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A Study of The Relationship Between Weakness in The Trunk Stabilising Muscles and Back Injuries Lumbar Injuries Among Boxers in Baghdad Clubs

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ABSTRACT

The aim of the study was to investigate the relationship between trunk muscle strength and lower back pain among boxers in Baghdad clubs, by measuring trunk muscle strength, assessing the level of lower back pain in the study sample, and identifying the nature of the correlation between the two variables. The researcher employed a descriptive approach using correlational methods, as this was appropriate to the nature and objectives of the study. The study population consisted of boxers officially registered with clubs in Baghdad and affiliated with the Iraqi Boxing Federation. The research sample was selected using a purposive sampling method and comprised eight boxers aged between 18 and 35 with at least two years' training experience. The researcher used a series of physical tests to measure trunk muscle efficiency, namely: the forward trunk stability test, the lateral trunk stability test and the Bering-Sørensen test, as well as the Visual Analogue Scale (VAS) and a specific questionnaire to record low back pain. After collecting and statistically analysing the data using the arithmetic mean, standard deviation, percentage and Pearson's correlation coefficient, the results showed that 87.5% of the sample had reduced trunk muscle efficiency compared to the levels recommended for athletes. It was also observed that 87.5% of the boxers suffered from lower back pain to varying degrees. The results demonstrated a strong, statistically significant inverse correlation between trunk muscle efficiency and lower back pain, with correlation coefficients ranging from (-0.74) to (-0.85); the Bearing-Sørensen test was the one most strongly associated with lower back pain. The researcher concluded that reduced trunk muscle function is associated with higher levels of lower back pain in boxers, and that weakness in the erector spinae and lateral trunk muscles may be an important factor associated with the onset of this pain. The researcher recommends the inclusion of core muscle strengthening and stability exercises in boxers' training programmes, the adoption of core muscle function tests as a means of periodic assessment, as well as the provision of medical supervision and rehabilitation in boxing clubs to reduce lower back pain and improve sporting performance.

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Keywords: Trunk muscle function; Low back pain; Boxers; Baghdad clubs; Muscle stability; Bering-Sørensen test; Visual analogue scale.

ABSTRAK

Tujuan dari penelitian ini adalah untuk menyelidiki hubungan antara kekuatan otot batang dan nyeri punggung bawah di antara petinju di klub Baghdad, dengan mengukur kekuatan otot batang bawah, menilai tingkat nyeri punggung bawah dalam sampel penelitian, dan mengidentifikasi sifat korelasi antara kedua variabel tersebut. Peneliti menggunakan pendekatan deskriptif menggunakan metode korelasional, karena ini sesuai dengan sifat dan tujuan penelitian. Populasi penelitian terdiri dari petinju yang secara resmi terdaftar di klub di Baghdad dan berafiliasi dengan Federasi Tinju Irak. Sampel penelitian dipilih menggunakan metode purposive sampling dan terdiri dari delapan petinju berusia antara 18 dan 35 tahun dengan pengalaman pelatihan minimal dua tahun. Peneliti menggunakan serangkaian tes fisik untuk mengukur efisiensi otot batang tubuh, yaitu: uji stabilitas batang depan, uji stabilitas batang lateral dan tes Bering-Sørensen, serta Visual Analogue Scale (VAS) dan kuesioner khusus untuk mencatat nyeri punggung bawah. Setelah mengumpulkan dan menganalisis data secara statistik menggunakan rata-rata aritmatika, standar deviasi, persentase dan koefisien korelasi Pearson, hasilnya menunjukkan bahwa 87,5% sampel telah mengurangi efisiensi otot batang dibandingkan dengan tingkat yang direkomendasikan untuk atlet. Juga diamati bahwa 87,5% petinju menderita nyeri punggung bawah pada tingkat yang berbeda-beda. Hasilnya menunjukkan korelasi terbalik yang kuat dan signifikan secara statistik antara efisiensi otot batang dan nyeri punggung bawah, dengan koefisien korelasi mulai dari (-0,74) hingga (-0,85); tes Bearing-Sørensen adalah yang paling kuat terkait dengan nyeri punggung bawah. Peneliti menyimpulkan bahwa berkurangnya fungsi otot batang dikaitkan dengan tingkat nyeri punggung bawah yang lebih tinggi pada petinju, dan bahwa kelemahan pada otot tulang belakang erektor dan batang lateral mungkin merupakan faktor penting yang terkait dengan timbulnya rasa sakit ini. Peneliti merekomendasikan dimasukkannya latihan penguatan dan stabilitas otot inti dalam program pelatihan petinju, adopsi tes fungsi otot inti sebagai sarana penilaian berkala, serta penyediaan pengawasan medis dan rehabilitasi di klub tinju untuk mengurangi nyeri punggung bawah dan meningkatkan kinerja olahraga.

