Lesions of the Lumbar Region in Asymptomatic Young Soccer Players: A Cross-Sectional Study

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Abstract

Background: Athletes generally exceed the limits of the body, which can result in various lesions. The pediatric musculoskeletal system is particularly susceptible to lesions through overuse for various reasons including an immature growth plate. While spinal column lesions are relatively rare, they can lead to permanent disability. Studies on spinal lesions in young athletes are rare. To assess abnormalities frequency of the lumbar region in asymptomatic young soccer players.

Methods: Cross-sectional study. Male adolescents from schools of grassroots soccer clubs and non-practicing activity controls were included by convenience. The abnormalities frequency. of the lumbar region was evaluated by magnetic resonance imaging (MRI), performed using 1.5T devices with multi-channel coils in model equipment models. The types of lesions evaluated were general, warning signs, instituted, anterior and posterior, and of the column. Comparisons between groups and the relative percentage of each lesion type were compared by Pearson's chi-squared test and Fischer's exact test. The inter and intra-observer analyses were compared by the Kappa test.

Results: Forty-five adolescents were included, of whom 25 (56%) were soccer-practicing teenagers. No significant differences were identified between the variables age (P=0.960) and the body mass index (BMI) Z-score (P=0.540) between the group of soccer players and the controls. However, the percentages of lesions (general, instituted, anterior and posterior, and in the spinal column) were significantly higher in the practicing football group than in the control group (P=0.002, P<0.001, P= 0.012, and P=0.006, respectively).

Conclusion: Young adolescent asymptomatic soccer players have more lumbar spine lesions than less active controls who do not practice sports regularly.

Introduction

Athletes generally exceed the limits of the body, which can result in various lesions [1–3]. In soccer adult players, 60–80% of such lesions are located on the lower extremities especially the knees and ankles [4–10]. In adult athletes, the lumbar region is the most common vertebral lesion site [11]. Chronic lesions—those that occur due to excessive use of the joints—are the most common [12, 13]. These lesions can start in adolescence and worsen in adulthood [14, 15]. While spinal column lesions are relatively rare, they can lead to permanent disability [12, 16].

Studies on spinal lesions in young athletes are rare [4]. The pediatric musculoskeletal system is particularly susceptible to lesions through overuse for various reasons including an immature growth plate [17, 18]. Chronic lesions formed through overuse occur via repetitive microtrauma to a tissue that exceeds the capacity to be repaired. This can lead to an increase in pressure at this articulation [17, 19]. In addition, during the fastest growth period of adolescents (i.e., growth spurts during puberty) can lead to locally imbalanced bone tissue and musculature—this may cause an increased risk of lesions especially on growth plates [14, 15]. Growth cartilage and centers of immature ossification are also more

susceptible to lesions due to compression, distraction, and rotation. Deficits in the ossification of pars interarticularis—especially at L5—contribute to the incidence of lesions in the posterior vertebral elements [13]. In addition to these injuries, such lesions can cause pain in the affected region to limit children's daily activities [18, 20].

Unfortunately, there are relatively few studies focused on lesions of the vertebral column in asymptomatic young soccer players. Existing studies have limitations including the use of niche groups and methods [20–22]. Thus, this study evaluated the frequency of abnormalities in the lumbar region that were diagnosed via MRI of asymptomatic young soccer players.

Materials And Methods

Study design

Cross-sectional study.

Participants

Participants were recruited by convenience from schools and two soccer clubs. Two groups of asymptomatic male adolescents were included: soccer players and adolescents not performing similar impact physical activity (control group), aged 13 to 18 years. The inclusion criteria for the asymptomatic adolescent soccer players were to have practiced the sport for at least two consecutive years with a minimum frequency of three times per week for a period of one to three consecutive hours. All soccer players were enrolled in the State Football Federation. The control group contained asymptomatic adolescents and was matched for age, gender, height, and weight. The inclusion criterion for the controls were an absence of soccer or similar sport more than once a week for more than one hour.

The exclusion criteria for both groups were a history of lesions, surgery or osteoarticular alterations, malformations, history of chronic disease (diabetes; hypertension; rheumatic, cardiac, renal, respiratory or neurological disease; chronic hepatitis disease; or a BMI Z-score greater than + 3. Thirty individuals in each group were invited to participate in the study. Five participants were excluded from the athletes due to previous surgery, while on control group 2 participants were excluded due to previous injuries, 5 for soccer-related sports participants and 3 due to symptoms.

