ORIGINAL

PAIN IN COMPETITIVE KARATE DURING TRAINING. CROSS-SECTIONAL STUDY

DOLOR EN EL ENTRENAMIENTO EN EL KARATE DE COMPETICIÓN. ESTUDIO DE PREVALENCIA

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ABSTRACT

Objectives: to find out the pain prevalence in competitive karate practitioners derived from training and its relation to anthropometric and sports factors. **Methods:** prevalence study. A total of 56 karate practitioners completed a questionnaire at the end of their karate training. **Results:** the pain prevalence was 67.9%. The knee has been shown to be the most prevalence zone related to pain (31%) as well as related to instability subjective feeling (50%). There were significant statistical correlations between pain and age (p=0.04), Body Mass Index (p=0.045), belt level (p=0.017) and karate training frequency (p=0.011). **Conclusions:** the pain in competitive karate practitioners during training shows a high prevalence in the sample studied. There was a statistically significant correlation in pain in karate practitioners with higher body mass index, higher age, higher belt level and higher karate training frequency.

KEYWORDS: martial arts, prevalence, pain, joint instability.

RESUMEN

Objetivos: conocer la prevalencia de dolor derivada del entrenamiento en karatekas de competición y su relación con los factores antropométricos y deportivos. **Métodos:** Estudio de prevalencia. Un total de 56 karatekas cumplimentaron un cuestionario al finalizar su entrenamiento de karate. **Resultados:** La prevalencia del dolor ha sido del 67.9%. Se ha demostrado que la rodilla es la zona más prevalente en relación con el dolor (31%) y con la sensación subjetiva de inestabilidad (50%). Se han encontrado relaciones estadísticamente significativas entre el dolor y la edad (p=0.04), el Índice de Masa Corporal (p=0.045), el grado de cinturón (p=0.017) y la frecuencia de entrenamiento de karate (p=0.011). **Conclusiones:** el dolor en karatekas de competición durante los entrenamientos muestra una alta prevalencia en la muestra estudiada. Hubo una correlación estadísticamente significativa en el dolor en los karatekas con un mayor índice de masa corporal, mayor edad, mayor grado de cinturón y mayor frecuencia de entrenamiento.

PALABRAS CLAVE: artes marciales, prevalencia, dolor, inestabilidad articular.

1. INTRODUCTION

Karate, whose meaning is "empty hand", is a martial art created in Okinawa (Japan). There are two types of competition in karate: 1) *kumite*: combat between two competitors under a series of rules; and 2) *kata*: sequence of pre-established, offensive and defensive techniques and movements before an imaginary adversary (1).

In the modality of combat or *kumite*, there are some scoring criteria that are divided into: 1) *Yuko* (1 point): any direct punch or *tsuki* or indirect or *uchi*, on any of the 7 scoring areas: head, face , neck, abdomen, chest, back and sides; 2) *Waza-ari* (2 points): kicks at *chudan* level: abdomen, chest, back and sides; and 3) *Ippon* (3 points): kicks at *jodan* level (face, head and neck) and any scoring technique on an opponent that has been knocked down, has fallen or has lost his/her balance (2). In addition, the *kumite* can be performed individually or by teams. The individual category is divided into cadet (14-15 years), junior (16-17 years), under 21 (18-20 years) and senior (+18 years). Each category is subdivided into different weights (2).

According to the consulted literature, during a simulated combat, approximately from 11 to 21 (16.3 ± 5.1) high-intensity actions are carried out, each lasting from 1 to 3 seconds (3), while in an international combat, there are from 10 to 24 (17 ± 7) actions with a duration of <1 to 5 seconds (4). The shortest offensive and/or defensive action, during a simulated combat, lasts 0.3 ± 0.1 seconds for 2- and 3-minute matches; and the longest is of 2.1 ± 1.0 seconds and 1.8 ± 0.4 seconds, for the 2- and 3-minute matches respectively (5).

Chaabène et al. (4) noted that karateka most frequently use upper limb techniques. The straight forward punch or jab punch with the upper limb to the face called *kisami-zuki* was the technique most used by athletes. The roundhouse kick to the trunk or *mawashi-geri chudan* was the most used kick. The straight forward punch with the upper limb, followed by the punch with the upper limb placed behind him/her and towards the face, or as it is also known *kisami kyaku-zuki jodan*, is the most used combination. However, no statistically significant differences were found between winning karateka and losing karateka in the physiological responses, nor were there in the techniques used (4). On the other hand, in relation to the score, Riveiro et al. (6) observed that *Yuko* (punch on any of the 7 scoring areas) is the most popular way to score nationally and internationally, while *Ippon* (kicks at the level of the head or foot sweeps) is more used internationally than nationally. In addition, international karateka perform more scoring actions than the group of national level karateka (6). Thus, karate is a sport where high-intensity actions are carried out, with strong movements of the lower limbs, and with predominance of punch techniques.

