

Low Back Pain in Adolescent Athletes: Etiology, Clinical Evaluation, Conservative Management and Return-to-Sport Considerations: A Narrative Review

Uroš Živković¹, Đorđe Hadži Pavlović², Miloš Drljan¹

¹ University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

² University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia

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Abstract

Low back pain (LBP) is a common musculoskeletal condition in adolescent athletes and an important cause of training interruption. Its prevalence varies across sports and appears to be influenced by age, training load, biomechanical demands, and underlying pathology. Both non-specific and specific causes should be considered. Therefore, the aim of this review is to provide an updated overview of the etiology, clinical evaluation, conservative management and return-to-sport considerations in adolescent athletes with low back pain. English-language publications from January 2016 to April 2026 were identified through PubMed, supplemented by Google Scholar and reference-list screening; 27 publications were included in the clinical synthesis, supplemented by contextual sources. Non-specific low back pain is commonly associated with muscular, biomechanical, and training-related factors, whereas spondylolysis is commonly reported as one of the most frequent specific diagnoses. Lumbar disc herniation and other less common conditions, including Scheuermann disease, apophyseal ring injuries, and sacroiliac joint dysfunction, should also be considered in the differential diagnosis. Clinical evaluation includes history taking, physical and neurological examination, and imaging when indicated. Conservative management remains the first-line approach in most cases and is based on activity modification, exercise-based rehabilitation, correction of biomechanical deficits, and gradual progression toward sport-specific activity. Because the clinical presentation and recovery process may differ depending on the underlying diagnosis and management, return-to-sport decisions should be individualized and based on symptom resolution, functional recovery, and sport-specific readiness, rather than on time alone. However, evidence for return-to-sport criteria in adolescent athletes remains limited.

Keywords: spondylolysis · lumbar disc herniation · exercise therapy · spinal stress injuries · trunk endurance · functional recovery

✉ Correspondence:

Uroš Živković

uroszivkovic4001@gmail.com

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Introduction

Low back pain (LBP) represents one of the most common musculoskeletal complaints worldwide and is a significant cause of disability across all age groups. A number of factors such as higher body mass index (BMI), family history, age and lack of physical activity have been associated with LBP (Guddal et al., 2017; Wall et al., 2022). Sex differences were reported in some papers, with females being more susceptible than males (Schachne et al., 2019), while no differences are reported in other publications (J. Müller et al., 2017). These variations demonstrate a lack of consensus on the topic, and could also be influenced by multiple interacting factors.

In adolescent athletes, LBP is particularly relevant due to the high physical demands and repetitive loading associated with sports participation. A 12-month prevalence of 42% and a point prevalence of 16% were reported in a meta-analysis on an adolescent athlete population, although with high variation between studies (Wall et al., 2022). These pooled estimates should be interpreted cautiously because of substantial heterogeneity in pain definitions, observation periods and sporting populations (Wall et al., 2022). Diagnostic proportions from retrospective clinical samples described athletes presenting with symptoms and should not be interpreted as prevalence estimates for all adolescent athletes (Selhorst et al., 2019; Wall et al., 2024). Prospective cohort findings on associated factors also require cautious interpretation, as observational associations do not establish causation (Kato et al., 2022). In a cross-sectional study of adolescent athletes, the seven-day prevalence of back pain showed different estimates across different sports (3-14%) (J. Müller et al., 2017), which may reflect differences between sports. Prevalence of back pain increased with age until around 16 years of age as well as with level of play, in a cross-sectional study of American youth (Schachne et al., 2019). Also, J. Müller et al. (2017) reported higher prevalence after the age of 14 in adolescent athletes. Limited hamstring flexibility has also been associated with the onset of LBP in adolescent athletes (Kato et al., 2022). Both non-specific and specific causes should be considered when evaluating LBP in adolescent athletes. Spondylolysis is an important specific diagnosis, particularly among symptomatic athletes (Patel & Kinsella, 2017). In a study with 1025 adolescent athletes presenting with low back pain, 30% were diagnosed with spondylolysis (Selhorst et al., 2019). However, non-specific LBP related to muscle imbalance, biomechanical dysfunction, and overuse

is still highly prevalent in sports (Dal Farra et al., 2022). Despite the growing number of studies in this field, and even though some reviews on LBP exist, there is still a lack of recent comprehensive reviews and clear protocols regarding optimal diagnostic strategies and management approaches, particularly in distinguishing between specific and non-specific causes of pain.

