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FINDING A PREDICTIVE VALUE FOR THE PAIN LEVEL OF ANTERIOR ADDUCTOR MUSCLE INJURIES BASED ON SOME BIOCHEMICAL MARKERS IN ATHLETES

Asst. Prof. Sahar Mohammed Salman,
University of Nahrain / College of Pharmacy, Iraq
dr.sahar073@gmail.com

Abstract

Improper rehabilitation procedures frequently result in adductor anterior injuries being associated with various levels of pain. Athletes frequently encounter difficulties in regaining peak performance due to these programs, adversely affecting athletic efficacy and heightening the risk of relapses or recurrences. The primary objective of rehabilitation is to restore normal muscular function and to avert the recurrence of the injury. Consequently, the researcher observed a disparity among athletes regarding pain levels and the recurrence of discomfort associated with injuries to the anterior adductor muscle during the medical rehabilitation phase. She analyzed the case by assessing the contribution percentage of each biochemical sign during the injury period to ascertain the pain level. The researcher performed measurements on a sample of 24 injured individuals throughout 8 weeks of observation, monitoring, and evaluation. She determined that the correlation between the enzyme (CRP) and the pain level in the adductor muscle is the strongest, signifying that it serves as the most evident signal of the resurgence of sports-related pain levels. She advocated for the adoption of the predictive value determined during the assessment of the medical rehabilitation procedure.

Keywords: Pain level, adductor anterior muscle, biochemical parameters.

Introduction

Engaging in sports entails hazards due to accidents or abrupt, unthoughtful movements. Sports injuries are a fundamental aspect of the athletic experience, particularly in competitive sports or those requiring significant exertion and direct physical contact. Notwithstanding considerable progress in training and rehabilitation techniques, muscular injuries, especially involving the anterior adductor muscles, persist as some of the most prevalent injuries among athletes. This is especially applicable in activities necessitating abrupt directional shifts or vigorous thigh motions, including football, taekwondo, squash, tennis, and several team sports. This results from the recurrent nature of these movements,

necessitating vigorous and swift thigh contractions, including abrupt directional shifts or unexpected acceleration. Such injuries are frequently associated with differing levels of discomfort. Athletes encounter difficulties in regaining ideal performance due to pain levels, which adversely affect athletic performance and heighten the probability of discontinuing sports participation. The primary objective of rehabilitation is to restore normal muscular function and to avert the recurrence of damage. Consequently, comprehending variations in pain levels may serve as a critical predictor of the probability of discontinuing training, particularly when associated with specific biochemical markers that signify the status of the body's musculature, notably the adductor muscles of the thigh, and their essential role in training. Abu Al-Ala Ahmed and Ahmed Nasr El-Din assert that biochemical indicators are crucial determinants for contemporary training aimed at enhancing achievement and performance; without these indicators, an athlete's progress is unattainable (Abdel Fattah and Nasr El-Din, 2003, p. 238). Consequently, it has become imperative to adopt scientific methodologies that can forecast pain levels, employing objective markers that facilitate timely and effective training and medical decisions. Biochemical markers serve as diagnostic and prognostic tools that correlate with the extent of muscle tissue injury or damage, as well as the severity of muscle inflammation post-injury, correctly reflecting the physiological and functional condition of the muscles. The indications comprise creatine kinase (CK), lactate dehydrogenase (LDH), and C-reactive protein (CRP). This research is crucial for elucidating the relationship between these indications and the pain level associated with an adductor anterior muscle injury, enabling athletes and therapists to prevent recurrence or avoid injuries. This is accomplished by developing a prediction model that mitigates the likelihood of injury recurrence and enhances the quality of sports care. The objective is to provide a scientific predictive value for pain levels. Greater forecast accuracy enables the development of specific rehabilitation regimens that mitigate injury risk or recurrence, while also preserving athletes' fitness and boosting their physical performance.

