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The Role of Biochemical Indicators in Predicting the Risk Severity of Lumbar Disc Herniation among Athletes

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Abstract: The study targets determining the influence of biochemical indicators in the blood on the health of athletes suffering from herniated lumbar discs. It describes the role and significance of lactic acid, potassium, and testosterone levels as indicators of health conditions in athletes and risks of injury with its prevention ways. The researcher formulated the research problem as follows: To what extent can the biochemical indicators in the blood play a predictive role in estimating the risk of lumbar disc herniation amongst athletes? Muscle fatigue is caused by the accumulation of lactic acid in the body; thus, it reduces joint stability. On the other hand, potassium maintains muscle balance and strength; and with testosterone, it promotes bone and muscle development. These indicators can serve as a valuable assessment tool for the coach both in injury prevention and improvements in performance. Through the use of the qualitative dynamic method to attain predictive values, it is suggested that the indicators of blood biochemistry can be informative about health states regarding athletes as well as their capacity to recover and react to enhanced physical stress. The model of the study makes it possible to explain mostly the variation of the joint space by the level of lactic acid and that of potassium because they reflect, and have a direct effect, on the specific biochemical indicators related to the muscles and joints.

1-1 Introduction and Significance of the Research:

In sports that require much physical effort such as weightlifting, football, basketball, and tennis, athletes often suffer spinal disc injuries. Shock absorbers and flexibility for the spine are provided by a series of vertebrae, cartilage discs separating each of them. Among the common injuries to athletes is a herniated disc, which takes place when there is a slippage or cracking of the disc from its place, exerting pressure over the nerves and causing severe pain with restriction of mobility. First in the list of the coaches' preferences is the prevention of these injuries because healthy bones and joints are the key to the athletes' good performance. The misuse of postures in daily life and even during exercises will affect the spinal alignment. The possibilities of injuries increase due to decreased motor performance and endurance.

Biochemical signs in liquid can act an important part in checking the health status of players and finding out their chance to get better and react to tough physical demands. In this idea, lactic acid works as a second sign of anaerobic metabolism, with its amount in the liquid growing during hard exercise. Its build up leads to tiredness and may lead to many injuries to the joints and bones. Also, potassium is a key mineral that controls muscle and nerve activity and helps keep fluid balance in and out of cells. Potassium is important for many body jobs and indirectly affects bone and joint wellness. It helps in normal muscle squeezing and has a role in keeping fluid balance inside cells and joints, which also helps prevent stiffness and erosion in the joints.

Testosterone is other important hormones that have an essential effect in the process of building muscle and bone tissues. It significantly is important in the improvement of physical strength and increasing bone density; therefore, it is crucial for the health of athletes. Testosterone mostly takes part in bone growth and density, which helps lessen the risks associated with osteoporosis and fractures; therefore, it is an important consideration for athletes. These elements can have direct and indirect

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impacts on bone and joint health, which is very important in injury prevention for athletes. Keeping the right levels of these markers helps prevent injuries and supports tissue recovery post high exercise. Therefore, observing these biochemical marks can be quite helpful in bettering athletic performance, keeping health for athletes of many disciplines, and improving their ability to assess the risk of lumbar disc herniation.

The study will be important as it will avail to the trainers and therapists essential information concerning the role played by biochemical indicators on bone and joint health. They will, therefore, be able to make appropriate decisions on exercises, injury prevention, and risk assessment concerning lumbar disc herniation among athletes. The information should, thus, help in optimizing the outcomes of the training process with due consideration for the safety and health of the athletes..

1.2. Research Problem:

Due to the increased prevalence of lumbar herniated discs among athletes and their high influence on sporting performance, particularly in weightlifting, there is an urgent need to develop diagnostic techniques for identifying risk factors at their onset. With the ability to explicitly detect such biochemical indicators as general precursors for the likelihood of injury amongst athletes, this will importantly provide a chance to prevent and reduce injury effects. Therefore, this study is guided by the research question: Do biochemical indicators in the blood have the potential to act as predictive tools regarding the risk that athletes face regarding lumbar herniated discs?

