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Relation between performance in side bridge and injuries in amateur soccer

Relação entre o desempenho na ponte lateral e lesões no futebol amador

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Abstract

Introduction: Central instability is associated with insufficient endurance and strength of the stabilizer muscles, and it can lead to muscle imbalance and injuries. **Objective**: Relate side bridge performance with the presence of injuries in amateur soccer athletes. **Materials and methods**: A cross-sectional study with a sample of 188 male athletes, aged between 11 and 17 years. To identify the injuries, a questionnaire developed by researchers was applied and the players' clinical records were reviewed. The time of the side bridge test was used to identify muscle imbalance. For statistical analysis, the following tests were used: chi-square test; Pearson's chi-square test; Fisher's exact test; Yates's correction for continuity; two-way

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ANOVA; one-way ANOVA; and t-test. The significance level (α) of 5% was adopted. **Results**: Injuries were reported by 59.6% of the athletes: sprain (31.3%); muscle strain (28.6%) and fracture; luxation and subluxation (19.6%) were the most frequently reported injuries. Athletes that reported any injury corresponded to 73.2% of the sample. The presence of injuries was not associated with muscle imbalance (p = 0.565), as it prevailed in athletes with both balance (64%) and imbalance (58%). Injury type and prevalence were not significant when compared with the presence of imbalance (p > 0.05). **Final considerations**: No significant relation between muscle imbalance and injury was observed in the studied sample.

Keywords: Prevention. Muscle. Physical endurance. Prevalence. Sport.

Resumo

Introdução*: A instabilidade central está associada à endurance e força insuficientes dos músculos estabilizadores, e pode levar a desequilíbrios musculares e lesões.* ***Objetivo****: Relacionar o desempenho na ponte lateral com a presença de lesões em atletas amadores de futebol.* ***Materiais e métodos****: Estudo transversal com amostra composta por 188 atletas do sexo masculino, com idade entre 11 e 17 anos. Para identificar as lesões foram utilizados um questionário elaborado pelos pesquisadores e uma pesquisa no prontuário dos jogadores. O tempo de desempenho no teste da ponte lateral foi utilizado para identificar desequilíbrios musculares. Para a análise estatística os seguintes testes foram utilizados: Qui-quadrado, Qui-quadrado de Pearson, teste Exato de Fisher, Qui-quadrado de Pearson com correção de Yates, ANOVA two way, ANOVA one way, e o Teste t. Foi adotado o nível de significância (α) de 5%.* ***Resultados****: A ocorrência de lesão foi relatada por 59,6% dos atletas: entorses (31,3%), distensões musculares (28,6%) e fraturas, luxações e subluxações (19,6%) foram as mais prevalentes. Apresentaram uma lesão 73,2% dos atletas. A presença de desequilíbrio muscular representou 73,4% da amostra. A presença de lesões não se mostrou associada com desequilíbrios musculares (p = 0,565), pois prevaleceu tanto nos atletas com equilíbrio (64%) como nos sem equilíbrio (58%). O tipo de lesão e a prevalência de lesões também não se mostraram significativos se comparados com a presença de desequilíbrio (p > 0,05).* ***Considerações finais****: Não foi encontrada relação significativa entre desequilíbrio muscular e lesões na amostra estudada.*

Palavras-chave*: Prevenção. Músculo. Endurance física. Prevalência. Esporte.*

Introduction

People play soccer in all regions of the world, totaling around 200,000 professional players and 240 million amateur players (1). Every year, the sport becomes more and more popular; however, it presents a high incidence of injuries (17–24 injuries per 1,000 hours of game time) when compared to other sports categories (2). The main risk factors are asymmetry in muscle performance parameters (torque production capability, work, power, and resistance) between the dominant and non-dominant limbs, and change in torque relation between agonist and antagonist muscles. The presence of such imbalance increases the risk of injuries (3-6); however, the identifying muscle imbalance allows preventive measures (1-3, 5), a fact that involves more and more health professionals in soccer (7).

Movements in soccer such as running, kicking, and maintaining unipodal support while the contralateral hip extends to kick the ball require column stabilization (8). The muscles that maintain such stabilization belong to the lumbo-pelvic-hip complex, called the core (9). The center of gravity in the human body is in this region, and all movements start there (8, 9). These muscles maintain stability and help generate and transfer energy from major to minor parts of the body while practicing sports, characterizing a mobilization function as well (8).

