Shoulder Pain: A Comparison of Wheelchair Athletes and Nonathletic Wheelchair Users

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ABSTRACT

FULLERTON, H. D., J. J. BORCKARDT, and A. P. ALFANO. Shoulder Pain: A Comparison of Wheelchair Athletes and Nonathletic Wheelchair Users. *Med. Sci. Sports Exerc.*, Vol. 35, No. 12, pp. 1958–1961, 2003. **Purpose:** The purpose of this study was to directly compare the onset and prevalence of shoulder pain in athletic and nonathletic wheelchair users. **Methods:** A questionnaire was distributed to athletic and nonathletic wheelchair-dependent populations. This inquired about presence and duration of shoulder pain, age of subject, level of injury, duration of time since injury, wheelchair use, involvement in sports, and training habits. A total of 257 subjects were involved in the study. **Results:** The odds of having shoulder pain were twice as high among nonathletes as they were among athletes. This finding represents a significant difference over and above age differences, differences in years spent in a wheelchair, and differences in level of spinal cord injury. Athletes also have an average of 12 yr free of shoulder pain after becoming wheelchair bound, whereas nonathletes have only 8 yr. **Conclusion:** Promotion of active exercise for wheelchair users is encouraged to decrease shoulder pain, resulting in more functional, pain-free years. **Key Words:** DISABLED, SPORTS, SPINAL CORD INJURY, EXERCISE

Shoulder pain is a well-known problem in manual wheelchair users. Up to 78% of individuals with spinal cord injury have been reported to have shoulder pain, but most studies report a prevalence of about one-third in paraplegics and slightly higher numbers for quadriplegics (3,7,8,10,11,14). One cause of this is thought to be the weight-bearing role of the shoulder: a joint that was designed for mobility rather than for stability (1,13). The increased load and repetitive stresses of daily life in a wheelchair contribute to development of shoulder pain, impingement syndrome, and rotator cuff tears. Muscle imbalances around the shoulder joint, whether a product of high injury level or as a result of functional movement patterns, are also thought to contribute to the development of shoulder disorders in wheelchair users (2,6,12).

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In addition to the stresses of daily life, wheelchair athletes put increased load and repetitive stress through their shoulders during sporting activities. Indeed, fast propulsion has been shown to create greater forces in the shoulder joint than free propulsion (5). The number of push cycles per minute increases as well, so that sports in which speed is involved, such as racing or basketball, put a high demand through the shoulder. Muscle imbalances have also been shown to be a factor in impingement syndrome in wheelchair athletes (2,5,6).

Previous investigators have studied shoulder pain in athletic or nonathletic wheelchair users, and the prevalence is high in both. A determination has not been made, however, whether the increased demands of athletic activity are associated with an increased prevalence (or earlier onset) of shoulder pain. Conversely, the increased strength and endurance of athletes may have a protective effect on the shoulder (15). The purpose of this study was to directly compare the onset and prevalence of shoulder pain in the athletic and nonathletic wheelchair populations.

METHODS

Study design. A 20-item questionnaire was developed for distribution to individuals participating in the study. This included questions about presence and duration of shoulder pain as well as markers of severity, including pain with activities of daily living, need to see a physician, and treatment. In addition, information about age of subject, level of spinal cord injury, duration of time since injury, wheelchair use, involvement in sports, and training habits was obtained. A visual analog scale for assessing pain severity was initially included but discarded due to subjects' difficulty with completion of the scale. Appropriate information for informed consent was provided on the questionnaire, and consent was acknowledged by completion of the form. Institutional Review Board approval was obtained from the University of Virginia Health Sciences Center and the Roosevelt Warm Springs Institute for Rehabilitation.

Subjects. Subjects for this study were obtained through distribution of a questionnaire. This document was mailed to a randomized group of 500 individuals through the Virginia Spinal Cord Injury Registry. As only a few responses were obtained from athletes, the questionnaire was also published in a newsletter for a leading wheelchair sports organization and hand distributed at disabled sporting events, from the local to international level. Incomplete submissions or those from individuals who were not primary manual wheelchair users were discarded. A total of 257 subjects were obtained. Eighty-six percent had spinal cord injuries, with the remaining having spina bifida, lower-extremity amputations, or unknown disorders.