Therefore, the aim of this review is to provide a comprehensive updated overview of the etiology, clinical evaluation, conservative management and return-to-sport considerations for low back pain in adolescent athletes.

Method

This narrative review was based on a literature search conducted primarily in the PubMed database, while Google Scholar was searched as an additional source. Study selection was performed by two authors. The search included studies published in English between January 2016 and April 2026. The following search string combining keywords with Boolean operators was used:

((("Low Back Pain"[MeSH Terms] OR "low back pain"[Title/Abstract] OR "lumbar pain"[Title/Abstract] OR "back pain"[Title/Abstract]) AND ("Adolescent"[MeSH Terms] OR "Pediatrics"[MeSH Terms] OR adolescent*[Title/Abstract] OR pediatric[Title/Abstract] OR "young athlete*" [Title/Abstract] OR "adolescent athlete*" [Title/Abstract]) AND ("Spondylolysis"[MeSH Terms] OR spondylolysis[Title/Abstract] OR "lumbar disc herniation"[Title/Abstract] OR "non-specific low back pain"[Title/Abstract] OR "Rehabilitation"[MeSH Terms] OR rehabilitation[Title/Abstract] OR "conservative treatment"[Title/Abstract] OR "physical therapy"[Title/Abstract] OR "return-to-sport"[Title/Abstract])).

The primary PubMed search yielded 779 publications. Additional relevant studies were identified through manual screening of reference lists of selected publications. The search strategy was not limited to a specific study design, given the narrative nature of this review. Original studies, review articles, and clinical papers relevant to the etiology, clinical evaluation, diagnosis, and conservative management of low back pain in adolescent athletes were considered for inclusion. Publications that focused on adolescent athlete populations were primarily reviewed, although selected publications involving the general pediatric

or adolescent population were also included when evidence specific to adolescent athletes was limited. Publications were excluded from the clinical synthesis if they were not available in English, focused exclusively on adults, or were not relevant to low back pain, sports participation, conservative management or rehabilitation in adolescents. Titles and abstracts were first screened for relevance, followed by full-text assessments of potentially eligible articles (total of 45 publications).

A total of 27 publications were included in the narrative synthesis. Because of the narrative nature of this review, formal risk-of-bias assessment or meta-analysis were not performed. During revision, the initial search was supplemented by targeted literature searches for topics that required clarification or additional evidence. Four additional publications were included from the targeted search. The 31 references comprise the 27 publications included in the clinical synthesis, one terminology source (Fardon et al., 2014), and three contextual sources addressing general training-related factors, training principles and psychological readiness for return to sport (Adekoya & Ayenigbara, 2026; Donald et al., 2024; Stone et al., 2022).

Etiology, clinical evaluation and diagnosis

The prevalence of low back pain in adolescent athletes is dependent on multiple factors. In addition to general risk factors, sport-specific biomechanical demands, repetitive loading and stress on the spine, and high training volume have been investigated as potential associated factors in the development of LBP (Wall et al., 2022), which can be divided into non-specific and specific cases.

Clinical evaluation

Assessment should document the onset, duration, location and radiation of pain, aggravating and relieving activities, previous episodes and any preceding trauma. Sport type, training volume, recent changes in workload and the effect of symptoms on daily activities and sports participation should also be recorded (Patel & Kinsella, 2017).