Kata Kunci: Fungsi otot batang, Nyeri punggung bawah, Petinju, Klub Baghdad, Stabilitas otot, Tes Bering-Sørensen, Skala analog visual.

INTRODUCTION

Boxing is a major competitive sport that demands a high level of physical and technical preparation, as it relies heavily on muscular strength, speed, agility, balance and motor coordination. Boxing has seen significant developments in training methods and physical preparation, thus becoming a focus of attention for researchers and specialists in the fields of sports training, sports medicine and biomechanics, particularly with regard to the study of sports injuries and their causal factors (Bliven and Anderson, 2013).

Boxing is characterised by a specific nature of movement, as boxers perform rapid, repetitive movements that include punches, rotations, bends, stretches and

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changes of direction, as well as defensive and offensive movements that require a high degree of physical stability. These movements place significant mechanical loads on the musculoskeletal system, particularly in the lumbar region, due to the important role played by the trunk muscles in maintaining balance and transferring force from the lower to the upper limbs during punches (Brown et al., 2020).

The trunk muscles are among the main factors responsible for stabilising the spine and maintaining correct body posture during sporting activities. These muscles include the transverse abdominis, the multifidus, the pelvic floor muscles, the diaphragm, and the internal and external obliques. These muscles contribute to the functional stability of the lumbar region and regulate the transfer of force between different parts of the body; therefore, their efficiency is a key factor in improving performance and reducing the risk of injury (Abreu-Sosa, 2023; Bliven and Anderson, 2013).

Given the nature of boxing, poor function of the trunk muscles can lead to compromised motor control and muscular stability, thereby increasing the strain placed on the lumbar vertebrae and surrounding tissues. This can manifest as lower back pain in boxers, particularly with the repetition of rotational movements, sudden bends and continuous physical load during training and competition (Stuber et al., 2014).

Studies indicate that core stability exercises help to improve motor control, increase the efficiency of the deep muscles surrounding the spine, and reduce the intensity of lower back pain, particularly in athletes subjected to repetitive training loads (Smrcina et al., 2022). Furthermore, poor trunk stability can be considered a factor associated with an increased risk of sports injuries, due to poor control of trunk and pelvic movement during physical performance (De Blaiser et al., 2018).

The significance of this study lies in examining the relationship between trunk muscle efficiency and low back pain among boxers in Baghdad clubs, as this topic has not received sufficient attention in local studies, despite its relevance in the fields of training and rehabilitation. The results of this study may assist coaches and specialists in sports medicine and physical rehabilitation in designing training and prevention programmes aimed at developing core muscle strength, improving postural stability and reducing lower back pain, which will have a positive impact on the sporting performance of boxers.

Research problem

Boxing is a sport that demands a high level of physical exertion and repetitive movements; during training and competition, boxers perform punches, turns, bends, stretches and changes of direction, as well as rapid defensive and offensive movements. These demands place mechanical and functional stress on the musculoskeletal system, particularly the lower back, as the core muscles play a vital role in stabilising the spine, maintaining balance and transferring force between the upper and lower limbs during activity.

The performance of the core muscles is a key factor in achieving postural stability and adequate muscle control when executing boxing techniques, as poor performance of these muscles can lead to a reduced ability to stabilise the lumbar spine and increased pressure on the lumbar vertebrae and surrounding tissues, which can contribute to the development of lower back pain in boxers.

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Through field observations at boxing clubs in Baghdad, the researcher noted frequent complaints of lower back pain among several boxers, accompanied by signs of weakness or reduced efficiency in the trunk muscles responsible for stability and motor control. Consequently, the research question arose with the aim of identifying the nature of the relationship between trunk muscle efficiency and lower back pain in boxers. Consequently, this study aims to answer the following question:

Is there a statistically significant relationship between trunk muscle efficiency and low back pain in boxers at clubs in Baghdad?