Subjects were considered athletes if they met at least two of the following three criteria: 1) trained at least 3 $h \cdot wk^{-1}$, 2) were involved in at least three competitions per year, and 3) had a wheelchair which had been modified for sports. The vast majority of athletes involved in the study, being at an elite level of competition, far exceeded these requirements. Twenty percent of the surveys received from athletes came through the mail, most from a newsletter for disabled athletes, yielding many highly qualified individuals. The remaining 80% were received in person from athletes at competitions, primarily national and international events. The most popular sport represented was basketball, at 51% participation. Other sports included are tennis (26%), rugby (23%), racing (19%), skiing (5%), and handcycling (5%), as well as many other less popular sports. The average athlete had been involved in wheelchair sports for 10 yr. Two-thirds (172) of the 257 subjects were athletes, and the remaining one-third were used as the comparison group.

Statistical analysis. Data were analyzed using the Statistical Package for the Social Sciences (SPSS, Chicago, IL) version 10.0. All analyses were conducted in the null form and alpha (rejection region) was set at 0.05.

To control for experiment-wise Type-I error rate, a modified Bonferroni procedure was used (4). The step-down Bonferroni procedure differs from the original in that it accounts for the magnitude of the effects in determining the adjusted critical alpha level for each test. This approach, although slightly less conservative than the original Bonferroni correction, was implemented in order to adequately control Type-I error rates while minimizing Type-II error. Type-II error is perhaps the more important of the two with regard to preliminary investigations such as this study. As such, the experiment-wise Type-I error rate remains 0.05.

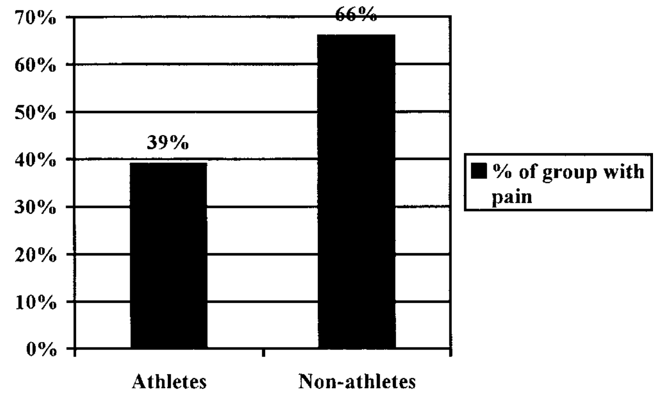

FIGURE 1—Percentage of subjects in each group (athletes $N = 172$ vs nonathletes $N = 85$) reporting shoulder pain.

Individual test results are reported along with unique critical alpha levels (α_{crit}). Significant results are flagged with an asterisk (*).

Values are presented as mean ± standard deviation (SD). For preliminary analyses, chi-square tests were used on data with categorical dependent measures (frequency counts), and *t*-tests were used for data with continuous dependent measures. Lastly, logistic regression was used to determine odds ratios and relative risk of relevant and unique predictors of the presence of shoulder pain (a categorical measure).

RESULTS

Overall, 48% of the subjects in this study reported shoulder pain at the time of completing the questionnaire. Of these, 70% had sought treatment for the pain, and at least 92% had pain with activities of daily living (8% unknown). In the nonathletic population, 66% of subjects reported pain, whereas only 39% of the athletes reported pain (χ^2 ($df = 1$, $N = 257$) = 16.53, $\alpha_{crit} = 0.0063$, $P < 0.0001$*). Figure 1 shows this difference between the two groups. The athletes in our sample were therefore less likely to report shoulder pain than were the nonathletes.

The number of years subjects had spent in a wheelchair was evaluated and related to the presence or absence of pain. There was no significant difference found between subjects with pain (16.41 ± 10.04) and without pain (14.38 ± 9.0; $t(243) = 1.67$, $\alpha_{crit} = 0.013$, $P = 0.10$), nor was there a difference in number of years in a wheelchair between athletes (15.79 ± 8.80) and nonathletes (14.56 ± 10.84; $t(243) = 0.96$, $\alpha_{crit} = 0.025$, $P = 0.34$). In our sample, therefore, neither pain status nor athlete status were significantly related to the number of years the subjects had been in a wheelchair.

