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Asymptomatic Degenerative Changes in the Lumbar Spine Among Professional Soccer Players

Eduard Bezuglov, MD,[a,b,c] Artemii Lazarev, MD,[a,b] Arseniy Petrov, MD,[d] Alesia Brodskaia, MD,[e] Anastasiya Lyubushkina, MD,[f] Kamila Kubacheva, MD,[g] Evgeny Achkasov, MD,[a] and Vladimir Nikolenko, MD[a]

Study Design. Cross-sectional study

Objective. The aim of this study was to evaluate the actual prevalence of degenerative spinal changes and their association with age in a cohort of professional soccer players.

Summary of Background Data. Presently, there are data that athletes have more degenerative changes than nonathletes; however, the research examining the prevalence of degenerative spinal conditions among professional elite soccer players is scarce.

Methods. Professional male soccer players were included in the study (n = 40, average age 26,6 ± 4,5 years, average height 18 ± 0.07 m, weight 76.7 ± 7.1 kg). Lumbosacral spine MRI scanning at the L1-S1 level has been performed. Two radiologists with at least 7 years of experience of working with athletes evaluated all images independently of each other

Results. 92.5% (n = 37) of soccer players had ≥1 spinal degenerative condition. Thirty-five percent (n = 14) of players had three to five, and 50% (n = 20) had six or more conditions. The average age of players who had six or more conditions was significantly higher than those who had zero to five or three to five conditions—28.1 ± 4.8 years *versus* 25.1 ± 3.6 years ($P = 0.029$), and 24.8 ± 3.6 years, respectively.

Kruskal-Wallis test has shown no association between the number of degenerative conditions and weight ($P = 0.98$) as well as body mass index ($P = 0.99$). The age was associated with degenerative changes ($P = 0.008$).

Disc desiccation was the most common pathologic condition, which was found in 82.5% of athletes. Facet joint arthropathy and spondylosis were present in 70, and 50% of the studied lumbar spine MRI scans, respectively. The spondylolysis prevalence of 20% was noted.

Conclusion. Elite professional soccer players demonstrate a high prevalence of asymptomatic degenerative lumbar spinal degenerative changes, which are significantly associated with age. These conditions might lead to the development of symptomatic lower back pain, given the high-intensity exercise required in professional soccer. It is presently unclear what measures might be applied for the primary prevention of these degenerative spinal conditions.

Key words: intervertebral disc degeneration, lumbosacral region, soccer, spine.

Level of Evidence: 4

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Soccer is a contact sport, characterized by the high-intensity motion activity, performed at high speed with decelerations and rapid movement direction change.[1,2]

A series of studies have shown a high prevalence of lower extremity joints degenerative changes as well as the pain of various localization among soccer players. Injuries are most commonly observed in knee and ankle joints, which highly likely have preexisting degenerative changes. This has to be considered by orthopedics professionals when choosing treatment.[3–5]

Although spinal injuries are relatively rare among soccer players, they might be severe, and debilitating.[1,6] Low back pain prevalence is high among professional soccer players.[7,8]

Surgical treatment is indicated in specific settings, which enables the return to sports. However, athletes undergoing discectomy need lengthy and challenging rehabilitation, which shortens the players' active career.[9]

The presently available sparse data regarding the prevalence of degenerative spinal changes among athletes of

From the [a]Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation; [b]High Performance Sports Laboratory, Moscow Witte University, Moscow, Russian Federation; [c]Federal Research and Clinical Center of Sports Medicine and Rehabilitation of Federal Medical Biological Agency, Moscow, Russian Federation; [d]Georg-August University of Göttingen, Göttingen, Germany; [e]Central Clinical Hospital of the Russian Academy of Sciences, Moscow, Russia; [f]Smart Recovery Clinic, Moscow, Russia; and [g]Saint-Petersburg State Public Institution, City Hospital №40, Saint-Petersburg, Russia.

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Address correspondence and reprint requests to Artemii Lazarev, MD, Sechenov, First Moscow State Medical University (Sechenov University), Moscow 121552, Russian Federation; E-mail: lazarevartemii@yandex.ru

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different sports specializations assume the negative impacts of sport on backbone health. Although most research papers focus on the spine health of athletes of different age groups, we could not identify any research on asymptomatic changes in the lumbar spine among adult elite soccer players.