Currently, the *kumite* modality has specific regulations developed by the World Karate Federation (WKF) (2) to avoid excessive contact and aggression among practitioners. Arriaza et al. (7) studied the incidence of injuries in karateka, before and after the implementation of the new competition regulations in 2000, obtaining a reduction of the overall rate of male and female injuries of 42% compared to the previous regulations. In addition, these injuries were minor, being caused by punches in 67% of cases (7). According to other studies, the injury rate has been 20.2 injuries per 100 practitioners during training (8); 9.87 is the proportion of injuries per 100 practitioners and 45.26 is the incidence rate of injuries per 1000 practitioners in national championships of young karateka (9); and 41.4 is the incidence of injuries per 1000 practitioners in high-level international championships in young karateka (16-20 years) (10).

Most studies have claimed that the most frequent injury mechanism is the contusion (7-13), while the body area affected in most cases is the region of the head, face and neck (7-10,12-14). Among all these studies, only two, one developed in Iran and another in Austria (8,11), analyse possible injuries during training, stating that most of these occur during combat or *kumite* training.

Karate is therefore a sport with a large number of federated players with very specific regulations and a growing future projection, taking into account its upcoming participation in the Olympics. The modality of combat or *kumite* is the one with the greatest risk of injury (8). For this reason, determining the prevalence of problems such as pain in this population of athletes during training would make it possible to focus, in a specific way, not only on their physiotherapeutic treatment but also on their prevention, thus improving their athletic performance.

The aim of this study is to determine the prevalence of pain resulting from training in karateka that compete in the *kumite* or combat modality, as well as the possible correlation between the presence of pain and subjective feeling of instability with anthropometric and sporting characteristics.

2. PARTICIPANTS, MATERIAL AND METHODS

2.1 DESIGN

A prevalence study was conducted between January and June 2018.

2.2 PARTICIPANTS

All those individuals, men and women, belonging to 7 karate clubs which are registered with the Madrid federation of karate, competitors of the combat modality (*kumite*), with a level equal to or greater than blue belt, within the cadet, junior, under 21 and senior (14 to> 18 years old) categories were included.

Those with any fracture or surgical intervention in the last year were excluded. Additionally, those who practice other sports with more weekly hours than in karate training were ruled out, as well as children under 14 and those practitioners over 50.

Participants who met both inclusion and exclusion criteria were informed about the purpose of the study and they provided written informed consent for their participation in the study.

2.3 DATA COLLECTION

A questionnaire was designed to collect the data, taking into consideration some of the variables analysed in other similar studies on the epidemiology of injuries resulting from karate training (8) and the prevalence of pain in other sports (15.16). The questionnaire was provided after completing the training in the facilities of each club analysed, in the presence of the main investigator.

The variables studied included: 1) Anthropometric factors: age, gender, body mass index (BMI); 2) Sports data: age of commencement of combat or *kumite*, belt level, current competitor and practice of other sports; 3) Trainings: frequency and time of karate training and weights; stretches and timing; 4) Pain: presence of pain (current, last 7 days or last month), characteristics (onset at rest, when performing some technique or during a sustained posture), subjective pain intensity according to the Visual Analogue Scale (VAS) (17) (during training and at rest), location (body map) and training limitations; 5) Feeling of instability in some articulation; and 6) Limitation of trainings for pain during the sports career (location on a body map).

2.4 DATA ANALYSIS

Both the sociodemographic variables and the outcome variables have been represented using the arithmetic mean and the standard deviation (SD) or the mean and the interquartile range (IQR), depending on whether we assume or not, respectively, their normality determined by the Kolmogorof-Smirnov (KS)

test. In the case of categorical variables, absolute and relative frequencies expressed in percentages were used.

To establish the measure of association between two categorical variables, evaluating the effect by the difference of means, the Pearson's chi-squared test or Fisher's exact test was used when the variables were dichotomous. The association between a dichotomous dependent variable and a quantitative dependent variable with parametric distribution was carried out using the Student's t-test for independent samples. When the variable affected the assumption of normality (K-S), the Mann–Whitney U test was used for two independent samples and the Kruskal–Wallis test for three independent samples, evaluating the measure of effect by the difference of means.

As a statistical significance level, a value of $p < 0.05$ was used in all cases.

The Statistical Package for the Social Sciences software (SPSS®), version 24, was used for statistical analysis.

