DOI: 10.1590/1809-2950/16168723042016

ORIGINAL RESEARCH

Association between low back pain and functional/kinetic aspects of surfers: disability, function, flexibility, range of motion and angle of the thoracic and lumbar spine

Associação entre dor lombar e aspectos cinético-funcionais em surfistas: incapacidade, funcionalidade, flexibilidade, amplitude de movimento e ângulo da coluna torácica e lombar

La asociación entre dolor lumbar y aspectos cinético y funcionales en surfistas: incapacidad, funcionalidad, flexibilidad, amplitud del movimiento y ángulo de la columna torácica y lumbar

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ABSTRACT | Although surfing can contribute to chronic low back pain, the relationship between functional/kinetic changes and low back pain are still not fully understood. The association between low back pain and functional/kinetic aspects was investigated in people who had surfed for different numbers of years, in a cross-sectional study involving 66 surfers from the coast of Paraná. The participants were allocated into three groups considering how long they had surfed: G1 (up to 4.9 years), G2 (from 5 to 9.9 years) and G3 (more than 10 years). The following items were evaluated: body mass index; level of physical activity; low back pain; intensity and frequency of low back pain, low back disability, low back function, low back flexibility, low back range of motion, low back and thoracic angles. To analyze the association between functional/kinetic aspects and low back pain, Pearson's Qui-Square test was used for categorical data, while for nominal data ANOVA with Bonferroni's *post-hoc* test ($p<0.05$) was used. The group which had surfed the longest (G3) showed an association with the occurrence of low back pain ($p=0.05$) and its highest intensity ($p=0.01$). The group with 5 to 9.9 years of surfing (G2) showed the largest low back angle ($p=0.04$). We conclude that the surfer's chronic low back pain is associated with greater pain intensity, the angle of the lumbar curvature and how long the person has surfed.

Keywords | Sports; Low Back Pain; Spinal Curvatures; Athletic Injuries; Lordosis.

RESUMO | Embora a prática do *surf* possa contribuir para o aparecimento de dor lombar crônica, ainda não está totalmente esclarecido se a lombalgia está associada a alterações cinético-funcionais. Assim, investigou-se a associação entre a presença de dor lombar com aspectos cinético-funcionais em surfistas com diferentes tempos de prática. Participaram deste estudo observacional de corte transversal 66 surfistas do litoral do Paraná. Os participantes foram alocados em três grupos, conforme o tempo de prática esportiva em anos: G1 (até 4,9 anos), G2 (de 5 a 9,9 anos) e G3 (acima de 10 anos de prática). Foram avaliados: índice de massa corporal, nível de atividade física, presença de dor lombar, intensidade e periodicidade da dor, incapacidade lombar, funcionalidade lombar, flexibilidade lombar, amplitude de movimento lombar, e ângulo torácico e lombar. Para a análise da associação entre os aspectos cinético-funcionais e a dor lombar foram utilizados o teste qui-quadrado de Pearson para dados

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categóricos e ANOVA com *post hoc* de Bonferroni (p<0,05) para dados nominais. O maior tempo de prática esportiva (G3) revelou associação com a presença (p=0,05) e maior intensidade da dor lombar (p=0,01). O grupo que praticava o esporte entre 5 a 9,9 anos (G2) apresentou maior ângulo lombar (p=0,04). Conclui-se que a presença da dor lombar crônica em surfistas apresentou associação com a intensidade da dor, o ângulo da coluna lombar e o tempo de prática de *surf*.

Descritores | Esportes; Dor Lombar; Curvaturas da Coluna Vertebral; Traumatismos em Atletas; Lordose.