Research objectives

The objective of this study is as follows:

1. To determine the level of trunk muscle strength among boxers in Baghdad clubs.
2. To determine the level of lower back pain among boxers in the study sample.
3. To identify the nature of the relationship between trunk muscle strength and lower back pain in boxers from Baghdad clubs.

Research Hypotheses

Based on the research objectives and the nature of the problem, the researcher proposes the following hypotheses: There is a statistically significant inverse correlation between trunk muscle strength and low back pain among boxers in Baghdad clubs; that is, the greater the trunk muscle strength, the lower the level of low back pain.

Scope of the research

Human scope: Boxers registered at sports clubs in Baghdad, a total of (8) boxers, aged between (18 and 35), with at least two years' training experience.

Spatial scope: Boxing training halls in Baghdad sports clubs and the Measurement and Evaluation Laboratory of the Faculty of Physical Education and Sports Sciences at the University of Baghdad.

Time frame: The period from January to the end of March of the 2024-2025 academic year.

METHOD

Research methodology

The researcher adopted a descriptive approach using a correlational method, as this was suited to the nature of the research and its objectives, which sought to uncover the relationship between two main variables: trunk muscle strength and lower back pain among boxers in Baghdad clubs.

The descriptive correlational approach is considered one of the most suitable methods for studying the relationships between variables as they exist in reality, as it helps the researcher to accurately describe the phenomenon under study and to measure the degree of correlation between its variables without directly interfering with their nature or circumstances (Mohammed, 2019, p. 87).

Research population and sample

Research population

The research population consisted of all boxers officially registered with sports clubs in the province of Baghdad and affiliated with the Iraqi Boxing Federation, amounting to a total of 32 boxers spread across various sports clubs in the capital, Baghdad, for the 2024-2025 sporting season.

Research sample

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The researcher selected the study sample using a purposive sampling method, comprising eight boxers from among those registered with sports clubs in Baghdad.

The researcher took the following criteria into account when selecting the sample members:

1. The boxer must be officially registered with one of the sports clubs in Baghdad.
2. The boxer's training experience in boxing must range from (2 to 10) years.
3. The boxer's age must be between 18 and 35 years.
4. The boxer must not suffer from chronic diseases of the musculoskeletal or nervous systems.
5. The boxer must train regularly during the study period.
6. Boxers suffering from acute injuries at the time of the test were excluded.
7. Boxers who had previously undergone spinal surgery were excluded.

This sentence can be added at the end of the paragraph:

The study sample therefore represented 25% of the total study population, which constitutes an adequate proportion for a descriptive correlational study.

Table 1. General characteristics of the study sample.

Player	Age (years)	Height (cm)	Weight (kg)	Years of experience
Player 1	22	172	77	4
Player 2	25	168	85	6
Player 3	28	175	94	8
Player 4	21	170	73	3
Player 5	30	178	102	10
Player 6	24	165	80	5
Player 7	27	173	91	7
Player 8	23	169	78	4
Average	25	171.25	85	5.87

Research variables

The research variables were identified as two main variables, namely:

Firstly: Trunk muscle efficiency

This refers to the ability of the trunk muscles to achieve stability, motor control and maintain spinal stability during physical performance in boxers. This variable was measured using a series of specific field tests to assess trunk muscle efficiency.

Second: Lower back pain

This refers to the level of pain or discomfort felt by the boxer in the lumbar region of the spine and was determined using a pain scale or a specific questionnaire to measure the intensity and frequency of lower back pain among the research sample.

Third: Concomitant variables

The researcher took into account a series of concomitant variables that may influence the nature of the relationship between the two research variables, including:

1. The age of the boxers.
2. Years of training experience.

3. Body mass index (BMI).
4. Weekly training volume.
5. Consistency in training during the study period.

Data collection tools and methods

Equipment and tools used

The researcher used various instruments and tools to collect the data required for the study.

Table 2. Equipment and tools used

Tool	Purpose
Standard medical scales	To measure body weight in kilograms
Height measuring device	To measure height in centimetres
Digital stopwatch	Measures test time in seconds
Standard sports mat	Performing the plank test
Visual analogue scale (VAS)	Assessment of pain intensity in patients
Injury record form	Documentation of the type, location and severity of the injury
Camera	Documentation of the tests performed

Physical tests used

The researcher adopted a set of field physical tests to measure trunk muscle strength in the study sample. These tests were selected for their suitability to the nature of the research and their applicability to boxers in sports halls, as well as for their use in measuring trunk muscle strength and its relationship to functional stability of the lumbar region (Bliven and Anderson, 2013; Stuber et al., 2014).

