LOW BACK PAIN AND JOINT POSITION CHANGES IN CYCLISTS: A CROSS-SECTIONAL STUDY

DOR LOMBAR E ALTERAÇÕES DO POSICIONAMENTO ARTICULAR EM CICLISTAS: UM ESTUDO TRANSVERSAL

DOLOR LUMBAR Y CAMBIOS EN LA POSICIÓN DE LAS ARTICULACIONES EN CICLISTAS: UN ESTUDIO TRANSVERSAL

Original Article
Artigo Original
Artículo Original

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ABSTRACT

Introduction: Low back pain is one of the most common complaints among cyclists. The disharmony of the cyclist-bike combination may be a predisposing factor. Bike Fit is a technique that aims to adjust the bike to the individual characteristics of the cyclist. Objectives: To investigate the relationship between the cyclist's position on the bicycle and the occurrence of complaints of low back pain. Methods: Data obtained during Bike Fit from 62 amateur cyclists were used in the study. Cyclists were filmed during the act of pedaling on a stationary roller and image analysis was performed using Kinovea® software. Data related to complaints of low back pain and positioning on the bicycle were used in the Chi-Square test and binary logistic regression. Results: The mean age was 38.06 ± 8.82 years, 87.7% of the sample was composed of men and low back pain was found in 40.3% (25/62) of the participants. Univariate analysis showed a positive correlation between low back pain and the following variables: ankle dorsiflexion angle (X^2=6.947, p=0.014) and upper limb reach (X^2=5.247; p=0.032). Binary logistic regression showed a positive association between reaching with the upper limbs and low back pain (r=2.728; p=0.002) and a negative association between knee advancement and low back pain (r= -2.281; p=0.007). Conclusion: Cyclists with low back pain present changes in their position on the bicycle, which reinforces the importance of evaluating the cyclist/bike combination. However, it is not possible to state whether the positional changes observed in the study sample are causes or consequences of low back pain. ***Level of evidence: Level III; Cross-sectional observational study.***

Keywords: Bicycling; Low back pain; Ergonomics; Posture.

RESUMO

Introdução: A dor lombar é uma das queixas mais comuns nos praticantes de ciclismo. Pode ter como fator predisponente a desarmonia do conjunto ciclista-bicicleta. O Bike Fit é uma técnica que visa ajustar a bicicleta às características individuais do ciclista. Objetivos: Investigar a relação entre o posicionamento do ciclista na bicicleta e a ocorrência de queixas de dor lombar. Métodos: Os dados obtidos durante o Bike Fit de 62 ciclistas amadores foram utilizados no estudo. Os ciclistas foram filmados durante a pedalada em um rolo estacionário e a análise das imagens foi realizada pelo software Kinovea®. Os dados relacionados com a queixa de dor lombar e ao posicionamento na bicicleta foram utilizados no teste do Qui-quadrado e de regressão logística binária. Resultados: A média de idade foi de 38,06 ± 8,82 anos, 87,7% da amostra foi composta por homens e a dor lombar foi constatada em 40,3% (25/62) dos participantes. A análise univariada mostrou correlação positiva entre a dor lombar e as seguintes variáveis: ângulo de dorsiflexão do tornozelo (X^2 = 6,947, p = 0,014) e alcance dos membros superiores (X^2 = 5,247; p = 0,032). A regressão logística binária mostrou uma associação positiva entre alcance dos membros superiores e dor lombar (r = 2,728; p = 0,002) e associação negativa para avanço dos joelhos e dor lombar (r = -2,281; p = 0,007). Conclusão: Os ciclistas com dor lombar apresentam alterações de posicionamento na bicicleta, o que reforça a importância da avaliação do conjunto ciclista-bicicleta. Entretanto, não é possível afirmar se as alterações de posicionamento observadas na amostra estudada são causas ou consequências da dor lombar. ***Nível de evidência: Nível III; Estudo observacional transversal.***