Addressing this question will guide preventive measures and aid in the development of training programs tailored to the identified risk levels. These biochemical indicators can assist trainers and therapists in establishing protocols for the periodic evaluation of athletes, enabling them to monitor physiological changes over time and detect any early signs of stress or health deterioration.

1.3. Research Objectives:

1. Identify key biochemical indicators and their relationship to the risk of lumbar herniated discs among athletes.
2. Develop a predictive equation for assessing the risk of lumbar herniated discs among athletes based on selected biochemical indicators.

1.4. Research Areas:

1.4.1 **Human Field:** (26) athletes with lumbar herniated discs

1.4.2 **Spatial Area:** Baghdad, Iraq

1.4.3 **Temporal Range:** April 22, 2024, to May 24, 2024

2. Research Methodology and Field Procedures:

2.1. Research Methodology

The descriptive analytical approach is employed, focusing on correlational relationships. This method aims to identify conditions and relationships and seeks to collect data from members of the population to "control and predict events, which is one of the tasks of scientific research; descriptive research achieves this" (Mahjoub, 2001, p. 295).

2.2. Research population and sample:

The research population was intentionally identified and represents (26) athletes with lumbar herniated disc who visit the Sports Medicine Hospital.

2.3. Data collection methods and devices used

2.3.1. Tools of data collection

1 .Foreign and Arab

2 .Internet Sources

3 .Face to face interviews and expert consultancy

4. Observation and analysis

2.3.2. Devices and tools used :

1. Computer
2. 2. stopwatches.
3. Hygienic paper for cleaning.
4. Antiseptic solution
5. Device type (Lactate Pro LT - 1710)
6. Magnetic Resonance Device (MRI)
7. Check Strip
8. Compressor belt attaches to the humerus area
9. Hand pipette
10. Centrifuge
11. Kits
12. Chemical solutions
13. Medical scale for measuring weight type (sartorius) German origin

4- Testing and measurement:

1. Measuring the size of the articular space:

Measurement objective: To determine the size of the articular space using an Magnetic Resonance Imaging (MRI) machine to assess the risk of lumbar herniated disc.

Procedures: After consultation from specialists, the subjects were examined on a German-made MRI scanner (3 Telsa Siemens Magnetom Erlangen) and the degree of functional structure of the lumbar vertebrae was determined in order to study the functions of this case by analyzing the images generated from the magnetic resonance machine (MRI) to detect these changes and determine the extent of their impact on the joint. And the possibility of magnetic resonance imaging from three directions (front, Lateral and vertical) The study used a protocol, which is a three-dimensional sagittal pulse DESS with a slice thickness of 0.7 mm, 16.3 ms TR, 140 mm field of view (FOV), matrix 384×307, and accuracy at level 0.37 mm ×0.46 mm Signs that can be detected with MRI include: Measurement (articular space and intervertebral space) to assess the risk of lumbar herniated disc, , as this measurement plays an important role in determining erosion in the synovial fluid within the joint. Decreasing the size of the articular space can lead to abnormal friction between the articular surfaces, increasing the risk of cartilage injuries such as a herniated disc in the lumbar region (lumbar spine).

Unit of measurement: millimeters (mm) - Used to measure the dimensions of the articular space such as the width of the space between adjacent bones. In normal lumbar spine, the distance between the lumbar vertebrae (the size between cartilage discs) is 8-12 mm. This distance ensures sufficient space

2- Measurement of lactic acid concentration in the blood (Al-Hazzaa, 1990, page 556):

Aim of the test: To determine the lactic acid concentration in the blood levels 5 minutes after the termination of the exercise

Instruments involved: Lactate Pro LT - 1710 device produced by the Japanese firm (Arakray), 2 needle drills, 2 check strips, 2 Calibration Strips, 2 test strips, medical cotton, sterile materials, 2 small hand towels, and a registration form

Performance Description: After completing one run test, lactic acid concentration in the blood post-exertion is measured, this duration is suitable for ensuring the lactic acid diffusion from muscles to blood. The researcher followed these steps Preparing the device to work by inserting the Check Strip then taking it out. And put the Test Strip and install it in the device

Registration: The reading displayed by the device after measurement for each tester is entered in the registration form. The unit of measurement is (millimol/L).

