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ORIGINAL

SHOULDER PAIN PREVALENCE IN COMPETITIVE SWIMMERS: A PILOT STUDY

PREVALENCIA DEL DOLOR DE HOMBRO EN NADADORES DE COMPETICIÓN: ESTUDIO PILOTO

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ABSTRACT

Objectives: to investigate the prevalence of shoulder pain in competitive swimmers and find out the characteristics of pain as well as its relation to anthropometric and sports factors. **Methods:** prevalence study. A hundred and forty competitive swimmers between 12 and 24 years old completed a questionnaire in a high intensity training phase. **Results:** 25.7% swimmers reported shoulder pain. There were significant statistical correlations between shoulder pain and previous episodes of pain ($p<0.001$), more than three years of experience ($p=0.014$), Body Mass Index ($p=0.015$) and stroke ($p=0.008$) and

distance (p=0.011) specialty. Pain was statistically correlated with activity (p<0.001). **Conclusions:** shoulder pain seems to be a frequent and repetitive problem in competitive swimmers between 12 and 24 years old, which increases with years of practice. Furthermore, it seems to be associated with the activity, a higher Body Mass Index and the swimmers' specialty.

KEY WORDS: swimming, prevalence, shoulder pain, pain, shoulder impingement syndrome.

RESUMEN

Objetivos: conocer la prevalencia de dolor de hombro en nadadores de competición, sus características y su relación con factores antropométricos y deportivos. **Métodos:** estudio de prevalencia. Ciento cuarenta nadadores/as entre 12 y 24 años cumplimentaron un cuestionario durante una fase de entrenamiento específico. **Resultados:** el 25,7% revelaron padecer dolor de hombro. Se hallaron relaciones estadísticamente significativas entre el dolor de hombro y episodios previos de dolor (p<0,001), experiencia superior a tres años (p=0,014), Índice de Masa Corporal (p=0,015) y la especialidad estilo (p=0,008) y distancia (p=0,011). El dolor fue significativamente más intenso durante la actividad que en reposo (p<0,001). **Conclusiones:** el dolor de hombro en nadadores de competición entre 12 y 24 años parece ser un problema frecuente y repetitivo, que aumenta con la experiencia y que se asocia a la actividad, a un mayor Índice de Masa Corporal y a la especialidad del nadador.

PALABRAS CLAVE: natación, prevalencia, dolor de hombro, dolor, síndrome subacromial.

1. INTRODUCTION

Severe injuries are less common among competitive swimmers in comparison with other sports[1]. Nevertheless, shoulder injuries are quite recurrent and may progressively prove disabling for the practice of competitive swimming[2]. Competitive swimmers train every day during 10-12 months a year covering between 7.315 and 18.288 meters per day, which involves more than 16.000 weekly movements of the shoulder joint[3,4].Moreover, most of the propulsive force is produced by the upper limb through concentric movements of adduction and the internal rotation of the glenohumeral joint[6]. These training conditions lead to great muscle fatigue due to the short recovery time[3,5,7]. Furthermore, glenohumeral joint positions compatible with a subacromial impingement have been reported during the Front Crawl stroke, which is the most practiced style during a training session[1,8,9], the Butterfly and the Backstroke[10,11].

Kennedy and Hawkins coined the term "swimmer's shoulder" to provide a name for a painful syndrome usually found in swimmers and which derives from a repetitive subacromial impingement caused by the constant movements of the

arms over the head[4]. It has ever since been generally used as a synonym for subacromial syndrome[4,10,12-15] although, in reality, it encompasses a series of articular and periarticular injuries that can cause pain in a swimmer's shoulder and whose etiology remains unclear[1,7,10,16].

The annual incidence of shoulder pain in competitive swimmers has been estimated in 38%[17]. The prevalence varies between 10%[18] and 35%[19] and the percentage of swimmers who have suffered from it during their sport career varies between 29,6%[2] and 91%[1].The variability of these figures, whose external validity is unknown, is partly due to the existing differences when a pain episode is considered positive[1,9,13,17-19], the lack of exclusion criteria[9,13,18,19] or the inclusion of only women in the study[9].

Furthermore, we were unable to find any research, in the analyzed and reviewed bibliography, referring to the moment of the season with which the participants were dealing. During the swimming season, the content of the swimmers' training sessions varies according to the competitive calendar, which could influence the epidemiology of the shoulder pain[20]. These circumstances hinder the comparison between them as well as the determination of the real prevalence of shoulder pain in competitive swimmers. In addition, the relation between shoulder pain and sport factors such as the amount of training, the swimmer's specialty or the use of hand paddles reveals varying results according to the study. In other cases, it could not be established due to the lack of statistical analysis of the results[13,18].

Thus, this study aims to determine the prevalence of shoulder pain during a specific training phase (high intensity) in competitive swimmers, identify its characteristics and check whether there is a relation between the pain and anthropometric and sport factors.

2. PARTICIPANTS AND METHODS

2.1 Design

A pilot prevalence study was conducted between January and April 2013.