Descritores: *Ciclismo; Dor lombar; Ergonomia; Postura.*

RESUMEN

Introducción: El dolor lumbar es una de las quejas más frecuentes en los practicantes de ciclismo. Puede tener como factor predisponente la falta de armonía del conjunto ciclista-bicicleta. Bike Fit es una técnica que tiene como objetivo ajustar la bicicleta a las características individuales del ciclista. Objetivos: Investigar la relación entre la posición del ciclista en la bicicleta y la aparición de quejas de lumbalgia. Métodos: En el estudio se utilizaron datos obtenidos durante el Bike Fit de 62 ciclistas aficionados. Los ciclistas fueron filmados durante el acto de pedalear sobre un rodillo estacionario y el análisis de las imágenes se realizó utilizando el software Kinovea®. Los datos relacionados con las quejas de dolor lumbar y la posición en la bicicleta se utilizaron en la prueba de Chi-Cuadrado y regresión logística binaria. Resultados: La edad media fue de 38,06 ± 8,82 años, el 87,7% de la muestra estuvo compuesta por hombres y se constató dolor lumbar en el 40,3% (25/62) de los participantes. El análisis univariado mostró una

Associate Editor responsible for the review process: José Maria Santarém

correlación positiva entre el dolor lumbar y las siguientes variables: ángulo de dorsiflexión del tobillo (X^2 = 6,947, p = 0,014) y alcance de las extremidades superiores (X^2 = 5,247; p = 0,032). La regresión logística binaria mostró una asociación positiva entre el alcance de las extremidades superiores y el dolor lumbar (r = 2,728; p = 0,002) y una asociación negativa para el avance de la rodilla y el dolor lumbar (r = -2,281; p = 0,007). Conclusión: Los ciclistas con dolor lumbar presentan cambios en su posición sobre la bicicleta, lo que refuerza la importancia de la evaluación del conjunto ciclista-bicicleta. Sin embargo, no es posible afirmar si los cambios posicionales observados en la muestra estudiada son causas o consecuencias del dolor lumbar. ***Nivel de evidencia: Nivel III; Estudio observacional transversal.***

Descriptores: *Ciclismo; Dolor de la región lumbar; Ergonomía; Postura.*

DOI: http://dx.doi.org/10.1590/1517-8692202329022021_0413i Article received on 10/17/2021 accepted on 08/15/2022

INTRODUCTION

Cycling is one of the world's most traditional sports and it can be a recreational or competitive sport option, as well as an alternative means of transportation, capable of improving the physical conditioning of its enthusiasts and, consequently, increasing their quality of life.[1,2,3] Pedaling is a highly complex bipedal activity that requires multi-articular work of the lumbopelvic region and lower limbs, producing and conducting mechanical energy to transform it into kinetic energy to generate propulsion.[4,5]

The pedaling cycle can be divided into the propulsion phase (starting at zero degrees – top dead center and ending at 180º - bottom dead center) and recovery (starting at 180º and ending at 360º).[6,7] The muscle groups most involved in pedaling are the hip and knee extensors and flexors and the plantar flexors and dorsiflexors of the ankle. The transfer of energy is ensured by the muscle co-contraction, with the uniarticular muscles as protagonists – generators of force. The task of conducting it to the pedals is the job of the biarticular muscles.[5]

In addition to the muscles responsible for pedaling, several others, including paravertebral, abdominal, and upper limb muscles, require constant activation to maintain the position of the trunk, head, and upper segments during the act of pedaling.[8]

Because it is a highly repetitive activity, cyclists are more prone to overuse injuries, be they acute or chronic. During an hour of activity, the cyclist can perform around 5,000 pedaling cycles.[9] The regions most affected by overuse injuries are the cervical spine, knees, inguinal region, buttocks, hands, and lumbar spine region. Usually, the reported injuries are less serious, but the high incidence, which can reach up to 87% of cyclists, should be viewed as a warning.[10,11]