The anthropometric evaluation measured weight and height for further body mass index calculations. The patients were weighed in light clothing, barefoot, and positioned standing in the center of the scale. Height was measured by positioning the barefoot patient in the center of the equipment with his head free of props while standing upright with heels attached and arms extended along the body according to the Frankfort horizontal plane. The heels, shoulders, and gluteal muscles were in contact with the stadiometer. The nutritional status of children and adolescents was classified according to the BMI Z-score [23]. The presence or absence of symptoms was evaluated via an interview with the researcher, who asked about the presence of pain, functional limitations, mechanical symptoms, and any discomfort in

the lumbar column in the prior six months. In this interview, the level of physical activity was evaluated using the physical activity questionnaire entitled Questionnaire on Physical Activity for Adolescents (QAFA). This questionnaire is composed of 24 questions and has been validated for use by young Brazilians [24].

Spine evaluation

The images were collected on 1.5 T devices with multi-channel coils, e.g., Achieva model equipped with 8-channel coils (Koninklijke Philips, Best, The Netherlands) and Magnetom Aera model (Siemens GmbH, Erlangen, Germany) equipped with 24-channel coil. Weighted fast spin-echo T1 sagittal sequences were obtained (TR:400 ms to 600 ms; TE: 6.3 ms to 15 ms), T2-weighted fast spin-echo sagittal (TR: 2200to 4500 ms/TE: 60 ms to 110 ms), fast sagittal in T2 with fat saturation (TR: 2200 to 4500 ms/TE: 60 ms to 110 ms) with the following minimum image parameters: matrix of 320 × 256; cutting thickness of 4.0 mm with a 1.0 mm interval; 30 cm field-of-view. Oblique fast spin-echo axial images were also acquired with the following parameters: 320 × 224 matrix; cutting thickness of 4.0 mm with a 1.0 mm interval; and 20 cm field-of-view.

Two radiologists with the title of specialist from the Brazilian College of Radiology with more than 5 years of experience in the evaluation of vertebral column images made an independent analysis of the images. The tests were randomly interpreted via double blinded analysis. Each MRI test was analyzed for the presence or absence of plateau edema, protrusions, and disc extrusions (sequestered or not). The evaluation also included stress reactions in the pedicles, spondylolysis, spondylolisthesis, hypertrophic alterations in the interfaces, ligament edema, and muscle edema. Individual analysis was performed by each radiologist (inter-observer). An intra-observer analysis was performed by one of the evaluators with an interval greater than two months for intra-observer variation calculations.

Muscular and bone ligament edema was characterized by a pre-lesion, i.e., an alert sign of the development of a structured lesion of the lumbar spine. Edema evaluation was restricted to the presence of signal alterations including the type of edema pattern in the projection of interspinous spaces, vertebral plateau, and paraspinal musculature. The diagnosis of displacements due to disc hernias was based on the criteria proposed by the working group from the North American Spine Society, the American Society of Spine Radiology, and the American Society of Neuroradiology [25].

Intervertebral discs are physiologically prominent in the age group of our subjects; thus, only cases in which there was some degree of disc degeneration associated with altered disc contours were considered. This avoids an overdiagnosis of bulging. Considering the age of the patients, any hypertrophy, sclerosis, or irregularity of the interface joints was also considered to be a positive finding. The presence of edema or fracture of the pedicles was considered positive for the diagnosis of a stress reaction. The occurrence of sclerosis was not considered. The presence of arthritis of the interfaces was inferred via the presence of synovitis in the facets or joint effusion.

The groups of lesions were classified as follows: Warning signs included edemamuscular and bone ligament edema (vertebral plateau, pedicle) and instituted lesions. Disc hernia include protrusion, extruded, or sequestered discs as well as spondylolysis, spondylolisthesis, and facet arthrosis/arthritis. Disc hernia of anterior lesions included protrusion, extruded, or sequestered discs. Posterior lesions include spondylolysis, spondylolisthesis, and facet arthrosis/arthritis.