2.2 Participants

A consecutive non-probability sampling was carried out in the accessible population, which consists of 12 training groups from clubs affiliated to the Swimming Federation of Madrid including regional, national and international swimmers. All the training groups belonging to the Children, Junior and Senior categories (table 1) had the same completion calendar, they were involved in a specific training phase (high intensity) in their preparation cycle and they had been training for five months since the start of the season. All the swimmers who complied with these characteristics were included.

All those participants who might have cervical radiculopathy, shoulder dislocation, a fracture or a surgical operation on their upper limbs or cervical spine last year; or a recent traumatism in their shoulder were discarded.

Table 1. Age according to category (2013).

	Male	Female
Children	14,15,16 years.	13-14 years.
Junior	17-18 years.	15-16 years.
Senior	19 years and over.	17 years and over.

All those swimmers who met the inclusion and exclusion criteria and gave their written consent to take part in the study after being informed were included.

2.3 Data collection

The collection of data was carried out after a training session in the facilities where each group was performing their activity in the presence of the JBC researcher in order to prevent the loss of information. Therefore, a self-completion questionnaire was designed grouping the analyzed variables according to previous studies[1,2,9,13] as well as other variables that were not collected by those studies such as the ones related to the practice of other sports involving the upper limbs, physiotherapy treatment, pain location, painful sensation extended from the back to the neck or the arm and the impact on training. The questionnaire was handed over to 15 swimmers in advance (5 of each group) to assess their understanding. After analyzing their contributions, five questions were made in order to replace technical terms with others that are more understandable by the target population.

All the groups participated during a period of a week in order to prevent possible differences as regards the training session.

2.4 Variables

The questionnaire collected the following data:

1- Personal and anthropometric data: date of birth, gender, weight and height.
2- Sport data: starting year of competition swimming, specialty, the practice of other sports involving the upper limbs and physiotherapy treatment.
3- Training: the performance of stretching and weightlifting exercises.
4- Pain and discomfort: previous and current, the intensity of pain during exercise and at rest using the Visual Analogue Scale, pain location on the body, painful sensation extended from the back to the neck or the arm, appearance time during the session, appearance time during the

arm stroke, its related stroke, aggravating factors and the impact on training.

The first 13 questions, corresponding to the first three sections of the questionnaire, concerned all the swimmers whereas the questions about shoulder pain were only answered by the swimmers who suffered the symptomatology at that time.

Thus, the coaches were asked to provide the following data about each swimmer's training: the number of training sessions in the pool and covered weekly kilometers at the time of the study, the number of training sessions outside the pool and its content.

2.5 Statistical analysis

The *Statistical Package for the Social Sciences software* (SPSS®) *17.0* was used for the statistical analysis.

The arithmetic mean and the standard deviation or the median and the interquartile range were used as indices of central tendency and quantitative variables dispersion of the sample distributions, depending or not, respectively, on the assumption that they are normal according to the Kolmogorof-Smirnov (K-S) test. Absolute and relative percentage frequencies were used for the categorical variables.

The measure of association between two categorical variables was carried out using Pearson's χ^2 or Fisher's exact test when both of them were dichotomous, in which case the evaluation of the effect was performed through the estimation of risk with the prevalence ratio (PR) and its precision with its confidence interval of 95%.

Student's T-Test was used for independent samples in order to determine the association between a dichotomous independent variable and a quantitative dependent variable of parametric distribution. The effect was assessed through the difference between averages and precision through the confidence interval of 95%. Mann Whitney U Test was used for independent samples when the dependent variable violated the assumption of normality, or Wilcoxon Test for paired samples. The measurement of the effect was assessed through the difference between the medians.

In all cases, the p value $p<0.05$ was used as the range of statistical significance.

3. RESULTS

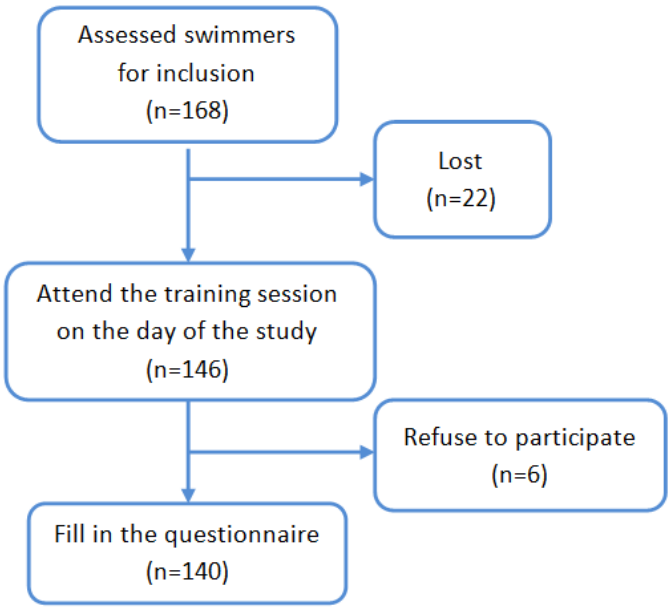

Figure 1. Participant flow.

One hundred and forty affiliated swimmers from the children, junior and senior categories were included. Figure 1 shows the passage of the participants through the stages of the study. None of the swimmers who missed the training session during which the questionnaire was completed, and which were considered lost, was due to shoulder pain.