A mismatch in the cyclist-bicycle combination may be a factor that predisposes to the appearance of non-traumatic injuries since biomechanical changes in the act of pedaling may be associated with injuries. An adjustment protocol called Bike Fit is used as a prevention tool. Based on the principles of kinesiology and biomechanics, this technique aims to improve performance, maximize comfort, and minimize the musculoskeletal injury rates. In Bike Fit, the professional will adjust the bicycle components to position the angles of the cyclist's joints according to the reference values found in the literature.[12,13] One of the most prevalent cycling disorders is low back pain, which can affect up to 60% of cyclists. Improper posture on the bicycle, as well as problems with the suitability of the bicycle components, can promote low back pain.[14]

Given this situation, the objective of the study was to investigate the existence of an association between the presence of low back pain and the changes in joint positioning on the bicycle observed in amateur cyclists during a Bike Fit consultation.

METHODS

Type of Study

Observational, cross-sectional study.

Ethical Diligence

All the recommendations of Resolutions CNS 466/2012, CNS 510/2016, and their complements were observed. The study was only initiated after approval of the research protocol by the Institutional Review Board, under opinion number 3.412.247.

Participants

The sample was composed by convenience and non-probabilistically. Data were collected from the records of 62 cyclists who had participated in a Bike Fit consultation.

Inclusion Criteria

The records of men and women aged between 18 and 60 years who had undergone a Bike Fit consultation between 2017 and 2019 were considered.

Procedures

All the evaluations were conducted by a single professional and each subject was submitted to the evaluation protocol only once. The evaluation protocol is summarized below.

Identification

This consisted of information related to the cyclist, such as sex, age, weight, height, time practicing, modality practiced, weekly frequency, and Bike Fit goals, among others. In addition, data related to the bicycle was also collected in this stage, for example, make, model, frame size, stem type and size, seat, and handlebars, among others.

Assessment of cleat positioning

The assessment and adjustment of the shoe cleats was conducted according to the positioning of the cyclist's foot on the ground and their anatomical characteristics. For each study participant, the pedal axis was adjusted to be positioned between the metatarsophalangeal joints of the first and fifth toes, with between 5 and 15º of lateral rotation. The procedure was conducted with the assistance of an Ergon® brand cleat template.

Dynamic pedaling evaluation

A two-dimensional dynamic evaluation was used to analyze the cyclist's joint positioning during the act of pedaling. For the process, eight markers were placed at the anatomical points recommended by the literature:[15] the metatarsophalangeal joint of the fifth toe, the point behind the shoe (aligned with the fifth metatarsal), the lateral malleolus of the fibula, the lateral epicondyle of the femur, the greater trochanter of the femur, the acromial angle of the scapula, the lateral epicondyle of the humerus, and the styloid process of the ulna. The point-marking process was performed with the cyclist on the bike, which was mounted on a stationary training roller (Tranzx®, model jd118). To obtain the images, each cyclist was filmed for about one minute in the sagittal plane (lateral view). Filming was done using a camera (Logitech® C920) positioned three meters from the cyclist at a height of 1.20 meters from the ground. The image analysis was performed using Kinovea® software. Each of the angles evaluated (plantar flexion, knee extension, knee over pedal spindle (KOPS), knee flexion, hip flexion, trunk flexion, and armpit) has reference values in the literature.[15]

The ankle plantar flexion and knee extension angles were analyzed with the pedal at 180º, that is, at the lowest point of the pedaling cycle (Figure 1). For the analysis of knee, hip, and trunk flexion and upper limb reach (armpit), the pedal must be at the highest point of the cycle (Figure 2). To analyze the positioning of the knee in relation to the pedal (KOPS), the crank must be at the midpoint of the cycle, with the foot of the side being evaluated positioned forward (Figure 3).

Statistical Analysis

The ordinal variables were submitted to descriptive statistical analysis, using measures of central tendency and dispersion (mean ± standard deviation), and the categorical variables were presented as absolute and relative frequency values (n and/or %).