3 - Testosterone (Al-Qatt, 1999, page 36)

Objective of the test: to know the level of testosterone concentration

Measurement method: The laboratory is asked to fast for a few hours before the test.

The test is often done in the morning because testosterone levels are at their peak at this time a small blood sample is taken from a vein, from the arm.

The sample is sent to the laboratory to analyze testosterone levels

Unit of measurement: ng/dL

2- **Potassium level**: (Al-Qatt, 1999, page 27)

Objective of the test: to know the level of potassium concentration in the blood

Measurement method: A small blood sample is taken from a vein, from the arm.

The sample is sent to the laboratory for analysis of levels where the potassium level is measured using a special device to measure mineral levels in the blood Electrolyte analyzer:

Unit of measurement: mm/L

1- Main experiment measuring the size of the articular space and biochemical variables:

The size of the articular space and the biochemical variables for the period from 22-4-2024 to 24-5-2024 were measured on a sample of (26) athletes with lumbar herniated disc to determine the size of the articular space using Magnetic Resonance Imaging (MRI) device to assess the risk of lumbar herniated disc at Medical City Hospital. The biochemical variables for the period were measured by Al-Shifa Medical Laboratory for pathological analyzes by the analyst by inviting the testers to draw a sample of blood estimated at (3cc) after the tester sits in a comfortable position on the chair where blood is withdrawn from the sample from the resting position, where this blood sample was taken in tubes to preserve blood free of the anticoagulant (EDTA) to extract testosterone values and potassium level. As well as the level of lactic acid concentration in the blood after (5) minutes from the end of the effort using a device of the type (Lactate Pro LT - 1710).

2-6 Statistical treatments:

The researcher used statistical means through the statistical bag (SPSS) statistical packages for social systems and using the relevant statistical laws

Statistical laws:

1. Arithmetic mean
2. Standard deviation and standard error
3. Kolmogorov-Smirnov Test
4. Mann-Whitney U Test (Nonparametric U test for two independent groups)

5. Multiple linear regression analysis –

3- Presentation, analysis and discussion of results:

3.1 Description of articular space size measurement and Biochemical Variables in the Injured Group.

Table (1): Descriptive Statistics of articular space size and Biochemical Variables in Injured Athletes

Maximum Value	Minimum Value	Standard Deviation	**Arithmetic mean**	Unit of Measurement	Variables
9	**3**	**1.534**	**6.300**	Millimeter	Articulated space size
13	**11**	**0.741**	**12.192**	Millimoles per liter	Lactic acid concentrate
400	**300**	**25.271**	**346.2**	Nanograms per deciliter	Testosterone
3.5	**3**	**0.140**	**3.250**	Millimoles per liter	Potassium level

Table (1) presents the results of some statistics, represented by the (Arithmetic mean, standard deviation, and the minimum and maximum values).

3.2 Multiple linear regression analysis

1- **Goodness-of-Fit Test for Normality:**

Multiple regression analysis checks how well a statistical model fits available data. The main aim of this test is to confirm the suitability of the model to actual data and evaluate its capacity for predicting and interpreting relationships between independent variables and the dependent variable fairly well. In order to indicate the extent to which the normal distribution of the variables aggregated through conversion at relative calibration factors (joint space width) can be assumed as a function of the prediction model under study as well as the validity of assuming a normal distribution of the outcome of the variables that explain the outcome of the function mentioned above, represented by biochemical markers (lactic acid, testosterone, and potassium level) among injured athletes, and determine whether the statistical model of the data used and its proportionality check can be assumed, Table (2) provides the results for the goodness-of-fit test of the normality model of those variables.