Examination should include posture, gait, lumbar range of motion, localized tenderness, and hip and lower-limb flexibility. Neurological assessment should document lower-limb strength, sensation and reflexes. Straight leg raise testing may help assess nerve-root irritation. Findings should be interpreted together with the history rather than used as isolated diagnostic criteria (Patel & Kinsella, 2017).

Persistent night or rest pain, systemic symptoms such as fever or unexplained weight loss, significant trauma, and focal neurological findings warrant further evaluation. New bladder or bowel dysfunction, saddle sensory disturbance, or progressive weakness require urgent medical assessment (Patel & Kinsella, 2017; Selhorst et al., 2021).

Imaging should be directed by suspicion of a specific diagnosis, concerning clinical findings or persistent symptoms. In presumed non-specific LBP, imaging is used to investigate a suspected specific cause. Radiographs may assess bony abnormalities or spinal deformity, while magnetic resonance imaging (MRI) and computed tomography (CT) are selected according to the suspected pathology and the diagnostic question. Condition-specific imaging considerations are outlined below (Patel & Kinsella, 2017; Selhorst et al., 2020). Table 1 summarizes the reported frequency, associated factors, clinical presentation, and imaging considerations for the main causes of low back pain in adolescent athletes.

Table 1. Reported Frequency, Associated Factors, Clinical Presentation and Imaging of Low Back Pain Conditions in Adolescent Athletes

Condition	Reported frequency	Etiology and associated factors	Clinical presentation	Imaging	References
Non-specific LBP	34% of 363 adolescent athletes presenting with LBP	Multifactorial; muscular, biomechanical and training-related associations	Low back pain without an identified specific cause; clinical assessment includes screening for red flags	Imaging is directed by suspicion of a specific cause	Wall et al., 2024; Dal Farra et al., 2022; Patel & Kinsella, 2017
Spondylolysis	30% of 1,025 adolescent athletes presenting with LBP	Pars interarticularis stress injury or defect; repetitive lumbar extension, rotation and loading	Insidious or recurrent activity-related LBP, often aggravated by extension	Anteroposterior and lateral radiographs initially; MRI for early stress injury or persistent suspicion after negative radiographs; selective CT for bony detail	Selhorst et al., 2019; Selhorst et al., 2020
Spondylolisthesis	NR	Isthmic vertebral slippage associated with bilateral pars defects	Activity-related LBP and possible functional limitation	Lateral radiographs to assess vertebral slippage	Patel & Kinsella, 2017
Lumbar disc herniation (LDH)	NR	Localized displacement of disc material; associated factors include trauma, biomechanical abnormalities and disc degeneration	LBP with possible leg pain or sensory symptoms; a positive straight leg raise test may be present	MRI when indicated; imaging findings should be correlated with symptoms and examination	Fardon et al., 2014; Zhang et al., 2025
Scheuermann disease	NR	Vertebral wedging and endplate irregularities associated with rigid kyphotic deformity	Back pain and rigid thoracic or thoracolumbar kyphosis	Plain radiographs, particularly lateral views	Patel & Kinsella, 2017
Apophyseal ring injuries	NR	Acute or repetitive trauma involving the immature vertebral ring; reported in wrestling and gymnastics	LBP with symptoms that may resemble LDH	MRI when associated LDH is suspected; CT to define a suspected bony fragment that is not clearly characterized on MRI	Patel & Kinsella, 2017; Sairyo & Nagamachi, 2016
Sacroiliac joint (SIJ) dysfunction	NR	Etiology and adolescent-specific associated factors remain uncertain	Low-back, buttock or pelvic-region pain; FABER and Gaenslen tests may reproduce symptoms, but positive findings alone do not confirm the pain source	Imaging when indicated to investigate alternative causes	Patel & Kinsella, 2017; Cucchiaro et al., 2022

Note. Numerical frequency estimates refer to symptomatic clinical samples and should not be interpreted as prevalence estimates for all adolescent athletes. NR indicates that no numerical frequency estimate is presented in this review for the condition. Imaging selection depends on clinical findings and the suspected pathology. Abbreviations: LBP, low back pain; MRI, magnetic resonance imaging; CT, computed tomography; LDH, lumbar disc herniation; SIJ, sacroiliac joint; FABER, flexion, abduction and external rotation.

