

Original Article

No correlation between stroke specialty and rate of shoulder pain in NCAA men swimmers

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ABSTRACT

Purpose: To establish an association between shoulder pain and the stroke specialization among NCAA men swimmers.

Materials and Methods: All members of the top 25 NCAA men's swim teams were invited to complete the survey. Eleven teams with a total of 187 participants completed the study survey. The teams were mailed surveys that included multiple choice questions regarding their primary stroke and their incidence of shoulder pain. Additionally, the survey included questions about risk factors including distance trained, type of equipment, weight training, and stretching.

Results: The analysis showed that there was no significant difference in the rates of shoulder pain among the four strokes and individual medley specialists. The other risk factors did not show a significant correlation with shoulder pain.

Conclusions: This study found no significant correlation between stroke specialty and shoulder pain in male collegiate swimmers.

Level of Evidence: Level 3.

Clinical Relevance: Descriptive epidemiology study.

Key words: competitive swimming, male swimmers, shoulder injuries, shoulder pain

INTRODUCTION

Competitive swimming has long been associated with shoulder pain,^[1,2] as 90% of the propulsion comes from the upper extremity.^[3] In addition, competitive swimmers usually train 6 to 7 days per week, 2 workouts per day, with yardage around 12,000–16,000 yards daily.^[4] It has been estimated that a swimmer training 10,000 yards per day takes around 400,000 strokes in a season.^[4] The amount of distance alone is a risk factor for shoulder injury; however, the different strokes used in swimming freestyle, backstroke, butterfly, and breaststroke may also present as another factor.

The biomechanics of the shoulder in butterfly, backstroke, and freestyle are very similar.^[4] The major difference is that freestyle and backstroke use a body roll during recovery and pull-through, whereas butterfly uses body lift. In fact, proper timing in the

stroke has shown butterfly to have a wave characteristic to it, and that finding an optimum frequency, amplitude, and phase characteristic could improve performance.^[5] Other published data show different muscle firing patterns in painful shoulders and non-painful shoulders.^[6] This study aims to prove a link between competitive swimmers who specialize in the butterfly stroke and have a higher risk of shoulder injury. If a statistically significant increase in the rate of shoulder injury among butterfly specialists could be proven to exist, it could be deduced that the stroke itself is responsible for injury, independent of other risks like the distance trained or technique used. It would suggest that high use of the butterfly stroke has an inherent risk to the shoulders.

MATERIALS AND METHODS

Study description

The study survey was mailed to the top 25 NCAA men's

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swim teams. The survey included questions pertaining to the incidence of swimmer's injuries, if any. The study was similar to that performed by Grote *et al.*,^[7] however, the shoulder was studied as opposed to the hip adductors. To eliminate gender differences that may bias the results, only men's teams were surveyed. No personal or identifying data were collected, to insure confidentiality among the participants.

The survey contained general questions about the athlete, such as age, height, weight, best stroke, age of entry into swimming, age of specialization into best stroke, and highest level of swimming attained. By surveying the top 25 teams, this study focused on those athletes who are among the country's most elite swimmers, and were on a similar level. However, there was still variation, from Olympic champions to conference team swimmers.

The survey also included questions about training in the water and out of the water. In addition, questions included distance per week, number of workouts per week, percentage of practice that was butterfly/best stroke, percentage of practice that used hand paddles, and participation in weight training, stretching, or other "dry land" exercises.

Finally, the survey asked for information about injuries. Questions included number of days of shoulder pain, severity of shoulder pain, number of days of training and competition missed, medical assistance sought, and types of treatment applied. The types of treatment included those that had been previously published with successful pain relief in competitive swimming.^[8] Space was also provided for additional comments.

This study was granted exemption from review status from the IRB based on 45 CFR 46.101(b)(2). The Department of Orthopedics funded the project.

Study protocol

The teams were selected from the final dual meet rankings of the 2004-2005 swimming season, as reported by the College Swimming Coaches Association of America, CSCAA, the official rankings of college swimming. All members of the swimming team were eligible and encouraged to participate in the study; however, we asked that members of the diving team not complete the questionnaire. The final team rankings were announced on March 10, 2005, and the top 25 teams (with rank and conference affiliation) were determined [Table 1].