1. Front plank test

This test aims to measure the strength of the anterior trunk muscles, particularly the rectus abdominis and the transverse abdominis. The participant performs the test from a prone position, with the body supported on the forearms and the tips of the feet, whilst maintaining a straight line from head to toe. The time, in seconds, is recorded from the moment the correct the longer the hold, the greater the efficiency of the anterior core muscles (Bliven and Anderson, 2013).

2. Side Plank Test

This test is used to measure the strength of the lateral core muscles, particularly the internal and external oblique abdominal muscles. The test subject performs the test from a side-lying position, with the body supported on the forearm and the outside of the foot, whilst the pelvis is raised and the body is kept straight. The time is measured in seconds for each side of the body, and the average of both sides is then calculated. A longer duration indicates greater performance of the lateral trunk muscles and their ability to maintain stability during movement (McGill, Childs and Liebenson, 1999).

3. Biering-Sørensen test

This test aims to measure the strength of the back extensor muscles, particularly the erector spinae and multifidus muscles. The subject performs the test from a prone position on the test table, with the lower body immobilised, whilst the upper body is positioned horizontally over the edge of the table. The subject is asked to maintain a horizontal trunk position for as long as possible, and the time in seconds is recorded until the trunk sags or the subject is unable to maintain the correct position. This test is one

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of the best known for measuring the strength of the back muscles and their relationship to the lumbar region (Biering-Sørensen, 1984; McGill et al., 1999).

Pilot study

A pilot study conducted from 1 to 7 January 2026 examined three athletes who were not included in the main study sample. The aim of the pilot study was to assess the suitability of the measurement tools, ensure the clarity of the test instructions, monitor the real and testing conditions (lighting, ventilation and temperature), train assistants in the proper preparation and conduct of the tests, and confirm the time required to complete them. The pilot project also highlighted difficulties in field implementation. Based on the test results, several adjustments were made, including allowing a 10-minute warm-up period, a 5-minute rest period between tests, standardising the test instructions, and ensuring that the exercise mat used during the tests was of an appropriate thickness.

Main experiment

Following a standardised strategy, the main experiment was carried out from 15 January to 15 February 2026. First, data were obtained following approval from the sports clubs' management, and then written permission was obtained from the athletes to participate. An initial medical examination was then carried out to ensure that the athletes had no acute injuries, and each participant completed an information form detailing their injury history. All physical tests were conducted in the morning, from 9:00 to 12:00, to maintain environmental consistency. Before the tests, each athlete performed a 10-minute warm-up. The tests consisted of the front plank test, the side plank test and the Biering-Sørensen test (with a 5-minute rest between tests). All test results were recorded and the relevant steps were videoed. Each athlete completed an injury history form and the information was cross-checked against all medical records available at the sports clubs. Following the tests, the data were compiled into statistical tables and entered into a computer for statistical analysis. The scientific supervisor then reviewed the results to verify their accuracy and validity.

Injury recording form

The researcher used a special form for recording injuries, which included the following sections:

Table 3. Special form for recording injuries

Subject	Details
Type of injury	Muscle strain, tendinitis, slipped disc, stress fracture
Location of injury	Lumbar vertebrae (L1-L5), surrounding muscles, intervertebral discs
Severity	Mild (1-3), moderate (4-6), severe (7-10) according to the VAS scale
Frequency of injury	Number of injuries during the current sporting season
Mechanism of injury	During the lift, during the descent, during the warm-up, during the competition
Duration of absence	Number of days the player stopped training due to the injury

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Statistical methods

Statistical methods (abridged version)

The research data were analysed using the SPSS (Statistical Package for the Social Sciences) software, version 25. Both descriptive and inferential statistical methods were applied. Descriptive statistics included the arithmetic mean, standard deviation and percentage to describe the level of performance in the physical tests and the distribution of injuries among the participants (Allawi and Ratib, Scientific Research in Physical Education, p. 234). Inferential statistics included Pearson's correlation coefficient to examine the relationship between trunk stabilising muscle strength and lumbar injuries, and the t-test for independent samples to compare trunk muscle strength between injured and uninjured athletes. The level of statistical significance was set at (0.05)(Allawi and Ratib, p. 267).