Ten minutes on average were spent to complete the questionnaire for the swimmers without pain and those with pain spent 20 minutes on average. No data was lost for any of the variables.

3.1 Sample description

The sample consisted of 72 men (51.4%) and 68 women (48.6%). The average age and its standard deviation was 15.8 (3.2) years. The men's age range was from 13 to 24 years whereas that of the women was from 12 to 24 years.

Table 2 shows the anthropometric data according to category and gender whereas table 3 shows the exposure to training.

Table 2. Characteristics of the sample. Mean (SD).

	Complete sample			Children			Junior			Senior		
	Male (n=72)	Female (n=68)	Total (n=140)	Male (n=34)	Female (n=27)	Total (n=61)	Male (n=14)	Female (n=21)	Total (n=35)	Male (n=24)	Female (n=20)	Total (n=44)
Age, years	16.8 (3.3)	14.8 (2.7)	15.8 (3.2)	14.1 (1)	12.56 (0.6)	13.41 (1.13)	16.6 (0.5)	14.57 (0.6)	15.4 (1.1)	20.8 (2.1)	18 (2.5)	19.5 (2.7)
Weight, kg.	66.2 (10.4)	53.4 (7.1)	60 (11)	59.6 (9.6)	49.4 (7.2)	55 (10)	67.9 (6.4)	54.5 (5.4)	59.9 (8.8)	74.5 (6.5)	57.8 (5.4)	66.9 (10.3)
Height, cm.	175.4 (8.4)	163.4 (6.9)	169.6 (9.7)	171.4 (8.6)	160.2 (7.4)	166.5 (9.8)	175.4 (4.6)	164 (6.2)	168.5 (7.9)	181.1 (6.4)	167.2 (4.7)	174.8 (9)
BMI, kg/m^2	21.4 (2.2)	19.9 (1.7)	20.7 (2.1)	20.2 (2.3)	19.2 (1.6)	19.7 (2.1)	22.1 (1.7)	20.3 (1.7)	21 (1.9)	22.7 (1.4)	20.6 (1.4)	21.8 (1.7)

Table 3. Exposure to training.

	Mean (SD)	Median (IQR)					
	Sessions in the pool/week.	Weekly volume (m)	Volume/session (m)	Strength session hypertrophy outside the pool	General strength training outside the pool	Starting age	Years of practice
Complete sample (n=140)	6.42 (1.41)	30.000 (17.000)	5.000 (921)	0 (2,75)	2 (2)	8 (2)	7 (4.75)
Children (n=61)	6.08 (0.99)	27.000 (14.000)	5.400 (1.964)	0 (0)	3 (1)	8 (3)	5 (3)
Junior (n=35)	6.09 (1.24)	30.000 (17.000)	5.000 (1.229)	2 (3)	1 (2)	8 (3)	7 (3)

Senior (n=44)	7.16 (1.73)	40.000 (32.250)	5.414 (1.667)	2 (3)	1 (2)	8 (2)	10 (5.75)

The 61% of the 71 swimmers who signaled the stretching of the upper limbs after the training session (figure 2) confirmed to do it in less than 10 minutes against 39% who revealed that between 10 and 20 minutes were spent on it. 78% claimed that they stretched 3 or more times every week.

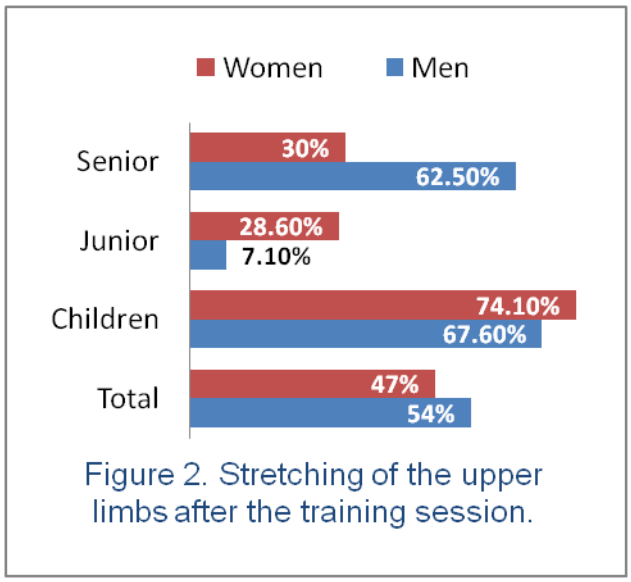

Figure 2. Stretching of the upper limbs after the training session.

3.2 Prevalence of shoulder pain

Thirty-six swimmers revealed (25.7%) shoulder pain or discomfort at the time of the study. According to the categories, the highest prevalence was found in senior swimmers (34.1%), followed by junior swimmers (28.6%) and children (18%).

Table 4 shows the prevalence data according to gender and category whereas figure 3 shows the prevalence of interfering shoulder pain, for which only the swimmers whose pain hampered their training sessions have been considered.