Non-specific LBP

Non-specific LBP is also important to consider in adolescent athletes without an identified specific underlying cause. In a retrospective study of 363 adolescent athletes with active LBP, non-specific LBP was the most frequent diagnosis (34%) (Wall et al., 2024). Non-specific LBP is defined as low back pain without a clearly identifiable structural source. In adolescent athletes, this form of pain is presumed to result from a combination of muscular and biomechanical (S. Mueller et al., 2017; Arampatzis et al., 2019), as well as training-related factors (Wall et al., 2022) rather than from a single underlying issue, such as a lesion. Non-specific LBP remains important to understand because it could significantly affect training continuity.

Several factors have been associated with the development of non-specific LBP in athletes. Duration, intensity and frequency of training sessions, as well as biomechanics and specific athletic actions have been investigated as potential factors associated with non-specific LBP as described in a review from Dal Farra et al. (2022). Also, in a small matched comparison study, adolescent athletes with back pain had lower trunk strength than the group without pain (S. Mueller et al., 2019). However, too much physical activity (high training volume) and repetitive spinal loading may contribute to non-specific LBP in athletes (Dal Farra et al., 2022), although findings specific to adolescent athletes remain limited. In addition to them, increased general risk factors like abdominal muscle weakness, and rapid growth of the vertebral column during puberty (Vij et al., 2022) may overload the musculoskeletal system and contribute to pain development.

Reported back pain prevalence varies across sports. J. Müller et al. (2017) reported different seven-day prevalence of back pain, ranging from 3% in soccer players to 14% in canoeists, while a separate study (Pasanen et al., 2016) found that the 12-month prevalence was higher in floorball players (62%) than basketball players (44%). These differences cannot be directly compared; however they suggest that sport-specific exposures could be investigated further. Highly technical sports and those involving repetitive or extreme loading of the spine were more associated with LBP than endurance activities (Guddal et al., 2017). Unlike specific causes of low back pain, non-specific LBP does not usually present with a distinct pathological finding, which makes its diagnosis largely clinical and based on exclusion of more serious or structurally defined conditions and red flags. From a practical perspective, non-specific LBP should be

understood as a functional and load-related disorder in which sport participation may act not only as a trigger, but also as a recurring factor.

Spondylolysis

Spondylolysis is one of the most commonly reported specific diagnoses of low back pain in adolescent athletes (Wall et al., 2022). Among 1025 adolescent athletes with low back pain, 30% were diagnosed with spondylolysis (Selhorst et al., 2019), while in a report focusing specifically on active spondylolysis in symptomatic athletes, active lesions were identified in 22% (Therriault et al., 2020), both in clinical samples. It is generally described as a stress injury or defect of the pars interarticularis and is especially frequent in young athletes exposed to high mechanical demands on the lumbar spine. Differences between sports exist and are related to the amount of repetitive axial loading and rotation, especially in an extended lumbar spine. Baseball is regarded as the highest risk sport in males and gymnastics in females (Selhorst et al., 2019). Examination findings of adolescent athletes with symptomatic spondylolysis are hip flexors and hamstrings tightness and weakness of the abdominal and gluteal muscles (Lawrence et al., 2016; Patel & Kinsella, 2017). Athletes with symptomatic spondylolysis generally present with insidious onset, recurrent, activity associated, low back pain (Lawrence et al., 2016).

In some cases, bilateral pars defects may be associated with isthmic spondylolisthesis, which involves anterior displacement of one vertebra relative to another and may further contribute to pain and functional limitation. The pain is aggravated by physical activity, especially those involving repeated extension, and rotation (Patel & Kinsella, 2017).