Core stability may be considered an ability to control the trunk position and movement of the pelvis to allow optimum force production, transfer and control, and distal movement in sports activities (8). The correct muscles should be used at the right moment to perform the movement and simultaneously protect the column from injuries (10).

Core instability is associated with insufficient endurance and strength of the stabilizer muscles, and it can lead to reduced movement efficiency and compensation patterns, causing low back pain (10-12) and muscle and articulation injuries in limbs (9, 12). For this reason, it is very important to identify and eliminate any inefficiency of the stabilizer muscles in order to reduce any injury risk (2, 5).

Based on this concept, the purpose of this study was to relate the side bridge performance with the presence of injuries in amateur soccer athletes.

Materials and methods

A cross-sectional study (13) was conducted to analyze a sample of 188 male athletes, aged between 11 and 17 years, from the basic categories of Sub-17, Sub-15, Sub-14, Sub-13, Sub-12, Sub-11, Sub-17 B, and Sub-15 B from a soccer team located in the metropolitan region of Porto Alegre, in Rio Grande do Sul. The inclusion criteria were: the athletes should be from the team and agree to participate in the study. The exclusion criteria were: athletes playing soccer for less than six months; athletes with injuries at the evaluation; athletes in a postoperative period for less than six months; minor athletes whose parents did not authorize their participation; and athletes who did not answer the questionnaire or who did not sign the informed consent term. The sample had no excluded athletes. This study was approved by the Research Ethics Committee of the University of Vale do Rio dos Sinos (Unisinos), Protocol 10/034.

The evaluation was conducted in July and August 2010, always in the afternoon shift, before the athletes' official training. A closed-ended questionnaire was applied, developed by the researchers, to characterize the sample in terms of age, dominant upper limb, category, and training frequency and duration. In addition, the players' clinical records were reviewed to identify their history of injuries (physical incidents during games or training sessions that forced them to miss the next game or training session) based on the exclusion criteria, in case of any injury present at the evaluation, and to classify the injuries of athletes included in the study (14).

To evaluate the endurance of core muscles and identify muscle imbalance, the side bridge test (15, 16, 17) was conducted. Before the test, the participants practiced the movement bilaterally for five seconds to become familiar with it. This period was adopted to prevent fatigue effects during the test (18). Then the participants were submitted to the test. The athletes were instructed to begin on the lateral decubitus on an exercise mat, hips in neutral position, stretched knees, and ankles in neutral position. The athletes were to raise their hips from the ground and maintain a straight line, supporting the body on the elbow and feet, without any hip flexion. The upper limb contralateral to the support was to remain in the anterior thoracic region, with the hand on the contralateral shoulder. The test ended when the athlete touched the mat with the hip (16).

The athletes were asked to maintain the position as long as possible. The test was conducted bilaterally, with a five-minute interval between the sides to allow the participants to recover their breath (16). The total time was measured in seconds (OREGON–SL 110 timer), and all of the tests were conducted by the same professional. Bilateral symmetry was evaluated by dividing the time of the dominant upper limb side by the time of the non-dominant upper limb, and a value above 1.05 or below 0.95 indicated muscle imbalance (19).

Descriptive statistics were used to calculate the distribution of simple and relative frequency, as well as mean values and standard deviation. The Kolmogorov-Smirnov test was used in data normality evaluation. The comparison of variable proportions was analyzed by Pearson's chi-squared test. The degree of association between two qualitative variables was also evaluated by the Pearson's chi-squared test, and non-parametric situations were evaluated by the Fisher's exact test. Two-way ANOVA was used in muscle imbalance analysis, and the Bonferroni test (post hoc) to investigate differences between the factors in specific situations. One-way ANOVA was used in the comparison among three or more groups, complemented by Tukey's multiple comparison test. The comparison of groups with and without muscle imbalance and side bridge times was analyzed by the Student's t-test. The association between the balance ratio and the dominant side was tested by using the Pearson's chi-squared test with the Yates correction factor. The comparison of the dominant side with the side bridge times, and between the groups with and without muscle balance and the side bridge times, was analyzed by the Student's t-test.

Data were analyzed using the SPSS 17.0 application, and a level of significance (α) of 5% was adopted.