Table 4. Prevalence of shoulder pain according to category and gender

	Complete sample	Children	Junior	Senior
Male	18/72 (25%)	8/34 (23.5%)	4/14 (28.6%)	7/24 (29.2%)
Female	18/68 (26.5%)	4/27 (14.8%)	6/21 (28.6%)	8/20 (40%)

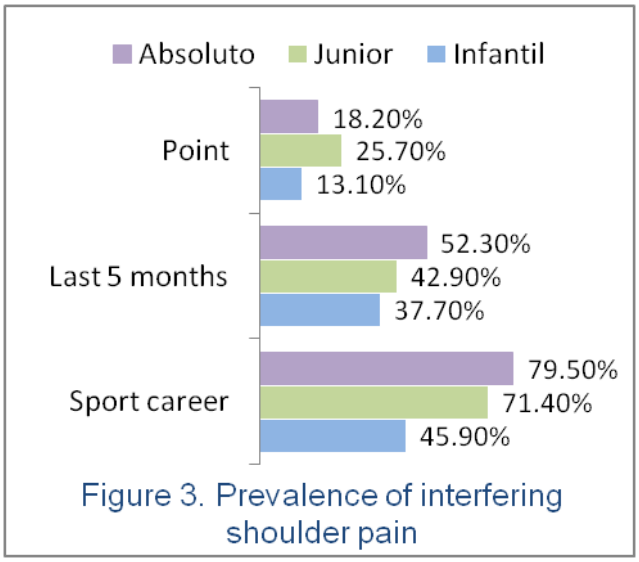

Figure 3. Prevalence of interfering shoulder pain

All the subjects suffering interfering shoulder pain or not were considered as positive cases for the statistical inference and the description of the characteristics of shoulder pain due to the limited size of the sample of swimmers with pain.

3.3 Pain in relation to anthropometric and sport variables (Table 5)

No statistically significant differences were found between gender and shoulder pain in any group. However, the Body Mass Index (BMI) and shoulder pain showed a statistically significant relation (p=0.015). The average BMI for the swimmers with pain was 21.43 whereas that of the swimmers without pain was 20.43.

The swimmers who had revealed some interfering shoulder pain episodes between September and January displayed 4.5 times more risk of presenting pain at the time of the study (IC95%: 2.2-9.2) than those who had no suffered from it, whereas those who had suffered from it at some time during their sport career showed 4.7 times more risk of presenting pain at the time of the study (IC95%: 1.8-12.6).

There was a statistically significant relation (p=0.014) between the presence of shoulder pain and having more than 3-year practice in competition swimming. The swimmers with 3 or less years of practice revealed 75% less probabilities of suffering shoulder pain (IC95%: 0.63-0.962).

There was a statistically significant relation (p=0.025) between the presence of shoulder pain and usually attending the physiotherapy treatment (2 or more times per month).

There were statistically significant relations between the presence of shoulder pain and swimmer's stroke (Figure 4) and distance (Figure 5) specialty.

Table 5. Pain in relation to anthropometric and sport variables.

Variables	Without pain (n=104)	With pain (n=36)	p-value
Anthropometric data. Mean (SD)			
Age.	15.63 (3.19)	16.39 (3.12)	.215[a]
Height, cm.	169.13 (9.76)	170.89 (9.73)	.354[a]
Weight, kg.	58.98 (11.07)	62.89 (10.21)	.065[a]
Body Mass Index, kg/m^2.	20.43 (2.06)	21.43 (2.11)	.015[a]
Exposure to training. Median (IQR)			
Sessions in the pool/week.	6.42 (1.34)	6.42 (1.59)	.981[a]
Weeklyvolume, m.	30.000 (17.750)	30.000 (18.750)	.547[b]
Average volumen per session.	5.000 (1.279)	5.200 (1.806)	.199[b]
Sessions outside the pool hypertrophy.	0 (2)	0 (3)	.589[b]
Sessions outside the pool general strength.	2 (2)	2 (2.75)	.436[b]
Startingage.	9 (2.15)	8.56 (1.54)	.208[a]
Exposure to training by ranges. Absolute frequencies.			
Weekly volume, m. (≤20.000m/>20.000)	20/84	5/31	.616[c]
Weekly volume, m. (≤30.000m/>30.000)	81/23	27/9	.818[c]
Weekly volume, m. (≤40.000m/>40.000)	58/46	21/15	.847[c]
Years of practice (0 a 3/>3)	25/79	2/34	0.014[c]
Sport data. Absolute frequencies.			
Gender (Male/Female)	54/50	18/18	.849[c]
Breath during the crawl (unilateral/bilateral)	67/37	20/16	.426[c]
Previous practice of other sports with UL* (yes/no)	37/67	11/25	0.685[c]
Weekly practice of other sports with UL* (yes/no)	18/86	9/27	.220[c]
Monthly physiotherapy treatment (yes/no)	15/89	12/24	0.025[c]
Weight lifting exercise (yes/no)	75/29	29/7	0.381[c]
Interfering pain during sport race (yes/no)	56/48	32/4	<0.001[c]
Interfering pain during this season (yes/no)	33/71	28/8	<0.001[c]
Stretching after the training (yes/no)	54/50	17/19	0.700[c]
Stretching time (<10 min./10-20 min.) (n=54)	32/22	11/6	0.458[c]
Stretching frequency (1-2/>2) (n=17)	12/42	4/13	1[c]

*Upper Limbs.
[a]T test.
[b]Mann-Whitney U Test.
[c]Fisher's exact test.

