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Changes in Some Biochemical Indicators and Fatigue Index in Response to Magnesium Lactate Supplementation Combined with a Specialized Training Program in Advanced Basketball Players

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Abstract

This study aims to evaluate the effect of magnesium lactate supplementation, combined with an intensive 8-week training program, on changes in muscle enzyme levels (CpK, LDH) in basketball players. These changes will be compared with a control group following the same training program but without supplementation. The study aims to determine whether magnesium lactate supplementation contributes to improving muscle recovery capacity and affecting the fatigue index. The research objectives were to identify the effect of magnesium lactate supplementation combined with the training program on some biochemical variables and the fatigue index in the experimental research sample. The hypotheses were that there were statistically significant differences between the post-tests in the control and experimental groups. After applying the program for 8 weeks, several conclusions were reached, including that the dietary supplement has a clear effect on delaying fatigue (muscle endurance). The researcher recommended paying attention to nutritional supplements during training units, especially supplements that help produce energy and delay the onset of fatigue

Keywords: Biochemical indicators, Fatigue index, Magnesium lactate supplements, Basketball players.

التغيرات في بعض المؤشرات البيوكيميائية ومؤشر التعب استجابةً لمكملات لاكتات المغنيسيوم المصاحبة لبرنامج تدريبي خاص لدى لاعبي كرة السلة المتقدمين

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الملخص

تهدف هذه الدراسة إلى تقييم تأثير مكملات لاكتات المغنيسيوم، المدمجة مع برنامج تدريبي مكثف لمدة 8 أسابيع، على تغيرات مستويات إنزيمات العضلات (CpK, LDH) لدى لاعبي كرة السلة. ستُقارن هذه التغيرات مع مجموعة ضابطة تتبع نفس البرنامج التدريبي ولكن دون تناول المكملات. تهدف الدراسة إلى تحديد ما إذا كانت مكملات لاكتات المغنيسيوم تساهم في تحسين قدرة استعادة العضلات وتؤثر على مؤشر التعب. كانت أهداف البحث هي تحديد تأثير مكملات لاكتات المغنيسيوم المدمجة مع البرنامج التدريبي على بعض المتغيرات الكيميائية الحيوية ومؤشر التعب في عينة البحث التجريبية. افترضت الدراسة وجود فروق ذات دلالة إحصائية بين الاختبارات البعدية للمجموعتين الضابطة والتجريبية. بعد تطبيق البرنامج لمدة 8 أسابيع، تم التوصل إلى عدة استنتاجات، منها أن المكمل الغذائي له تأثير واضح في تأخير التعب (تحمل العضلات). وأوصى الباحث بضرورة الاهتمام بالمكملات الغذائية خلال الوحدات التدريبية، خاصة تلك التي تساعد في إنتاج الطاقة وتأخير ظهور التعب.

الكلمات المفتاحية :المؤشرات البيوكيميائية ، مؤشر التعب، مكملات لاكتات المغنيسيوم، لاعبو كرة السلة.

1-Introduction :

Magnesium plays a vital role in many vital functions in the human body, especially for athletes. Magnesium lactate is a form of magnesium that is well absorbed in the digestive tract, making it a popular choice for nutritional supplements.

Magnesium lactate supplements are a good option for people who may not get enough magnesium from their diet, or for athletes whose magnesium needs may be increased due to high physical exertion. Magnesium lactate is well absorbed and less likely to cause gastrointestinal upset than some other forms of magnesium

The high demands of basketball on an athlete's physical and mental capabilities drive coaches and specialists to seek methods that aid in energy production, such as nutritional supplements. While nutritional supplements serve a variety of purposes worldwide, only 5% are designed for high-performance athletes to complement their

diet and improve metabolic function and performance—a field of significant importance [(Rawson, E.S.; Miles, M.P.; Larson-Meyer, D.E 2018),(Peeling, P.; Castell, L.M.; Derave, W.; de Hon,2019)]. The safe use of nutritional supplements becomes essential, as it is a viable and reliable way to meet the high nutritional requirements that cannot be obtained solely from your daily diet and improve athletic performance [,] 2019 Vitale, K.; Getzin, (.2012Maughan, R.J.; Shirreffs, S.M) Coenzyme Q10 (CoQ10) has garnered attention for its potential role in enhancing athletic performance due to its involvement in mitochondrial energy production and its antioxidant properties. Numerous researchers have explored the use of this supplement in studies on athletes and non-athletes alike. One such study, "The effects of Coenzyme Q10 on biochemical markers and physical performance in team sport athletes" by Matthews Santos de Souza Fernandez et al.(Fernandez, M.S.d.S.; et al 2023], summarized the effects of CoQ10 supplementation on metabolic and biochemical outcomes and performance in athletes. The study concluded that CoQ10 supplementation in athletes leads to significant improvements in antioxidant activity and performance while reducing oxidative stress.