3. RESULTS

56 federated karateka in the Community of Madrid belonging to the categories of cadet, junior, under 21 and senior were included in the study. The flow of participants can be seen in Figure 1. Subjects considered as losses, refused to participate in the study (n = 3) or did not attend the training due to causes other than pain (n = 4). On the other hand, those participants who underwent surgery in the previous year (n = 2), those who practiced other sports in a greater number of hours than karate (n = 3) and those who were younger than 14 years (n = 4) or greater than 50 years (n = 1) were excluded. No data was lost from the variables analysed in the questionnaires.
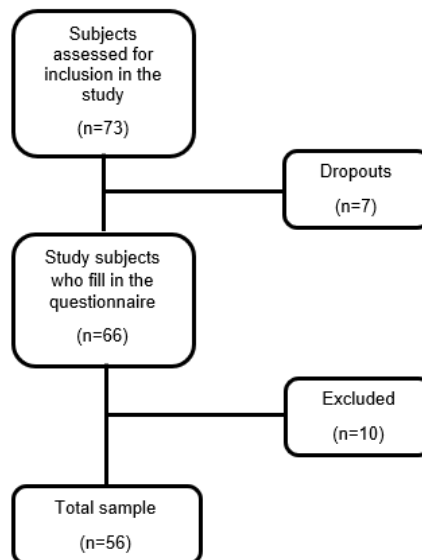

Figure 1. Flow of participants.

3.1 DESCRIPTION OF THE SAMPLE

The sample consisted of 38 men (67.9%) and 18 women (32.1%), with a mean age of 22 (8) years. The anthropometric data can be seen in Table 1.

Table 1. Anthropometric characteristics of the sample.

| Mean (SD)	Sample			Cadet			Junior			Absolute		
	Man (n=38)	Woman (n=18)	Total (n=56)	Man (n=5)	Woman (n=4)	Total (n= 9)	Man (n=7)	Woman (n=5)	Total (n=12)	Man (n=26)	Woman (n=9)	Total (n=35)
Age (years)	23 (9)	18 (3)	22 (8)	14 (0.5)	14 (0.5)	14 (0.5)	16 (0.4)	16 (0.4)	16 (0.4)	27 (9)	21 (2)	26 (8)
Weight (kg)	72.02 (10.73)	57.97 (7.24)	67.51 (11.72)	62.2 (9.8)	56.75 (10.3)	59.77 (9.8)	63.57 (7.11)	59.26 (8.74)	61.77 (7.76)	76.19 (9.25)	57.81 (5.6)	71.46 (11.69)
Height (cm)	174.92 (6.87)	164 (6.78)	171.41 (8.51)	170.2 (8.07)	167.5 (8.58)	169 (7.89)	172.14 (5.24)	163 (5.09)	168.33 (6.82)	176.58 (6.59)	163 (7.01)	173.09 (8.93)
BMI (kg/m²)	23.45 (2.58)	21.52 (2.02)	22.83 (2.56)	21.36 (2.25)	20.07 (1.64)	20.78 (2)	21.42 (1.91)	22.31 (3.12)	21.79 (2.39)	24.4 (2.29)	21.73 (1.14)	23.71 (2.36)

3.2 SPORTS DATA

The sample had a commencement age in the kumite modality of 13 (3) years, with a minimum of 6 years old and a maximum of 35 years old. 48.6% of the sample did not practice other sports, and of those who did practice other sports, 19.6% practiced soccer and 17.9% athletics. The sports data can be seen in Table 2. Statistically significant differences have been noticed between the belt level and the combat categories (p <0.01). In other words, the higher the belt level, the higher the combat category.

3.3 PAIN PREVALENCE AND INSTABILITY

The prevalence of pain in the sample was of 67.9% (n = 38). There were 24 subjects (42.9%) who showed pain at the time of the study. The absolute category presented a greater number of subjects with current pain (70.8%, n = 17), followed by the junior category with 25% (n = 6) and finally the cadet category with 4.2% (n = 1). Regarding the pain variable in the last 7 days or last month, 38 subjects were registered (67.9%). The absolute category had most of the study subjects registered, being 65.8% (n = 25), followed by the junior category with a 23.7% (n = 9) and the cadet category with 10.5% (n=4).