RESUMEN | La práctica del *surf* puede ocasionar dolor lumbar crónica. Pero todavía no se sabe si la lumbalgia está asociada con los aspectos cinéticos y funcionales. En este trabajo se asoció la presencia del dolor lumbar con los aspectos cinético y funcional en surfistas con distintos tiempos de práctica. Del estudio de corte transversal participaron 66 surfistas del litoral de Paraná, Brasil. Se dividieron a los participantes en tres grupos según su tiempo, en años, de práctica deportiva: G1 (hasta 4,9 años), G2 (de 5 a 9,9 años) y G3 (más de 10 años). Se evaluaron: el índice de masa corporal, el nivel de actividad física, la presencia de dolor lumbar, la intensidad y periodicidad del dolor, la incapacidad lumbar, la funcionalidad lumbar, la flexibilidad lumbar, la amplitud del movimiento lumbar, el ángulo torácico y lumbar. Para analizar la asociación de los aspectos cinético y funcional con el dolor lumbar se empleó la prueba de chi-cuadrado de Pearson para los datos categóricos y para los datos nominales la prueba ANOVA con *post-hoc*, de Bonferroni (p<0,05). El mayor tiempo de práctica deportiva (G3) fue asociado con la presencia (p=0,05) y mayor intensidad del dolor lumbar (p=0,01). El grupo que practicaba de 5 a 9,9 años (G2) este deporte presentó mayor ángulo lumbar (p=0,04). Se concluye que la presencia de dolor lumbar crónica en surfistas estuvo asociada con la intensidad del dolor, el ángulo de la columna lumbar y el tiempo de práctica del *surf*.

Palabras clave | Deportes; Dolor Lumbar; Curvaturas de la Columna Vertebral; Traumatismos en Atletas; Lordosis.

INTRODUCTION

Surf is an intermittent type of sport that requires the person to alternate between high, moderate and low intensity activities[1]. It is performed by people of different ages and requires long periods of practice. Moreover, it requires a high level of neuromuscular ability and balance, with movements from higher and lower limbs and the spine[2]. Thus, pains and discomforts associated with the muscle demands of these movements from the sport may arise over time[3,4].

Of the chronic muscle dysfunctions, lower back pain stands out among surfers from different countries[3,5,6], at times making them find the sport intolerable or giving it up. In Brazil, chronic low back pain affects three of every 10 athletes who surf[7]. The higher incidence of low back pain in surfers in comparison with a group of sedentary people[8] reveals the need of specialized professional attention in the search for the kinetic/functional factors demanded by the sport.

Professional surfers who train most of their time present better control of their posture, especially in unstable surfaces[9]. Similarly, recreational surfing may cause beneficial adaptations to the neuromuscular function on the long term, with lower rates of posture oscillation in the standing position, with closed eyes and in a smooth surface[2]. However, when we compare amateur surfers with active individuals who perform different sports, there is no different in their balance control[10]. Thus, we conclude that lower back pain in surfers is not caused by posture instability, since higher rates of oscillation may be related to low back pain[11].

However, isometric hyperextension while paddling[7] and doing the *pop-up* (quick movement to change from the position of paddling to standing up on the surfboard)[12] were mentioned as probable causes for lower back pain. As a result, our hypothesis is that kinetic and functional changes in the thorax and lower back could be related to pain in the area.

Up to the moment, we did not identify any study that investigated the association between low back pain and kinetic and functional factors in surfers. Thus, the present study aimed to investigate the relationship between the presence of lower back pain (and its intensity) and some of the variables of the kinetic/functional condition of the region (lumbar disability caused by pain, lumbar function and flexibility, range of motion and angle of the thoracic and lumbar spine) in surfers from the coast of Paraná who had been surfing for different numbers of years.

METHODOLOGY

The participants of this cross-sectional study were professional, amateur or recreational surfers from the coast of Paraná who had been surfing for at least 6 months. They were from both sexes, and their age ranged between 18 and 42. We excluded individuals with peripheral neurological and vascular comorbidities, who had had back surgery less than a year before or who had a herniated disk and/or spine fractures.