Table (2) Kolmogorov-Smirnov Test for Goodness-of-Fit of the Normality Model for the Variables Integrated with the Transformation of Relative Standardized Scores

Decision	**Y**	**third X3**	**second X2**	**first X1**	**Goodness-of-Fit Index**
Accept the hypothesis	**26**	**26**	**26**	**26**	**Sample Size (N)**
	0.651	**0.914**	**0.802**	**0.594**	**Z-Statistic for the (K-S) Test**
	0.790	**0.374**	**0.541**	**0.872**	**Sig.**
	NS	**NS**	**NS**	**NS**	**C.S.(*)**

NS: Not Significant (F-value greater than 0.05)

Decision: The distribution follows a normal distribution.

It is clear through reviewing the results of Table (2), the validity of the assumption of the normal distribution of the results of the biochemical variables (lactic acid concentration, testosterone, potassium level) among injured athletes, which is confirmed by the validity of the application of point estimates to estimate the parameters of the assumed normal model of the population mean in addition to the validity of testing the hypothesis of analysis of variance for multiple linear regression and the accompanying estimates represented by the total correlation coefficient, determination coefficient, and estimation coefficients for the prediction model. The Goodness-of-Fit Test for Normality is the cornerstone for conducting all approved statistical steps and operations that fail when this quality is not achieved inevitably.

3.3 Present and analyze the results of the predictive model:

To apply the multiple linear regression model, Table (3) includes the presentation of the results of the analysis of variance for multiple linear regression that indicate whether or not there was a statistically significant difference between the various groups that were used in the multiple regression analysis. This determines whether the independent variables have a significant effect on the dependent variable to ascertain the degree of confidence merited by the estimates of the parameters of the model for purposes of prediction, evidenced by the Goodness-of-Fit Test for Normality. This test upgrades the impact of explanatory variables (e.g., size of articular space). The variability of the general hypothesis test is expressed as its value was 23.857 in comparison with the tabulated F-value and also against the level of significance 0.000. According to the presented results, the implemented model is successful in providing the required reliability and is considered practical. This achieves the significance of the common variance between the proposed model: mean height of the articular space, and the predictor parameters: biochemical parameters (lactate, testosterone, and potassium levels). Thus truthfulness grows for the forecast model b.

Table (3) Results of the Analysis of Variance (ANOVA) for Multiple Linear Regression of the Combined Variables

Analysis of Variance (ANOVA) for Multiple Linear Regression with Weighted Estimates						Significance
Sources of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F-value**	**Significance**	
Regression	**45.036**	**3**	**15.012**	**23.857**	**0.000**	**significant**
Residuals	**13.844**	**22**	**0.629**			
Explanatory variables represented by X_1, X_2, X_3						
The dependent variable represented by Y						

3.3 Estimates of some multiple linear regression analysis coefficients (Model Summary)

Following the above, Table (4) gives estimates of some multiple linear regression analysis coefficients represented by the multiple correlation coefficient between the model function variable (the size of the articular space) and the explanatory variables represented by the biochemical variables (lactic acid concentration, testosterone, potassium level), Coefficient of Determination, Adjusted Coefficient of Determination, and Standard Error of the Coefficient**.**

Table 4. Some Estimates of the Multiple Linear Regression Model with Predictors Weighted for the Variables: Total Correlation Coefficient, Coefficient of Determination, Adjusted Coefficient of Determination, and Standard Error of Estimate.