Similarly, a study by Sepideh Talebi, Mohammad Hossein Pourgharib Shahi et al., titled "The effects of Coenzyme Q10 on biochemical markers and physical performance in team sport athletes" aimed to elucidate the dose-dependent effect of CoQ10 supplementation on exercise-induced muscle damage (EIMD), physical performance, and oxidative stress in adults -(Talebi, S.; Pourgharib Shahi, M.H.; Zeraattalab-Motlagh, S.; Asoudeh 2024,)

This research stems from the hypothesis that CoQ10 supplementation can positively influence certain functional and biochemical variables, potentially improving some physical abilities in basketball players, including aerobic endurance. Hence, the

importance of research using this supplement to assist individuals in producing energy and maintaining optimal performance in basketball.

Research Problem:

Dietary supplements are a critical element in the routine of basketball players, especially during training and competitions. These products play a vital role in providing players with the energy needed to perform intense exercises and compensate for fluids and salts lost through sweating, especially in hot weather. Thus, they contribute to improving physical performance and endurance, delaying the onset of fatigue and exhaustion.

The researcher, being a coach and professor of basketball at the College of Physical Education and Sports Science - Al-Mustansiriya University, noticed a significant decline in the physical and skill performance of basketball players during extended training units, especially in hot weather. The researcher attributed this decline to the lack of energy and essential minerals in the players' bodies due to the physical exertion. Hence, the importance of this research emerges.

Research Objective:

- To identify the effect of magnesium lactate supplementation combined with the training program on some biochemical variables in the experimental research sample.
- To identify the effect of magnesium lactate supplementation combined with the training program on the fatigue index in the experimental research sample.

Research Hypotheses:

- There are statistically significant differences between pre and post -test measurements on the control group in some functional biochemical and aerobic endurance variables.

- There are statistically significant differences between the pre- and post-measurements of the experimental group in some biochemical and aerobic functional endurance variables.

Research Scope:

Human Scope: Players from Al-Mustansiriya University team.

Spatial Scope: Outdoor courts of Al-Mustansiriya University.

Temporal Scope: From 1/3/2024 to 20/5/2024.

2-Research Methodology and Field Procedures:

2.1 Research Methodology: To achieve the research objectives and test the hypotheses, the experimental design with two groups (control and experimental) was chosen as the best methodology. The experimental method was applied using a two-group design to address independent variables and evaluate their effect on dependent variables.

2-2 Research Sample: The study was conducted on a sample of 12 players from Al-Mustansiriya University basketball team. After excluding injured players, the sample was randomly divided into two equal groups (5 players each) .

2-3 Sample Homogeneity: To ensure the validity of the results, statistical procedures were applied to ensure sample homogeneity. The skewness coefficient was used to assess the deviation of variable distribution (height, weight, training age) from the normal distribution, which is a basic condition for data analysis. This procedure aims to reduce the effect of extraneous variables and improve the power of statistical tests, as shown in Table (1)

Table (1)Sample Homogeneity in Variables of Height, Mass, Age, and Training Age

Variables	Unit of Measurement	Mean	Standard Deviation	Skewness Coefficient
Height	Cm	182.6	3.36	0.54
Weight	Kg	71.6	5.94	0.78
Age	Year	20.4	1.14	0.12
Training Age	Year	4.7	0.96	0.1

The negative value of the skewness coefficient, which falls within the range (-1, 1), indicates that the data distribution in the studied variables is close to normal, indicating sample homogeneity. This homogeneity ensures the validity of the statistical tests used in this study.

2-4 Data Collection Tools and Instruments Used

2-4-1 Data Collection Tools

The researcher relied on a variety of data sources to collect the necessary information for his study, including books, scientific articles, various sources from books, periodicals, websites, personal interviews with experts, and questionnaire data and laboratory results forms.

2-4-2 Instruments Used

The researcher used a set of tools, including a multi-purpose medical scale to measure height and weight, sterile syringes of different sizes, special tubes for collecting blood samples, containers to safely store these samples, in addition to medical cotton and sterilizing materials.

2-5 Identification of Tests and Measurements Used

To ensure the accuracy of the selection of measurements and tests, the researcher conducted a comprehensive survey of scientific references and electronic databases to determine the most appropriate tools for the nature of his research. The researcher was careful to select measurement and testing tools compatible with his research objectives through an intensive survey of relevant scientific sources.