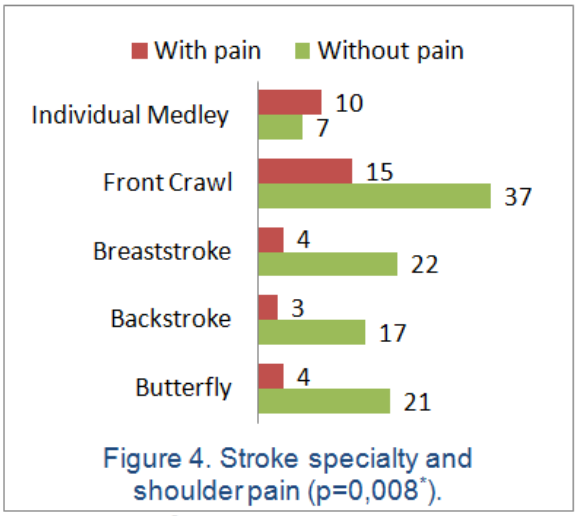

Figure 4. Stroke specialty and shoulder pain (p=0,008*).

*Pearson's χ^2

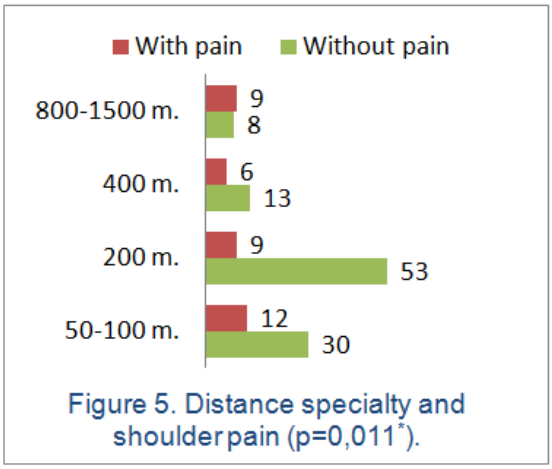

Figure 5. Distance specialty and shoulder pain (p=0,011*).

The impact of pain upon on training is shown in Figure 6.

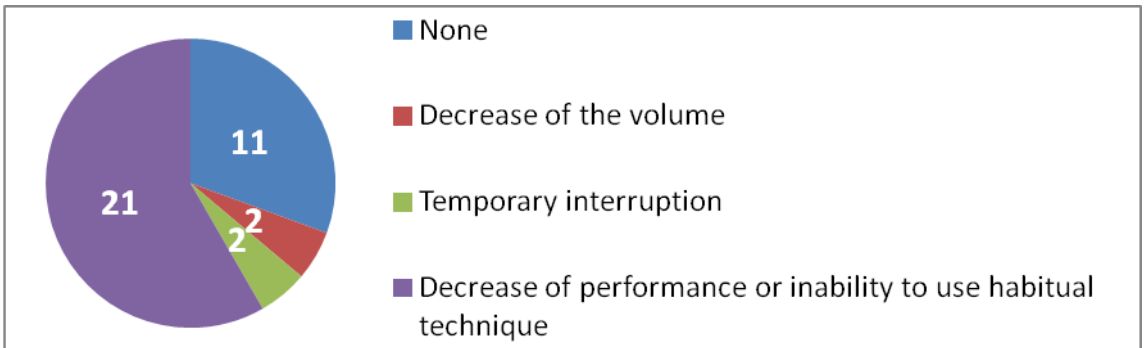

Figure 6. Consequences of pain on training.

3.4 Characteristics of pain

Among the 36 swimmers with shoulder pain, 24 suffered unilateral pain, more frequently on the right (15) than the left (9). Bilateral pain was found in 12 swimmers. The lateral and anterior areas were reported as being painful by 23 swimmers, whereas the posterior area was reported as painful by 20 swimmers. 21 swimmers claimed that the pain spread from the back or neck or towards the arm.

As regards the moment of appearance, 21 swimmers said that the pain was produced or became acute only during the training, most frequently in the second half (14) than the first (7); 12 swimmers claimed that it was produced or became acute before, during and after the training whereas 3 swimmers mentioned that it only occurred before and after the training. As regards the phase of the stroke cycle, the pain was produced or became acute during the recovery phase in 13 swimmers, in the underwater phases in 13 swimmers and continuously in 9 swimmers. Only one swimmer claimed that it was not produced nor became acute during any of the phases.

The Front Crawl stroke was identified as an aggravating factor of shoulder pain by 32 of the 36 swimmers, the Butterfly stroke by 17 swimmers, the Backstroke by 15 swimmers and the Breaststroke by 11.

The use of hand paddles was identified as aggravating factor of shoulder pain by 24 swimmers, the use of dumbbells by 9 swimmers, the use of swimming boards by 5 and stretching in only one case.