1- Introduction and importance of the research:

Engaging in sports entails inherent dangers due to accidents or impulsive, uncalculated moves. Sports injuries are a fundamental aspect of the athletic experience, particularly in competitive or high-impact sports that entail direct physical contact. Notwithstanding considerable progress in training and rehabilitation techniques, muscle injuries, especially of the anterior adductor muscles, persist as some of the most prevalent injuries among athletes. This is especially applicable in sports necessitating abrupt directional shifts or intense thigh motions, including football, taekwondo, squash, tennis, and several team sports. This results from the recurrent nature of these movements, necessitating powerful and swift thigh contractions, such as abrupt directional shifts or quick acceleration. Such injuries frequently entail differing levels of pain. Athletes encounter difficulties in regaining ideal performance due to pain levels, which adversely affect athletic performance and heighten the probability of discontinuing sports participation. The primary objective of rehabilitation is to restore normal muscular function and to avert the recurrence of damage.

Consequently, comprehending fluctuations in pain levels may serve as a critical predictor of the probability of ceasing training, particularly when associated with specific biochemical markers that signify the state of the body's musculature, notably the thigh adductor muscles, and their essential role in training. Abu Al-Ala Ahmed and Ahmed Nasr El-Din assert that biochemical indicators are critical determinants for contemporary training aimed at enhancing achievement and performance; without these indicators, an athlete's progression is unattainable (Abdel Fattah and Nasr El-Din, 2003, p. 238). Consequently, it is imperative to adopt scientific methodologies that can forecast pain levels, employing objective indicators that facilitate timely and effective training and medical decisions. Biochemical markers serve as diagnostic and prognostic tools that correlate with the extent of muscle tissue injury or damage, as well as the severity of muscle inflammation post-injury, correctly reflecting the physiological and functional condition of the muscles. The indications comprise creatine kinase (CK), lactate dehydrogenase (LDH), and C-reactive protein (CRP). This research is crucial for elucidating the correlation between these indications and the intensity of pain associated with an adductor anterior muscle injury, enabling athletes and therapists to prevent recurrence or avoid injuries. This is accomplished by developing a prediction model that mitigates the likelihood of injury recurrence and enhances the quality of sports care. The objective is to provide a scientific predictive value for pain intensity. Enhanced prediction accuracy facilitates the development of specific rehabilitation programs that mitigate injury risk or recurrence, while also preserving athletes' fitness and improving their physical performance.

1-2 Research Problem:

Many athletes experience injuries, and even after post-rehabilitation, they often encounter recurrent injuries to the anterior adductor muscle. This results in extended absence from training and competition, and occasionally premature cessation of their sports careers. The researcher, via her work in medical rehabilitation, noted disparities in the intensity of pain experienced by athletes after injuries and the recurrence of pain in the adductor anterior muscle throughout the rehabilitation period. This may result from the nature of the injury and the extent of its impact on the biochemical markers influencing the functional integrity of the adductor muscle throughout recovery. This prompted the researcher to inquire about the correlation between specific biochemical markers during the damage phase and the intensity of pain. What is the role of each biochemical indicator in assessing pain severity during the injury period? The absence of precise predictive techniques to assess injury likelihood complicates the prevention of recurring injuries. This research investigates the predicted significance of pain severity by easily measurable and scientifically interpretable biochemical indicators. Consequently, it prevents harm or the recurrence of injury during the medical rehabilitation phase.

1-3 Research Objectives:

1- To ascertain the correlation between specific biochemical indicators during the medical rehabilitation phase and the pain intensity experienced by athletes with anterior adductor muscle injuries.

2- To formulate predictive equations for pain levels in athletes with anterior adductor muscle injuries, utilizing the assessment of certain biochemical markers during the medical rehabilitation phase.

1-4 Research Hypothesis:

A statistically significant correlation exists between pain levels and biochemical markers during the medical rehabilitation phase for the research cohort.

1.5: Research Areas

1-5-1 Temporal domain: From January 12, 2025, until March 15, 2025.

1.5.2 Human domain: A cohort of injured athletes.

1-5-3 Geographical area: Baghdad / Sports Medicine Hospital.

Research Methodology and Field Procedures

2-1 Research Methodology:

The investigation necessitated the researcher to employ a descriptive methodology. Descriptive research seeks to "control and predict events, a fundamental objective of scientific inquiry, which it accomplishes"(Mahjoub, 2001, p. 295).