The coaching staff of all teams was contacted either by phone or e-mail. Teams that agreed to participate were mailed packets containing the survey, pens, and a return envelope. Enough surveys were sent so that every member of the swimming team, but not the diving team, was able to participate. Participation was entirely voluntary, and participants were again reminded of the confidentiality of their answers.

Of the 25 teams, 11 teams agreed to participate, two teams declined participation, and 12 teams did not respond. The 11 participating teams returned 187 surveys. There were a total of 296 surveys sent to the teams, based on the number of swimmers listed on their men's team roster, obtained from each team's website. No surveys were sent to diving team members. This gave a total return rate of 63.1%. The institutional biostatistics department completed the analysis of the data using ANOVA, chi squared, and Fisher's exact test.

RESULTS

The primary outcome, days per week of shoulder pain, showed no significant difference between strokes [Figure 1]. The results showed that 43% of butterfly specialists reported no shoulder pain, and 73% reported shoulder pain 2 days per week or less. This is consistent with the other strokes—43% of breaststroke specialists, 42% of freestyle specialists, and 41% of backstroke specialists reported zero days of shoulder pain.

Additionally, the intensity of shoulder pain was not significantly different [Figure 2]. Using a scale of 1-5, with 5 being maximal shoulder pain, butterfly swimmers reported a similar intensity to other strokes. This level and frequency of pain had very little impact on practice and competition participation. Among butterfly specialists, 92% of athletes were not limited in butterfly training, and 8% were limited in 1-2 practices per week. The majority of swimmers specializing in other strokes also reported zero days of training limited by shoulder pain. Those reporting zero days of pain—individual medley (89%), Freestyle (82%), Backstroke (93%), and Breaststroke (72%)—is similar to butterfly swimmers. All butterfly swimmers reported that they had missed 0-3 competitions because of shoulder pain. All swimmers specializing in the individual medley, backstroke, and breaststroke also reported 0-3 competitions missed because of shoulder pain. Freestyle swimmers had 97% with 0-3 competitions missed, 2% with 4-6 competitions missed, and 2% missed greater than 12 competitions.

Table 1: Teams ranking in the top 25 in the final poll of the 2004-2005 season with their conference affiliation

California (Pac 10)	Minnesota (Big 10)	Georgia (SEC)	Texas A&M (Big 12)	Notre dame (Big East)
Auburn (SEC)	Texas (Big 12)	Kentucky (SEC)	Tennessee (SEC)	Florida State (ACC)
Stanford (Pac 10)	Arizona (Pac 10)	Indiana (Big 10)	Wisconsin (Big 10)	BYU (Mt. West)
Florida (SEC)	Southern Cal (Pac 10)	Northwestern (Big 10)	Hawai'i (NIC)	Harvard (Ivy)
Michigan (Big 10)	Virginia (ACC)	Purdue (Big 10)	North Carolina (ACC)	Ohio State (Big 10)

The bolded teams are those who participated in the study

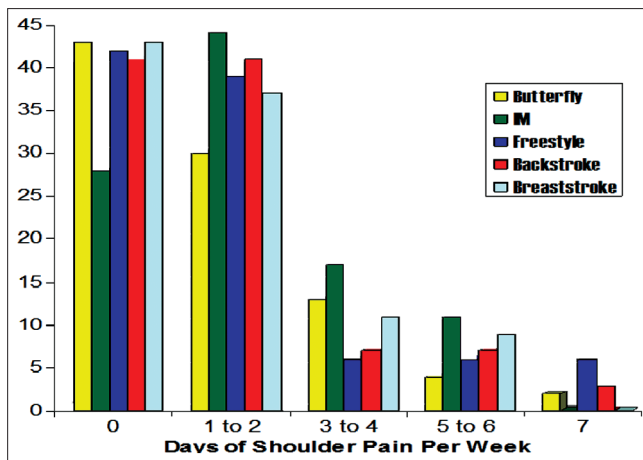


Figure 1: This table shows the percentage of athletes reporting the number of days of shoulder pain per week. As the figures show, the different strokes have a similar percentage of self reported injuries

Training was also found to be similar among the different strokes, specifically the distance trained. Swimmers reported training between 50,000 and 75,000 yards per weeks, with 88% of butterflyers, 83% of individual medley specialists, 58% of freestylers, 66% of backstrokers, and 70% of breaststrokers reporting this distance.