There is no universally accepted imaging protocol for suspected spondylolysis; imaging should be guided by the clinical findings. When indicated, anteroposterior and lateral radiographs are commonly used initially. Routine oblique views are not recommended because they increase radiation exposure with little additional diagnostic benefit. MRI is useful for early stress injuries and when suspicion persists despite negative radiographs. CT may be considered selectively when further definition of a bony defect is required (Selhorst et al., 2020). For spondylolisthesis, lateral radiographs are used to assess vertebral slippage (Patel & Kinsella, 2017).

A diagnostic prediction model for spondylolysis was developed (Therriault et al., 2020) and it consists of 3 clinical variables: pain with extension, difference between active and resting pain $\geq 3/10$, and male

sex, and it can be used to help rule out active spondylolysis in adolescent athletes. This model should be additionally validated through a prospective study in order to broaden the application. With the percentage of spondylolysis diagnoses in mind, it should be considered a key diagnosis in the evaluation of low back pain in adolescent athletes.

Lumbar disc herniation

Lumbar disc herniation (LDH) represents a less common but clinically important specific cause of low back pain in adolescent athletes. It refers to localized displacement of disc material beyond the intervertebral disc space. It may be classified as a protrusion or extrusion; sequestration describes an extruded fragment that has lost continuity with the parent disc (Fardon et al., 2014). The most common level of injury is L4–5 followed by L5–S1. The pain may or may not radiate to the legs and generally neurological signs are absent in many children and adolescents (Karademir et al., 2017). Scarcity of literature concerning adolescent lumbar disc herniation may be linked to the low prevalence of LDH among adolescents. LDH is uncommon in children and adolescents, although estimates are difficult to compare because studies differ in their age definitions and clinical settings (Karademir et al., 2017; Zhang et al., 2025). The cause of LDH in the adolescent population is not fully understood, and it is generally believed that the relevant factors include trauma, developmental abnormalities, biomechanical abnormalities, premature disc degeneration, obesity, and environmental factors. Among these factors, trauma is considered to be the most likely cause or at least a triggering event for the deterioration of preexisting lesions in the disc, which is of particular importance in adolescent athletes (Zhang et al., 2025).

Clinically, lumbar disc herniation may present with low back pain associated with pain radiating to the lower extremity, sensory symptoms, or limitations during sport participation. In athletes, pain during spinal flexion can be associated with disc herniation, but is not specific to this condition (Sairyo & Nagamachi, 2016). A positive straight leg raise test is commonly reported in adolescents with LDH (Zhang et al., 2025). Additionally, hamstring tightness is another commonly reported finding. MRI is most commonly used for imaging, and it is important to connect MRI findings to clinical findings because asymptomatic imaging abnormalities are common and that could be misinterpreted (Zhang et al., 2025). Therefore, LDH should be considered an important differential diagnosis in adolescent athletes with low

back pain, particularly when symptoms radiate beyond the lumbar region.

Other causes

Other causes of low back pain in adolescent athletes include a number of less common but clinically relevant conditions. Scheuermann disease may contribute to LBP in adolescents. It is a rigid kyphotic deformity associated with vertebral wedging and endplate irregularities. Its thoracolumbar form may present in adolescent athletes with back pain and reduced lumbar lordosis (Patel & Kinsella, 2017). When Scheuermann disease is suspected, plain radiographs, particularly lateral views, are used to assess vertebral wedging and the kyphotic deformity (Patel & Kinsella, 2017). Apophyseal ring injuries and other stress-related lesions of the immature spine should also be considered. Symptoms may resemble those of LDH in adults (Sairyo & Nagamachi, 2016). This most often occurs in wrestling and gymnastics and may result from acute or repetitive trauma (Patel & Kinsella, 2017). When a bony fragment is suspected but cannot be clearly distinguished from disc herniation on MRI, CT can help define the fracture (Sairyo & Nagamachi, 2016).

