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The correlation between low back pain and strength training in elite athletes: a literature review
La correlación entre el dolor lumbar y el entrenamiento de fuerza en deportistas de élite: una revisión de la literature

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Abstract. This study aims to analyze the correlation between LBP and elite athletes who practice sports where strength training intervenes via weightlifting. To analyse the correlation between low back pain and athletes who practice sports where strength training programs, a narrative review was conducted by two independent author through MEDLINE database search. Inclued study's methodology quality has been evaluated using NIH quality assessment tool for Observational Cohort and Cross-Sectional Studies. Out of 830 retrieved articles, after titles, abstracts and full text assessment, four studies met the inclusion criteria and were included in the present narrative review. The NIH total score ranged from 10 to 12 points. Demographic and sport-specific factors can influence the prevalence of LBP. Our findings highlight the importance of developing future research to provide prevention programs to reduce the incidence of LBP, taking into account the demographics of athletes and the unique nature of their sport activity.
Keywords: Low back pain, weight lifting, strength sport, strength training, rehabilitation, muscle injuries, correlation.

Resumen. Este estudio tiene como objetivo analizar la correlación entre el DL y los atletas de élite que practican deportes donde interviene el entrenamiento de fuerza a través del levantamiento de pesas. Para analizar la correlación entre el dolor lumbar y los atletas que practican deportes donde se programa entrenamiento de fuerza, dos autores independientes realizaron una revisión narrativa a través de una búsqueda en la base de datos MEDLINE. La calidad de la metodología del estudio incluido se evaluó utilizando la herramienta de evaluación de calidad de los NIH para estudios transversales y de cohortes observacionales. De los 830 artículos recuperados, después de la evaluación de los títulos, los resúmenes y el texto completo, cuatro estudios cumplieron los criterios de inclusión y se incluyeron en la presente revisión narrativa. La puntuación total del NIH osciló entre 10 y 12 puntos. Los factores demográficos y específicos del deporte pueden influir en la prevalencia del dolor lumbar. Nuestros hallazgos resaltan la importancia de desarrollar investigaciones futuras para proporcionar programas de prevención para reducir la incidencia de LBP, teniendo en cuenta la demografía de los atletas y la naturaleza única de su actividad deportiva.
Palabras clave: Lumbalgia, levantamiento de pesas, deporte de fuerza, entrenamiento de fuerza, rehabilitación, lesiones musculares, correlación.

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Introduction

Low back pain (LBP) is a growing health problem in the industrialized world, and despite economic investment in research and treatment, the prevalence of low back pain has continued to grow (Ferrari et al., 2015). LBP is a heterogeneous condition, and identifying different subgroups could help to make management decisions (O'Sullivan, 2005). Non-specific LBP, defined as LBP of unknown cause, accounts for 85-90% of cases of chronic LBP. In contrast, LBP is reported to have a known cause (attributable to specific pathologies, such as infections, tumors, osteoporosis, fractures, structural deformities, radicular syndrome, inflammatory pathology, radicular syndrome, or cauda equina) in only 10-15% of cases, with the diagnostic label of Specific LBP (Balague et al., 2012).

The probability of suffering acute LBP at some point in life is close to 70–85%, and 90% of those will suffer more than one episode. Of all the patients who suffer acute LBP, 10–15% will suffer a chronification of their symptoms (Negrini et al., 2013).

Atrophy and fatty infiltration in the lumbar multifidus and transverse abdominal muscles have been reported in patients with LBP, and how exercise therapy aimed at restoring activation and endurance of these muscles improves the health status of LBP patients (Ballestra et al., 2022; Pillastrini et al., 2015).

The lumbar multifidus and transversus abdominis are deep stabilizing spinal muscles that are the most widely assessed in this context. Studies have reported significant atrophy, asymmetry, reduced thickness, decreased cross-sectional area, and altered patterns of recruitments of the transversus abdominis and lumbar multifidus muscles in individuals with LBP (Ferreira et al., 2004; Pillastrini et al., 2015).