Statistical analysis

The age variable was symmetric, and the between-group comparisons used a t-test for independent samples. The BMI z-score was measured via asymmetric behavior, and the groups were compared via the Mann-Whitney test. We compared the percentage of lesions between the groups via Pearson's chi-squared test except for anterior lesions that used Fischer's exact test. The inter and intra-observer analysis (evaluators 1 and 2) were compared via the Kappa test. Data analysis used SPSS software® version 19.0.

Considering the fixed sample size of 25 subjects in the group of athletes and 20 in the control group, the proportion of lesions in each of the groups was 76% and 35%, respectively. The power of the test to compare the groups was 90% at a significance level of 5%.

Ethical considerations

The study was approved by the Ethics Committee, Opinion No. 2.561.459. The parents or guardians gave free and informed consent.

Results

Forty-five adolescents were included of whom 25 (56%) were soccer-playing adolescents. No significant differences were identified between the age and BMI Z-scores between the groups of soccer players and controls (Table 1). However, the percentage of general lesions anterior and posterior in the spine was significantly higher in the soccer players than the controls ($P = 0.002$; $P < 0.001$; $P = 0.012$ and $P = 0.006$, respectively) (Table 1; Figs. 1 and 2). Both the inter-observer analysis and the intra-observer analysis had results that were in perfect agreement. These were evaluated via Kappa statistics with an equal value of 1.0.

Table 1
Comparison between general characteristics and percentage of lesions between the control group and the athletes.

	Controls n = 20	Athletes n = 25	P Value
Age, (years), mean ± SD	15.4 ± 1.2	16.2 ± 1.7	0.086*
BMI (z-score) median (IQ25-75)	0.6(0.1–1.2)	0.9(0.1–1.5)	0.343**
Presence of lesions. n (%)	7 (35)	21 (84)	0.002***
Presence of warning signs. n (%)	5 (25)	12 (48)	0.135***
Presence of structured lesions. n (%)	4 (20)	20 (80)	< 0.001***
Presence of anterior lesions. n (%)	1(5)	10 (40)	0.012#
Presence of posterior lesions. n (%)	4 (20)	16 (64)	0.006***

*T-test for independent samples; ** Mann-Whitney test, *** Pearson chi-square test; # Fischer exact test, IQ: interquartile interval, n = frequency of participants.

Discussion

Asymptomatic young adolescent soccer players have a high number of lesion abnormalities in the lumbar region. Adult studies suggest that running races with impacts, jumps, and strong axial loads all of which are typical in soccer are harmful to the lumbar spine [26–28]. High-impact activity services generate intense loads in this region and are harmful to intervertebral discs and articular facets. This reinforces the relevance of our study in ascertaining and comparing studies of spinal image exams in athletes and adolescent non-athletes.

The intense and repetitive training of a sports modality provides muscle hypertrophy and decreased flexibility. It can lead to an imbalance between the agonist and antagonist musculatures and favors the installation of postural alterations. These alterations are common in soccer players [27–29]. Repetitive loads as well as repeated bending and extensions are implicated in most sports with higher rates of spondylolysis. The kick movement in soccer quickly reaches the lumbar spine via extension to hyperflexion while loading and rotating the vertebral lumbar leads to asymmetric articulations [30].

It is not clear if the bone edema is a source or the cause of low back pain in adolescents. Edema in the lumbar spine can present after repeated trauma in sports but may also be present when adolescents present themselves with incorrect postures and carry excessive weight. Here, the presence of lesions was not significantly different, which may suggest that the groups did not differ in relation to other possible exposure factors [31].

Magnetic ressonance is an objective and consistent approach to evaluate bone marrow signal intensity [31]. It should always be complementary to clinical judgments for decision-making. It is unclear whether the intensity of the MRI signal and vertebral edema can be interpreted similarly for athletes from other sports or for lesions due to bone stress in other anatomical regions [31, 32].

Our study found a high number of lesions in soccer practitioners probably due to the high sensitivity of MRI for the detection of lesions—this is in contrast to most other studies that did not use MRI [16, 22, 33]. Recent published studies have found a similar frequency of spinal lesions evaluated by MRI in young athletes practicing beach volleyball and gymnastics. The latter had more serious lesions [33, 34]. The most common lesions in athletes are found in the posterior vertebral elements likely due to greater movements found during extension of the trunk and lumbar spine [35, 36].