We speculate that this group of players might demonstrate a high prevalence of marked degenerative conditions, which are caused by repetitive flexion and extension fatigue loads and repetitive microtrauma. These conditions might cause symptomatic lower back pain or represent asymptomatic incidental findings on magnetic resonance imaging (MRI) scans. Therefore, we studied the real prevalence of degenerative spinal changes and its association with age in a population of elite professional soccer players.

MATERIALS AND METHODS

The study was conducted according to the ethical principles of the WMA Declaration of Helsinki and approved by the local ethics committee of the Sechenov University. All athletes signed informed consent for study participation.

Elite male professional soccer players ($n = 40$, average age, 26.6 ± 4.5 years; height, 1.8 ± 0.07 m, weight, 76.7 ± 7.1 kg) were recruited in the experimental cohort during the December 2014 to January 2019 period in a retrospective manner. All players underwent a thorough medical examination before signing an employment contract with the leading soccer clubs of the Russian Premier League. MRI imaging of the lumbosacral spine at the L1-S1 levels ($n = 40$) was performed before being employed. All players started professional soccer training at the age of 6 to 7 years. They represented their respective national soccer junior and adult teams and took part in at least 80 competitive soccer matches in their respective country of origin.

Inclusion criteria were as follows: age >18 years; no sacral or spinal complaints at the point of the enrollment clinical examination; no history of spinal or sacral surgery; no spinal or sacral surgery within 12 months after the MRI at study enrollment; signed a contract with the respective soccer club after undergoing selective clinical examination.

Exclusion criteria were as follows: a history of spinal surgery; professional soccer training start was at the age of >7; participation in a soccer match 5 days before the study MRI to exclude the impact of a match on the joint.

Imaging

1.5 T MRI scanners (Philips Ingenia и Siemens Magnetom) were used to obtain T2, T1 and T2 FAT SAT weighted, as well as STIR sequence recovered images in sagittal, coronal, and axial planes. The MRI slice thickness was 3 mm.

MRI scans of the L1-S1 levels were obtained to evaluate degenerative spinal changes, that is, annular fissures, disc desiccation, bulge and herniation, spondylolisthesis, spondylosis, spondylolysis, facet joint arthrosis, and various aspects of spinal canal stenosis.

A healthy disc is composed of a central nucleus pulposus, which has a high signal intensity on T2-weighted imaging (T2WI), and peripheral annulus fibrosus, which has a low-intensity signal on T2WI. The disc is within the boundaries of the disc space, as defined, cranial and caudal by the vertebral body endplates and peripherally by the planes of the outer edges of the vertebral apophyses.

Annular fissures were identified as separations between the annular fibers or separations of annular fibers from their attachments to the vertebral bone, seen as high-intensity zones on T2WI representing fluid or granulation tissue.

Disc desiccation was classified according to the Pfirmann disc degeneration grading system.

Grade I—homogeneous, bright white, hyperintense, or isointense signal.
Grade II —inhomogeneous structure with or without horizontal bands, hyperintense or isointense signal.
Grade III—inhomogeneous gray structure, the unclear distinction between nucleus and annulus, intermediate signal intensity.
Grade IV—inhomogeneous gray to black structure, no distinction between nucleus and annulus, intermediate to hypointense signal intensity.
Grade V—inhomogeneous, black signal, no distinction between nucleus and annulus, intermediate to hypointense signal intensity.

Disc bulging is the presence of disc tissue, extending beyond the edges of the ring apophyses throughout the circumference of the disc, and is not considered the form of herniation. There are two variants of disc bulge: the asymmetric and the circumferential one.

Herniated discs may be classified as protrusion or extrusion based on the shape of the displaced material.

A protrusion is present if the most significant distance between the edges of the disc material presenting outside the disc space is less than the distance between the edges of the base of that disc material extending outside the disc space.

Extrusion is present when, in at least one plane, any given distance between the edges of the disc material beyond the disc space is greater than the distance between the edges of the base of the disc material beyond the disc space or when no continuity exists between the disc material beyond the disc space and that within the disc space.

Intravertebral herniation or Schmorl node is herniation of disc material in the vertical direction through a gap in the vertebral endplate.