The research community consisted of athletes suffering from anterior adductor muscle injuries in Baghdad. The research sample, "representing the original community or the model upon which the researcher bases his overall work" (Al-Kazemi, 2012, p. 24), comprised players documented in the sports medicine records. The researcher administered a questionnaire to the study community to assess the injury, its history, and severity. The findings indicated that there were 32 injured athletes registered with the Sports Medicine Department from October 20, 2024, to December 30, 2024. A random sample was subsequently chosen from the study community, comprising 24 wounded players who had completed their medical treatment and were in rehabilitation, along with those who had attended the Sports Medicine Hospital.

2-3 Methodologies for the collection of information and data:

- Arab and international sources. - Authorities and professionals. - Assessments and evaluations.

2.4 Devices and instruments employed in the research:

-1 Small tube (cuvette).

-2 Ultraviolet-Visible Spectrophotometer.

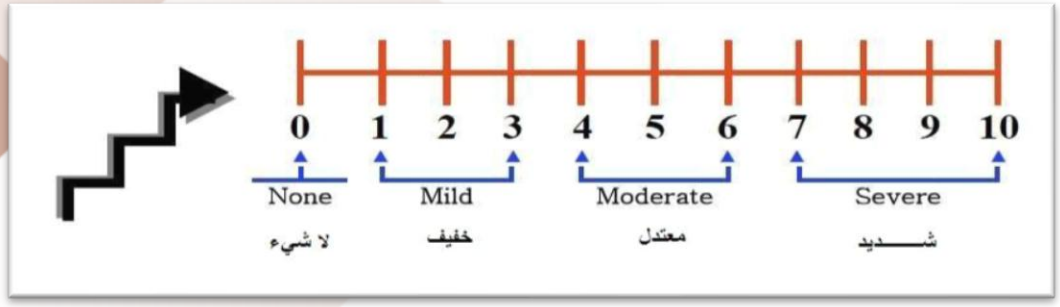
2.5 Measurement and Testing:

1. Assessment of pain intensity: (Wikstrom, Tillman, Chmielewski, et al., 2007, p. 671)

Assessment title: Pain intensity evaluation.

Test objective: To assess pain intensity in the flexed position and pain intensity in the extended position.

Materials: A sheet of paper or a ruler segmented into ten sections, each having numbers from 1 to 10, as seen in Figure 1.



Figure(1)
Pain score (V.A.S)

Procedures and Conditions:

The participant is instructed to assess the intensity of discomfort experienced while abducting the afflicted leg laterally to its utmost extent. The pain level is assessed based on the individual's perception and the specialized physician's evaluation, who asks the degree and quantification of the pain intensity.

Registration: The intensity of pain experienced by the participant during maximal bending is documented. A score of 10 indicates the utmost level of agony that the individual is unable to endure. The pain level is documented from two distinct locations, each recorded independently. The first indicates the level of discomfort from the adduction position, while the second indicates the level of pain from the extension position.

Measurement unit: The degree for each of the two conditions.

1- Measuring biochemical indicators

Assessment of CK (creatine kinase), LDH (lactate dehydrogenase), and CRP (C-reactive protein) biomarkers through a laboratory blood sample. The specimen is typically obtained from venous blood. Before breakfast, to mitigate the influence of circadian rhythms, trained analysts transferred laboratory blood utilizing a UV-Vis spectrophotometer to ascertain the concentrations of the three biochemical markers: CK, LDH, and CRP. This measurement process utilizes enzyme spectroscopy, a laboratory technique that measures light absorption by compounds produced during an enzyme reaction at certain wavelengths.

3.11 Field Research Protocols:

3-11-1 Primary Experiment:

The researcher devised a timetable to analyze the research sample. The researcher performed biochemical marker tests on the research sample from January 12, 2025, to March 15, 2025, at the Sports Medicine Hospital. The sample was chosen from individuals who had finished the therapy phase and commenced the rehabilitation phase. The researcher, aided by a trained medical team, collected a sample following consultation with a specialist physician, by the visitation schedule for injured patients under specialist care. The mean score was utilized. The researcher assessed to laterally extend the damaged leg to its

maximum capacity, quantifying the pain level in the adductor muscle region and the necessity to cease due to discomfort in that location. The examiner thereafter documented the intensity of pain under the prescribed scale.