Hand paddles are used in approximately equal amounts for training among the different strokes. The most common response, using hand paddles between 20% and 40% of training, was selected by 54% of butterflyers, 61% of individual medley specialists, 42% of freestylers, 48% of backstrokers, and 41% of breaststrokers. These differences were not statistically significant.

Additional information was obtained regarding out of water training, including weight training, and stretching. The majority of athletes report participating in 2-3 weight training sessions per week. By stroke, this was reported as 65% of butterflyers, 89% of individual medley specialists, 76% of freestylers, 79% of backstrokers, and 80% of breaststrokers. These differences were not statistically significant. Of these, the majority reported that 40 to 60% of the workouts focused on upper body conditioning. By stroke, this was reported as 78% of butterflyers, 50% of individual medley specialists, 61% of freestylers, 66% of backstrokers, and 52% of breaststrokers. These differences were also not statistically significant. The results for stretching showed the greatest amount of variation among the participants. The most frequently given answer was 5-6 stretching sessions per week. This was answered by 17% of butterflyers, 67% of individual medley specialists, 39% of freestylers, 38% of backstrokers, and 33% of breaststrokers. These results were not statistically significant. The most common response among butterflyers was 4-5 sessions per week, which was chosen by 26% of the participants.

Athletes also had no difference among the different strokes in seeking medical treatment for their injuries. Fifty-eight percent

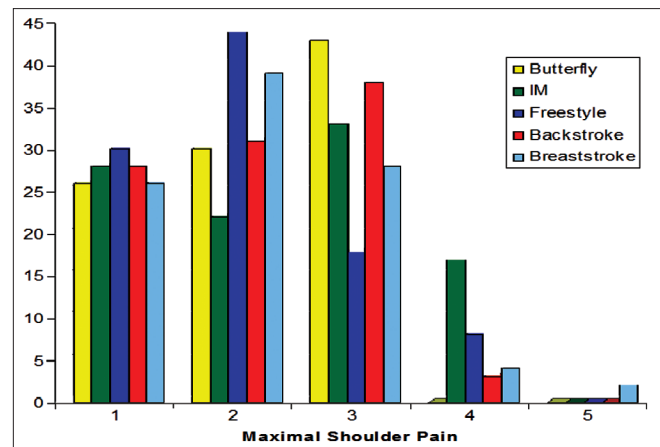


Figure 2: The maximal amount of shoulder pain reported is similar in percentage between the different strokes. Most athletes experience mild to moderate pain, while very few report severe pain. This is consistent across each stroke

of butterflyers consulted medical professionals, while individual medley swimmers (61%), freestylers (37%), backstrokers (59%), and breaststrokers (54%) were all similar ($P = 0.125$). Ice and rest were the most commonly selected forms of treatment, while only 5 of the 187 athletes required surgery.

The athletes were able to write their diagnosis, if known. Common injuries reported were consistent with repetitive motion and overuse type injuries, including tendonitis and bursitis. Additional injuries included adhesive capsulitis and rotator cuff tear.

DISCUSSION

The primary outcome of the study shows that no single stroke has a higher incidence of shoulder pain. This is contrary to the hypothesis for the study, which is that the butterfly stroke, based both on personal experience and biomechanical evidence previously published, is a risk for shoulder pain.^[5,6] The results of the study clearly disprove that hypothesis. This is further confirmed by the similarities among training patterns with this group of high level athletes. Figure 3, indicating distance per week, shows striking similarities in training. It is important to note that these different risk factors did not influence the results.

A recent study performed by Wolf *et al.*^[9] followed a single Division I university for five years, and showed a higher rate of injury in non-freestyle swimmers, with a relative risk of 1.33. To our knowledge, our study is the first to survey multiple teams. This can correct for injury rates that are due to the training protocol at a single university, also discussed by the authors. Additionally, our study focused only on men's teams to eliminate gender bias. Although this study followed both men's and women's teams, and did not prove a statistical difference in injuries by gender, there is still a chance gender could alter the rate of injury by stroke.