Spondylolisthesis denotes the slippage of one vertebra relative to the one below. The Meyerding classification system was utilized for spondylolisthesis severity grading.

Grade I—0 to 25% slippage on the adjacent vertebra
Grade II—25% to 50% slippage on the adjacent vertebra
Grade III—50% to 75% slippage on the adjacent vertebra
Grade IV—75% to 100% slippage on the adjacent vertebra
Grade V—>100% slippage, spondyloptosis

Spondylosis is a degenerative process of the spine involving annulus fibrosus and vertebral body apophysis, characterized by anterior and lateral marginal osteophytes arising from the vertebral body apophyses, whereas the intervertebral disc height is normal or only slightly decreased.

Spondylosis severity grade was estimated according to the Kellgren radiographic classification system, which comprises four grades.

Grade 0—no degenerative changes
Grade I—minimal anterior osteophyte formation, no reduction of intervertebral disc height, no vertebral endplate sclerosis
Grade II—definite anterior osteophyte formation, subtle or no reduction in Intervertebral disc height (<25%), just recognizable sclerosis of the endplates
Grade III—definite anterior osteophyte formation, moderate narrowing of the disc space (25%–75%), definite sclerosis of the endplates and osteophyte sclerosis
Grade IV—large and multiple large osteophyte formation is seen, severe narrowing of the disc space (>75%), sclerosis of the endplates with irregularities

Spondylolysis is a defect in the pars interarticularis of the neural arch, the portion of the neural arch that connects the superior and inferior articular facets.

Facet joint arthritis was evaluated utilizing the radiographic classification, including three grades.

Grade 0—no degenerative changes
Grade I—joint space narrowing or mild osteophyte
Grade II—sclerosis or moderate osteophyte.
Grade III—marked sclerosis or marked osteophyte.

Two radiologists with at least 7 years of experience of working with athletes evaluated all images independently of each other.

Statistical Analysis

Descriptive statistics (mean, SD) were calculated. Spearman rank correlation coefficient, Logistic regression, χ^2 test, Fisher test, Kolmogorov-Smirnov test, Mann-Whitney *U* test were used for the analysis. The appropriate statistical methods are listed in the legends of the various tables.

RESULTS

92.5% (n = 37) of soccer players had one or more spinal degenerative condition. Thirty-five (n = 14) of players had three to five, and 50% (n = 20) had six or more conditions. The average age of players who had six or more conditions was significantly higher than those who had zero to five or three to five conditions -28.1 ± 4.8 years *versus* 25.1 ± 3.6 years ($P = 0.029$), and 24.8 ± 3.6 years, respectively.

Kruskal-Wallis test has shown no association between the number of degenerative conditions and weight ($P = 0.98$) as well as body mass index (BMI) ($P = 0.99$). The age was associated with degenerative changes ($P = 0.008$). Figure 1 shows the prevalence of various lumbar spinal degenerative changes.

Annular Fissures

Annular fissures were observed in 18% (n = 7) of players. The age, weight, or BMI was not the risk factor for annular fissures (logistic regression, $P < 0.05$).

Disc Desiccation

Disc desiccation was observed in 82.5% (n = 33) of players (Figure 2). It was the most common asymptomatic condition seen. Grade II desiccation was observed in 45% (n = 18) of players, Grades III, and IV were observed in 25% (n = 10) and 7.5% (n = 3) of players, respectively.

There was no correlation between desiccation severity and weight or BMI ($P < 0.05$, Spearman correlation coefficient).