Sacroiliac joint (SIJ) dysfunction may present with low-back, buttock or pelvic-region pain, although its etiology and frequency in adolescent athletes remain uncertain (Patel & Kinsella, 2017). The FABER (flexion, abduction and external rotation) and Gaenslen tests may reproduce pain in this region, but positive findings alone do not establish the SIJ as the source. Their diagnostic value specifically in adolescent athletes remains insufficiently established. The available literature includes a small retrospective case series of 13 patients, which does not establish the diagnostic accuracy of individual provocation tests (Cucchiari et al., 2022). These tests should therefore be interpreted alongside the history and examination of the lumbar spine and hips. Imaging may be used when indicated to investigate alternative causes of symptoms (Patel & Kinsella, 2017). While these conditions are reported less frequently than spondylolysis or lumbar disc herniation, they remain important differential diagnoses in adolescent athletes presenting with low back pain.

Conservative management

Conservative treatment remains the first-line approach for most cases of low back pain in adolescent athletes (Vij et al., 2022). Conservative modalities include rest, pain management, therapeutic exercise, bracing, improving biomechanics, improving sport techniques,

appropriate conditioning and training and gradual return to sport. Although treatment strategies may vary, exercise-based rehabilitation and activity modification remain the core components of management. Additionally, in adolescent athletes, treatment should be individualized according to the sport and underlying pathology (Patel & Kinsella, 2017).

Activity modification and relative rest

Conservative management of LBP in adolescent athletes commonly includes activity modification and exercise-based rehabilitation, with the approach tailored to the underlying condition (Vij et al., 2022). Activity modification involves maintaining tolerated levels of activity whenever possible. This approach is especially relevant in adolescent athletes diagnosed with spondylolysis, in whom prolonged inactivity may lead to deconditioning, reduced performance, and delayed return to sport (Selhorst et al., 2020). Differences in extent and duration of sports activities restriction depend mainly on severity of the symptoms and the underlying diagnosis. Complete bed rest is not recommended in adolescent athletes with acute back strains or sprains. Daily activities may be continued and followed by rehabilitation exercises as pain improves (Patel & Kinsella, 2017).

Exercise-based rehabilitation

Exercise-based rehabilitation represents the cornerstone of conservative management in adolescent athletes in most cases of low back pain. Most rehabilitation programs are aimed at improving trunk strength, enhancing lumbopelvic control, increasing flexibility of shortened muscle groups and optimization of movement mechanics that may contribute to pain development (Selhorst et al., 2021; García-Moreno et al., 2025). In addition to pain reduction, the goal of rehabilitation is to restore functional capacity and allow a safe and progressive return to sport. Evidence on exercise-based prevention in adolescent athletes remains limited. Implementation of specific interventions, aimed at improving trunk muscle strength, in the training process of adolescent athletes could be meaningful. The average three-month prevalence of LBP was 51% during the usual-training year and 26% during the next year with added perturbation-based trunk exercises, in a non-randomized two-year study on the same sample of 37 adolescent athletes (Arampatzis et al., 2021).

Condition-specific conservative treatment

Although the general principles of conservative treatment are similar across most causes of low back

pain, condition-specific modifications are often necessary.

In non-specific LBP, regular levels of physical activity are recommended in order to help reduce non-specific LBP risk (Frosch et al., 2022); however adolescent athletes should keep in mind that high training loads have been associated with non-specific LBP in athletes (Dal Farra et al., 2022). Further research focusing specifically on adolescent athletes with non-specific LBP is needed to clarify how different levels of physical activity relate to non-specific LBP. In children and adolescents with non-specific LBP, a meta-analysis found that exercise, alone or in combination with manual therapy, reduced pain intensity compared with no treatment, with no statistically significant difference between the two exercise approaches (García-Moreno et al., 2025). However, this evidence concerns children and adolescents generally, rather than adolescent athletes specifically, and primarily addresses pain intensity. Its applicability to sport-specific rehabilitation outcomes and return-to-sport criteria therefore remains indirect. Exercise programs should primarily focus on improving trunk strength and correction of biomechanical deficits, although evidence specific to adolescent athletes remains limited.