A total of 7 subjects (12.5%) showed three different pain locations, 9 practitioners (16.07%) presented two pain locations, while 22 karatekas (39.28%) reported a single pain location. In relation to the pain location (Figure 2), the knee was the most prevalent area (31%), followed by the shoulder region (15%), the metacarpophalangeal joint of the 1st finger (11%), and the foot region (11%).
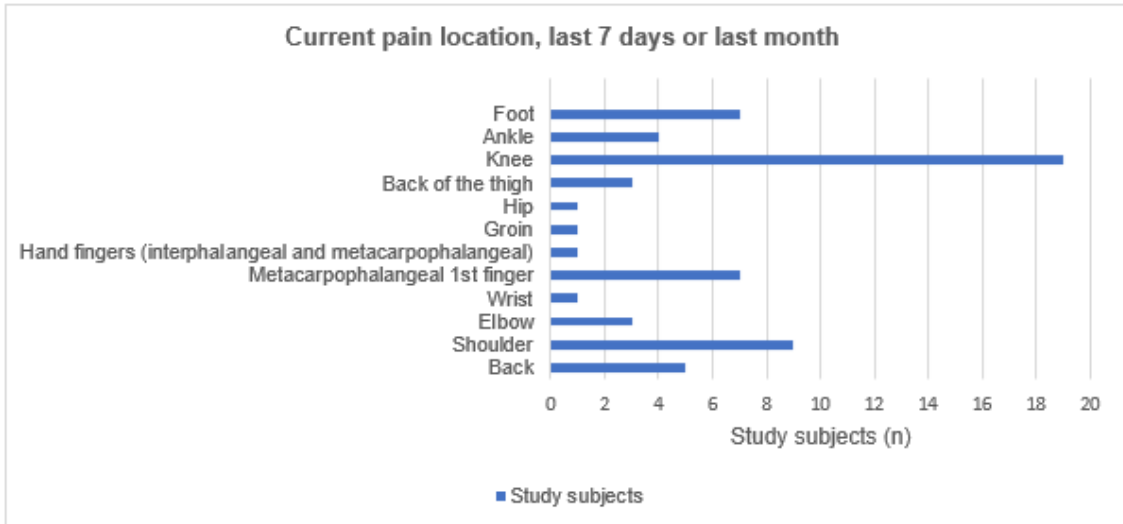
Figure 2. Current pain location, last 7 days or last month.

On the other hand, the pain was not very limiting in most of the participants who reported current pain/7 days/month, having to interrupt the training temporarily, and retaking it 60.5% of the subjects (n = 23). Only two cases could not continue with the training or did not train again due to pain (2.6%). In addition, 80.4% (n = 45) of the participants claimed to have suffered pain or discomfort that limited them during their sports career. The most prevalent pain during the sports career (Figure 3) was the knee area (32.1%), followed by the ankle area (28.6%) and the back (25%). There were 28 subjects (50%) who had a feeling of instability in some joint at the time of the study. The knee was the joint with the highest number of cases of instability with 50% (n = 14), followed by the shoulder with 17.9% (n = 5) and the ankle, with 14.3% (n=4).
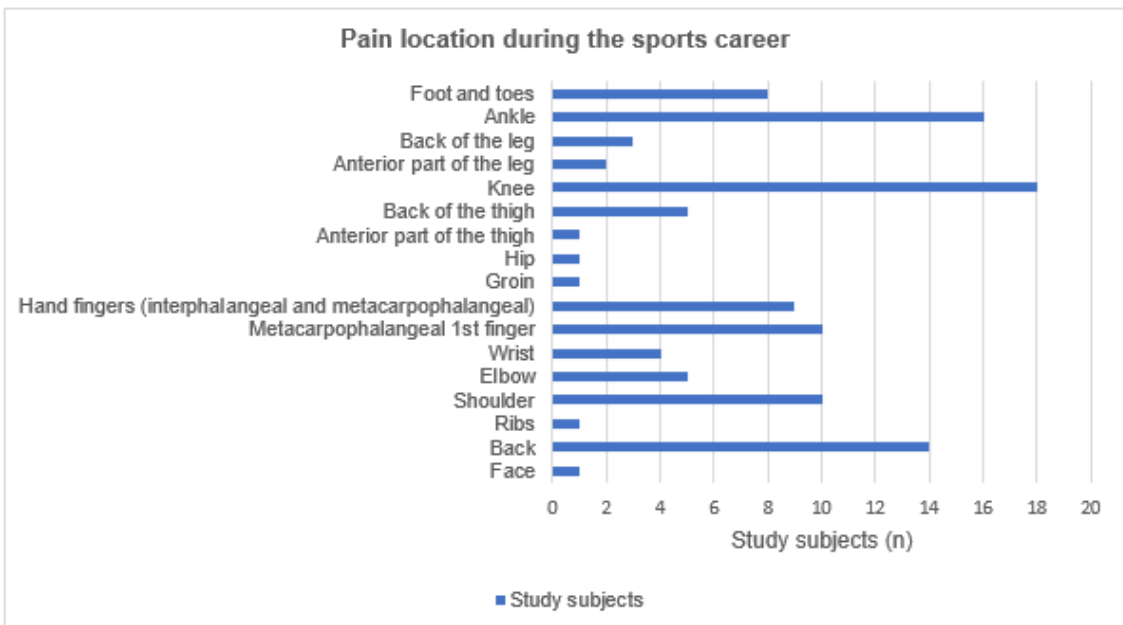
Figure 3. Pain location during the sports career.