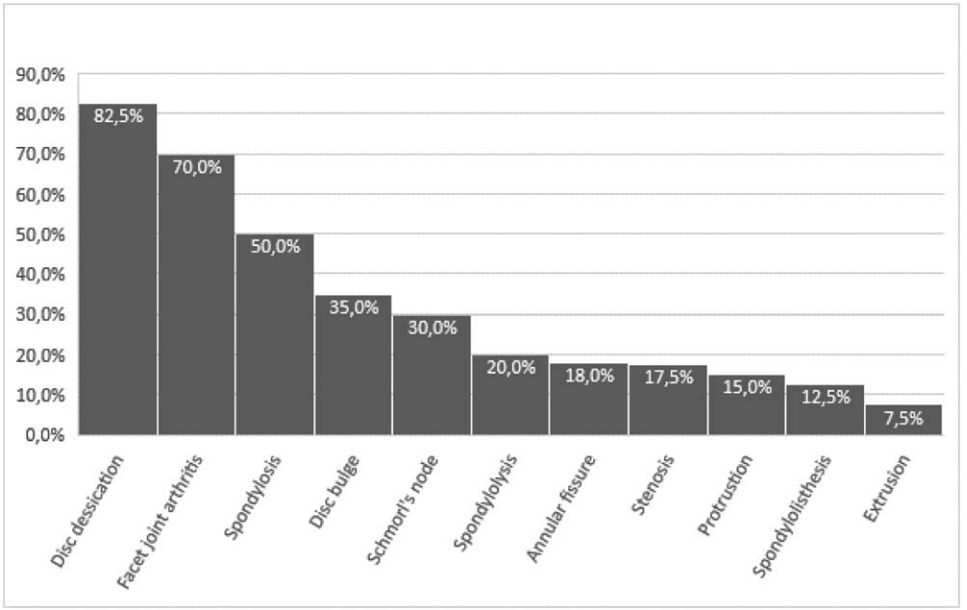

Figure 1. Prevalence of asymptomatic spinal degenerative changes.

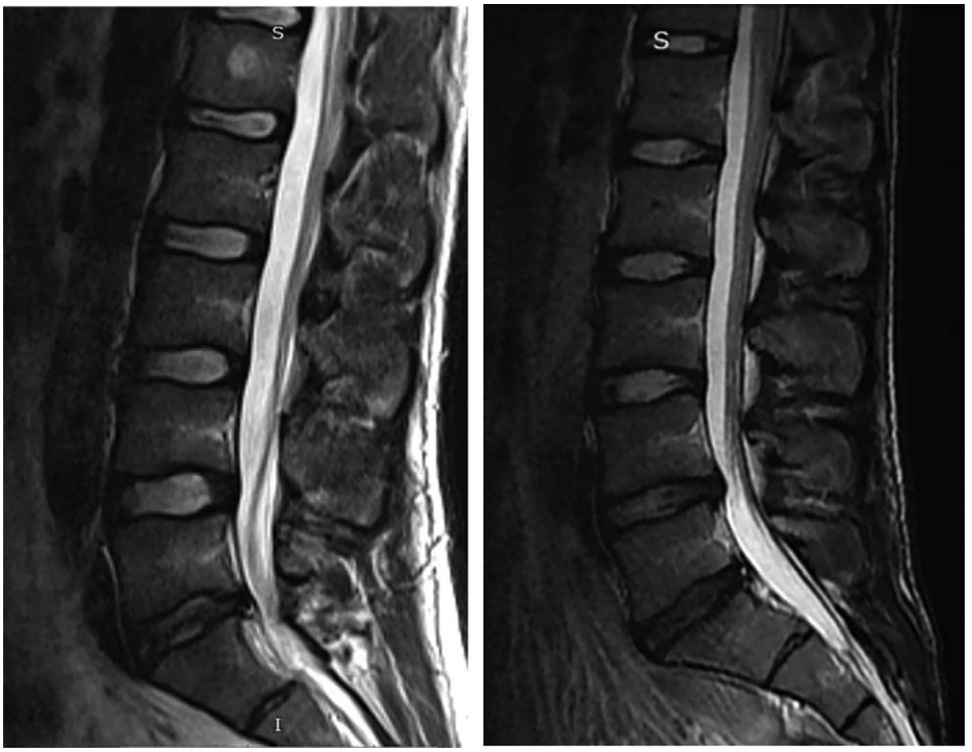

Figure 2. Disc dessication. Grade I and Grade IV.

Disc Bulge

A disc bulge was detected in 35% (n = 14) of players. The asymmetric bulge was observed in 30% (n = 12) of players, and symmetric in 5% (n = 2). Circumferential disc bulge was associated with higher grades of disc desiccation ($P = 0.009$, Mann-Whitney *U* test), and spondylosis ($P = 0.019$, Mann–Whitney *U* test). Asymmetric disc bulge was associated with anterior longitudinal ligament thickening ($P = 0.008$, Fischer exact test), and spondylolysis ($P = 0.036$, Fischer exact test).