Results

Sample characterization

Mean age was 13.8 ± 1.8 years, with a prevalence of categories Sub-17 (n = 37; 19.7%), Sub-12 (n = 30; 16%), Sub-15 (n = 27; 14.4%), and Sub-11 (n = 27; 14.4%). The prevalent training period was nine hours a week (69.7%; n = 131) versus athletes receiving six hours (30.3%; n = 57), and prevalent training frequency was three times a week (69.7%; n = 131) versus twice a week (30.3%; n = 57) ($p < 0.001$).

Prevalence and situation of injury occurrence and muscle balance

Injuries were reported by 59.6% (n = 112) of athletes, which was significantly higher (p = 0.009) than the number of athletes that did not report any injury (40.4%; n = 76). The most prevalent types were knee or ankle sprain; fracture, luxation, and subluxation in the upper limbs (UL) and lower limb (LL); and hip adductor strain (Table 1).

Table 1 - Absolute and relative distribution of injury type and number

(To be continued) / (Conclusion)

Variables	N = 188
Injury type *	
Knee or ankle sprain	35 (31.3%)
Fracture, luxation, and subluxation (UL or LL)	22 (19.6%)
Adductor strain	21 (18.8%)
General strain	11 (9.8%)
Contusion	18 (16.1%)
Low back pain	18 (16.1%)
Achilles tendon injury or Osgood-Schlatter disease	11 (9.8%)
Pain	7 (6.3%)
Muscle spasm	3 (2.7%)
Ligament injury	1 (0.9%)
Number of injuries **	
One	82 (73.2%)
Two	21 (18.7%)
Three	4 (3.6%)
Four	3 (2.7%)
Five	2 (1.8%)

Note: * = proportion obtained from the analysis of the number of occurrences (multiple choice question, where the percentage was obtained from the total athletes that reported an injury – n = 112). ** = Percentages obtained from the total athletes that reported an injury.

Regarding the number of injuries, 73.2% (n = 82) reported one injury, 18.7% (n = 21) two injuries, 3.6% (n =4) three injuries, 2.7% (n = 3) four injuries, and 1.8% (n = 2) five injuries. When asked about the situation where the injuries occurred, 56.2% (n = 63) said that they occurred during the training, and 44.6% (n = 50) said during a game. Five athletes reported injuries during both a game and training. In addition, three athletes reported Achilles tendon injury and eight presented with Osgood-Schlatter disease, which were not considered specific situations related to either a game or training.

The balance ratio presented a mean of 1.03 ± 0.25. The balance ratio classification showed that 26.6% (n = 50) of the athletes presented balance values and 73.4% (n = 138) imbalance values ($p < 0.001$); that is, the proportion of athletes with imbalance measurements was significantly higher in this sample.

Relation among category, injury, and muscle imbalance

To evaluate the balance ratio profile, the independent variables were injury and categories, with Sub-15 B and Sub-17 B grouped together because they trained together. According to the results of Table 2, there were no significant differences between the mean values of the balance ratio for injury and categories, or in the interaction between them ($p > 0.05$).

Table 2 - Mean and standard error for balance ratio according to injury and categories

Categories	Balance ratio by category (total)	Injury	
		Yes	No
Sub-17	0.98 ± 0.06	1.03 ± 0.04	0.94 ± 0.11
Sub-15	1.01 ± 0.06	1.01 ± 0.05	1.00 ± 0.11
Sub-14	1.04 ± 0.05	1.02 ± 0.08	1.06 ± 0.07
Sub-13	0.98 ± 0.06	1.04 ± 0.06	0.93 ± 0.09
Sub-12	1.00 ± 0.04	0.98 ± 0.07	1.02 ± 0.06
Sub-11	1.1 9± 0.05	1.34 ± 0.08	1.05 ± 0.06
Sub-17 B/Sub-15 B	1.02 ± 0.06	1.04 ± 0.09	0.99 ± 0.07
Balance ratio (total)	1.03 ± 0.02	1.06 ± 0.03	1.00 ± 0.03

Effects*	
Variables	**p (value)**
Injury	0.138
Categories	0.069
Injury x Categories	0.307

Note: * = Two-way ANOVA; *Post Hoc* Bonferroni.

Relation between training hours and frequency and muscle imbalance and injuries

No significant difference was observed ($p > 0.05$), indicating that the balance ratio does not depend on the other variables addressed (Table 3). When comparing the balance ratio to injury and training frequency, no significant difference was observed either ($p > 0.05$), indicating an independent relation among the studied variables.