Table 2. Sporting features of the sample.

Absolute frequencies n (%)		Cadet (n=9)	Junior (n=12)	Absolute (n=35)	Total (n=56)	p*
Belt level	Blue	0 (0)	1 (8.3)	1 (2.9)	2 (3.6)	**<0.01**
	Brown	4 (44.4)	1 (8.3)	2 (5.7)	7 (12.5)	
	Junior black belt	5 (55.6)	5 (41.7)	0 (0)	10 (17.9)	
	1st DAN Black belt	0 (0)	5 (41.7)	15 (42.9)	20 (35.7)	
	2nd DAN Black belt	0 (0)	0 (0)	9 (25.7)	9 (16.1)	
	3rd DAN Black belt or higher	0 (0)	0 (0)	8 (22.9)	8 (14.3)	
Current competitor	Yes	8 (88.9)	10 (83.3)	31 (88.6)	49 (87.5)	0.886
	No	1 (11.1)	2 (16.7)	4 (11.4)	7 (12.5)	
Frequency of karate training	1-2 times	1 (11.1)	1 (8.3)	2 (5.7)	4 (7.1)	0.613
	3-4 times	7 (77.8)	8 (66.7)	30 (85.7)	45 (80.4)	
	5 or more times	1 (11.1)	3 (25)	3 (8.6)	7 (12.5)	
Training more than once a day	Yes	0 (0)	3 (25)	6 (17.1)	9 (16.1)	0.292
	No	9 (100)	9 (75)	29 (82.9)	47 (83.9)	
Time of karate training	30-60 minutes	1 (11.1)	3 (25)	7 (20)	11 (19.6)	0.398
	60-90 minutes	5 (55.6)	7 (58.3)	25 (71.4)	37 (66.1)	
	More than 90 minutes	3 (33.3)	2 (16.7)	3 (8.6)	8 (14.3)	
Weight training	No	6 (66.7)	11 (91.7)	21 (60)	38 (67.9)	0.368
	1-2 times	2 (22.2)	1 (8.3)	9 (25.7)	12 (21.4)	
	3-4 times	1 (11.1)	0 (0)	5 (14.3)	6 (10.7)	
Time of Weight training	30 minutes	2 (66.7)	0 (0)	4 (28.6)	6 (33.3)	0.423
	30-60 minutes	0 (0)	0 (0)	5 (35.7)	5 (27.8)	
	60-90 minutes	1 (33.3)	1 (100)	5 (35.7)	7 (38.9)	
Stretching	No	0 (0)	1 (8.3)	6 (17.1)	7 (12.5)	0.334
	Yes, only legs	2 (22.2)	6 (50)	11 (31.4)	19 (33.9)	
	Yes, arms and legs	7 (77.8)	5 (41.7)	18 (51.4)	30 (53.6)	
Stretching time	5 minutes	4 (44.4)	6 (54.5)	9 (31)	19 (38.8)	0.718
	10 minutes	5 (55.6)	4 (36.4)	15 (51.7)	24 (49)	
	15 minutes	0 (0)	1 (9.1)	4 (13.8)	5 (10.2)	
	20 minutes or more	0 (0)	0 (0)	1 (3.4)	1 (2)	

* Pearson's chi-squared test.

3.4 PAIN CHARACTERISTICS

18 subjects (32.1%) were found with pain at rest and 32 subjects (57.1%) with pain during the performance of a technique at the time of the study. The technique with the highest number of cases where pain was suffered was the *kisami-zuki* or the straight forward punch with the upper limb (46.9%), followed by the *gyaku-zuki* or the reverse punch with the upper limb placed behind him/her (40.6%), and the *mawashi-geri* or roundhouse kick with the instep (40.6%). On the other hand, in terms of painful postures, *seiza* (posture during the initial greeting) was the one selected in most cases by 8 study subjects (14.3%).

The pain of the sample had an intensity during training of 4.6 (2.8) cm (mean and interquartile range), while at rest it was of 0.8 (2.7) cm. The pain intensity depending on the category and gender can be seen in Table 3. No statistically significant differences were found between pain and categories, nor between pain and gender. Although no differences have been seen, women and junior karateka have a higher pain intensity during training.