The median and the interquartile range of the pain intensity in the Visual Analog Scale (VAS) during practice was 5 (2.88) cm, significantly higher ($p<0.001$) than the intensity during rest, whose median and interquartile range was 2.25 (2.68) cm.

3.5 Sample size for future research into prevalence

Accepting an alpha risk of 0.95 with a precision of +/- 0.05 units in a bilateral contrast for an estimated proportion of 0.179 subjects with interfering shoulder pain, we need a random population-based sample of 226 subjects, assuming that the population is endless. A replacement rate of 0% was estimated. Under the same circumstances, for an estimated proportion of 0.257 subjects with shoulder pain, which has no impact on training, we need a random population-based sample of 294 subjects.

4. DISCUSSION

As far as the authors of this manuscript know, this is the first study ever conducted into the prevalence of shoulder pain in Spanish swimmers and which refers to the corresponding moment of the season at which there are, a specific high intensity training phase.

With a confidence interval of 95% and a precision of +/- 0.064 units, the prevalence of interfering shoulder pain for sport activity in swimmers is of 17.9% whereas the prevalence of this pain, which does not undermine training sessions at the time of the study, is of 25.7% and +/- 0.072. This pain, which is linked to activity and does not reveal a more frequent location, showed a statistically significant relation with the previous pain episodes, the BMI and the swimmer's specialty. Furthermore, having more than 3-year experience was considered as risk factor.

4.1 Prevalence

The division of the sample into age groups varies according to the distribution of the competition categories and is different according to the country where the study is conducted. Despite this, the data obtained in this study regarding the prevalence of impairing shoulder pain according to age groups are similar to those published by McMaster & Troup[18] in 1993, with a sample of 1262 North

American swimmers. The age groups in this study were 13-14 years, 15-16 years, 19.5 years and revealed a prevalence of 10%, 23% and 26% respectively against 13%, 26% and 18% found in this study. In 2012, Tate et al.[9] published a study on swimmers whose age groups, which were similar to those in this study (12-14 and 15-19 years), also revealed similar prevalence-based findings: 18.6% in the first group and 22.6% in the second one.

The percentage of swimmers who reported in this study having suffered from some interfering shoulder pain during their sport career is also very similar in all the groups to that observed by McMaster & Troup[18] (46%, 65%, 73%) against 45.9%, 71.4%, 79.5% found in this study. However, considering the whole sample, the 62.9% found is inferior to the 91% reported by Sein et al.[1] in 2010. This may be due to the fact that they considered any pain episode positive regardless of whether there was any impairment involved.

4.2 Pain related to anthropometric and sport factors

No relation is found between the prevalence of shoulder pain and gender in accordance with the findings from other previous studies[13,18,21]. Nonetheless, there is in the sample of this study a statistically significant relation (p=0.015) between the BMI and the prevalence of shoulder pain, which is higher among swimmers with a greater BMI. A prior study in competitive swimmers[9] did not reveal any relations in this sense even though a sample of athletes who use the upper limbs did show some[2]. This might be due to the amount of strenuous exercise done by those swimmers' upper in order to propel the body.

On the other hand, the swimmers who suffered from prior pain episodes show 4.7 times more risks of suffering from them in accordance with the results obtained in a prospective study by Walker et al.[17] in which they determined that swimmers with pain showed 4.1 times more probability of suffering from a new episode. Additionally, a statistically significant relation between shoulder pain and the years of competitive swimming practice was found. The fact that they had practiced it for less than 3 years proved to be a protective factor. Similar results were obtained from previous studies[1,9,13,18]. The variables of the exposure to training, related to shoulder pain in some cross-sectional studies, do not reveal any statistically significant relation in this sample in line with other longitudinal (retrospective[21] and prospective[17]) and cross-sectional studies[12,13]. Studies with a greater sample size are required for the analysis of this relation within each age group.

The presence of shoulder pain during the study and the stroke specialty of the swimmer revealed a statistically significant relation (p=0.008) as well as the distance specialty (p=0.011), which shows higher prevalence in swimmers who specialize in the Individual Medley or Front Crawl events and those who compete in swimming events of more than 400 meters. During the phase of specific training sessions involving the participants of this study, mainly the distance and stroke specialty of each swimmer are practiced, which could shed

some light on the difference with previous studies where no relations in this sense were found[1,9,20,21].

During a training session, the Front Crawl is the most practiced stroke by swimmers. Accordingly, 32 of the 36 swimmers with shoulder pain in this study pointed that the Crawl stroke produced or worsened their symptomatology whereas McMaster & Troup[18] found the Butterfly stroke to be the most painful. However, Wymore et al. did not find any significant differences regarding the intensity of pain and the stroke. This variability of results refers to the fact that swimmers with pain cannot find any more painful stroke to practice.

The use of hand paddles was considered as a shoulder pain worsening factor by 24 of the 36 swimmers with pain in line with what had previously been published[18,13]. Tate *et al*.[9], in a recent cross-sectional study, did not find any relation between the use of hand paddles and shoulder pain, which indicates that it might not be the origin but an aggravating factor.