There are also different methods to assess low back fatigue or neuromotor capacity in patients with LBP, such as surface electromyography. However, a recently published systematic review found inconsistent findings of its validity and reliability (Campanario et al., 2022; Villafane et al., 2016; Villafane et al., 2015). The spinal erectors are essential paraspinal muscles for supporting the spine and can be assessed with tensiomyography, which uses a linear displacement sensor that evaluates skeletal muscle thickening and low-frequency lateral oscillations of active skeletal muscle fibers during twitch contractions (Moreno and

Romero Jurado, 2022; Park, 2020).

Since the trunk muscles are active in almost all activities (including sitting, standing, and turning), they should be able to work without fatigue throughout the day. Muscular endurance is recognized to be a significant factor in LBP patients, acknowledging that lack of muscular endurance may play an essential role in the development of movement disorders in LBP patients (Bozorgmehr et al., 2018).

However, although a lower prevalence of LBP is observed in active sports people (Klomklorm et al., 2020; Shariat et al., 2019), it increases in elite athletes, presenting spinal injuries that could cause abstinence from the competition and substantially affect the professional life of the athlete (Moreno and Romero Jurado, 2022; Norambuena et al., 2021). However, strength training and muscle development seem to prevent sports injuries. Even strength training can effectively reduce LBP and has been shown to reverse specific aging factors in skeletal muscle (Vázquez and Rebollo, 2022; Verdugo et al., 2020).

This study aims to analyze the correlation between LBP and elite athletes who practice strength training via weightlifting.

Methods

The literature search was conducted independently by two authors (L.B. and A.B.) on MEDLINE, for articles published before January 1, 2022, using the keywords: "low back pain", "weight lifting", "strength sport", "strength training", "rehabilitation" and "muscle injuries" combining with Boolean operators, MeSH terms and completing the searching operation with manual research by a search methodology expert. The search strategy was restricted to English-language publications and human research, including all study designs.

Population, Intervention, Control, and Outcomes

The selected studies' participants had to be male or female elite athletes who practice strength training via weightlifting, considered as the analyzed intervention. The selected outcome was the LBP incidence among strength-trained élite athletes.

Studies selection

After the independent titles and abstracts screening of the identified studies by two authors (L.B. and A.B.), full texts of the potentially relevant articles were retrieved. All disagreements between the reviewers were settled with a third author (J.H.V.) (Villafane, 2022). The manual search of relevant studies' references was applied to retrieve additional articles. Exclusion criteria based on study design were case reports, letters to the editor and secondary studies. The studies that included subjects less than 16 years of age and paralympic athletes were excluded.

Quality assessment

The quality assessment of the selected studies has been conducted using the National Institute of Health (NIH) quality assessment tool for Observational Cohort and Cross-Sectional Studies [https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools], a 14-items questionnaire developed to focus on the key concepts for evaluating the internal validity of a study.

Results

Study selection

Out of 830 retrieved articles, four studies (Fares et al., 2020; Fett et al., 2017; Schulz et al., 2016; Shimozaki et al., 2018; Siewe et al., 2011) were eligible for inclusion (Figure 1). Detailed study characteristics are reported in **Table 1**. Totally, 2,393 athletes were included in this literature review. The four included articles (Fares et al., 2020; Fett et al., 2017; Schulz et al., 2016; Siewe et al., 2011) were cross-sectional studies. Three studies were conducted in German. One study did not report the country in which it was conducted; however, based on the author's affiliations, it was presumably conducted in Lebanon. Studies were published between 2011 and 2020.

Risk of bias within and across the studies

The NIH total score ranged from 10 (Fares et al., 2020; Siewe et al., 2011) to 12 (Shimozaki et al., 2018) points. Item#3 (rate of participation almost of 50%) was not met in two study (Fett et al., 2017; Schulz et al., 2016). Two studies (Fares et al., 2020; Siewe et al., 2011) did not satisfy item#10 (assessment of the exposure). All other items were met in all studies.