RESEARCH RESULTS

Presentation of the results of the trunk muscle strength tests

Table 4. Results of the forward bend test for individuals in the sample (in seconds)

Player	Result (seconds)	Level
Player	95	Weak
Player 2	110	Normal
Player 3	88	Poor
Player 4	125	Good
Player 5	78	Very poor
Player 6	115	Average
Player 7	92	Weak
Player 8	105	Normal
Normal	101	Average - Poor
Standard deviation	15.00	

Analysis of Table 4: The results show that the mean score for the front plank test was 101 seconds with a standard deviation of 15.2, which is below the acceptable standard for athletes trained in e, i.e. 120 seconds. Five of the eight athletes performed poorly or very poorly, indicating insufficient strength in the anterior trunk muscles (Al-Obaidi, 2016, p. 170).

Table 5. Results of the side plank test for the sample (in seconds)

Player	Right side	Left side	Average	Level
Player 1	72	68	70	Weak
Player 2	85	82	83.5	Normal
Player 3	65	60	62.5	Very weak
Player 4	98	95	96.5	Good
Player 5	58	55	56.5	Very poor
Player 6	88	85	86.5	Average
Player 7	70	67	68.5	Poor

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Player 8	80	78	79	Average
Average	77	73.75	75.37	Poor
Standard deviation	13.1	13.5	13.2	

Analysis of Table 5: Table 5 shows that the mean result of the side plank test for the individuals in the sample was (75.37) seconds, which is below the acceptable standard of (90) seconds for each side. An imbalance between the right and left sides is also observed in all players, indicating an imbalance in the trunk musculature that may predispose them to injury (Al-Rawi, Sports Medicine and Spinal Injuries, p. 218).

Table 6. Results of the Bering-Sørensen test for the individuals in the sample (in seconds)

Player	Result (seconds)	Level
Player 1	145	Weak
Player 2	168	Normal
Player 3	132	Very weak
Player 4	195	Good
Player 5	118	Very poor
Player 6	172	Average
Player 7	140	Weak
Player 8	160	Normal
Normal	153.75	Low - Average
Standard deviation	24.8	

Analysis of Table 6: The results in Table 6 reveal that the mean results for the Bering-Sørensen test were (153.75) seconds with a standard deviation of (24.8), which is below the acceptable standard for athletes (180) seconds, indicating a weakness in the endurance of the back extensor muscles () and the multifidus muscles in the majority of the sample; these muscles play a fundamental role in stabilising the spine during the lifting of heavy weights (Biering-Sorensen, F., 'Physical measurements as risk indicators for low back trouble', Spine Journal, p. 109).

Presentation of the results of the injury questionnaire

Table 7. Distribution of lumbar injuries in the sample

Player	Type of injury	Location of injury	Pain intensity (VAS)	Recurrence of injury	Duration of absence (days)
Player 1	Muscle strain	L4-L5	6	3 times	14
Player 2	Tendinitis	L3-L4	4	Twice	7
Player 3	Herniated disc	L4-L5	8	4 times	30
Player 4	No injuries		0	0	0
Player 5	Herniated disc	L5-S1	9	5 times	45
Player 6	Muscle strain	L3-L4	3	Once	5
Player 7	Muscle strain	L4-L5	5	Twice	10
Player 8	Tendinitis	L3-L4	4	Twice	7

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Analysis of Table 7: Table 7 shows that 7 out of 8 players suffer from lower back injuries (87.5%), which is a very high percentage reflecting the seriousness of the health situation among boxers in Baghdad's clubs. The injuries ranged from muscle strains, which were the most common at 42.8%, to tendinitis at 28.6% and herniated discs at 28.6%. The injuries were concentrated in the L4-L5 and L5-S1 vertebrae, which is consistent with scientific studies indicating that these two levels are the most vulnerable to injury in boxers (Al-Rawi, Sports Medicine and Spinal Injuries, p. 222).