The most common impact of shoulder pain on training is the decrease of performance and the inability to use the usual swimming technique. In this sense, in swimmers with shoulder pain and clinical signs of the impingement syndrome, variations of muscle contraction and of the swimming technique have been identified[22,23], which could imply positions prone to injuries[10,11].

4.3 Characteristics of pain.

Swimmers usually suffer from unilateral pain according to the findings of this and other previous studies[1,12,13]. In addition, there is a tendency towards a higher frequency of the right side although no statistically significant relation was found with the side of respiration during the Front Crawl.

Previous studies had suggested that shoulder pain in competitive swimmers would most frequently be anterolateral. Richardson *et al.*[13], retrospectively retrieved the information regarding the characteristics of pain from part of the sample, with the possible information bias it implies. The sample analyzed by Bak & Fauno[12] consisted of swimmers with pain and clinical signs of impingement syndrome, for which a more intense pain in the anterolateral area should be expected. In contrast, the results obtained in this study, where no predominance of any painful area has been identified, comply more with the multifactorial cause of shoulder pain as well as a recent study that reveals a high prevalence of small muscular contractions called myofascial trigger points[24] in competitive swimmers' muscles, which in turn may cause pain in different areas of the shoulder[25].

In the sense, 21 of the 36 swimmers with pain in this study, reported that the pain spread from the back or neck or towards the arm, which could point to the presence of myofascial trigger points in muscles such as the pectoralis major, latissimus dorsi or teres major muscles, the main swimming propelling

muscles[13,26,27], and the subscapularis, serratus anterior, trapezius superior and the teres minor muscles, which are active during all the Front Crawl stroke cycle[26,27]. Moreover, the pain was significantly more intense during the practice than during rest ($p<0.001$). Both characteristics are found in people with active myofascial trigger points[24]. After checking the bibliography, we could not find any study that had previously analyzed pain both during practice and rest as well as its distribution in competitive swimmers.

Considering the repetitive character of shoulder pain and the conditions of muscular fatigue implied in this sport, the findings point out the need to improve some prevention methods of musculoskeletal injuries in athletes, as well as the practice of stretching, which is carried out by only 50% of the swimmers, and the physical therapy intervention that is usually claimed once the pain episode appears.

4.4 Limitations of the study

The cross-sectional design of the study prevents the establishment of a causal relation between the analyzed factors and shoulder pain. Additionally, it implies that the most serious cases, where the swimmers had to permanently stop training, were not taken into consideration. Therefore, more studies with greater sample size are necessary as well as a prospective longitudinal study that allows for a corroboration of the results in this study and also extend the findings to all the population of competitive swimmers with the adequate margins of error.

5. CONCLUSIONS

Shoulder pain in competitive swimmers aged between 12 and 24 years seems to be a frequent and repetitive issue (during a specific training phase). Its prevalence seems to increase in swimmers with more than 3 years' experience. It is also likely to affect these athletes' performance and to be linked to those swimmers with a higher body mass index, to those whose specialty is the Front Crawl or the Individual Medley and to events of more than 400 meters. Furthermore, the pain seems to be more frequently unilateral, to be linked to practice and to be found on the anterior, lateral and posterior parts of the shoulder.

6. REFERENCES

(1) Sein M, Walton J, Linklater J, Appleyard R, Kirkbride B, Kuah D, et al. Shoulder pain in elite swimmers: primarily due to swim-volume-induced supraspinatus tendinopathy. Br J Sports Med. 2010;44(2):105-13. http://dx.doi.org/10.1136/bjsm.2008.047282

(2) Mohseni-Bandpei M, Keshavarz R, Minoonejhad H, Mohsenifar H, Shakeri H. Shoulder Pain in Iranian Elite Athletes: The Prevalence and Risk Factors. J Manipulative PhysiolTher. 2012;35(7):541-8. http://dx.doi.org/10.1016/j.jmpt.2012.07.011

(3) Borsa P, Scibek J, Jacobson J, Meister K. Sonographic Stress Measurement of Glenohumeral Joint Laxity in Collegiate Swimmers and Age-Matched Controls. Am J Sports Med. 2005;33(7):1077-84. http://dx.doi.org/10.1177/0363546504272267

(4) Pink MM, Tibone JE. The painful shoulder in the swimming athlete.Orthop Clin North Am. 2000;31(2):247-61. http://dx.doi.org/10.1016/S0030-5898(05)70145-0

(5) Weldon EJ, Richardson AB. Upper extremity overuse injuries in swimming. A discussion of swimmer's shoulder. Clin Sports Med. 2001;20(3):423-38. http://dx.doi.org/10.1016/S0278-5919(05)70260-X

(6) Bak K, Magnusson SP. Shoulder strength and range of motion in symptomatic and pain-free elite swimmers. Am J Sports Med. 1997;25(4):454-9. http://dx.doi.org/10.1177/036354659702500407

(7) Bak K. The Practical Management of Swimmer's Painful Shoulder: Etiology, Diagnosis, and Treatment. Clin J Sport Med. 2010;20(5):386-90. http://dx.doi.org/10.1097/JSM.0b013e3181f205fa

(8) Heinlein S, Cosgarea A. Biomechanical Considerations in the Competitive Swimmer's Shoulder. Sports Health. 2010;2(6):519-25. http://dx.doi.org/10.1177/1941738110377611

(9) Tate A, Turner G, Knab S, Jorgensen C, Strittmatter A, Michener L. Risk Factors Associated With Shoulder Pain and Disability Across the Lifespan of Competitive Swimmers. J Athl Train. 2012;47(2):149-58.