For the sample calculation, we considered the percentage of surfers was 1.47%[13,14] (2,803,770) of the total of the population in Brazil (190.732.694), according to data from the last Census/IBGE 2010. When adopting these parameters, based on the equation of a previous study[14], the result was 62 surfers, and 66 were selected (figure 1). The participants were allocated into three different experimental groups according to how long they had been surfing: group 1 (G1, up to 4.9 years of surfing, n=22), group 2 (G2, between 5 and 9.9 years of surfing, n =17) and group 3 (G3, more than 10 years of surfing, n=27). Table 1 shows the characteristics of the participants. All procedures carried out in this study were approved by the Research Ethics Committee (Statement 335,941).

The procedures of this study were carried out individually by a single inter-rater.

To characterize the participants, we used a demographic questionnaire which assessed: age, gender, surfing category, years of surfing, number of hours per day and weekly frequency of the surfing training.

The Body Mass Index (BMI) was obtained by dividing the mass of the individual by the square of their height (kg/m^2) and the participants were classified as underweight, eutrophic, overweight or obese[15].

The level of physical activity was investigated by the IPAQ (International Physical Activity Questionnaire – long version)[16] and the participants were classified as sedentary, insufficiently active, active and very active.

Acute lower back pain was analyzed by asking if an episode of acute lower back pain had occurred in the previous four weeks, with its intensity being assessed with the 11-point pain intensity numerical rating scale (PI-NRS)[17], which consists in 11 numbers, from 0 (no pain) to 10 (worst pain), over a horizontal 10-cm line.

Chronic lower back pain was evaluated using the Nordic Musculoskeletal Questionnaire (NMQ)[18], which asked if chronic lower back pain had occurred for longer than 4 weeks in the previous 12 months. The participant also answered if the pain was associated with surfing.

Lumbar disability was investigated with the QUEBEC Back Pain Disability Scale Questionnaire[19], and the participant evaluated how hard it is to perform 20 daily activities. The scores of the items were added up, to a total score within the range of 10 and 100, with higher numbers representing greater levels of disability.

Lumbar function was evaluated with the Back Performance Scale (BPS)[20], which consists in conducting 5 tests to evaluate the physical performance of the lower back region in different daily life activities. The score was obtained by adding up the individual scores of each tests, with the higher scores indicating the worst performance.

Lower back flexibility was measured by Schober's test[21], with a variation equal or greater than 5 cm being considered normal.

The range of motion of the lumbar spine was evaluated with goniometry[21]. The maximal active range of motion of the flexion and extension of the lumbar spine was requested, in degrees. A freedom of movement between 0 and 95 º was considered normal for lumbar flexion, and between 0 and 35 º for lumbar extension[21].

The thoracic and lumbar angles were measured in degrees with a spline. Previous evidences[22] indicate that the method is strongly correlated with the gold standard test performed in radiography. The method[22] consists in the palpation and marking of the spinous processes, molding the flexible ruler of 80 cm (spline) from the seventh cervical vertebrae (C7) to the first sacral vertebrae (S1) and then drawing the form in graph paper. The angle is determined by an algorithm developed in the Matlab software with a third-degree polynomial. The measurement was done in three repetitions by a single inter-rater which presented an intra-class correlation coefficient of: ICC lumbar=0.83, p=0.003; ICC thoracic=0.82, p=0.004. Values between 20 and 60º for the thoracic curvature and 22 and 54 º for the lumbar curvature were considered normal. Values below the reference values were considered rectifications of the curvature, and those above it, thoracic hyperkyphosis or lumbar hyperlordosis.

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 21.0. All the data were submitted to an analysis of normality and homogeneity of variances with the Kolmogorof-Smirnov and Levene tests, respectively. The nominal and/or ordinal variables were described in

frequency and in percentage, while numerical variables were described in average and standard deviation.

To analyze the categorical dada, we used Pearson's chi-square test. For the numerical variables, ANOVA was used among the groups with Bonferroni's *post-hoc* test. For all the analyses, the level of significance was fixed at $p<0.05$. The size of the effect was determined through the calculation of the omega, with $\omega = 0.01$ being considered a small effect, $\omega = 0.06$ a moderate effect and values above 0.14 a large effect[23].