Figure 1. Position for analysis of the ankle plantar flexion and knee joint extension angles. Respective reference values: 90º to 100º and 35º to 40º.

Figura 3. Position for analysis of the angles of flexion of the knee, hip, trunk, and armpit. Respective reference values: 105° to 115º, 60º to 80º, 40º to 60º, and 70 to 80º.

Univariate analyses were performed using the chi-squared test, when all the contingency table cells had at least five subjects, and Fisher's exact test for the other analyses, with the aim of evaluating the association between two categorical variables. All the data referring to low back pain (outcome variable) were cross-referenced against the data referring to the positioning of the cyclist in relation to the bicycle (explicative variables). After this verification, the statistically significant associations were highlighted and, to perform the multivariate analysis, all the associations with a p-value equal to or less than 0.20 were included. A significance level of 0.05 was established for all the multivariate analyses. Descriptive statistics, Chi-squared and Fisher's exact tests, and binary logistic regression were performed using the Statistical Package for Social Sciences (SPSS® – version 25.0) software package.

RESULTS

The mean age of the participants in the sample was 38.06 ± 8.82 years and 88.7% of the participants were men. Regarding the Bike Fit objective, 85.5% of the sample was seeking comfort and performance. As for the time cycling, 98.4% of the subjects had a minimum of three months and a maximum of 360 months of experience, with a mean of 91.95 months (± 92.39). Low back pain was observed in 40.3% (n = 25) of the cyclists.

As for positioning adjustments, 98.4% of the cyclists needed some adjustments to the cleats (see Table 1).

The univariate analysis showed an association between low back pain and upper limb reach (X^2=5.247, p=0.022) and dorsiflexion (X^2= 6.947,

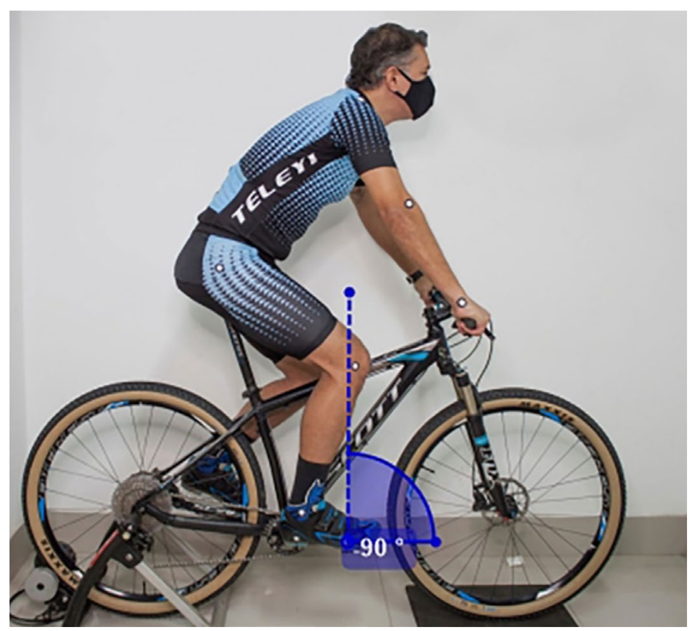

Figure 3. Position for analysis of the KOPS. Reference value: lateral femur epicondyle marker, behind the line drawn perpendicular to the ground (-).

Table 1. Distribution of the changes in positioning of the bicycle in relation to the cyclist (n=62).

	n	%
Seat	27	43.5
Hip Flexion	28	45.2
Knee Advancement (KOPS)	32	51.6
UL Reach (ARMPIT)	39	63
Ankle Dorsiflexion	40	64.5
Plantar Flexion	44	71
Knee Extension	52	84
Cleats	61	98.4

*UL = upper limbs.

p=0.008). All variables with p<0.2 in the univariate analysis were included in the binary logistic regression: upper limb reach, ankle dorsiflexion, knee advancement, and knee extension (see Table 2).