Table 8. Distribution of lumbar injuries by type and percentage

Type of injury	Number	Percentage
Muscle strain	3	42.8
Tendinitis	2	28.6
Herniated disc	2	28.6
No injuries	1	12.5
Total	8	100

Presentation of correlation results

Table 9. Pearson correlation coefficient values between the results of the trunk muscle tests and lumbar injuries

Test	Correlation coefficient (r)	Significance level	Statistical significance
Front planks and pain intensity	-0.82	0.01	Statistically significant
Frontal plane and recurrence of the lesion	-0.79	0.01	Statistically significant
Lateral plane and pain intensity	-0.76	0.05	Statistically significant
Lateral views and recurrence of the injury	-0.74	0.05	Statistically significant
Bering-Sorensen and pain intensity	-0.85	0.01	Statistically significant
Bering Sorensen and recurrence of the injury	-0.81	0.01	Statistically significant

Analysis of Table 9: The results in Table 9 reveal a strong and statistically significant inverse correlation between all tests of the trunk stabiliser muscles and lumbar injuries in the sample, with correlation coefficients ranging from (-0.74) to (-0.85), indicating a strong inverse relationship, that is, the lower the strength of the trunk stabiliser muscles, the greater the severity and frequency of injuries. The strongest relationship was observed between the Bering-Sørensen test and pain severity, with a correlation coefficient of (-0.85), indicating the fundamental role of the back extensor muscles in the prevention of lumbar injuries in boxers (Hassan, Prevention of Sports Injuries, p. 89).

Table 10. Results of the t-test comparing injured and uninjured individuals in terms of trunk muscle strength

Test	Mean for injured individuals	Mean for uninjured individuals	t-value	Significance level	Significance
Frontal lobe	94.7 seconds	125 seconds	3.82	0.05	Function
Lateral Planck	71.8 seconds	96.5 seconds	3.45	0.05	Function
Perry Sornsen	147.8 seconds	195 seconds	4.12	0.01	Function

Analysis of Table 10: Table 10 shows statistically significant differences between injured and uninjured players in all tests of the trunk stabiliser muscles, with uninjured players recording significantly higher means in all tests compared to their injured counterparts. This confirms that the level of trunk muscle strength is an important protective factor against lumbar injuries in boxers (Al-Samarai, Modern Sports Training, p. 195).

DISCUSSION

Discussion of the results of the trunk muscle fitness tests

The results of the trunk muscle fitness tests showed that most boxers from Baghdad clubs exhibit a clear reduction in trunk muscle strength, as their average performance in the tests used fell below the levels recommended for athletes. This may be attributed to a lack of focus on core muscle strengthening exercises in daily training sessions, as well as to the fact that some training programmes prioritise technical and tactical aspects at the expense of preventive physical conditioning.

The trunk muscles are considered essential for a boxer's motor performance, as they help to stabilise the spine, maintain body balance and transfer force from the lower to the upper limbs when throwing punches. Furthermore, weakness in these muscles can lead to impaired motor control, reduced performance efficiency and increased pressure on the lumbar region of the spine (Bliven and Anderson, 2013).

These findings are consistent with those of some studies suggesting that poor trunk stability may be a contributing factor to an increased risk of sports injuries, as the trunk muscles play an important role in controlling the movement of the pelvis and spine during repetitive physical activity (De Blaiser et al., 2018). Furthermore, boxing relies heavily on rapid trunk rotation and movement of the pelvis and shoulders during attack and defence, making the efficiency of the trunk muscles a key factor in protecting the lower back and improving technical performance.

Analysis of the results regarding lower back pain

The results indicated a high prevalence of lower back pain among the study sample, with 87.5% of all boxers reporting such pain. This may be due to the nature of boxing, which involves repetitive and ex e movements such as punching, twisting, bending, stretching and changes of direction, as well as rapid defensive movements that place repeated mechanical stress on the lower back.

When performed repeatedly in the presence of weak core muscles, these movements can place increased strain on the muscles and ligaments surrounding the spine, leading to the onset or worsening of lower back pain. Studies indicate that lower back pain in athletes is often associated with poor muscle control, a reduction in the

length of the muscles responsible for stabilising the spine, and a muscular imbalance between the abdominal and back muscles (Stuber et al., 2014).

Furthermore, weakness in the back extensors and lateral trunk muscles can reduce a boxer's ability to absorb the forces generated by rotation and thrust during punches, thereby increasing the risk of lower back pain, particularly when training is repeated at high intensity or without sufficient rest periods.

Discussion of the correlation results

The results showed a strong inverse correlation between trunk muscle efficiency and lower back pain in boxers from Baghdad clubs, with correlation coefficients ranging from (-0.74) to (-0.85). This means that as trunk muscle strength decreases, the level of lower back pain increases, and vice versa.