1-Lactic Endurance Test: (Abu Al-Ala Ahmed Abdel Fattah, Muhammad Subhi Hassanein: 1997, p.229)(Cunningham and Faulkner)

-Purpose of the Test: To measure the fatigue index (lactic endurance)

-**Test Specifications**: Device speed: 12.5 km/h, incline angle: 9 degrees.

-**Test Duration:** Until the player reaches fatigue.

-**Procedures**

After the player completes a proper warm-up for 5-10 minutes, the player mounts the treadmill, and the device starts at the specified speed (12.5 km/h). The device gradually increases the speed until it reaches the specified speed, giving the tester enough time to work on the device in a consistent and coordinated manner. After reaching the specified speed, the timers are started by the referees, and the player continues to work on the device until reaching severe fatigue, where they can no longer run on the device, and the timers are stopped.

-Recording: The tester's time is recorded from the start of the test (when the device reaches 12.5 km/h) until stopping (fatigue).

-Biochemical Measurements and Tests

LDH Measurement

CPK Measurement

2-6 Pilot Experiment : The pilot experiment was conducted on two players who were excluded from the main experiment at 2:00 PM on Monday, 4/3/2024.

The objectives of the pilot experiment were:

To ensure the safety and ease of handling the devices and tools.

To ensure the suitability of the tests for the research sample and the method of their implementation.

To identify potential problems that may accompany the application of exercises associated with magnesium lactate supplementation and the implementation of tests.

2-7 Pre-Tests: Pre-tests for both the control and experimental groups were conducted over two days. On **Tuesday, March 5, 2024**, the lactate tolerance test (Cunningham and Faulkner) was administered according to testing conditions, and each player's test time was recorded on a dedicated form. On the second day, **Wednesday, March 6, 2024**, and 24 hours after the exertion, a 5 cc blood sample was drawn by a medical assistant. The blood was then dispensed and stored in anticoagulant-containing tubes, labeled with the names of the research sample

individuals, placed in cooled containers, and sent to the medical laboratory for the measurement of the investigated variables (**LDH, CPK**).

2-8 Main Experiment: The main experiment was conducted on Sunday, 10/3/2024, where the participants were divided into two groups. The experimental group received magnesium lactate tablets (84 mg) twice daily, two tablets per day, one every 12 hours, half an hour before each training session, according to a medical prescription. In contrast, the control group received placebo capsules and was informed that they contained magnesium lactate. Training continued three times a week for 8 weeks, relying on the coach's training program.

All participants underwent the same training program, which consisted of three units per week.

2-9 Post-Tests: The post-tests and measurements were conducted for both the control and experimental groups on Sunday, 12/5/2024. These procedures were conducted under the same conditions as the pre-tests. These procedures included the lactic endurance test and blood samples were drawn from all players in both groups. After that, the blood samples were stored in individually labeled tubes inside a cooling box and sent to the laboratory for analysis.

2-10 Statistical Methods Used: Statistical analysis of the data was conducted using a set of statistical measures, including calculating the mean, standard deviation, median, skewness coefficient, in addition to applying the T-test.

3-Results, Analysis, and Discussion:

3-1 Presentation and Analysis of Pre- and Post-Test Results for the Control Group:

Table (2) Shows the means, standard deviations, and calculated t-values for the biochemical variables and
fatigue index for the pre- and post-tests of the control group.

Variables	Unit	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Calculated t-value	Tabular t-value	Significance Level
LDH	U/L	203.8	8.49	222.4	7.70	0.06758	2.132	Random
CPK	U/L	129.2	5.89	199.8	9.18	1.39	2.132	Random
Lactic Endurance	m/s	10.78	1.12	12.35	1.35	02.04	2.132	Random
Under a significance level of 0.05 and a degree of freedom of n-1								

Table (3) Shows the means, standard deviations, and calculated t-values for the biochemical variables and fatigue index for the pre- and post-tests of the experimental group.

Variables	Unit	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	Calculated t-value	Tabular t-value	Significance Level
LDH	U/L	183.11	8.11	228.2	7.27	5.34	2.132	Significant
CPK	U/L	124.2	6.53	189.72	9.40	6.21	2.132	Significant
Lactic Endurance	m/s	11.08	0.971	13.24	0.657	02.23	2.132	Significant
Under a significance level of 0.05 and a degree of freedom of n-1								

Table (4): Shows the means, standard deviations, and calculated t-values for the biochemical variables and fatigue index for the post-tests of the control and experimental groups.