Most vertebral lesions can be identified via a case history including sport participation, physical exams, and imaging; most can be treated conservatively [28, 29]. Accurate diagnosis and treatment of lumbar lesions not only prevents deformities and long-term impairment but also helps young athletes play sports safely [20].

This study has some limitations. First, we enrolled a relatively small number of participants. However, the frequency of lesions in the soccer group is more than double that in the control group. Importantly, a power calculation suggested 90% power in our case. Another limitation is that the athletes were analyzed at the time of the championship, and there are likely to be more mechanical overloads to the lumbar spine during this period of intense training. Thus, a longitudinal study might be warranted to evaluate any temporal differences in lesion formation.

Conclusion

Young adolescent asymptomatic soccer players have more lumbar spine lesions than less active controls who do not practice sports regularly, although they also have a considerable injury rate. Primary prevention efforts adapted to specific sports-related activities are critical to reducing the impact of lumbar spine lesions. These lesions can lead to irreversible damage to children. Effective diagnosis and management of these lesions can promote positive outcomes avoiding abandonment of the sport and more serious consequences as a result of injury in adulthood.

List Of Abbreviations

MRI: magnetic resonance imaging

BMI: body mass index

QAFA: Questionnaire on Physical Activity for Adolescents

Declarations

Ethics approval:

The study was approved by the Ethics Committee of the Pontifical Catholic University of Rio Grande do Sul, Opinion No. 2.561.459.

Consent to participate:

The parents or guardians gave free and informed consent.

Consent for publication:

The authors agree with the publication

Availability of data and material:

The data is stored for any clarifications

Conflicts of interest/Competing interests:

No conflicts of interest

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Authors' contributions:

CJ and RM conceived the study. All authors contributed intellectually to the interpretation of the data, participated in manuscript development, and approved the final version.

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Figures

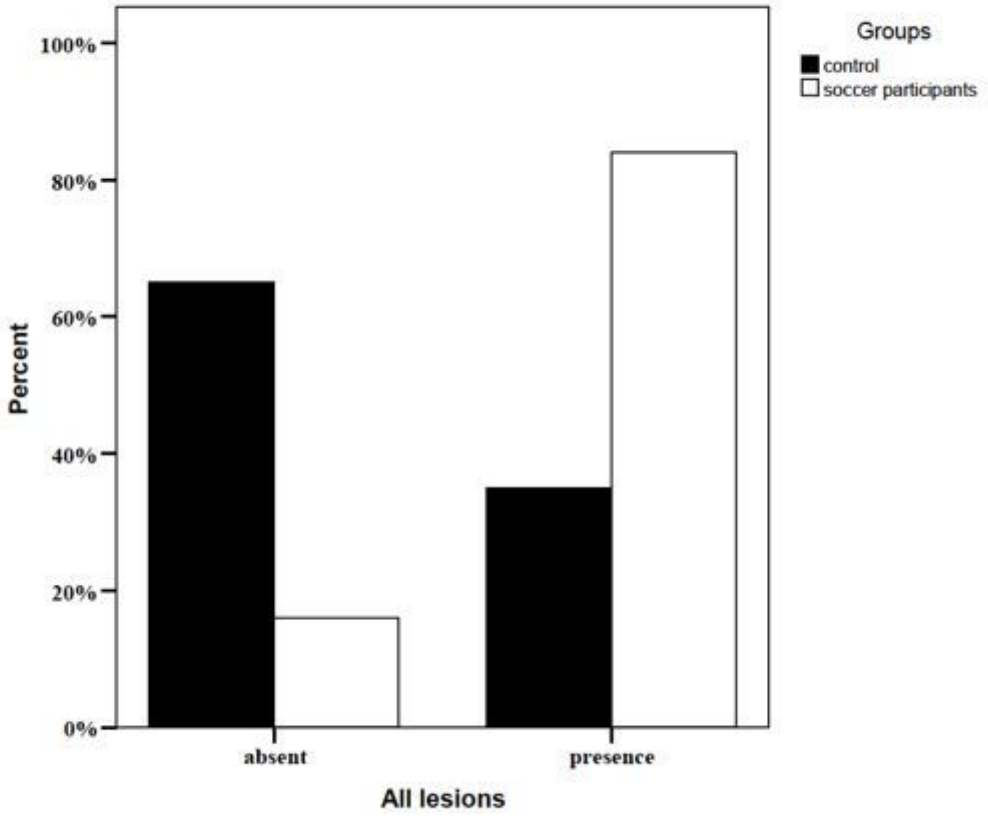

Figure 1

Frequency of vertebral lesions in soccer-practicing adolescents and school children.