This relationship is explained by the important functional role of the trunk muscles in maintaining spinal stability, improving force distribution across the lumbar vertebrae and increasing intra-abdominal pressure, which provides additional support to the spine during movement (Bliven and Anderson, 2013). In boxing, this role is particularly important due to the heavy reliance on rotational movements and the transfer of force from the ground, through the lower limbs and the trunk, to the striking arm.

The results also showed that the Biering-Sørensen test had the strongest association with lower back pain, with a correlation coefficient of (-0.85), indicating the importance of the length of the back extensors in protecting the lumbar region. This finding is consistent with Biering-Sørensen's (1984) observation that reduced flexibility of the back muscles may be associated with a higher likelihood of experiencing lower back problems.

These findings support the importance of incorporating core stability and strengthening exercises into boxers' training programmes, as they can help reduce lower back pain and improve athletes' functional capacity a finding confirmed by several studies that have highlighted the effectiveness of core stability exercises in reducing lower back pain and improving functional performance (Smrcina et al., 2022).

Research findings

In light of the presentation, analysis and discussion of the results, the researcher reached the following conclusions:

1. The test results showed that 87.5% of boxers from Baghdad clubs had reduced trunk muscle efficiency compared to the levels recommended for athletes. It was found that 87.5% of the study sample suffered from lower back pain of varying degrees, ranging from mild to moderate and severe.
2. The results showed a strong and statistically significant inverse correlation between trunk muscle strength and lower back pain in boxers.
3. The correlation coefficients between trunk muscle strength and lower back pain ranged from (-0.74) to (-0.85), indicating a strong relationship between the two variables.
4. The Biering-Sørensen test showed the strongest correlation with lower back pain, with a correlation coefficient of (-0.85), indicating the importance of the erector spinae muscles in protecting the lumbar region.
5. Clear differences in trunk muscle strength were observed between boxers with low back pain and those without, with boxers without pain demonstrating greater strength.

6. The results showed that weakness of the trunk muscles, particularly the lateral and posterior muscles, is associated with an increase in the frequency and severity of low back pain among boxers.
7. The high prevalence of lower back pain could be related to the lack of specialised exercises to strengthen the trunk muscles in the training programmes of Baghdad boxing clubs.

CONCLUSIONS AND RECOMMENDATIONS

In light of the research objectives, hypotheses and results, the following conclusions were drawn:

1. Most boxers from Baghdad clubs show a clear decrease in trunk muscle strength, in both the anterior, lateral and posterior muscles, as their results in physical tests were below the levels recommended for athletes.
2. The prevalence of low back pain among boxers in Baghdad clubs was high, affecting 87.5% of the sample, indicating a physical and functional problem that warrants attention in training and prevention programmes.
3. There is a strong, statistically significant inverse correlation between trunk muscle strength and low back pain in boxers; that is, lower trunk muscle strength is associated with higher levels of low back pain.
4. Weakness of the back extensor muscles, as revealed by the Biering-Sørensen test, was most clearly associated with low back pain, confirming the importance of these muscles in stabilising the spine and protecting the lumbar region.
5. The nature of boxing, with its rotational, flexion, extension and change-of-direction movements, requires a high level of core muscle strength to maintain stability and reduce strain on the lower back.
6. A lack of focus on core muscle strengthening and stability exercises in training programmes may be one of the factors contributing to the high incidence of lower back pain among boxers.

In light of the researcher's findings and conclusions, the following recommendations are made:

1. Core muscle strengthening and stability exercises should be incorporated into boxers' daily training programmes, with a minimum of three training sessions per week, given their important role in preventing lower back pain.
2. The adoption of trunk muscle function tests, such as the forward stability test, the lateral stability test and the Biering-Sørensen test, as tools for periodic assessment at the start and midway through the training season.
3. Focus on developing the back extensor muscles and the lateral trunk muscles, given their important role in stabilising the lumbar region during boxing movements.
4. The need to provide medical and rehabilitation supervision in boxing clubs, through sports medicine specialists and physiotherapists, to monitor athletes' health and regularly record cases of lower back pain.
5. Train coaches and boxers on the importance of the trunk muscles in technical performance, particularly in punching, turning, defence and changes of direction.
6. Rest periods and training loads should be scientifically organised to reduce muscle tension and repetitive stress in the lumbar region.

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7. Future studies should be conducted to design preventive training programmes aimed at strengthening the trunk muscles and to measure their impact on reducing lower back pain among boxers from various Iraqi provinces.

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