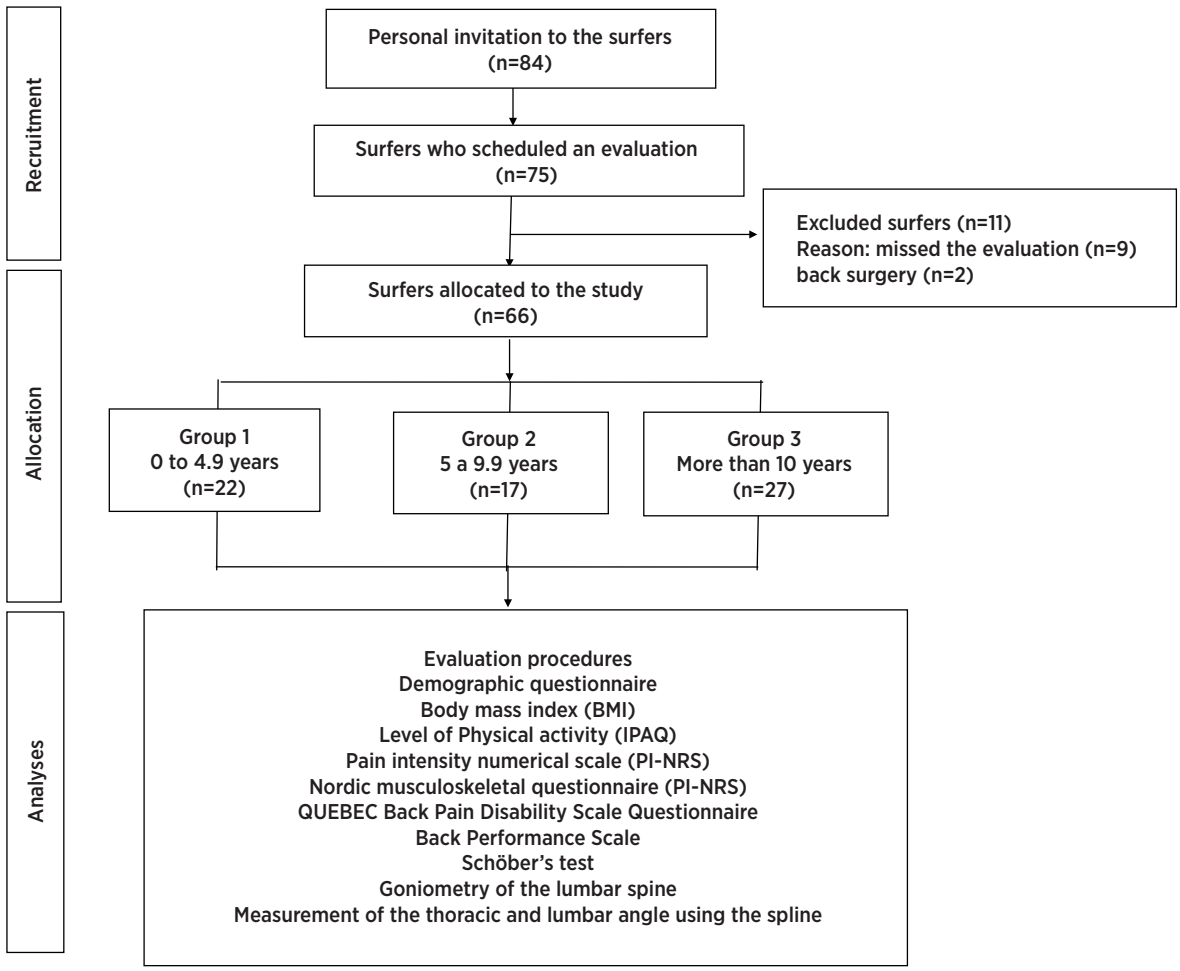

Figure 1. Experimental design

Table 1. Characteristics of the surfers from the three different experimental groups