Disc Herniation

Schmorl node was observed in 30% (n = 12) of players, and protrusions in 15% (n = 6) (Figure 3A). Disc extrusions were observed in 7.5% (n = 3) of players (Figure 3B). Schmorl node was not associated with age, weight, or

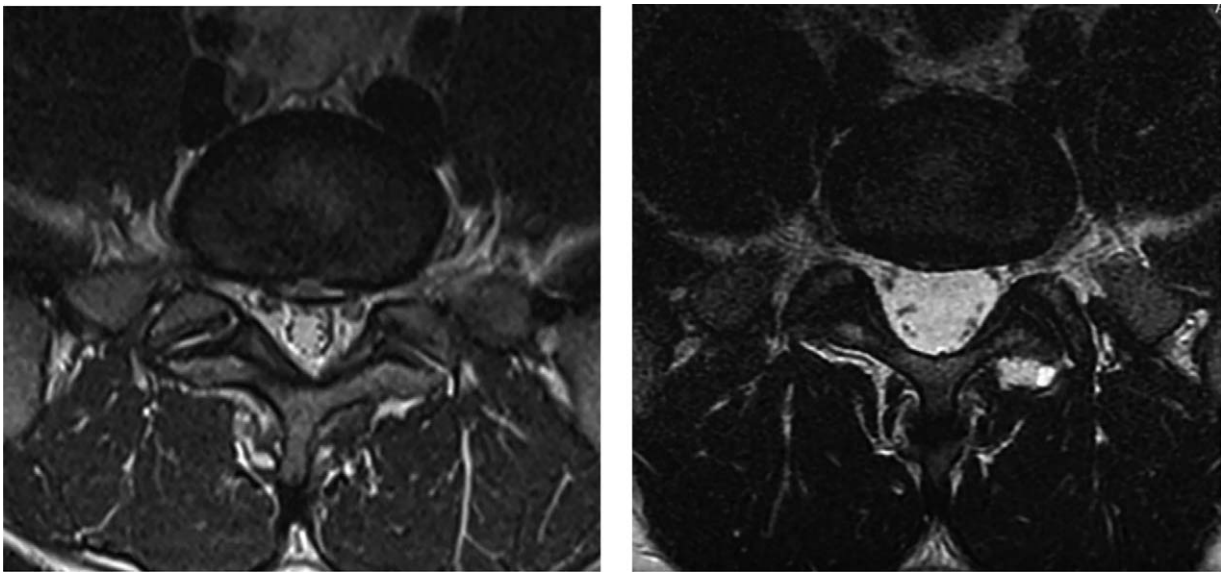

Figure 3. Extrusion (**A**) and Protrusion (**B**).