Studies description

1) In the cross-sectional study, Fett et al. (Fett et al., 2017) assessed the prevalence of back pain in athletes competing at national or international level in various sports using three online questionnaires (i.e., Nordic Questionnaire for prevalence of occupational symptoms, grading of chronic pain intensity, and questions on symptoms related to sport activity) sent to approximately 4,000 elite athletes of the German Olympic Sports Confederation. The questionnaires were also sent to 253 physically active non-elite sports students. The authors received responses from 1,114 elite athletes and 166 non-elite physically active controls. Elite athletes with high training volume reported a lifetime, 12-month, and 3-month prevalence of LBP equal to 77.0%, 65.0% and 50%, respectively. Control subjects reported the following LBP prevalence: lifetime prevalence: 71%, 12-month prevalence: 59%, and 3-month prevalence: 46%. Notably, only lifetime prevalence was significantly higher ($p=0.045$) compared to 166 physically active sports students. The study had a NIH quality score of 11/14. (Table 1).

Table 1.
Results of the methodological quality

Author, yrs	Aim of the study	Study design	Participants	Methods and Outcome measures	Reported results	NIH quality score
Fett et al 2017	To establish the prevalence of back pain in German elite athletes; to examine the influence of age, sex, sports discipline and training volume; and to compare elite athletes with a physically active control group.	Cross sectional study	N athletes = 1,114 elite athletes (46.5% male and 53.1% female) N control = 166 physically active sports students (74.7% male and 24.1% female)	A 3-parts standardized and validated online back pain questionnaire 1. Nordic Questionnaire for prevalence of occupational symptoms 2. Grading of chronic pain intensity 3. Questions on symptoms related to sport activity	In elite athletes: - Lifetime prevalence for low back pain = 77.0%, - 12-month prevalence for low back pain = 65.0%, the - 3-month prevalence for low back pain= 65.0%	13
Saskia Sarah Schulz et al 2016	To evaluates the prevalence, localization, treatment, and influencing factors of back pain in Germany's elite athletes.	Cross sectional study	N = 929 athletes (505 female and 424 male)	Self-developed survey with 59 questions on: - Demographic data - Athlete's sports, training and competitions - Location, intensity, influencing factors and treatment of back pain.	A high prevalence of back pain exists (55.3%) mainly found in the lumbar spine (56.1%), independent of sex, age, and BMI. Even though the 252 athletes in G1 (VAS=1–4/10) did more back-strengthening athletic training, they reported lower back pain intensities than the athletes in G2 (VAS≥5/10). A high intensity of back pain led significantly to a reduction in the athletes' power to perform TLCS. An extra burden of education or job in addition to athletic training did not aggravate back pain. Physical medicine and rehabilitation treatments were the most efficient therapies to reduce BP. Athletes with back pain: 58.8% Average intensity of worst back pain: 6.7/10 Localization of worst back pain: Lumbar Percentage of athletes with extra stress: 82.4%	13
Siewe J. et al 2011	To identify pain encountered during routine training, assign it to particular exercises and assess the data regarding injuries as well as the influence of intrinsic and extrinsic factors.	Cross sectional study	N = 245 competitive and elite powerlifters (219 male, 26 female) in activity.	Self-developed questionnaire. - General questions such as gender, age, weight, number of competitive wins, competitive level of success, the subjects' maximum load for each of the 3 powerlifting disciplines. - Workout-related data In addition, the athletes were requested to localize pain symptoms during workouts and relate them to particular exercises	Injuries of the lumbar spine were mentioned by 108 (40.8%) athletes. The most frequent diagnoses were sciatica and myogelosis. The following parameters yielded no significant difference in injury rates: gender, open / master class, medical support, exercise weight, duration of work out (< 120 / > 120 min), competition level, routine endurance training, warm-up	11
Mohamad Y. Fares et al 2020	To explore the nature and cause of LBP in weightlifting adolescents and young adults in an aim of extrapolating proper preventive measures	Cross sectional study	N = 93 patients (87 men and 6 women) Inclusion criteria: Nonspecific LBP, all of which partook in weightlifting and fitness exercises.	- Pain rating and localization - Neurological assessment (motor and sensory deficits) - Back positioning during observation of weightlifting techniques along with other exercise habits.	Localized pain was found in 43 patients (46%). Pain radiating to the left side was found in 31 patients (33%), while pain radiating to the right was found in 19 patients (21%). LBP localized at the level of L4-L5 was found in 44 cases (47%), while that localized at L5-S1 was found in 43 cases (46%). Only six cases localized pain at the level of L3-L4 (7%). A total of 23 cases required surgery (25%), while others were managed conservatively. All the participants (100%) reported their pain to be initiated during or after weightlifting maneuvers.	11