2-8 Statistical Processing:

The researcher employed statistical methodologies utilizing the SPSS software for social systems, incorporating relevant statistical principles: arithmetic mean, standard deviation, standard error, the Kolmogorov-Smirnov test, the nonparametric U test for two independent groups, and multiple linear regression analysis.

3- Presentation, analysis, and discourse on the findings:

3.1. Assessment of pain intensity and biochemical markers (CK, LDH, and CRP):

Table (1) Descriptive statistics

Variables	**lonliness Measurement**	Average Arithmetic	deviation Standard	Less **value**	**highest value**
CK enzyme	U/L	188.08	47,268	40	190
enzyme LDH	U/L	191.29	40,465	150	280
CRP enzyme	mg/L	5.666	2,078	2	9
degree of pain	degree	4,083	1.886	1	7

Table No. (1) presents the statistical results, including the arithmetic mean, standard deviation, and the minimum and maximum values, according to the pain intensity of the adductor muscle and other biochemical indicators.

3-2 Multiple Linear Regression Analysis:

1- Evaluating the Goodness of Fit of the Normal Model:

Assessing the goodness of fit of the normal model for the variables to substantiate the validity of the normal distribution assumption for the variables in quantifying the severity of pain in the adductor muscle as a function of the predictive model under examination. Furthermore, concerning the validity of the normal distribution assumption for the results derived from the function above, represented by the biochemical indicators (CK enzyme, LDH enzyme, and CRP enzyme), Table (2) presents the results of the goodness of fit test for the normal model for these variables.

Table (2) (Kolmogorov-Smirnov) test assessing the goodness of fit of the normal model for the combined variables utilizing the relative normalized score transformation.

Fitment Check Indicator	first X1	second X2	Third X3	Y	decision
Number of sample members (N)	24	24	24	24	Accept the hypothesis
(KS) To test the Z - statistic	0.762	0.879	0.616	0.699	
Error level	0.607	0.432	0.842	0.713	
significance	Non-moral	not moral	not moral	not moral	

N3: Not statistically significant at a threshold exceeding 0.05: The distribution function adheres to the normal distribution.

An examination of the results in Table (2) indicates that the assumption of normal distribution for the biochemical indicators (enzyme (CK), enzyme (LDH), enzyme (CRP)) is substantiated. This validates the application of point estimates for the parameters of the presumed normal model, including the measurement mean, standard deviation, and standard error of the population mean. Furthermore, it affirms the legitimacy of hypothesis testing in the analysis of variance for multiple linear regression, along with the associated estimates such as the total correlation coefficient, coefficient of determination, and estimation coefficients for the predictive model. Evaluating the goodness of fit of the normal model is fundamental for executing all sanctioned statistical procedures, which will invariably falter if this criterion is not met.

3-3 Presentation and Analysis of the Results of the Prediction Model

Following the initial presentation of the multiple linear regression model, Table (3) displays the findings of the analysis of variance for the multiple linear regression. The objective is to assess the reliability of the weighted coefficient estimates of the predictive model by evaluating its goodness of fit. This involves analyzing the impact of the explanatory variables, biochemical indicators (enzyme CK, enzyme LDH, and enzyme CRP), on the dependent variable that quantifies adductor muscle pain, as articulated through the hypothesis of the joint variance test. The analysis results demonstrate a considerable degree of success regarding the reliability of the accepted model. This was accomplished by analyzing the joint variance among the model's functions, which indicates the dependability of the prediction model being examined.