Injuries throughout career

Regarding the absolute and relative distribution of injuries in relation to the imbalance ratio classification, 32 athletes (64%) among those who reported an injury were also balanced, while 80 athletes (58%) who reported an injury were imbalanced. Among those who reported no injury, 18 (36%) were balanced and 58 (42%) imbalanced. When evaluating this relation, the presence or absence of injuries was not significantly associated with the balance ratio ($p = 0.565$) once both balanced and imbalanced athletes reported injuries.

No significant association was observed between the injury type and the balance ratio ($p > 0.05$), considering that the group of balanced athletes showed similar results to the group of imbalanced athletes (Table 4). When evaluating the injury occurrence situation in relation to the balance ratio classification, the differences were not significant ($p = 0.480$), considering that both the group of balanced athletes (18 athletes, 46.5%) and the group of imbalanced athletes (45 athletes, 41.7%) incurred the prevalence of injuries during training. Another relation that was not significant was between the number of injuries and the muscle imbalance classification ($p = 0.410$), as the occurrence of one injury predominated in the two classifications, represented by 22 balanced athletes (56.4%) and 66 (61.1%) imbalanced athletes.

Association between muscle balance ratio and dominant side and measures of central tendency and variability

The association between balance ratio and dominant side was not significant ($p = 0.766$). Similar results were observed in muscle balance/imbalance between right and left dominance. The results showed a prevalence of 72.8% (n = 126) muscle imbalance in right dominant athletes and 80% (n = 12) in left dominant athletes. Among balanced athletes, 27.2% (n = 47) were right dominant, and 20.0% (n = 3) were left dominant.

When analyzing the mean time of right side bridge (RSB) and left side bridge (LSB), and when associating them with right and left dominance, a similarity between the mean times was observed, without statistical significance (p > 0.05). The characterization of the balance ratio and the RSB and LSB times showed that, for every variable, the differences observed between the mean times were not significant (p > 0.05). Regardless of the muscle imbalance classification, the times were similar (Table 5).

Table 3 - Mean and standard error for the balance ratio according to injury and training hours, main and interaction effect for independent variables

Training hours	Balance ratio by training hours (total)	Injury	
		Yes	No
6 hours	1.09 ± 0.03	1.14 ± 0.05	1.04 ± 0.04
9 hours	1.01 ± 0.02	1.03 ± 0.03	0.99 ± 0.03
Balance ratio (total)	1.03 ± 0.02	1.08 ± 0.03	1.02 ± 0.03
		Effects*	
	Variables	**p (value)**	
	Injury	0.132	
	Training hours	0.074	
	Injury x Training hours	0.346	
Training frequency	**Balance ratio by training frequency (total)**	**Injury**	
		Yes	**No**
Twice a week	1.09 ± 0.03	1.14 ± 0.05	1.04 ± 0.04
Three times a week	1.01 ± 0.02	1.03 ± 0.03	0.99 ± 0.03
Balance ratio (total)	1.03 ± 0.02	1.08 ± 0.03	1.02 ± 0.03
		Effects*	
	Variables	**p (value)**	
	Injury	0.132	
	Training frequency	0.074	
	Injury x Training frequency	0.346	

Note: * = Two-way ANOVA; *Post Hoc* Bonferroni.

Table 4 - Injury type in relation to balance ratio classification

(To be continued)

Injury type	Muscle balance ratio		
	Balance (n = 50)	Imbalance (n = 138)	p (value) *
Knee or ankle sprain	11 (28.2%)	24 (22.2%)	0.805
Fracture, luxation, and subluxation (UL or LL)	7 (17.9%)	15 (13.9%)	

Table 4 - Injury type in relation to balance ratio classification

(Conclusion)

Injury type	Muscle balance ratio		
	Balance (n = 50)	Imbalance (n = 138)	p (value) *
Adductor strain	7 (17.9%)	14 (13.0%)	0.805
General strain	1 (2.6%)	10 (9.3%)	
Contusion	4 (10.3%)	14 (13.0%)	
Low back pain	5 (12.8%)	13 (12.0%)	
Achilles tendon injury or Osgood-Schlatter disease	1 (2.6%)	10 (9.3%)	
Pain	2 (5.1%)	5 (4.6%)	
Muscle spasm	1 (2.6%)	2 (1.8%)	
Ligament injury	0 (0.0%)	1 (0.9%)	

Note: Percentages based on total number of each balance ratio classification.* = Fisher's exact test by Monte Carlo simulation.