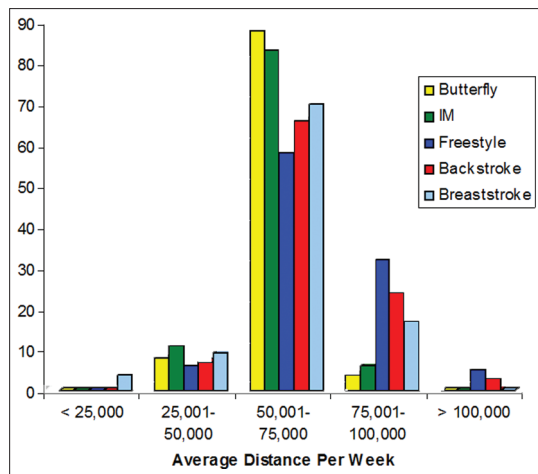


Figure 3: Training volume is not statistically different between the five specialties. Because the distance trained in each stroke is so similar, it is reasonable to assume that it is an independent risk factor for all swimmers, not a risk associated with ones best stroke

The injuries reported were almost exclusively overuse type, especially tendonitis. This is consistent with previously published data.^[10,11] Because these were not clustered around a specific stroke, it would be reasonable to conclude that the high volume of training for competitive swimming is responsible for the overuse injuries. This supports the link between competitive swimming and painful shoulders, which has been previously published. Additional information about “warm-up” exercises was not collected, and could be valuable for future studies. Physiologic warming has been shown to be beneficial in muscular injury prevention.^[12]

The study has possible areas of bias. Because the information is self-reported, athletes may be unlikely to self-report injury. This could be for a variety of reasons. Some swimmers may not consider their pain to be out of the ordinary, just a normal feeling associated with training, and thus not report having days of shoulder pain. One coach refused participation because he was afraid of suggesting shoulder injuries to his team. This is an example of how psychological issues can affect athletes and their injuries.

The time of the season may determine the frequency of shoulder pain. Athletes may experience different amounts of pain at different times during the year. The swimming season typically consists of long-distance training in the fall and winter, and shorter, speed-oriented workouts in the spring.^[7] If, for example, the surveys were sent early in the year, before the heaviest training has taken place, the rate of shoulder pain may be less, whereas after the heaviest training part of the season, the rate may be higher.

Because participation was voluntary, athletes with injuries may have been hesitant to complete the survey. Also, because the project was completed at practice, athletes with injuries severe enough to prevent participation would not have been present. This would mean that the study selected for healthy

athletes. Additionally, the surveys were administered in the spring following the NCAA championships. At this point in the season, the majority of graduating seniors have “retired” and would not be attending practices. This may give a falsely low participation rate of 61.8%, and it is likely that a higher percentage of athletes who actually were given a survey completed and returned their survey.

Also, the teams were not selected at random, and one of the authors was previously an athlete on one of the invited teams. Although this should not have any effect on the results reported, it is important to note that coaches known personally may be more likely to follow instructions carefully and work to obtain a higher rate of participation.

It would also be important to involve causes of shoulder pain not related to swimming. Previous injuries from non-swimming, or even non-athletic sources—a car accident, for example—may be responsible for the shoulder pain reported. Additionally, the shoulder pain could come from non-swimming training methods, such as weight lifting, which is worsened by swimming training. Other medical conditions can cause shoulder pain which are not swimming or even musculoskeletal in origin. These can include autoimmune arthritis, infectious arthritis, and thoracic outlet syndrome, among others. Non-swimming causes of shoulder pain were not addressed in the survey and should be included for future studies.

As with any survey study, this also has the inherent limitation of recall bias, specifically with injury diagnosis. Ideally, all the participating athletes could be examined for diagnosis of their shoulder pain. One possible way this could be accomplished would be to distribute the survey at a competition, where a physical examination could also be performed.

Although this study did not produce results showing any increased rate of shoulder pain among any single stroke, future research can be conducted to further clarify this issue. As suggested, different times of the season may yield different results. A study to compare the same groups of athletes at the beginning, middle, and end of the season may show different rates of shoulder pain between the different strokes at the different points in the season.

CONCLUSIONS

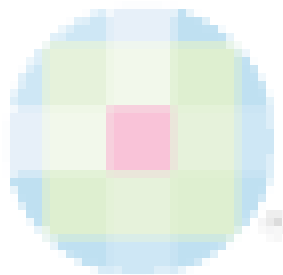
There was no difference in the rate of self-reported shoulder pain among collegiate male swimmers based on their primary stroke.

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