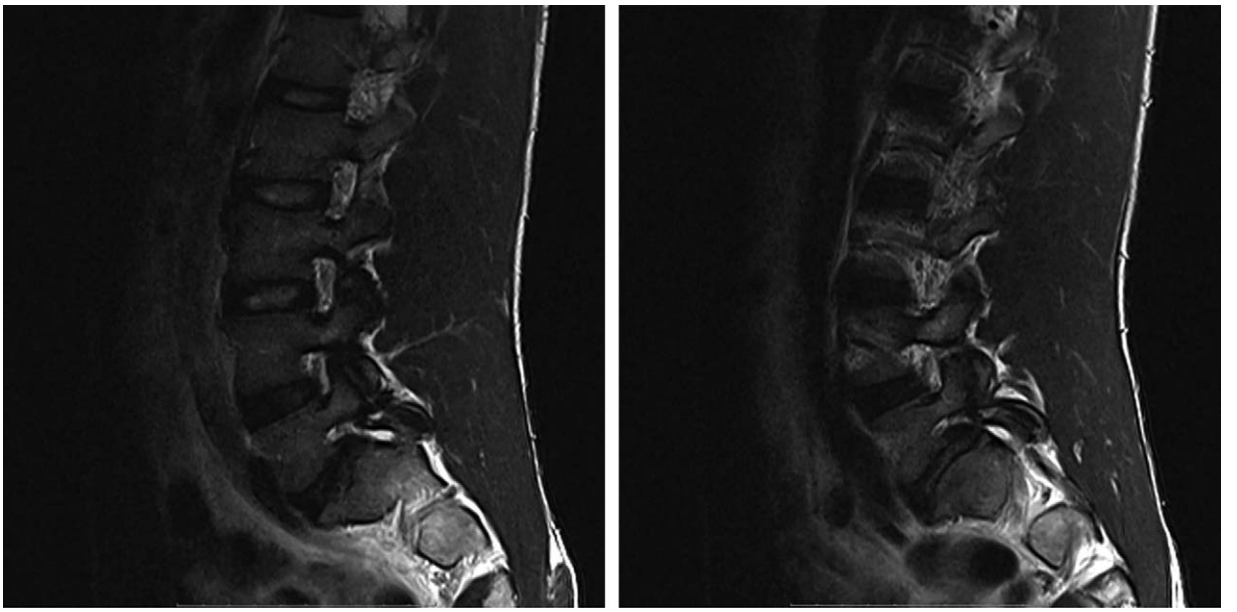

Figure 4. Spondylolysis.

BMI. Weight and BMI were not risk factors of disk protrusion ($P < 0.05$). Older age was associated with higher risk of disc extrusions ($P = 0.049$, odds ratio [OR] = 1.63, 95% confidence interval [CI] 1.0–2.66, logistic regression). Disc extrusion was associated with lordosis ($P < 0.001$, χ^2).

Spondylolysis

Spondylolysis was detected in 20% (n = 8) of players (Figure 4). Spondylolysis was not associated with age, weight, or BMI, and was significantly associated with grade I spondylolisthesis ($P < 0.0001$, Fisher exact test). However, spondylolisthesis was not a risk factor of spondylolysis ($P = 0.99$, logistic regression analysis).

Spondylolysis was significantly associated with spondylosis severity grade ($P = 0.025$, Mann–Whitney U test), asymmetric disc bulge ($P = 0.036$, Fischer exact test), disc pseudoherniation ($P = 0.001$, Fischer exact test), and supraspinous ligament thickening ($P = 0.036$, Fischer exact test).

Spondylosis

Spondylosis was detected in 50% (n = 20) of players. Grade II spondylosis was most commonly observed.

Spondylosis severity grade was associated with lordosis abnormalities, that is, lordosis effacement and hyperlordosis ($P = 0.018$, Kruskal-Wallis-test). Spondylosis was associated with circumferential disc bulge ($P = 0.019$, Mann–Whitney U test).

A weak positive correlation was observed between spondylosis grade and facet joint arthrosis ($R = 0.32$, $P = 0.044$).

Spondylolisthesis

Spondylolisthesis was observed in 12.5% (n = 5) of athletes (Figure 5).

Figure 5. Grade I spondylolisthesis.

The age, weight, or BMI was not risk factor of spondylolisthesis ($P \geq 0.05$).

Spondylolisthesis grade had a strong positive correlation with foraminal stenosis ($R = 0.54$, $P < 0.001$, Spearman rank correlation coefficient), and spondylosis ($R = 0.53$, $P < 0.001$, Spearman rank correlation coefficient).

Facet Joint Arthritis

Facet joint arthritis was observed in a total of 70% (n = 28) of players, with 60% (n = 24) of players suffering grade II, and 10% grade III arthritis.

Stenosis

Stenosis was detected in 17.5% (n = 7) of players. Foraminal stenosis was observed in 12.5% (n = 5) of players. The age, weight, or BMI was not associated with a higher risk of foraminal stenosis ($P < 0.05$). Endplate changes had a weak positive correlation with foraminal ($R = 0.37$, $P = 0.019$, Spearman rank correlation coefficient), as well as central stenosis ($R = 0.42$, $P = 0.006$, Spearman rank correlation coefficient).

DISCUSSION

Our study has shown a high prevalence of asymptomatic degenerative changes in the lumbar spine among professional soccer players, which did not impair their regular training. Fifty percent (n = 20) had six or more such conditions. The number of such degenerative conditions was significantly higher in older players, which is in line with the findings of the previous studies.[10,11]

Disc desiccation was the most common pathologic condition, which was found in 82.5% of athletes. Disc herniation was also commonly observed with Schmorl node being the most common type. Facet joint arthritis and spondylosis were present in 70% and 50% of the studied lumbar spine MRI scans, respectively. The spondylolysis prevalence of 20% was noted.