Model Summary				
R (Correlation Coeff.)	**R Square (Determination Coeff.)**	**Adjusted R Square**	**Std. Error of the Estimate**	**Durbin-Watson**
0.875	**0.765**	**0.733**	**0.793**	**2.588**
Predictors: (Constant)X1, X2, X3,				

From Table (4), it is clear the degree of relationship between the effect of the explanatory variables, which are biochemical variables (lactic acid concentration, testosterone hormone, potassium level) and the model function variable, relating to the size articular space. The total correlation coefficient is 0.875, with a determination of 0.765, which translates the percentage of variance in the dependent variable that can be explained by independent variables of the regression model for changes induced by values of the model function variable. It essentially helps us to measure the strength of the relationship between the independent variables and the dependent variable. The adjusted coefficient of determination (0.733) translates percentage changes induced by values of the model function variable, removing misfit effects from residual sources in the mentioned model. The results indicate that the model performs well in forecasting future values of the dependent variable and, therefore, can be used to test whether adding further variables into the model does indeed help improve the model's performance.

3-3 Presentation of Multiple Linear Regression Analysis Results for Building the Prediction Model

Table (5) Estimates of the Coefficients for the Multiple Linear Regression Model of the Combined Variables

Coefficients	Unstandardized Coefficients		Standardized Coefficients	t-test	Significance Level	Significance Comparisons
	Coefficients B	Random Error	Coefficients Beta			
X1	**0.688-**	**0.285**	**0.333**	**2.413**	**0.025**	**HS**
X2	**0.006**	**0.009**	**0.102**	**0.688**	**0.499**	**NS**
X3	**6.291**	**1.464**	**0.574**	**4.296**	**0.000**	**HS**
Intercept	**-7.891**	**3.055**		**2.582**	**0.021**	**HS**

Statistically significant with a p-value greater than 0.05

The results showed significant differences according to the approved significance level (0.05) for the multiple linear regression model coefficients, which indicates a clear effect of some biochemical variables, such as lactic acid level and potassium level, in explaining the outcome of the articular space size results. It is worth noting that testosterone has lower effect rates compared to lactic acid and potassium, suggesting that its role in explaining changes in the size of the articular space may be limited, or that its effect is related to other factors or variables not included in the model.

The final formula of the prediction model clearly expresses the impact of each of these variables, as follows:

$$\hat{y}_i = 7.891 - 0.688X_{1i} + 0.006X_{2i} + 6.291X_{3i}$$

Where:

X_{1i}: Represents the results of the relative calibrated aggregate values for the variable of lactic acid level.
X_{2i}: Represents the results of the relative calibrated aggregate values for the variable of testosterone hormone.
X_{3i}: Represents the results of the relative calibrated aggregate values for the variable of potassium.
$\hat{y}_i$: Represents the results of the relative calibrated aggregate values for the variable of joint space volume, which represents the relative calibrated values of the joint space volume.

3-6 Results of the Prediction Equation.

It is evidenced by the high level that has been achieved by the coefficient of determination which indicates that the study factors explain the changes in the variables lactic acid level and potassium level in the model function variable represented by the articular space size variable; the other factors (residuals) constitute only a small percentage. This model measures the actual reality achieved in the occurrence of impact levels resulting from biochemical indicators by presenting the results of correlation coefficients and it must be noted that the statistical relationships related to (lactic acid level, potassium level, and testosterone), each indicator of the indicators is complementary to the other and directly reflects the size of the articular space of the lumbar vertebrae and the researcher believes that this model indicates that lactic acid and potassium have important moral effects in the size of the articular space, as the Lactic acid shows a negative effect, because its accumulation causes muscle fatigue that plays an important role in stabilizing and protecting joints during movement. When muscles are stressed or tired, their ability to support joints diminishes.

This exposes the joints to excessive pressure, and here he asserts (Shaker Al-Shikheili 2001) that "lactic acid collects in the muscles, which hinders the work of the energy system leading to fatigue, after the end of the effort and during recovery" (Al-Shikheili, 2001, p. 47) Muscle fatigue leads to a lack of muscular coordination and the speed of nervous response, which increases the likelihood of unbalanced movements. Knowing how the accumulation of lactic acid affects muscles and joints enables trainers to adjust the intensity of the exercises to avoid excessive stress, thus reducing the likelihood of The occurrence of stress-related injuries. It agrees with a study (Mohamed Ahmed and Bakr Mohamed 1995) which indicated that "high levels of lactate resulting from prior anaerobic exertion somewhat hinder extra glyclosis and that glycogen stores are consumed to some extent and cannot be converted into lactate when performing subsequent anaerobic exertion" (Abdo and Ahmed, 2001, p. 297).