Table 5 - Measures of central tendency and variability (mean ± standard deviation) for RSB and LSB between right and left dominant athletes and between balanced and imbalanced athletes

Side bridge	Dominant right hand (n = 173)	Dominant left hand (n = 15)	p (value) *	Unbalance (value <0.95 or value > 1.05) (n = 138)	Balance (value between 0.95 and 1.05) (n = 50)	p (value) *
RSB time (s)	73.7 ± 24.8	71.4 ± 22.7	0.716	73.1 ± 26.7	74.6 ± 17.6	0.646
LSB time (s)	72.7 ± 23.5	68.7 ± 26.0	0.566	71.6 ± 25.5	74.5 ± 17.7	0.391

Note: * = Student's t-test for two independent groups assuming heterogeneous variances.

Discussion

The literature indicates a relation between insufficient endurance and strength, core stabilizer muscle imbalance, and muscle and articular injuries (9-12, 17, 9, 20). This study attempted to associate core stabilizer muscle imbalance in endurance with the presence of injuries in amateur soccer athletes.

Regarding the prevalence of injuries, sprain, muscle strain (18.8% in adductor muscles of the hip), and fracture, luxation and subluxation were most prevalent (Table 1). In the study conducted by Selistre et al. (7), the most frequent injuries were muscle injury (37.6%), contusions (30.6%), and sprain (23.5%). Le Gall et al. (21) observed a higher frequency of contusions (30.6%), sprain (16.7%), and strain (15.3%). In the study conducted by Ribeiro et al. (22), most injuries were contusions (29%), strain (24%), and sprain (22.6%). This variability seems to be related to the tournament type and athlete characteristics (23); however, according to literature reviews, the most common injuries are sprain, strain, and contusions (1, 24).

The studied sample reported a 16.1% occurrence of low back pain, while Lundin et al. (25) observed 53.4% occurrences of low back pain in 30 elite athletes from 16 to 25 years old who were monitored for 12 to 15 years. In the general population, the prevalence of low back pain among adolescents is 50% or more, ranging from 17% to 50% in a one-year period, and is even more prevalent in athletes (26). Considering that the sample in this study was comprised of athletes aged between 11 and 17 years and that their history of injuries was analyzed, the prevalence of low back pain was low in relation to the literature. This result may be due to shorter and less frequent trainings than those described in the literature. This fact agrees with the study conducted by Ribeiro et al. (22), which monitored 110 athletes aged between 14 and 18 years during one season. These athletes trained nine hours a week and the prevalence of low back pain/neck pain was 6.7%, a low percentage with training hours similar to those in this study.

In the studied sample, 73.2% of athletes reporting injuries presented with one injury and 18.7% with two injuries. The results agree with the literature for athletes aged between 14 and 18 years, which showed 71.3% with one injury (27). However, such data contrast with those from a study conducted by Peterson et al. (28), in which most athletes (63.8%) aged between 14 and 18 years as well as adults reported more than one injury occurrence. The number of injury occurrences may also be related to the tournament type, athlete characteristics, and training hours.

Regarding the injury occurrence situation, 56.2% of athletes reported that the injury occurred during training. This result is similar to that observed in 287 athletes from Greece aged between 12 and 15 years, who reported that 52.6% of their injuries occurred during training (29). Le Gall et al. (21) observed in athletes aged between 14 and 16 years from France that 69.1% of injuries occurred during training, but with a significantly higher incidence in games than in trainings. Brito et al. (30) obtained results similar to the study with French athletes, with 69.8% of injury occurrences in trainings of 674 athletes from Portugal aged between 12 and 19 years, with a higher injury incidence in games. The incidence of injuries in games is on average four to six times greater than in training. The injury incidence by game and training should be calculated for individual athletes, by calculating the number of injuries per 1,000 hours of game or training; in addition, injuries should be prospectively recorded, allowing for the identification of groups and risk factors and evaluation of the incidence of injuries (31). This study did not calculated the incidence of injuries because it was a retrospective study.

The proportion of imbalanced athletes (73.4%) was significantly higher ($p < 0.001$) when compared to balanced athletes. This high percentage may be related to prior injuries and specific demands in sports (6), which may generate asymmetry between the dominant and non-dominant limbs (5). In addition, in the development phase, an increase occurs simultaneously in the height of the center of mass and of the body mass and body levers, which does not allow for full trunk muscle control (32).