The previous research evaluating the prevalence of asymptomatic degenerative spinal changes demonstrated a higher prevalence of these conditions among athletes active in various sports compared to the general population. This association is observed even in the groups of younger athletes.[12–16]

The previous studies regarding the prevalence of degenerative spinal changes in symptomatic athletes showed a high incidence of these conditions. However, it was not higher than in the group of asymptomatic athletes. Ong *et al* demonstrated that the incidence of various disc displacement conditions was 58% (most often disc bulges) in a population of adult Olympic athletes (Sydney Summer Olympics) who reported lower back pain. However, the prominent degenerative features in the spine do not necessarily correlate with lower back pain.[17]

Rajeswaran *et al*[14] showed that disc herniation frequency in asymptomatic young tennis players was ≥30%. This finding is in line with our study, which showed a large proportion of asymptomatic athletes who had several degenerative spinal conditions.

On the other side, such changes as a disc bulge, degeneration, extrusion, protrusion, and spondylolysis are mostly present in the general population under the age of 50 years with symptomatic lower back pain, in contrast to asymptomatic athletes in our study.[18]

Disc herniation might cause symptomatic lower back pain in athletes and lead to lengthy conservative treatment courses.[19] One of the most common degenerative changes in the lumbar spine is the disc desiccation, Pfirmann grades I and II desiccation being the most prevalent.

Abdalcader *et al* demonstrated the disc desiccation prevalence as high as 26% in both male and female Olympic athletes participating in the Rio Summer Olympics. The highest prevalence was detected in the track and field, weightlifting, and judo athletes. Grade IV desiccation was observed in 9% of athletes, specifically among athletes of track and field disciplines, and Olympic divers.[15]

Our study has shown a higher prevalence of Grades II and III desiccations, which was as high as 70%. The Grade IV desiccation was observed in 7.5% of athletes. High prevalence of lumbar spine degenerative changes among soccer players might be associated with soccer-specific exercises, which are characterized by repetitive flexion and extension fatigue loading, which was shown to cause changes in the vertebral growth plates and end plates, thus provoking injuries of the disc, vertebral apophysis, and growth zone in adolescent age.[20]

The other widely spread spinal degenerative change is the intervertebral disc herniation. Witwit *et al*[16] showed the prevalence of thoracic disc herniation as high as 52% in a group of soccer players under the age of 16 years, which is significantly higher than in the general population.

The present study had several limitations. A control group was not included in the study design. Moreover, the musculoskeletal system's specific properties, for example, extremity length, muscle balance, and strength, could be associated with the severity of degenerative changes. It also should be noted that the sample is small given the necessarily limited number of elite professional soccer players of that level: this obviously affects the statistical power of our investigation.

Physical activity in the adolescent age, which could have had a particular impact on backbone health during the growth periods of the spine, was not evaluated.

Professional soccer players demonstrate a high prevalence of asymptomatic degenerative changes in the lumbar spine. Its prevalence is increasing with age. The prevalence and severity of these changes might be asymptomatic and does not impair regular training. This fact must be considered when interpreting MRI scans of athletes with lower back pains and those undergoing selection medical examination before signing the employment contract. Further research should focus on examining risk factors of degenerative spinal changes progression and developing efficient prevention programs.

CONCLUSION

Elite professional soccer players demonstrate a high prevalence of asymptomatic degenerative lumbar spinal degenerative changes, which are significantly associated with age. These conditions might lead to the development of symptomatic lower back pain, given the high-intensity exercise required in professional soccer. It is presently unclear what measures might be applied for the primary prevention of these degenerative spinal conditions.

➢ Key Points

- ❑ Elite professional soccer players demonstrate a high prevalence of asymptomatic degenerative lumbar spinal degenerative changes, which are significantly associated with age.
- ❑ The most commonly seen degenerative conditions are disc desiccation, facet joint arthropathy, and spondylosis.
- ❑ This degenerative conditions may be absolutely asymptomatic in professional soccer players and do not impair their regular training.

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