Table 3. Pain intensity according to category and gender.

Mean (IQR)	Category			p	Gender		p
	Cadet	Junior	Absolute		Man	Woman	
VAS Training, cm.	4.7 (1.8)	5 (2.7)	4.1 (3.2)	0.753[a]	4.1 (3.4)	4.8 (2.8)	0.083[b]
VAS Currently, cm.	2.7 (3.2)	0.7 (1.5)	0.9 (2.6)	0.851[a]	0.7 (2.5)	1.1 (5.1)	0.243[b]

[a] Kruskal–Wallis test, [b] Mann–Whitney U test

3.5 PAIN AND INSTABILITY IN RELATION TO ANTHROPOMETRIC AND SPORTING FACTORS

Concerning the current pain variable and the anthropometric factors (Table 4), statistically significant differences were found in terms of age (p = 0.04) and BMI (p = 0.045) of the sample studied. In other words, the older and higher BMI, the more cases of pain. Regarding pain in the last 7 days or last month and as for the instability compared to the anthropometric factors, the differences analysed were not statistically significant (Table 4).

On the other hand, in relation to sports data (Tables 4 and 5), the current pain showed statistically significant differences with respect to the belt level. Thus, the higher belt level, the more cases of pain (p = 0.017). In addition, statistically significant differences were detected between the pain in the last 7 days or last month and the frequency of karate training (p = 0.011), i.e., the higher the frequency of training, the more cases of pain. For the other variables, no differences were noticed.

Table 4. Pain and instability in relation to anthropometric and sporting factors.

	Current pain			Pain in the last 7 days or month			Instability		
	Yes (n=24)	No (n=32)	p	Yes (n=38)	No (n=18)	p	Yes (n=28)	No (n=28)	p
Anthropometric factors. Mean (SD)									
Age, years	24 (9)	20 (7)	**0.04[a]**	23 (8)	20 (8)	0.261[a]	23 (8)	21(8)	0.348[a]
Weight, kg.	70.76 (13.23)	65.06 (9.98)	0.072[a]	68.84 (12.11)	64.69 (10.64)	0.219[a]	70.04 (11.4)	64.97 (11.69)	0.106[a]
Height, cm.	172.33 (8.87)	170.72 (8.13)	0.488[a]	172.34 (8.46)	169.44 (8.53)	0.238[a]	172.5 (8.23)	170.32 (8.8)	0.343[a]
BMI, kg/m^2.	23.67 (3)	22.2 (2.01)	**0.045[a]**	23.04 (2.73)	22.38 (2.19)	0.370[a]	23.43 (2.64)	22.23 (2.38)	0.08[a]
Gender (man/woman). Absolute frequency.	18/6	20/12	0.322[b]	27/11	11/7	0.457[b]	20/8	18/10	0.567[b]
Sports data. Absolute frequencies.									
Category (cadet/junior/absolute).	1/6/17	8/6/18	0.11[b]	4/9/25	5/3/10	0.253[b]	2/8/18	7/4/17	0.126[b]
Belt level (blue/brown/junior black/1st DAN Black belt/2nd DAN Black belt/3rd DAN Black belt or higher	1/0/4/10/2/7	1/7/6/10/7/1	**0.017[b]**	1/3/7/15/4/8	1/4/3/5/5/0	0.116[b]	0/1/5/13/3/6	2/6/5/7/6/2	0.065[b]
Current competitor (yes/no)	20/4	29/3	0.414[b]	34/4	15/3	0.516[b]	24/4	25/3	0.686[b]
Frequency of karate training (1-2 times/3-4 times/5 or more times)	0/21/3	4/24/4	0.195[b]	0/33/5	4/12/2	**0.011[b]**	1/26/1	3/19/6	0.059[b]
Time of karate training (30-60 minutes/60-90 minutes/more than 90 minutes).	6/16/2	5/21/6	0.437[b]	7/26/5	4/11/3	0.863[b]	6/18/4	5/19/4	0.943[b]

Table 5 (continued from previous page). Pain and instability in relation to anthropometric and sporting factors.