No correlation was observed between the balance ratio and injuries or categories. The literature provides few indications related to the association of trunk side muscle endurance with injuries (17). Childs et al. (33) compared the effect of a training program of core stabilization that included side bridge, and a program for superficial abdominal muscles and hip flexors, for 1,141 North American soldiers. These authors observed that the soldiers with low back injury from the stabilization training group presented with faster recovery when compared to the other group. FIFA (the International Federation of Soccer) has created a prevention program with several exercises, also for stabilization, called 11+, that has presented good results in reducing soccer injuries (34, 35). Specifically in terms of side bridge, according to Leetun et al. (36), performance in the side bridge test was not a risk factor for low back and LL injuries during a season in basketball and track and field athletes. Evans et al. (37), in their study of golfers, reported that athletes with a difference of over 12.5 s between sides presented more episodes of low back pain than more balanced athletes. Other factors may have influenced the results of this study, such as shorter and less frequent trainings, a study population of young people in the development phase, and the fact that this is a retrospective study (31).

Athletes with longer and more frequent training were expected to have more injuries and, consequently, core muscle imbalance, but there was no significant relation. In addition to the factors discussed above, training hours and frequency may have had an influence, as the training was not really different among categories. The weekly training hours were similar to the base categories of clubs from the state of Minas Gerais, which reported nine hours a week for athletes aged between 14 and 18 years (22). However, in one club in Paraná, there was, for instance, an eight-hour difference in training hours when comparing athletes aged between 10 and 11 years with athletes aged between 16 and 17 years, with a direct correlation between longer training and higher number of injuries (38).

The presence or absence of injuries did not show any correlation with muscle balance/imbalance, which does not concur with the literature, as it indicates core muscle imbalance generates greater susceptibility to injuries. McGill et al. (39) observed a correlation between a history of low back pain and core muscle imbalance in 76 industrial workers, considering that, if a core muscle is impaired or incorrectly activated, compensations occur in synergistic, stabilizer, and neutralizer muscles, which may result in low back and LL and UL injuries (9).

The classification of number of injuries and muscle imbalance, as well as the injury occurrence situation in relation to the balance ratio, was not significant. The fact that the athletes were young may explain the reduced number of injuries in the studied groups, considering the tendency toward increased number of injuries with age (1, 40). The reason for such lack of association may also be related to the young age of the athletes and the fact that they are still in the development phase and not physically prepared to meet sports demands which, regardless of the presence or absence of core muscle balance, makes body control more difficult, generating compensation movements and injuries. The training hours and frequency may also have influenced these results.

In addition, no correlation was observed between the injury type and the balance ratio. However, the literature indicates that athletes with core muscle imbalance may present more low back injuries (10, 17, 19), as well as hip adductor strain (20). Again, training hours and frequency and the athletes' age may have influenced these results.

The association between balance ratio and dominant side did not present a significant difference. No study was found in the literature addressing this theme; however, the results of this study indicate that muscle imbalance is not associated with the dominant side in amateur soccer players.

Side bridge time and balance ratio were similar among balanced and imbalanced athletes. In a sample of 108 healthy male and female subjects, mean age of 19.4 years, lower values were obtained, that is, a mean RSB of 51 s and LSB of 50 s (41). However, it should be noted that the test was conducted with the upper limb not supported along the trunk, a different position from this study. Few studies have analyzed the population of athletes, especially in soccer. However, Evans et al. (15) evaluated 12 elite soccer athletes, mean age of 17.3 years and mean RSB of 133.8 s and LSB of 128.7 s. Despite the small sample, higher times were recorded when compared to this study. Regarding balance, no systemic study has been found in the literature that evaluates core stabilizer muscle balance in soccer players.

Final considerations

Although no relation has been found between core muscle imbalance and the presence of injuries, new studies should be conducted, considering that the identification of athletes with a risk of injury allows preventive measures to correct asymmetry, and reduce injury occurrences and losses to clubs and athletes.

This sample of young people in the development phase did not allow for full trunk muscle control, and the training characteristics in this phase of the athlete may have influenced the results.

Future studies may investigate the population of amateur and professional athletes of both genders, conduct prospective research, and use additional tests and other sports categories to help explain the importance of core stabilization in the prevention of injuries.

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