A binary logistic regression was conducted to verify whether the upper limb reach, knee advancement, ankle dorsiflexion, knee extension, and plantar flexion are predictors of low back pain. The model containing upper limb reach and knee advancement was significant [$x^2(1) = 15.533$, p<0.001, $R^2_{Negelkerke}=0.299$]. Upper limb reach was a significant predictor (OR=15.296, CI 95%= 2.637 – 88.731), as was knee advancement (OR=0.102, CI 95%=0.02 – 0.534). The ankle dorsiflexion, plantar flexion, and knee extension variables were not included in the regression model.

A positive association was observed between the upper limb reach and the presence of low back pain, that is, a change in the upper limb reach is directly associated with the presence of low back pain (b0 coefficient = 2.728). There is also a negative association between knee advancement and low back pain, which indicates that, considering the ideal reference values, the advancement of the knees minimizes the occurrence of low back pain (b0 coefficient = -2.281) (see Table 3).

DISCUSSION

The objective of the present study was to investigate the association between the presence of low back pain and changes in joint positioning on the bicycle in amateur cyclists. Assuming that Bike Fit is meant to ensure safety, comfort, and effective performance, and to prevent injuries by adapting the bicycle and adjusting its components to the peculiarities of each individual, a significant association between low back pain and some joint positioning measures was observed.

The study sample consisted mainly of men (88.7%), which corroborates the findings of several international and national studies. Araújo,[16] for example, discussed the existence of a social prejudice against women in cycling, which can interfere with women's participation in this activity. However, currently there is an increase in participation by women in cycling, both as sports and recreation.[17]

It is also worth mentioning the substantial percentage of cyclists who sought out Bike Fit aiming for comfort and performance (85.5%). This fact is possibly related to the objectives of the technique, which are to maximize performance and comfort, in addition to minimizing the risk of injuries.[12]

According to the findings of the present study, the change in the reach of the upper limbs (armpit) are significantly and positively associated with the complaint of low back pain. According to the studies by Savelberg, Van de Port, and Willems;[18] Dorel, Couturier, and Hug;[19] and Diefenthaeler et al.,[20] the increase in reach results in an increase in trunk flexion, which in turn interferes with lumbar region muscle recruitment, which can cause biomechanical changes and generate musculoskeletal compensations, which together could explain the cyclist's complaints.

Table 2. Univariate analysis between the exposure variables and low back pain (n=62).

	With low back pain		Without low back pain			
	Yes n(%)	No n(%)	Yes n(%)	No n(%)	X^2	p-value
UL reach	20(32.3)	5(8.13)	19 (30.6)	18 (29)	5.247	0.022*
Dorsiflexion	21(33.9)	4(6.5)	19(30.6)	18(29)	6.947	0.008*
Knee advancement	10(16.1)	15(24.2)	22(35.5)	15(24.2)	2.262	0.133
Knee extension	23(37.1)	2(3.2)	29(46.8)	8(12.9)	2.046	0.153
Hip flexion	13(21)	12(19.4)	15(24.2)	22(35.5)	0.791	0.374
Plantar flexion	20(32.3)	5(8.1)	24(38.7)	13(21)	1.659	0.198
Seat leveling	12(19.4)	13(21)	15(24.2)	22(35.5)	0.338	0.561
Positioning of the cleats	24(38.7)	1(1.6)	37(59.7)	0	1.504	0.22

*p<0.05

Table 3. Binary logistic regression model of the factors associated with low back pain.