Abbreviations: LBP = low back pain; N = number; MRI = magnetic resonance imaging; BMI = body mass index, NIH = National Institute of Health

2) In the cross-sectional study, Schulz et al. (Schulz et al., 2016) studied the prevalence, localization, treatment, and factors influencing back pain in elite athletes. The authors sent to 3564 elite athletes of Germany a self-developed survey containing questions about the athlete's demographic information, athlete sports, training, and competitions, data and the location, intensity, influencing factors, and back pain treatment. Nine hundred and twenty-nine athletes with high training voume from 36 different sports responded to the survey. Regarding back pain, n=514 (55.3 %) subjects answered that they experienced pain up to 12 months earlier. Although not all the participants (4.9%) responded to the question concerning how frequently back pain occurs, the authors reported 489 out of 514 athletes (95.1%) answers. 13.1 % (n = 64) stated that the back pain happened just once, 20.3 % (n = 99) reported that back pain persisted for several days, 29.8 % (n = 146) answered that pain recurred based on the same

movements, seventeen percent (n = 85) that it persisted for several weeks, and nineteen percent (n = 95) that it was constant, 17.4 % (n = 85) experienced back pain for several weeks, and 19.4 % (n = 95) stated the back pain was constant. Overall, responders noted that the worst pain mainly occurred in the lumbar region (56.1%). The risk of back pain (55.3%) was independent of demographic factors (such as sex, age, and BMI), education, job). The study reported a quality score of 11/14 NIH scale, (Table 1).

3) In the cross-sectional and retrospective epidemiological study, Siewe et al. (Siewe et al., 2011) investigated the pain reported by competitive and elite powerlifters during their routine training and studied the factor influencing the injuries. The authors distributed to 245 competitive and elite powerlifters a questionnaire to evaluate demograpich and factual player data (i.e., sex, age, weight, number of competitive wins, competitive level of success, the subjects' maximum load for each of the three powerlifting disciplines), workout-related data (i.e., warm-up programs, use of supporting devices, routine endurance training, maximum weights during workouts and workout duration, medical support during workouts and competitions), the frequency and localization of previous injuries and / or disorders of the musculoskeletal system, general disorders, and parameters regarding lifestyle, nutrition, and medical therapy. Their results reported that n=108 (40.8%) athletes suffered injuries in their lumbar spine. The most frequent diagnoses were sciatica and myogenesis. No demographic and workout-related data influenced the injury rates. Additionally, lumbar spine pain was reported by athletes wearing supporting gear (such as belts, supportive shirts, and suits) substantially more frequently (p = 0.035) than individuals who did not. The study reported a quality score on the NIH of 10/14 (Table 1).

4) In the cross-sectional study, Fares et al. (Fares et al., 2020) studied the LBP characteristics in 93 weightlifting adolescents and young adults (mean age: 21 years old; ranging from 16 to 26 years old) through rating and localization of pain and neurological assessment. In addition, psychological and social symptoms were investigated by interviewing the patients and/or their parents. Forty-three (46%) athletes reported localized pain. A third (N=31) athletes reported pain radiating to the left side, while 19 (21%) athletes reported pain radiating to the right side. LBP was mainly localized at the L4-L5 segment. i.e., 44 cases (47%) while 43 participants (46%) referred pain at L5-S1. Only six cases (7%) reported pain at the level of L3-L4. According to the NIH, the study's quality score was 10/14.

