\pm$ 2.51	0-10	7.56-8.56
How much have arm problems affected your relationship with your coaches, management, and agents?	9.06 $\pm$ 2.02	0-10	8.64-9.47
How much have you had to change your stroke due to your arm?	8.11 $\pm$ 2.39	0-10	7.62-8.59
How much has your velocity and/or power suffered due to your arm?	8.16 $\pm$ 2.45	0-10	7.66-8.66
What limitation do you have in endurance in competition due to your arm?	7.90 $\pm$ 2.57	0-10	7.38-8.42
How much has your control suffered due to your arm?	8.56 $\pm$ 2.07	1.4-10	8.14-8.99
How much do you feel your arm affects your current level of competition (ie, is your arm holding you back from being at your full potential)?	8.33 $\pm$ 2.25	1-10	7.87-8.79
Total	78.96 $\pm$ 18.73	29.2-100.0	75.15-82.78

<sup>a</sup>KJOC, Kerlan-Jobe Orthopedic Clinic.

with arm trouble (60.0  $\pm$  18.9;  $P < .001$ ). Athletes competing  $\leq 10$  years scored 86.4  $\pm$  11.4, significantly higher compared with those competing  $\geq 11$  years (72.0  $\pm$  22.1;  $P = .007$ ). There was no difference between KJOC scores in athletes aged 19 years and younger (81.8  $\pm$  17.2) and those older than 19 years (75.6  $\pm$  20.2;  $P = .132$ ).

Mean scores by individual questions are summarized in Table 2. The lowest score was in response to question 1, "How difficult is it for you to get warm before competition or practice?" (6.46  $\pm$  2.75). The highest score was in response to question 5, "How much have arm problems affected your relationship with your coaches, management, and agents?" with a mean of 9.06  $\pm$  2.0.

## DISCUSSION

Our results showed that the swimmers have a significant amount of shoulder trouble at baseline. As expected, those

athletes competing with injury or arm trouble have a significantly lower score than their peers without injury or arm trouble. The final mean score of 79.0 was lower than we expected in athletes active at an elite level. The significant difference between groups swimming  $\leq 10$  years and  $\geq 11$  years would also argue toward a cumulative effect as a cause of shoulder pain in swimmers. It is interesting that question 1 regarding warm-up was the lowest scoring individual question. Published research shows that warm-up protocols can deter injury.<sup>23</sup> If athletes had difficulty feeling warmed up before practice or competition, this could theoretically lead to increased arm trouble.

To our knowledge, this project is the first to use the KJOC score to establish a baseline score among active swimmers. Because of this, no literature is available for direct comparison. The overall score of 79.0 would indicate a level of arm trouble that interferes with athletic performance when compared with published reports from other

overhead sports. In the initial description of the KJOC score, Alberta et al<sup>1</sup> reported a mean KJOC score of 94.4 for athletes without arm pain (compared with 85.9 in our study) and 64.1 for those competing with pain (compared with 60.0 in our study). The initial study included 38 swimmers out of 282 total athletes, which also included baseball, volleyball, water polo, tennis, diving, football, softball, and golf. No analysis by sport was reported. Kraeutler et al<sup>11</sup> studied healthy minor league baseball pitchers with a mean KJOC score of 94.82 for all pitchers. The investigators' definition of "healthy pitcher" was a pitcher active at his assigned level. This was similar to our definition of "active" for swimmers. The conclusion was that healthy pitchers should have baseline scores above 90. Our study shows that active swimmers have KJOC scores that are similar to reported scores in injured or postoperative athletes. Domb et al<sup>7</sup> reported on KJOC scores in throwers after ulnar collateral ligament reconstruction at a mean of 38.2 months (range, 12-92 months). The investigators concluded that a KJOC score above 81.3 indicates with 95.1% accuracy that a patient is ready to return to play. This score, in athletes returning from surgery, is still higher than the baseline scores we found for active swimmers. Wei et al<sup>22</sup> reported a KJOC score of 60.3 among Little League players with medial elbow pain. Neuman et al<sup>15</sup> showed a KJOC score of 73.6 after arthroscopic superior labrum anterior-posterior (SLAP) repair in throwing athletes. Jones et al<sup>8</sup> reported postoperative results for overhead athletes with instability after capsular plication, showing KJOC scores of 82 at final follow-up.

Swimming literature has demonstrated a high rate of shoulder pain in the sport. McMaster and Troup<sup>14</sup> reported a current incidence of shoulder pain of 26% in elite swimmers, with a career incidence of 73%. Wolf et al<sup>24</sup> reported similar data. Over a 5-year span at a single university, the swim teams had an overall injury rate of 72.7% (32/44 men) and 70.0% (35/50 women). Wymore et al<sup>25</sup> showed that regardless of stroke specialty, more than 50% of swimmers have at least 1 day per week of shoulder pain. Richardson et al<sup>18</sup> reported an overall rate of shoulder pain of 42% among swimmers. Kennedy and Hawkins<sup>9</sup> reported on 81 of 2496 (3%) Canadian swimmers with shoulder pain. This low percentage has never been duplicated. The low KJOC score we report is consistent with historic reports of high incidence of shoulder pain in swimmers.

This study had several strengths. This is the first study to identify baseline scores, which contributes to the swimming literature. A validated scoring system specific to overhead athletes was used, and we followed procedures similar to those used to study other sports.<sup>11</sup> The number of athletes participating was high. Our study also has limitations. The KJOC survey is subjective and self-reported, which can be subject to recall bias. Although anonymity was ensured at the time of participation, some athletes may have chosen not to disclose more pain or lower function for fear of losing opportunities for competition or scholarship. The low average scores would indicate that the athletes were truthful in their answers. Because we only selected collegiate athletes, generalization of the

results may be inappropriate to youth swimmers or recreational athletes. Previous survey studies indicated that youth swimmers had a lower incidence of both current (10% vs 26%) and career (47% vs 73%) shoulder pain when compared with elite athletes.<sup>14</sup> This is in line with our data, which show significantly lower KJOC scores in athletes competing for 11 years or more. Further studies would be needed to identify a difference, if any, in their baseline functional scores.

The baseline KJOC scores in competitive swimmers were lower than expected.<sup>1,7,11,22</sup> When compared with published reports in other sports, the scores are lower for active swimmers than for athletes in other overhead sports. The scores for active swimmers were more similar to those seen in injured athletes in other sports. Further research can be directed toward improving warm-up, as the question regarding warm-up had the lowest score among participants. Additional research into scores at different points of the season, to look for a difference when training focus changes from longer distance at lower speeds to less distance at higher speeds, may be beneficial. Physicians and athletic trainers who work with collegiate level swimmers can use these baseline scores for comparison when athletes have complaints of arm trouble. Lower scores may be a sign of injury and should prompt further work-up and treatment.

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