In spondylolysis, temporary restriction of extension-based activities is required, along with phased rehabilitation and gradual return to sport. In a randomized trial, adolescent athletes with active spondylolysis who began physical therapy within 7 days after diagnosis met return-to-sport criteria earlier than those who rested until the symptoms resolved (median 74 vs 112 days) (Selhorst et al., 2026). This randomized trial provides direct evidence supporting earlier initiation of physical therapy in active spondylolysis. However, its sample of 64 participants limits sport-specific conclusions and generalization to other causes of low back pain (Selhorst et al., 2026). Main treatment exercises consist of motor control exercises, transversus abdominis training, lumbar multifidus training, and dynamic lumbar stabilization exercises. Trunk coordination, functional strengthening, and endurance exercises are also of value in the early phase of treatment. It is important for athletes to progressively work into extension and rotation motions in order to be successful when they return to sport (Selhorst et al., 2020). Along with physical exercises, bracing may be considered for spondylolysis-based LBP in patients whose symptoms fail to improve with exercise treatment (Selhorst et al., 2020). Despite generally good outcomes, recurrence may still occur. In a retrospective study, 41 of 121 young athletes

(33.9%) reported recurrent symptoms requiring medical treatment over a mean follow-up of 3.4 years (from 1.5 to 5.6 years) (Selhorst et al., 2016). In the absence of neurological signs in adolescent athletes diagnosed with LDH, the initial treatment is conservative with relative rest and restriction from sport, followed by exercise-based rehabilitation, although it is less effective than in adults. A short- to long-term success rate of 25-50% of conservative treatment is reported in adolescents (Zhang et al., 2025). Unlike in non-specific LBP or spondylolysis, greater caution is needed in athletes with disc-related pain because of the possibility of nerve root irritation and more pronounced functional limitation. Adolescents with incapacitating persistent low back pain or radicular pain lasting more than 6 weeks despite rest and medication should be considered for specialist referral to assess further treatment options (Karademir et al., 2017). Neurological signs warrant earlier specialist assessment (Patel & Kinsella, 2017).

Overall, conservative management remains the cornerstone of treatment for most adolescent athletes with low back pain, regardless of whether the underlying cause is non-specific or associated with an identifiable condition. In most cases, successful treatment depends not only on pain reduction, but also on improvement of movement quality, functional capacity, and control of training load. This approach forms the basis for a safe and individualized return to sport.

Return-to-sport considerations

In adolescent athletes with LBP, return to sport (RTS) is generally considered when pain has resolved or is minimal, functional movement has been restored, and sport-specific activities can be performed without symptom aggravation. The RTS rate differs across sports, and this depends on the extent and type of the injury, physical demands of the sport, motivation levels and age of the athlete (Zhang et al., 2025). In conditions such as spondylolysis, return to sport is usually introduced in a phased manner, with gradual reintroduction of extension and rotation movements, and it is reported that 92% of athletes returned to sport with little or no pain within six months of non-surgical treatment (Selhorst et al., 2020). In lumbar disc herniation, improvement during conservative treatment is reported over 6-12 weeks, although this does not establish a fixed RTS interval (Patel & Kinsella, 2017). Greater caution is required when radicular symptoms or neurological findings are present. In athletes with non-specific LBP, return to sport may often be achieved earlier than in athletes

with structural causes such as spondylolysis or lumbar disc herniation; however this finding should be interpreted cautiously because of the small sample size (Selhorst et al., 2021). For spondylolysis, the rehabilitation process should start with an isolated training phase of the local musculature, most closely related to the underlying problem, followed by a period of integrated training of the entire musculoskeletal system with an increase in dynamic- and balance-based activities. The final phase before RTS should include sport-specific movements that should be assessed for impaired movement or compensations throughout the kinetic chain. Before progressing to the next phase, athletes should fulfill predefined clinical and functional criteria (Selhorst et al., 2020).