Variables	Unit	Control Post-Test Mean	Control Post-Test SD	Experimental Post-Test Mean	Experimental Post-Test SD	Calculated t-value	Tabular t-value	Significance Level
LDH	U/L	222.4	7.70	228.2	7.27	7.34	1.860	Significant
CPK	U/L	199.8	9.18	189.72	9.40	3.18	1.860	Significant
Lactic Endurance	m/s	12.35	1.35	13.24	0.657	2.67	1.860	Significant
Under a significance level of 0.05 and a degree of freedom of n-2								

2-3 Discussion of Results: It is evident from Tables 2, 3, and 4 that there are statistically significant differences between the pre- and post-tests for both the control and experimental groups, as well as statistically significant differences between the post-tests of the control and experimental groups.

In the LDH measurement, the results show an increase in the post-tests for both the control and experimental groups, but the increase was within normal limits, as the normal range for men is 105-235. The researcher believes that during strenuous exercise, some muscle fibers are damaged, leading to the leakage of LDH enzyme from these damaged cells into the blood. Consequently, the level of LDH in the blood temporarily rises. LDH (Lactate Dehydrogenase) is an enzyme found in almost all cells of the body. It plays an important role in the process of converting pyruvic acid to lactic acid during metabolism, especially under oxygen deficiency. During physical exertion, the demand for energy in the muscles increases, leading to an increase in metabolic rate and increased production of lactic acid. An increase in LDH levels after strenuous exercise is normal and not a cause for concern.

" Maglisho (1982) states that enzyme activity leads to an increase in the rate of energy released as well as an increase in the rate of their restoration. A study by Diatl et al. (1984) indicates a relationship between the increase in these enzymes and the level of physical fitness" (Raysan Khuraibet Majeed and Ali Turki Musleh: 1999, pp. 101-112).

Regarding the CPK enzyme, the results indicate statistically significant differences between the pre- and post-tests for both the control and experimental groups. The researcher attributes the noticeable difference in the results of the experimental group that took magnesium supplements to a significant increase in the concentration of CPK enzyme in the blood. This is due to the vital role of magnesium in activating many enzymes, including CPK, which plays a fundamental role in energy production

in the cell. Many studies have proven that magnesium contributes to improving muscle performance and increasing endurance.

When we engage in strenuous exercise or perform intense physical exertion, muscle fibers are slightly damaged. This damage leads to the leakage of CPK enzyme from the muscles into the blood, causing an increase in its levels. An increase in the level of creatine phosphokinase (CPK) after physical exertion accelerates the process of phosphorylation of adenosine diphosphate (ADP) to form adenosine triphosphate (ATP). This biochemical reaction, catalyzed by CPK, represents the fundamental step in the production of energy necessary for muscle contraction. "The CPK enzyme is important in stimulating energy production reactions necessary for athletes (muscular), so it is concentrated in skeletal muscles and the heart muscle, which are important parts of sports movements" (mindy millard and others serum(cpk) 1985).

It is (enzyme CPK). " a protein enzyme important in muscles and various organs of the body, including skeletal muscles, the brain, and the heart. This enzyme plays an important role in metabolic processes, but an increase in enzyme levels may be an indication of muscle or neurological disease, and it is also present in the heart muscle. This enzyme is primarily found in muscles in general and plays an important role in energy production" (Sprwan Hamed: The effect of using creatine phosphate loading on the development of the CPK enzyme and the completion of tests: 2016).

"The effect of magnesium doses, which are considered a source of energy during training units for basketball players, has an important and purposeful role in stimulating and increasing the concentration of the enzyme, as "increasing the muscle store of creatine phosphate by consuming supplementary elements will lead to an increase in the activity of the enzyme responsible for the reaction of this compound, which is the creatine phosphokinase enzyme CPK "(Hayat Al-Sudan Ibrahim: Biochemistry of Enzymes in the Human Body: 2007).

Regarding the lactic endurance test, the results showed significant differences in favor of the post-test for the experimental group. The researcher attributes the significance of the differences to the effect of the magnesium lactate dietary supplement given to the experimental group. Studies indicate that magnesium lactate helps delay the feeling of fatigue during exercise, allowing athletes to exercise for longer periods and with greater intensity. Magnesium helps improve the energy metabolism process in muscles, reducing the production of lactic acid. It is essential for the functioning of many enzymes that play a vital role in muscle contraction and relaxation. Magnesium contributes to energy production in cells, providing additional energy for muscles during exercise, and thus helps speed up the recovery process after exercise, allowing athletes to return to training faster.

4-Conclusions and Recommendations

4-1 Conclusions:

1. There is an effect of the magnesium lactate dietary supplement on muscle enzymes CpK and LDH.
2. There is an effect of the magnesium lactate dietary supplement on energy production.
3. The dietary supplement has a clear effect on delaying fatigue (muscle endurance).

4-2 Recommendations:

Pay attention to dietary supplements during training units, especially supplements that help produce energy and delay the onset of fatigue.Conduct similar studies on other team and individual sports.

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