Weight training (no/1-2 times/3-4 times).	13/8/3	25/4/3	0.131[b]	23/10/5	15/2/1	0.233[b]	18/6/4	20/6/2	0.68[b]
Stretching (no/yes, only legs/yes, arms and legs).	3/10/11	4/9/19	0.546[b]	6/13/19	1/6/11	0.520[b]	2/11/15	5/8/15	0.415[b]
Stretching time (5 minutes/10 minutes/15 minutes/20 minutes or more)	7/11/2/1	12/13/3/0	0.633[b]	12/15/4/1	7/9/1/0	0.770[b]	12/12/2/0	7/12/3/1	0.505[b]
Limitation for pain (no/yes, I had to stop temporarily, but I was able to resume the training/yes, I could not continue the training/yes, I did not train again due to my pain).	7/16/0/1	17/14/1/0	0.153[b]	13/23/1/1	11/7/0/0	0.253[b]	9/18/0/1	15/12/1/0	0.195[b]
Limitation during the career (yes/no).	21/3	24/8	0.319[c]	31/7	14/4	0.732[c]	25/3	20/8	0.093[b]

[a] Student's t-test, [b] Pearson's chi-squared test, [c] Fisher's exact test

3.6 SAMPLE SIZE FOR A FUTURE PREVALENCE STUDY

Assuming that the population is infinite, we need a random sample of 335 study subjects to estimate a population percentage of 67.9%, with a confidence interval of 95% and an accuracy of +/- 5 percentage units with a replacement rate of 0%.

4. DISCUSSION

To the best of the knowledge and belief of the authors, this is the first study of pain prevalence during training in combat karate practitioners carried out in Spain. Furthermore, although other studies have been found on competition karate practitioners or kumite, these are epidemiological studies that collect injuries mainly in competition (7,9-11,18). Regarding the only two studies found on the prevalence of injuries in training (8,11) these present the percentages of injuries in a generic manner based on their injury mechanisms, as well as on their non-specific location, without collecting information about pain or other subjective feelings such as instability in specific anatomical areas.

The prevalence of pain in this study has been divided into three variables: presence of pain, current pain and pain in the last 7 days or last month. The presence of pain was based on any positive case present both in the current pain variable and in the pain suffered in the last 7 days or last month, obtaining a prevalence of 67.9%. The results obtained show the absolute category to be more prevalent.

Despite the fact that no statistically significant differences were obtained between genders, concerning both the presence of pain and their frequency according to categories, the average age of men was 5 years higher than that of women of the study. These results are similar to those of other studies (7,13) showing a similar injury rate in men and women. It also contrasts with studies (10, 12) whose results show a lower rate in women, or even an increased risk of injury in women aged 12-17 years (9). The differences with the latter may be due to the sampling used in this study, since it is a non-probability consecutive sampling where participants are mostly men and older than 18 years. In addition, the age difference between men and women in the sample could lead to a different experience in competition.

In the case of men in the present study, as they are older, they have more experience in combat. The karate practitioners with less sport experience have shown to have a higher injury rate (8), since the higher the belt degree, the shorter the reaction time (19-21) and the greater the speed of visual perception (22), having thus a greater possibility to avoid the adversary's contacts, and therefore, a lower risk of injury. However, in contrast to the above, another study (10) shows a higher injury rate in athletes with more experience, as they can potentially develop dangerous and defensive offensive techniques with more strength and speed.

In this study, pain was not very limiting in 60.5% of the sample. This coincides with most of the studies (7-13), where the injuries are minor, mostly contusions. Likewise, since the subjective pain intensity has been found to be moderate (23), this may also explain the fact that they have been found to be not very constraining, as it has been proven that athletes who practise contact sports become more pain-tolerant than those who do not practise them (24).

In terms of location, the knee area has been proved to be the most prevalent area of pain at the time of the study (36.8%) and during the sports career (32.1%). This coincides with the results of Tischer et al. (18), who state that the knee was the area with the highest number of medical attentions in the 2014 Karate World Championship, both in kata and in kumite (28.7% and 26.7% respectively). Nonetheless, it also contrasts with most studies (7-10,12-14) conducted in competitions and during training, which have registered the head as the most commonly injured area. This may be due to the fact that, in competition, the most commonly used technique is the *kisami-zuki* (4) or the straight forward punch with the upper limb. in the meantime, the Yuko or the punch to any of the 7 scoring areas, is the most used way to score (6), performing this technique on the adversary's face, and, therefore, generating greater exposure to contusions in this area. Although this technique directed to the face is the most used in competition, during training, excessive contacts to the face of clubmates is usually avoided.

In addition, in the knee, the overuse or excessive request of this joint could be one of the causes of the origin of pain, because fast movements are carried out in competition or kumite (25) as well as techniques (6) that request said joint while needing an eccentric control to stop the kicks (26) in order to avoid excessive contacts. A study was developed in taekwondo (27) where a high prevalence of chronic pain due to overuse was observed (65.8%), mainly in the lower body (61.5%) and in the knees (26.4%). Taekwondo could be considered similar to karate since they perform analogous kicking techniques, and carry out at rest similar movements and bounce.