Characteristics	Experimental groups		
	Group 1 0 to 4.9 years (n=22)	Group 2 5 to 9.9 years (n=17)	Group 3 More than 10 years (n=27)
Age (years, average ± SD)	23.6 (4.2)	23.6 (5.5)	29.9 (5.8)
Gender			
Female (n, %)	8	6	2
Male (n, %)	14	11	25
BMI (kg/m², average ± SD)	22.8 (3.6)	22.9 (3.1)	23.8 (2.6)
Classification according to the BMI			
Underweight (n, %)	3 (13.6)	1 (5.9)	0 (0)
Eutrophic (n, %)	16 (72.7)	13 (76.5)	19 (70.4)
Overweight (n, %)	2 (15.4)	3 (17.1)	8 (29.6)
Obese (n, %)	1 (4.5)	0 (0.0)	0 (0.0)

Characteristics	Experimental groups		
	Group 1 0 to 4.9 years (n=22)	Group 2 5 to 9.9 years (n=17)	Group 3 More than 10 years (n=27)
Sports category			
Recreational (n, %)	19 (86.4)	12 (70.6)	12 (44.4)
Amateur (n, %)	3 (13.6)	4 (23.5)	8 (29.6)
Professional (n, %)	0 (0)	1 (5.9)	7 (25.9)
Daily hours of training (average ± SD)	2.1 ± 1.0	2.5 ± 1.1	2.6 ± 1.3
Number of training days per week (average ± SD)	3.3 ± 1.6	3.8 ± 1.8	3.4 ± 1.5
Level of physical activity			
Very active (n, %)	8 (36.4)	12 (70.6)	21 (77.8)
Active (n, %)	14 (63.6)	4 (16.7)	6 (22.2)
Sufficiently active (n, %)	0 (0.0)	1 (5.9)	0 (0.0)

RESULTS

Presence of lower back pain, periodicity and association with surfing

Table 2 shows there was a significant association between the presence of chronic low back pain and surfing, χ^2 (1) = 5.97 (p=0.05). However, there was no statistically significant difference between the three groups of the study for the occurrence of lower back pain (acute or chronic) or for its periodicity.

Kinetic and functional aspects (intensity of the lumbar pain, disability, function, flexibility, range of motion and angle of the thoracic and lumbar spine)

Table 3 presents the kinetic and functional aspects of the three different experimental groups. The effect of the number of years surfing was significant for pain intensity, F (2, 39) = 4.40, p = 0.01, ω = 0.15 (large effect size).

The analyses also revealed that the lumbar angle was greater for those who had been surfing for a period between 5 and 9.9 years, in comparison with those who had surfed for less time (up to 4.9 years), F (2, 65) = 3.38, p = 0.04, ω = 0.07 (moderate effect size). However, this difference was not confirmed in Group 3, which had the longest surfing period (p > 0.05).

As a result, to eliminate the effect of the changes caused by age, we conducted statistical analyses using age as a covariate. The results showed that age had no significant relationship with pain intensity nor with the lumbar angle, F (2, 39) = 2.49, p = 0.12, *r*= 0.37 (large effect size).

Table 2. Occurrence of acute or chronic lower back pain, periodicity of the pain and its association with surfing, for the three different experimental groups

Characteristics	Experimental groups			Total (n=66)	χ^2	p-value	Φ
	Group 1 0 to 4.9 years (n=22)	Group 2 5 to 9.9 years (n=17)	Group 3 More than 10 years (n=27)				
Acute lower back pain (last 4 weeks)	13 (59.1)	8 (47.1)	19 (70.4)	40 (60.6)	2.40	0.30	0.19
Chronic lower back pain (last 12 months)	12 (54.5)	14 (82.4)	19 (70.4)	45 (68.2)	3.51	0.17	0.23
Periodicity of the chronic lower back pain							
Never	10 (45.5)	3 (17.6)	8 (29.6)	21 (31.8)	8.53	0.20	0.20
Rarely	7 (31.8)	9 (52.9)	8 (29.6)	24 (36.4)			
Often	4 (18.2)	2 (11.8)	9 (33.3)	15 (22.7)			
Always	1 (4.5)	3 (17.6)	2 (7.4)	6 (9.1)			
Association between lower back pain and surfing	7 (31.8)	11 (64.7)	17 (63.0)	35 (53.0)	5.97	0.05*	0.30