Explicative variables	β	OR (CI 95%)	p
UL Reach	2.728	15.296 (2.637-88.731)	0.002
Knee advancement	-2.281	0.102 (0.20-0.534)	0.007

This result can be explained, at least partially, by the fact that spinal muscles, when stretching excessively, tend to produce less force, which can compromise postural adjustment and result in fatigue and discomfort. The excessive retraction of the seat leads to a position of upper limb advancement generating excessive trunk flexion and greater stretching of the spinal muscles.[20]

Another important result was the negative association observed between the advancement of the knees (KOPS) and the presence of low back pain. According to the data presented, advancement of the knees is associated with a lower chance of low back pain. Repositioning of the seat, advancing it in relation to the top tube of the bicycle, can reduce trunk flexion and alleviate low back pain. It is known that reducing trunk flexion is a factor that can minimize the occurrence of low back pain.[18,19,20] However, it is necessary to consider that an advancement of the position of the knee in relation to the axis of the pedal can increase the compressive forces of the patella over the femur and, thus, predispose the cyclist to condition related to anterior knee pain and/or premature wear of the articular cartilage.[21] Therefore, it is necessary to find optimal seat positioning to allow the relief of muscle tension in the lumbar region and to prevent the increase of patellofemoral compression forces.

Although it was not the focus of investigation in this study, it is important to emphasize that another factor that may be associated with low back pain is the weakness of the lumbopelvic muscles, which interferes with stability in the region, generating overload and discomfort. Lumbopelvic stability is also important to ensure adequate energy conservation and transfer to the pedals.[22-24] This possibility has been raised in patients with chronic pain in the lumbar region for some time, however, recent studies have shown that neuromuscular activation of the core muscles does not occur less intensely or later in patients with low back pain than in patients without it.[25] Another important point on the subject is that for the practice of cycling there is no need for extreme force in the muscles of the lumbar spine-pelvis-hip complex. Neuromuscular control and reasonable muscle strength can be considered satisfactory.[15]

Refuting these hypotheses, a systematic review by Streisfeld et al.[24] sought to determine whether there are relationships between body positioning, spinal kinematics, and muscle activity in active cyclists with non-traumatic low back pain. They demonstrated that imbalances in the activation of the central musculature and spine can indeed be considered risk factors for low back pain in cyclists. In the present study, muscle activation and muscle imbalances were not under investigation.

It is still premature to say whether muscle imbalances affect spinal kinematics or whether it is a change in spinal kinematics that results in an imbalance in muscle activation. Regardless of whether they are a cause or an effect, the findings indicate that inadequate motor control may be important in the mechanism of low back pain in cyclists. It is important to highlight that to maximize the production of force[4] or to alleviate a perceived symptom, a cyclist can change his position on the bike.[26,27]

This study had some limitations. The practice time of the sample was measured but the training volume could not be established, so it was not possible to infer whether the time and volume of practice impacted the presence of complaints. Another limitation is that activation or muscle imbalances were not assessed during the study. Furthermore, the non-probabilistic sampling used here prevents the results from being generalized. It is important to point out that studies of Bike Fit are still scarce, which hinders comparisons of the finding presented here with those of other studies. It is suggested that new studies be conducted to address issues not discussed in this study. It is also necessary for healthcare professionals to pay attention to cycling for, after all, it is a constantly growing sports activity in Brazil.[28]

CONCLUSION

Cyclists with low back pain present changes in their positioning on the bicycle, which suggests that positioning should be evaluated in cyclists with low back pain. However, it is not possible the say whether the positioning changes observed in the sample studied were the causes or consequences of low back pain.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. LF: concept, study design, writing and review of the content, approval of the final version of the manuscript for publication, and responsibility for all aspects of the work and for the assurance that any issue related to the integrity or accuracy of any of its parts will be duly investigated and resolved; VVAFL: substantial contribution to the study concept and design, data analysis and interpretation, writing and review of the content, approval of the final version of the manuscript for publication, and responsibility for all aspects of the work and for the assurance that any issue related to the integrity or accuracy of any of its parts will be duly investigated and resolved; MTTS: writing and content review; LOPR: data acquisition and content review; VAG: study design, content review, and approval the final version of the manuscript for publication; CFA: study design, writing and review of the content, and approval of the final version of the document for publication; APP: writing, study design, content review, and approval of the final version of the manuscript for publication.

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