As the athlete has been at a reduced level of activity, their aerobic capacity, endurance, and sport-specific muscle strength may have decreased. General training principles support developing foundational strength and work capacity before progressing to more sport-specific training (Stone et al., 2022). This evidence comes from a narrative review of athletic training, and its application to adolescent LBP rehabilitation is indirect. Practical assessment before full RTS may include lumbar range of motion, trunk strength, movement quality during sport-specific tasks and tolerance of training demands. In non-specific LBP, pain-free lumbar movement and sport-specific activity without symptom aggravation may guide progression towards full participation (Patel & Kinsella, 2017).

In spondylolysis, assessment may include trunk endurance tasks, such as prone double leg raise or timed side plank, alongside pain-free extension, rotation and sport-specific movement (Selhorst et al., 2020). In the randomized study of adolescent athletes with active lumbar spondylolysis, RTS clearance required repeated lumbar movements to end range in all directions without pain, two weeks of pain-free RTS activity during physical therapy and a Micheli Functional Scale score of 0% (Selhorst et al., 2026).

For LDH, reassessment should additionally address radicular symptoms and lower-limb strength and sensation (Patel & Kinsella, 2017). Psychological readiness, including athletes' confidence and concerns about returning to sport, should also be considered alongside physical recovery. Evidence from university athletes suggests that these factors are relevant to the RTS process (Adekoya & Ayenigbara, 2026; Donald et al., 2024). However, this evidence is indirect for adolescent athletes with low back pain and does not establish validated psychological criteria for progressing training load. For this reason, return-to-sport decisions should be

based on a combination of symptom status, functional assessment, psychological readiness and sport-specific readiness rather than on time from injury alone. Functional progression strategies described in a small non-randomized pilot study of adolescent athletes with extension-based low back pain should be considered preliminary (Selhorst et al., 2021). Detailed rehabilitation and return-to-sport frameworks also draw on clinical commentary and expert recommendations (Selhorst et al., 2020). The ability of these proposed criteria to predict successful return to sport and symptom recurrence requires further validation.

Limitations and future directions

This review has several limitations. The main search was restricted to English-language publications from January 2016 to April 2026, which may have excluded relevant earlier and non-English-language evidence. Because of its narrative design, study selection was not based on a systematic review protocol. Also no risk-of-bias assessment was performed, which may limit the interpretation of the methodological quality of the included studies. Some studies included only symptomatic athletes assessed in clinical settings and may be affected by referral bias, limiting their generalizability. Differences in study designs, populations and outcome definitions also limit direct comparison between findings. Lastly, papers that focus solely on adolescent athletes remain scarce for some conditions regarding LBP, which required the inclusion of secondary sources and studies from a broader adolescent population and because of that not all recommendations are directly supported by research in adolescent athletes.

Future studies should include prospective, sport-specific designs in adolescent athletes to better clarify the role of each individual cause of low back pain. Further research should evaluate rehabilitation progression and return-to-sport criteria for specific conditions in adolescent athletes. This would aid the individualization process of low back pain management in adolescent athletes.

Conclusion

Low back pain in adolescent athletes is a common condition that includes both non-specific and specific causes. In most cases, conservative treatment remains the first-line approach and is based on activity modification, exercise-based rehabilitation, correction of biomechanical deficits, and gradual return to sport. Rehabilitation should be adapted to the underlying diagnosis and the demands of the athlete's sport. Proposed return-to-

sport criteria remain largely informed by clinical commentary and expert recommendations and require further validation in adolescent athletes. Future research should establish diagnosis- and sport-specific criteria and evaluate their relationship with successful return to sport and symptom recurrence.

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