Table (3) Results of the analysis of variance for multiple linear regression, including estimates for the variables.

nificance	Analysis of variance for multiple linear regression with weighted estimates					
	nificance	ha value F	ean squares	gree of freedom	um of squares	urces of variance
moral	0.022	4,015	10,253	3	30,760	The decline
			2.554	20	51,073	Remaining
e adductor muscle the functional structure Explanatory variables represented						
. the dependent variable represented by the pain levelY is						

3-3 Estimates of various coefficients from multiple linear regression analysis:

According to what was mentioned before, Table (4) presents estimates of various coefficients from the multiple linear regression analysis, including the multiple correlation coefficient between the dependent variable—the level of pain in the adductor muscle—and the independent variables. It also includes the coefficient of determination, the adjusted coefficient of determination, and the standard error of the aforementioned coefficients, which are represented by the biochemical indicators (enzyme (CK), enzyme (LDH), and enzyme (CRP)).

Table (4)
Estimates of the multiple linear regression model for the variables: total correlation coefficient, coefficient of determination, adjusted coefficient, and standard error of the estimate.

Model summary				
Debern-Westin test	Standard error of estimate	Corrected coefficient of determination	coefficient of determination	overall correlation coefficient R
2,589	1.598	0.282	0.376	0.613
Explanatory variables represented by the functional structure of the adductor muscle X1, X2, X3, X4, X5				

The correlation between the explanatory variables, namely biochemical indicators (enzyme (CK), enzyme (LDH), enzyme (CRP)), and the model function variable, which denotes the intensity of pain in the adductor muscle, is evident. The perfect correlation coefficient (0.613) and the coefficient of determination (0.376) denote the proportion of variance in the dependent variable elucidated by the independent variables, while the adjusted coefficient of determination (0.282) reflects the percentage of variance attributed to the independent variables after accounting for the influence of model inadequacy on the residual sources in

the specified model. The Debern-Westin test (2.589) was conducted, indicating that the model received approval.

3-3 Presentation of the outcomes of the multiple linear regression analysis and the predictive model

Table 5 Estimates of the coefficients for the multiple linear regression model utilizing degree transformation on the combined variables

Moral comparisons	Significance level	T-test t-test	Standard transactions And	Non-standard transactions		Transactions
			Transactions	random error	Transactions B	
HS	0.042	2.112		0.682	1.641	fixed limit
HS	0.032	2,300	0.536	0.009	0.021	X1
HS	0.000	4.50	0.125	0.014	0.063	X2
HS	0.041	2.137	0.240	2 0.10	0.218	X3

Significant at a level exceeding 0.05,

Table (5) illustrates the significance of the differences at the standard significance level (0.05) for the coefficients of the linear regression model concerning the biochemical indicators (enzyme (CK), enzyme (LDH), and enzyme (CRP)). This significance level underscores the relevance of these variables in elucidating the anticipated degree of pain in the adductor muscle. The model presented below constitutes the final formula for the predictive model under construction.

$$\hat{y}_i = 1.641 + 0.021X_{1i} + 0.063X_{2i} + 0.218X_{3i}$$

Where:

X_1i: The cumulative values of the CK enzyme concentration.

X_2i: The cumulative values of the LDH enzyme concentration.

X_3i: The aggregate values of the CRP enzyme concentration.

ŷ_i: The cumulative values of the adductor muscle pain intensity variable.

3-6 Analysis of the outcomes of the prediction equation.

The interpretation is conveyed using biochemical markers (CK, LDH, and CRP), with the model's functional variable denoting the extent of adductor muscle relapse. The resultant alterations are elucidated by the intensity of adductor muscle discomfort with the model's functional variable. The constant (1.641) signifies the anticipated value of the baseline pain level in the absence of the biochemical markers for the three enzymes. This signifies the existence of a primary degree of pain and is associated with additional elements not accounted for in the model. Injuries to the adductor muscles provide both physical and psychological challenges for athletes, necessitating a comprehensive grasp of the