While potassium shows a positive effect. That is, the nerve stimuli in the muscle fiber are associated with an increase in the level of potassium Knowing how to improve potassium levels in the body can enhance muscle strength and reduce cases of muscle fatigue in the motor unit with the same strength and if a muscle is stimulated through the nerve, the motor unit either does not respond due to poor stimulation or responds by a fixed amount if the stimulation is sufficient, as well as any specific stimulation may be sufficient to cause a response in some motor units and this is what Leads to injury and accordingly, the greater the strength of the motivation, the higher the number of motor units responding, and here appears from the equation the importance of the variable potassium exercises and here confirms (Abu Ela Ahmed, Ahmed Nasr El-Din) that "biochemical indicators are one of the most important factors on which modern training depends to raise the level of achievement and performance, and without that can not advance the level of the athlete, " (Abdel Fattah and Nasr El-Din, 2003, p. 238).

Low testosterone may cause symptoms including fatigue and muscle weakness, and sometimes affect joint health, but it does not necessarily directly lead to joint and muscle damage. Here's how low testosterone can be related to these symptoms: testosterone has an essential role in boosting energy levels in the body, and when levels drop, a person may feel constantly tired and exhausted. Although a decrease in this hormone does not necessarily mean direct damage to joints or muscles, it can affect muscle strength and bone health indirectly. This study agrees with (Hägglund, M., et al. (2018) who noted that "people with low testosterone tend to complain of low physical activity and chronic fatigue, which reinforces the importance of maintaining healthy levels of this hormone." (Ml & al, 2018, pp. 243-274) and the results were logical.

4. Conclusions and Recommendations

4.1 Conclusions

1. The results revealed that the study model significantly explains the changes in size of articular space based on lactic acid and potassium levels, reflecting their clear and direct impact on the biochemical indicator associated with muscles and joints.
2. The high coefficient of determination indicates that most of the changes in size of articular space are attributed to the factors included in the study, while other factors constitute a small percentage, enhancing the model's accuracy in reflecting actual reality.

3. The potassium indicator contributed the highest percentage to the size of articular space and the risk level of lumbar disc herniation among athletes.
4. Lactic acid appears to play a negative role, as its accumulation leads to muscle fatigue. Previous studies have also pointed to its inhibitory effect on energy production.
5. The lactic acid indicator contributed the second-highest percentage to the size of articular space and the risk level of lumbar disc herniation among athletes.
6. The decrease in testosterone hormone levels did not have a significant impact in terms of contribution to the size of articular space and the risk level of lumbar disc herniation among athletes.
7. A prediction equation was derived:

$$\hat{y}_i = 7.891 - 0.688X_{1i} + 0.006X_{2i} + 6.291X_{3i}$$

4.2. Recommendations:

1- The need to pay attention to the contribution ratios shown by the study

1- Trainers should adjust the intensity of the exercises based on the accumulation of lactic acid to avoid muscle strain, which reduces the chances of burnout-related injuries.

2- Raising awareness among coaches and athletes of the importance of biochemical health and its role in optimal sports performance, which contributes to the application of more effective and safe training programs.

3- It is recommended to pay attention to increasing potassium levels in the body, through proper nutrition or supplements, to support muscular performance and maintain effective nerve stimulation.

4- Adoption of the contribution ratios shown by the study for each of the indicators of potassium and lactic acid index by the size of the articular space and the risk of lumbar herniated disc among athletes

5- Adopting the prediction equations reached in evaluating the levels of lumbar disc injuries among athletes.

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