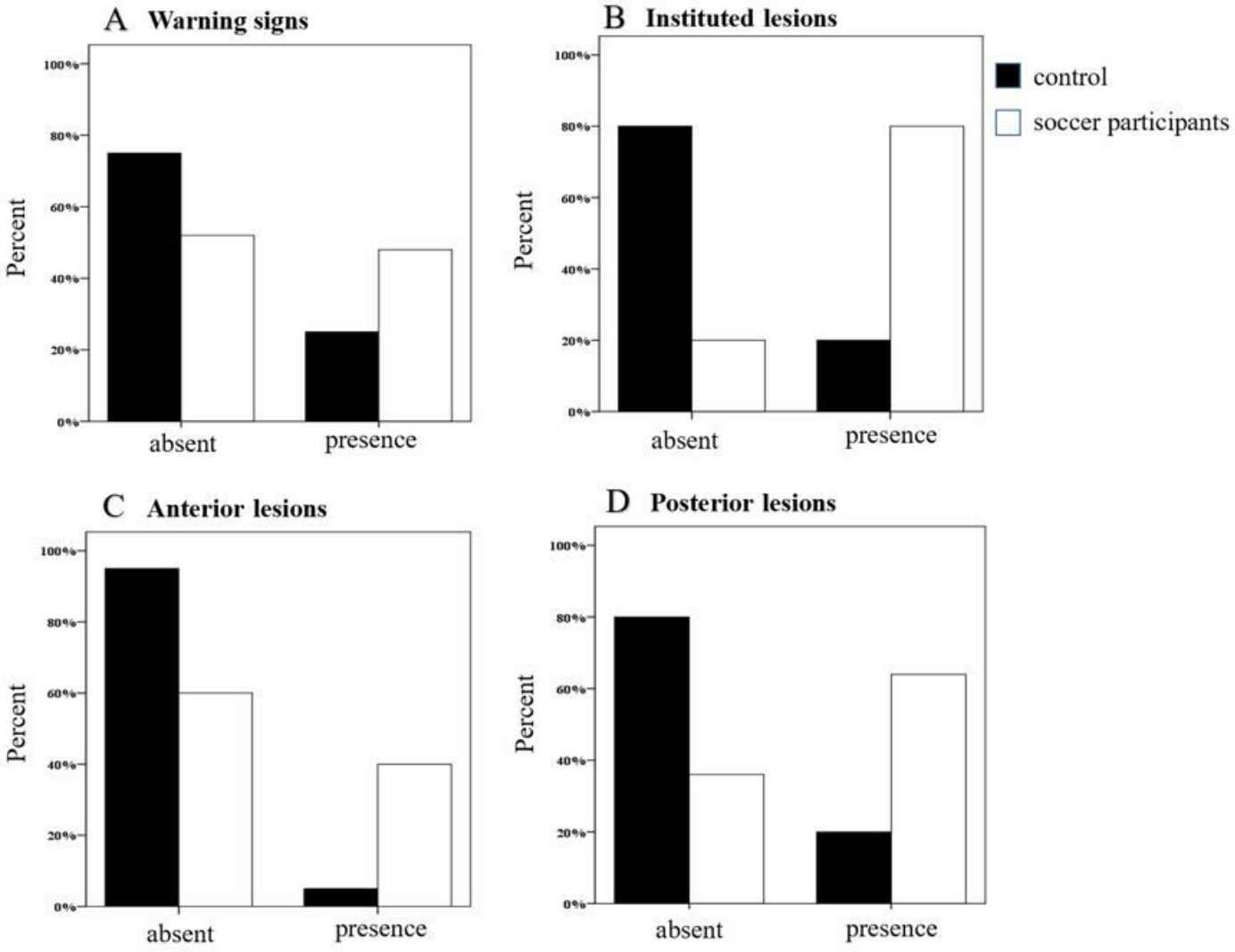

Figure 2

Frequency of lesions classified as warning signs (A), instituted (B), anterior (C) and posterior (D) in soccer-practicing adolescents and school children.