(10) Yanai T, Hay JG, Miller GF. Shoulder impingement in front-crawl swimming: I. A method to identify impingement. Med Sci Sports Exerc. 2000;32(1):21-9. http://dx.doi.org/10.1097/00005768-200001000-00005

(11) Yanai T, Hay JG. Shoulder impingement in front-crawl swimming: II. Analysis of stroking technique.Med Sci Sports Exerc. 2000;32(1):30-40. http://dx.doi.org/10.1097/00005768-200001000-00006

(12) Bak K, Faunø P. Clinical findings in competitive swimmers with shoulder pain. Am J Sports Med. 1997;25(2):254-60. http://dx.doi.org/10.1177/036354659702500221

(13) Richardson AB, Jobe FW, Collins HR. The shoulder in competitive swimming. Am J Sports Med. 1980; 8(3):159-63. http://dx.doi.org/10.1177/036354658000800303

(14) McMaster WC, Long SC, Caiozzo VJ. Shoulder torque changes in the swimming athlete. Am J Sports Med. 1992;20(3):323-7. http://dx.doi.org/10.1177/036354659202000315

(15) Ludewig PM, Reynolds JF. The Association of Scapular Kinematics and Glenohumeral Joint Pathologies.J Orthop Sports Phys Ther. 2009;39(2):90-104. http://dx.doi.org/10.2519/jospt.2009.2808
(16) Allegrucci M, Whitney SL, Irrgang JJ. Clinical implications of secondary impingement of the shoulder in freestyle swimmers.J Orthop Sports Phys Ther. 1994;20(6):307-18. http://dx.doi.org/10.2519/jospt.1994.20.6.307
(17) Walker H, Gabbe B, Wajswelner H, Blanch P, Bennell K. Shoulder pain in swimmers: A 12-month prospective cohort study of incidence and risk factors. Phys Ther Sport. 2012;13(4):243-9. http://dx.doi.org/10.1016/j.ptsp.2012.01.001
(18) McMaster WC, Troup J. A survey of interfering shoulder pain in United States competitive swimmers. Am J Sports Med. 1993;21(1):67-70. http://dx.doi.org/10.1177/036354659302100112
(19) McMaster WC, Roberts A, Stoddard T. A Correlation Between Shoulder Laxity and Interfering Pain in Competitive Swimmers. Am J Sports Med. 1998;26(1):83-6.
(20) Wymore L, Reeve RE, Chaput CD. No correlation between stroke specialty and rate of shoulder pain in NCAA men swimmers. Int J Shoulder Surg. 2012;6(3):71-5. http://dx.doi.org/10.4103/0973-6042.102555
(21) Wolf BR, Ebinger AE, Lawler MP, Britton CL. Injury Patterns in Division I Collegiate Swimming. Am J Sports Med. 2009; 37(10):2037-42. http://dx.doi.org/10.1177/0363546509339364
(22) Scovazzo ML, Browne A, Pink M, Jobe FW, Kerrigan J. The painful shoulder during freestyle swimming.An electromyographic cinematographic analysis of twelve muscles. Am J Sports Med. 1991;19(6):577-82. http://dx.doi.org/10.1177/036354659101900604
(23) Pink M, Jobe FW, Perry J, Browne A, Scovazzo ML, Kerrigan J. The painful shoulder during the butterfly stroke. An electromyographic and cinematographic analysis of twelve muscles.Clin Orthop. 1993;(288):60-72. http://dx.doi.org/10.1097/00003086-199303000-00008
(24) Simons DG, Travell JG, Simons LS. Dolor y Disfunción Miofascial: El manual de los puntos gatillo. Volumen 1. Mitad superior del cuerpo. 2ª ed. Madrid: Editorial Médica Panamericana; 2002.
(25) Hidalgo Lozano A, Fernández-de-las-Peñas C, Calderón-Soto C, Domingo-Cámara A, Madeleine P, Arroyo-Morales M. Elite swimmers with and without unilateral shoulder pain: mechanical hyperalgesia and active/latent muscle trigger points in neck-shoulder muscles. Scand J Med Sci Sports. 2011;23(1):66-73. http://dx.doi.org/10.1111/j.1600-0838.2011.01331.x
(26) Pink M, Jobe FW, Perry J, Kerrigan J, Browne A, Scovazzo ML. The normal shoulder during the butterfly swim stroke. An electromyographic and cinematographic analysis of twelve muscles.Clin Orthop. 1993;(288):48-59. http://dx.doi.org/10.1097/00003086-199303000-00007
(27) Pink M, Perry J, Browne A, Scovazzo ML, Kerrigan J. The normal shoulder during freestyle swimming. An electromyographic and cinematographic analysis of twelve muscles. Am J Sports Med. 1991;19(6):569-76. http://dx.doi.org/10.1177/036354659101900603

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