The number of years athletes had been involved in wheelchair sports was also evaluated. There was no difference found in this regard between subjects with pain (11.08 ± 6.73) and subjects without pain (9.73 ±5.38; $t(167) = 1.45$, $\alpha_{crit} = 0.017$, $P = 0.15$).

Contrary to previous findings (3,11), quadriplegic spinal cord injured subjects in this study were no more likely than

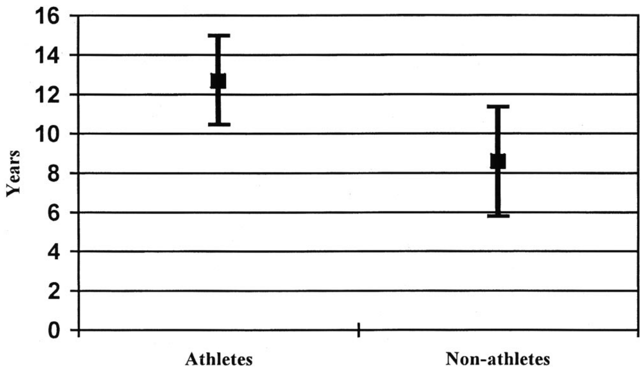

FIGURE 2—Average number of years the subjects (athletes vs nonathletes) spent in a wheelchair before developing shoulder pain (with 95% confidence intervals represented by *error bars*). Wheelchair athletes have more pain-free years than do nonathletes.

paraplegics to have shoulder pain, as 46% of the subjects reporting pain were quadriplegic and 54% were paraplegic (χ^2 ($df = 1, N = 111$) = 0.73, $\alpha_{crit} = 0.05$, $P = 0.39$). There were no statistically significant differences that we detected between quadriplegics and paraplegics in our sample.

There were differences between groups in our sample, however. Specifically, there was a significant difference in age between athletes (34.34 ± 10.11) and nonathletes (46.06 ±12.54; $t(255) = 8.05$, $\alpha_{crit} = 0.0071$, $P < 0.0001$*). There was also an age difference between subjects with pain (41.73 ± 12.04) and without pain (34.99 ± 11.60; $t(255) = 4.57$, $\alpha_{crit} = 0.0083$, $P < 0.0001$*). Athletic individuals in our sample were younger than nonathletes, and subjects with pain were older than those without shoulder pain. Additionally, nonathletes with pain developed their shoulder problems 4 yr earlier than did the athletic population with shoulder pain, as measured by the number of years subjects had been in a wheelchair when the pain developed (12.73 ± 8.15 yr for athletes vs 8.61 ± 9.88 yr for nonathletes; $t(112) = 2.44$, $\alpha_{crit} = 0.01$, $P = 0.01$*). Figure 2 shows the means (and 95% confidence intervals) of pain-free years between the athletic and nonathletic populations.

Given the presence of strong age effects for both pain and athletic status, it is important to rule out the possibility that the effect of athletic status on reported pain is an artifact. Additionally, it is important to investigate whether other variables might be driving the effect of athletic status on reported pain based on previous studies and/or significant findings within our sample. As such, univariate logistic regression was used to determine the effect of athletic status on reported pain over and above: 1) age; 2) number of years in a wheelchair (α_{crit} =0.01, $P = 0.10$); and 3) level of spinal cord injury (for which previous research has found an effect on pain).

Table 1 shows the parameters from the logistic model including odds ratios and 95% confidence intervals for each of the predictors with presence of pain (yes or no) as the dependent measure. The overall model accounted for 13% of the variance in pain status (Cox and Snell R square = 0.13) and the overall model was significant (χ^2 ($df = 4$) = 30.12, $\alpha_{crit} = 0.0056$, $P < 0.0001$*). Notably, athletic status was significantly related to pain status over and above all other predictors in the model (odds ratio = 2.15, 95% CI = 1.11–4.18, $P = 0.02$).

In our sample, the odds of having shoulder pain were more than twice as high (or 115% higher) for nonathletes as for athletes. This finding represents a significant difference over and above age differences, differences in years spent in a wheelchair, and any possible differences in level of spinal cord injury.