Note: The data were presented in n (%). Pearson's Chi-square test, with the level of significance* fixed at p<0.05.

Table 3. Kinetic and functional aspects of surfers from the three experimental groups

Kinetic/functional aspect	Experimental groups			F	p-value	ω
	Group 1 0 to 4.9 years (n=22)	Group 2 5 to 9.9 years (n=17)	Group 3 More than 10 years (n=27)			
Intensity of lumbar pain	3.5 (1.8)	5.3 (1.5)	5.6 (2.2)[a]	4.404	0.019*	0.15
Lumbar disability	3.7 (3.8)	4.7 (6.2)	3.0 (4.5)	0.642	0.530	0.01
Lumbar function	0.4 (0.6)	0.2 (0.5)	0.4 (1.0)	0.467	0.629	0.02
Lumbar flexibility	4.9 (1.0)	5.0 (0.7)	5.0 (0.9)	0.154	0.857	0.03
Range of motion						
Lumbar flexion	92.2 (10.8)	89.8 (17.3)	93.3 (14.2)	0.321	0.727	0.02
Lumbar extension	35.6 (6.9)	39.2 (10.6)	39.1 (11.0)	0.983	0.380	0.01
Spinal curvature						
Thoracic angle	36.5 (8.6)	31.6 (8.2)	37.9 (9.5)	2.698	0.075	0.05
Lumbar angle	18.6 (6.3)	26.7 (13.4)a	22.2 (8.8)	3.383	0.040*	0.07

Note: The data were presented in average ± standard deviation from the average. Anova with Bonferroni's *post-hoc* test. [a]p<0.05 when compared with group 1

DISCUSSION

In this study, most young men who were eutrophic, active, who surfed recreationally three times a week, with a larger angle of the lumbar curvature and who had surfed the longest presented more intense lower back pain.

In the present study, more than half of the interviewees (60.6%) reported that at least one episode of lumbar pain had occurred in the previous 4 weeks. Similarly, 68.2% of surfers reported having lumbar pain in the previous 12 months.

Steinman et al.[7] revealed the high prevalence of recurring lower back pain (28.4%) in recreational surfers from Brazil who had surfed for more than 5 years. The authors suggest that after years of surfing, due to the repetitive movements of compressing and rotating the spine, the dehydration of intervertebral disks may occur, leading to pain and even disk degeneration. Moreover, the cervical and thoracic spines may suffer injuries, causing muscle imbalance due to the isometric hyperextension during paddling and predisposing surfers to musculoligamentous injuries caused by trauma.

There is also evidence[12] that accelerating the *pop-up* (quick movement to change from paddling to standing up on the surfboard) is a probable cause for the occurrence of lower back pain and injury. This is based on the physical relationship between the acceleration and the forces of tension at work during the movement, since it is an intense and explosive movement of rotating and compressing the lumbar spine.

With the goal of identifying the prevalence of lower back pain in surfers from Rio de Janeiro, Souza et al.[8] observed that lower back pain was more common in surfers than in non-surfers. These findings corroborate the results of the present study, where we found a significant association between the presence of chronic lower back pain and surfing.