Discussion

LBP has a high prevalence both in the general population and in athletes and is the most frequent physical complaint in these populations (Bergstrom et al., 2004; Eriksson et al., 1996; Hoy et al., 2012; Schulz et al., 2016; Walker, 2000). This study investigated the occurrence of LBP in elite athletes who engage in sports with strength training. Four studies were included in this review. This review shows a prevalence of LBP in athletes between 40.8% (Siewe et al., 2011) and 77%. Furthermore, a higher prevalence among these athletes was found compared to physically active subjects (Fett et al., 2017). Notably, demographic and training-related factors seem to influence the risk of encountering injuries to the lumbar spine, even if there no consenus among the studies.

LBP prevalence varies widely in the included studies. About half of the athletes reported an episode of LBP. The present study indicates that LBP is a common musculoskeletal disorder in this category of athletes. The prevalence reported previously in the literature on athletes varies widely due to the sports discipline and study design. Methodologically, among factors influencing the reported prevalence, the most significant are; frequency, duration, intensity, and severity of LBP. However, our results are comparable with results from other sports disciplines. For example, Ng et al. (Ng et al., 2014) observed a point prevalence of 64% in male rowers. However, various methodologies to identify the prevalence have been used in these studies (Trompeter et al., 2017). Thus, comparing athletes from different disciplines or within the same field remains challenging. Scientifically sound and internationally accepted outcome measures and tools should be adopted to allow for a better comparison of results.

Demographic and training-related factors seem to influence the prevalence of LBP in this population. Older athletes showed a higher prevalence than younger athletes, and females reported a higher prevalence than males (Fett et al., 2017). Furthermore, differences were found in the prevalence between athletes and mathched controls (Fett et al., 2017; Schulz et al., 2016). Moreover, the amount of training (i.e., weekly training hours) appears to influence the risk of developing LBP (Fett et al., 2017). On the other hand, Siewe et al. (Siewe et al., 2011) reported no significant differences in the injury rates of 106 powerlifters in the following variables: gender, open / master class, medical support, exercise weight, duration of workout (<120 /> 120 min), competition level, routine endurance training, warm-up Even though the authors reported that Squat and Deadlift activities both aggravate back pain. Finally, Shultz et al. (Schulz et al., 2016) reported that a high load of athletic training does not lead to a significantly higher intensity of back pain.

Siewe et al., (Siewe et al., 2011) found that the two most common injuries leading to LBP in competitive weight lifting were muscle strains and intervertebral disc bulge or herniation; furthermore, Fares et al., (Fares et al., 2020) found that 54% of athletes reported radiating LBP radiating pain. Kinesologically, during the sport of weightlifting, the sporting gesture, especially if not correctly performed, can cause a considerable load on the spine, and when it is excessive, it could lead to significant

muscle strains and intervertebral disc bulge or herniation.

Athletes with a pain intensity between 0-4 out of 10 points measured on a Visual Analogue Scale (VAS) spent slightly more time with athletic back strengthening training than athletes with a VAS pain intensity between 5-10 points out of 10 (Schulz et al., 2016); The literature suggests that athletic training would not be able to avoid an episode of LBP, but the episode of LBP could be of lower intensity. According to this point of view, a prevention program would probably be suitable for these individuals. Therefore, future studies should investigate LBP preventive strategies for individuals engaged in weightlifting as strength training, taking into account the sport-specific features in the preventive programme.

Limits

This narrative review presents some limitations, regarding the restricted number of included studies and their inhomogenety in presented LBP data, which reduce the strengths of the results. The analysed population shows a moderate inbalance of gender towards male rappresentations, reducing the impact of the presented results on female elite athletes. Moreover, one of the included studies slightly deviate from other ones' aim, dedicating a consistent part of the results on injury rates and risk factors, without deeply analyzing their correlation with LBP insurgence.

Conclusion

LBP is a common musculoskeletal disorder in this type of athlete, as shown by the high prevalence obtained in this review. Demographic and sport-specific factors can influence the prevalence of LBP. Our findings highlight the importance of developing future research to provide prevention programs to reduce the incidence of LBP, taking into account the demographics of athletes and the unique nature of their sport activity.

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