DISCUSSION

The objective of this study was to determine whether participation in wheelchair sports has an effect on the development of shoulder pain. As such, there are two major findings to report. First, wheelchair athletes are less likely to have shoulder pain than their nonathletic counterparts. Indeed, the odds of a nonathlete having shoulder pain are more than twice as high as those for a wheelchair athlete. This finding holds true when other variables in the sample are adjusted for, such as age, level of injury, and number of years spent in a wheelchair.

Second, individuals who participate in wheelchair sports enjoy more years postspinal cord injury free of shoulder pain than do nonathletes. In our sample, athletes were without shoulder pain for an average of 12 yr after becoming wheelchair users. Nonathletes, on the other hand, averaged only eight pain-free years.

It has been purported that the high incidence of shoulder pain in wheelchair users is primarily due to overuse. If this were the case, the demands of wheelchair sports would be expected to accelerate the overuse process. The results of this study, however, suggest that athletic activity has a protective effect on the shoulder, with wheelchair athletes having less pain overall and more pain-free years. As the cause of this is unknown and cannot be explained from this study, further research is needed to look at the role of fitness, strength, and muscle imbalances in shoulder pain, comparing the athletic and nonathletic wheelchair populations.

Studies have shown that advancing age has an effect on presence of shoulder pain in wheelchair users. Indeed, there was an age difference between our sample groups, with the nonathletic group being both older and having more shoulder pain. Age effects were likely to have contributed to the high percentage of individuals with shoulder pain in the nonathletic sample. However, our finding that nonathletes are twice as likely to have shoulder pain as athletes remains statistically valid despite the age difference between our groups. A study by Pentland and Twomey (9) showed shoulder pain to be associated with duration of wheelchair use, exclusive of age. In our study, there was no difference in duration of wheelchair use among athletes and nonathletic wheelchair users. The number of years individuals had been involved in wheelchair sports, which put high forces through the shoulder, was also unrelated to the presence of shoulder pain.

There were more quadriplegic individuals than paraplegic in our nonathletic sample. The argument could be made that

TABLE 1. Effect of athletic status and other predictors on pain.

Predictor Variable	β	SE	OR	95% CI	P
Age	0.036	0.015	1.04	1.01–1.07	0.01
Years in wheelchair	0.030	0.019	1.03	0.99–1.07	0.13
Injury level (C)	0.393	0.294	1.48	0.83–2.64	0.18
Athletic status (C)	0.765	0.339	2.15	1.11–4.18	0.02

Parameters from the logistic regression model including standardized beta (β), standard error (SE) odds ratios (OR), 95% confidence interval (CI), and P values for each predictor variable with presence of shoulder pain (yes or no) as the dependent variable. Categorical variables are noted with (C) after the variable name.

quadriplegics tend not to be athletes *because* they have shoulder pain, therefore trending our nonathletic sample toward more shoulder pain. However, despite the findings of other authors that show quadriplegic persons to have more shoulder pain than paraplegics, this was not the case in our sample (3,10,11). Quadriplegic status was not related to shoulder pain. More likely, quadriplegics were less likely to be athletes than paraplegics because there are fewer sporting opportunities available to them.

A weaknesses of this study was that the nature of its design precludes determining a causal relationship between pain and involvement in sports. In other words, do nonathletes have more pain because they're not athletic, or are they not involved in sports because they have shoulder pain? Given the fact that 39% of our athletes reported shoulder pain, this does not seem to be a high deterrent to athletic involvement. Further study is needed, however, to help differentiate between these possibilities. In addition, because many of the questionnaires were hand distributed, there is a possibility of sampling bias.

Freedom from shoulder pain is advantageous to wheelchair users because it translates into increased function and independence, and a higher activity level. This in turn promotes social and physical well-being. Wheelchair users, particularly spinal cord injured individuals, are living to more advanced ages than in the past. They, like the able-bodied population, receive benefit from an active lifestyle to prevent ailments such as heart disease. Promotion of active exercise for wheelchair users is encouraged for disease prevention and to decrease shoulder pain, resulting in more functional, pain-free years.

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