With respect to the presence of lower back pain and the years of surfing, Daniels et al.[24] state that lower back pain is a common complaint among athletes, with traumas and infections being the most frequent causes in teenagers, while for adults they are mechanical or a consequence of osteoarthritis. De Luigi[25] states that the high incidence of structural injuries and lower back pain is associated with young athletes. Contrarily, Nathanson et al.[3] affirm that older surfers (age higher than 40) and more experienced surfers (more than 20 years of surfing) have higher relative risks of injuries, with the 35-55 age bracket being the most affected by lower back pain[26]. These statements partially contradict the findings of our study, in which no significant differences were found between the three studied groups, which were subdivided according to years of surfing for acute pain, occurrence of chronic lumbar pain or its periodicity. As for pain intensity, those who had surfed the longest (Group 3) had more intense lower back pain. However, when we eliminated the effect of the changes which could be related to age, the results indicated that age does not have a significant relationship with pain intensity.

Posture changes may occur due to factors such as muscle hypertrophy, imbalance between agonist/antagonist muscles, the decrease of flexibility due to repetitive movements and intense training for athletes[27]. Moreover, the increase of lumbar lordosis may directly cause lumbar pain, which was previously demonstrated by wrestling athletes who had chronic lumbar pain – the angle of their lumbar curvature was greater than that of

asymptomatic individuals[28], but this association has not been investigated for surfers up to the present moment.

Surfers spend about 45-50% of their time on the surfboard paddling, which favors spine hyperextension[7], which strengthens the posterior chain isometrically, possibly leading to muscle imbalance[29]. These results are compatible with the findings of the present study, in which the lumbar angle was greater for those who had surfed the longest when compared with those who had surfed less, suggesting that surfing may contribute to the increase of the lumbar curvature. However, the increase was not confirmed in Group 3, which had surfed the longest. Moreover, when we eliminate statistically the effect of changes brought by age, the results indicate that age did not have a significant relationship with the lumbar curvature and/or pain intensity.

In addition to the increase of the lumbar curvature, there are evidences that low back pain can be related to the loss of flexibility in the region[30]. Considering these indications, in our study we did not find an association between low back pain and flexibility and/or the range of motion of the lower back. Most participants (53%) presented values of normality for flexibility, but 57.5% showed loss of motion for lumbar flexion, and 36.3% showed restrictions for lumbar extension. Thus, in this study it was not possible to state that a restricted motion of the lower back leads to pain in the area.

There was also no association between lower back pain and lumbar disability, which was evaluated with the QUEBEC questionnaire, and no surfer presented a score greater than 30. This suggests that low back pain in surfers is not disabling. This finding is compatible with the evaluation of lumbar function, for which 95.5% of surfers presented a performance with no limitation (level 0) or minimally limited (level 1). In addition, the same occurred with the assessment of the thoracic curvature, for which 95.5% of the surfers presented angles considered normal. Thus, due to the indices of normality obtained in the sample of this study, the results of these variables should be interpreted with caution. Hence, future studies should analyze the relationship between lumbar disability and the loss of thoracic and lumbar curvature, and the flexibility of surfers with low back pain.

Although the present study explored the association between low back pain and kinetic and functional aspects, such as disability, function, flexibility, range of motion and the curvature of the thoracic and lumbar spines of surfers, some limitations can be mentioned so that they are studied by future researches, such as the aspect of practicing other sports in addition to surfing and specific training. Moreover, other methods can be used to collect data on low back pain instead of questionnaires and interviews.

We highlight that the clinical contribution of this work is relevant, since it shows the importance of evaluating the angle of the lumbar curvature for the choice of therapies aimed at preventing and reducing the intensity of low back pain in surfers. The data presented in this study showed some factors that cause low back pain in surfers, in particular the increase of the lumbar curvature. Hence, we single out the importance of postural re-education to correct the angle of the lumbar curvature in the prophylaxis of low back pain, as well as to control this type of pain in surfers.

CONCLUSION

There is a significant association between the occurrence of low back pain and surfing. A higher number of years of surfing seems to be associated with more intense low back pain and a larger angle of the lumbar curvature. However, for surfers low back pain is not associated with lumbar disability, function, flexibility, range of motion of the lumbar spine and the angle of the thoracic spine.

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