contributing variables and their short- and long-term ramifications. The researcher posits that pain intensity is frequently associated with the degree of abrupt and erroneous movement, as well as inadequate muscle warm-up. The results indicated that each unit increase in the enzyme level (CK) corresponds to an anticipated rise in pain severity by 0.021, hence underscoring the enzyme's role as a definitive marker of muscle injury or damage. Nonetheless, it is not the most robust signal, as the injured individuals are in the medical rehabilitation phase following treatment, which means they do not subject themselves to significant stress, hence reducing the likelihood of tears, an important indicator. The enzyme's peak levels occur following intense physical exertion and substantial contractions; however, during recovery, these levels revert to baseline and may signal impending injuries, as elevated enzyme levels suggest damage to muscle fiber cells. This aligns with the findings of the study (Brancaccio et al., 2007), which demonstrate that elevated levels of the enzyme creatine kinase (CK) occur following prolonged activities such as long-distance running or strength training involving muscle contractions. He also signified. CK levels remain markedly raised for 24 hours post-exercise and progressively revert to baseline values at rest. Another source indicates that they are linked to muscular tears or strains (Brancaccio, Maffulli, & Limongelli, 2007, pp. 209-230). The enzyme lactate dehydrogenase (LDH) had a significantly higher coefficient than creatine kinase (CK), indicating that each one-unit elevation in its level corresponds to a 0.063 increase in the intensity of pain in connective tissues. This enzyme is linked to muscle cell degradation, and its increased levels signify extensive muscular injury. Consequently, rehabilitation therapists operate at an accelerated pace to prevent injury recurrence. Tiidus (2008) asserts that lactate dehydrogenase (LDH) serves as a biomarker to assess the degree of muscle damage caused by physical exertion or direct trauma (Tiidus, 2008, p. 84). The enzyme (CRP) showed the most significant effect among additional biochemical indications were identified at the adductor muscle pain score level of 0.218. The rise of this enzyme signifies a distinct inflammatory response, as resuming exercise post-injury involves motions that the wounded individual is unaccustomed to, owing to the inactivity of these muscles during the rehabilitation phase. Thus, vigorous or rapid motions may induce inflammation in the affected region, supporting the concept that inflammatory processes are integral to the complexity and extent of muscular discomfort. Pepys and Hirschfield (2003) affirm that C-reactive protein (CRP) is the first protein identified among acute-phase proteins and is regarded as a very sensitive marker of inflammation and tissue injury. It is distinctly raised in instances of acute and chronic inflammation, serving as an indicator of the potential exacerbation or complication of muscle injury. They noted the correlation of this enzyme with compromised cell membranes (Pepys & Hirschfield, 2003, pp. 3-6). The results of the prediction equation demonstrated logical links.

4 .Conclusions and Recommendations:

4-1 Conclusions:

1. The researcher formulated the prediction equation:

Relapse Rate^_i = 1.641 + 0.021 CK enzyme + 0.063 LDH enzyme + 0.218 CRP enzyme

2. A correlation exists between biochemical signs and the intensity of discomfort in the adductor muscle.
3. The correlation between the CRP enzyme and pain severity in the adductor muscle was noted to be the most pronounced, signifying it as the clearest signal of the resurgence of sports-related pain severity.
4. The correlation between CK enzyme levels and pain severity in the adductor muscle was documented as minimal, suggesting it is the least definitive indicator of the resurgence of sports-related pain severity.
5.The correlation between LDH enzyme levels and pain severity in the adductor muscle was documented as moderate, suggesting it serves as a fairly important predictor of the recurrence of sports-related pain severity.

4-2 Suggestions:

1. Examine the biochemical markers identified in the study to evaluate the severity of adductor muscle discomfort in injured athletes.
2 .Utilizing the contribution ratios indicated by physical therapists as a framework for preventing injury recurrence in athletes during the therapy phase.
3. Implementing the anticipated value obtained from the assessment of the medical rehabilitation procedure. Utilizing the CRP enzyme as a principal biochemical marker is advised for primary diagnostic purposes in the regular assessment of athletes, particularly during recovery and reintegration into sports activities.
4. Developing rehabilitation regimens that consider biochemical enzyme levels: Monitoring CK, LDH, and CRP levels in athletes' routine laboratory assessments is crucial.
5. It is essential to do extensive future investigations to validate the efficacy and precision of the predictive equation. Comparable investigations ought to be performed for additional factors and enzymes.

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