On the other hand, in relation to instability, 50% of the study subjects had this feeling, with the knee being the joint with the most cases of instability (50%). According to the study by Solis et al. (28), the higher the BMI and the older, the greater the knee dysfunction. This matches the results of this study, where the subjects with instability had higher BMI and were older, although no statistically significant differences were obtained. Pop et al. (29) stated that the karate group with an age ranging from 9 to 19 years old had better body stability compared to a control group ranging from 10 to 16 years old who did not perform physical activity. This could suggest, that the karateka, in this case younger than 19 years, show a greater knee stability compared to the sedentary population.

As for the onset moment of the pain, most individuals with pain reported it during the performance of karate techniques (57.1%) while a lower number of them reported it at rest (32.1%). The most painful technique has turned out to be the *kisami-zuki* or straight forward punch with the upper limb (46.9%), followed by the *gyaku-zuki* or reverse punch with the upper limb placed behind

the practitioner and the *mawashi geri* or roundhouse kick with the instep (40.6% both of them). These techniques match the study by Chaabène et al. (4) since they are the most used in kumite. Additionally, karateka in kumite perform more techniques with the upper limbs than with the lower limbs (4), with Yuko being the most widely used scoring method nationally and internationally (6). The overuse of these techniques could explain the pain during their performance, as it seems to indicate the study of Koh on prevalence of the pain by overuse in taekwondo (27).

Regarding the correlation between pain and instability with anthropometric factors, statistically significant differences have been detected in the current pain variable, so that the older they are and the higher the BMI, the more pain they suffer. In terms of age, the mean of the study subjects with pain resembles that observed in a retrospective study (12), where a high rate of injury was shown around 20-24 years old. Langley et al. (30) affirm that the association between the prevalence of pain in Spain and the age is not entirely clear. However, in their study, the population between 40 and 59 years old suffered pain more frequently, resulting in an age higher than the mean of the sample of this study.

Concerning the BMI, it is observed that, in the sample, the subjects with pain have an average of 5 kg more than the subjects without pain (70 vs 65 kg). This differs from the study by Ziaee et al. during karate training, where the weight range with the highest number of injuries was between 50 and 60 kg (8). The differences with this study could be due to the age of the sample, since 46% of the sample of the previous study (8) ranged from 14 to 19 years old. Likewise, the difference in relation to experience (less than 3 years in 88% of the injured practitioners (8) compared to the 13 years old of age of commencement in kumite of this study) could explain the higher risk of injury.

In competition, in the under-21 category, a higher rate of injuries was registered when the competition was divided into three weight categories, instead of five as of 2015, which may be due to the confrontation of karate practitioners with a great difference of weight within the same category (10). Furthermore, the study by Solis et al. (28), states that the greater the BMI, the greater the symptomatology and dysfunctionality of the knee. This coincides with the results of this study, since both the area of pain and the most prevalent area of instability have been proved to be the knee region. It was also evidenced by both studies that people with instability and pain have higher BMI values. The knee joint supports a greater load in these subjects, thus generating a greater risk of pain and instability.

With respect to sports data, statistically significant differences have been observed between the current pain and the belt level. The higher the belt level, the greater the number of cases of pain. This may be due to the fact that, in the absolute category, where high levels predominate, the combat time increases to 3 minutes (2) as it does the exposure time of the athletes, and consequently their risk of injury. Nevertheless, it must be taken into account that the sample is not balanced in terms of the belt level, since according to the age of the study participants, they cannot opt for any belt.

Statistically significant differences have also been noticed between pain in the last 7 days or last month and the frequency of karate training so that, the higher the frequency of training, the greater the pain. Most of the study population tends to train 3-4 times a week. By training a greater number of hours, the time of exposure to injuries during the practice of *kumite* increases. It should also be noted that the study subjects are mostly current competitors (49vs7), which could influence a greater number of hours of exposure to injuries during competitions and during training.

This research is not without limitations. The main drawback is based on its design, since, by being a cross-sectional study, the correlations between pain and the variables studied do not allow establishing causal relationships. More studies with a larger sample size in a balanced way, in terms of age, gender and competition categories, with a longitudinal design, would be necessary to confirm the results of this study and extrapolate them to the population of karateka.

5. CONCLUSIONS

Pain in competitive karateka during training is a frequent problem that shows a high prevalence in the sample studied. The knee is the most affected area due to both pain and instability. The pain is significantly correlated to those karateka with a higher body mass index, older age, higher belt level and higher frequency of training. In addition, the pain appears to be moderate and occurs mainly with the punching technique with the straight forward punch with the upper limb or *kisami-zuki*.

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