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The Effect of Magnesium on Cardiovascular and Muscular Systems Recovery

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Abstract

The study aimed to examine the effect of magnesium intake, both regular and high doses, combined with exposure to its primary absorption catalyst, ultraviolet radiation (UV), on the efficiency of the cardiovascular and muscular systems. A pilot study was conducted using an experimental method on a sample of three runners to assess the validity and reliability of the tests and the feasibility of applying them across different domains. The main study involved a targeted sample of eight senior-level middle-distance runners (800–1500 meters) in Algeria, divided into two groups: control and experimental. Participants underwent several tests, including the Ruffier test, blood lactate measurement, resting heart rate, and statistical analysis using the t-test.

Keywords: *magnesium, cardiovascular system, muscular system*

L'effet du magnésium sur la récupération des systèmes cardiovasculaire et musculaire

Résumé

L'étude visait à examiner l'effet de l'apport en magnésium, à doses régulières et élevées, combiné à l'exposition à son principal catalyseur d'absorption, le rayonnement ultraviolet (UV), sur l'efficacité des systèmes cardiovasculaire et musculaire. Une étude pilote a été menée à l'aide d'une méthode expérimentale sur un échantillon de trois coureurs afin d'évaluer la validité et la fiabilité des tests et la faisabilité de leur application dans différents domaines. L'étude principale a porté sur un échantillon ciblé de huit coureurs de demi-fond de haut niveau (800 à 1 500 mètres) en Algérie, répartis en deux groupes : un groupe témoin et un groupe expérimental. Les participants ont subi plusieurs tests, notamment le test de Ruffier, la mesure du lactate sanguin, la fréquence cardiaque au repos et une analyse statistique à l'aide du test t.

Mots clés : *magnésium, système cardiovasculaire, système musculaire*

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Introduction:

Ultraviolet (UV) radiation is an electromagnetic wave with a wavelength shorter than visible light but longer than X-rays. It is called ultraviolet because the violet color in the spectrum has the shortest wavelength among colors, with wavelengths ranging from 10 to 400 nanometers and energy from 3 to 124 electron volts. UV radiation is part of sunlight, emitted by electric arcs or black lights, and as ionizing radiation (which separates electrons from atoms), it can cause chemical reactions, make many materials fluorescent or yellowish, and has effects on the body such as sunstroke. However, the UV spectrum has other effects which may be beneficial or harmful to human health **(Hockberger, 2002).**

The Earth's atmosphere significantly modifies incoming solar radiation by absorption and scattering due to oxygen gas, water vapor, carbon dioxide, ozone, water droplets, dust particles, and other components of biosphere driven by human and volcanic activities. A linear correlation has been found between global and solar UV radiation, particularly in areas with moderate to low solar energy values **(Koronakis, 2002, p.36).**

The primary natural source of magnesium is the synthesis of cholecalciferol in the lower layers of the skin through a chemical reaction dependent on sun exposure to UV radiation (**MacDonald & James, 2019).** The main positive effect of exposure to medium wavelength ultraviolet (UVB) is its role in producing vitamin D in the skin, which in turn stimulates magnesium absorption. Estimates suggest tens of thousands of annual cancer deaths in the US are due to vitamin D deficiency **(Grant, 2002, p.186).**

Vitamin D is a group of fat-soluble secosteroids responsible for increasing intestinal absorption of calcium, magnesium, phosphate, and other biological effects **(Bikle & Daniel, 2014).**

Magnesium is an essential mineral nutrient for the human body. It exists in the form of a divalent cation (Mg^{+2}) and is vital for life (Hluchan and Pomerantz, 2006,p.94). It stabilizes polyphosphate compounds within cells, including those involved in synthesis of ribonucleic acid (RNA) and deoxyribonucleic acid synthesis (DNA). Additionally,adenosine triphosphate (ATP), the main cellular energy source, requires binding with magnesium ions to be active and functional, commonly existing as a chelated compound with magnesium **(Romani & Anderia, 2013).**

Modern sports training science integrates other sciences serving athletic performance. Key factors developing sports performance and regulating training include attention to recovery processes after physical exertion **(Ghazi, 2001).** To ensure the development of an athlete's physical and functional capabilities,proper recovery is essential to restore phosphate and glycogen stores in muscles, oxygen binding to hemoglobin, and lactic acid is removed from muscles and blood **(Aldin, 2006, p.191).**

This study explores the impact of magnesium on recovery development in athletes, based on biological indicators related to cardiovascular and muscular systems. To facilitate the research process, the study is divided into two partial hypotheses:

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- Magnesium has an effect on cardiovascular system efficiency.
- Magnesium has an effect on muscular system efficiency.

1. Research methodology:

An exploratory study examined a purposive sample of three athletes from the same team, who were then excluded from the main group. The experimental protocol was applied on them, measured resting heart rate using a Smart Pro M4 heart rate monitor, systolic and diastolic blood pressure with a Beurer blood pressure device, and blood lactic acid levels with a LactateScout 4 lactate meter. The Ruffier and Vameval tests were conducted with a one-hour interval between the two previous mentioned tests , then repeated after 24 hours of complete rest enforced on the athletes. The validity and reliability of tests and measured parameters were assessed.

Table (01): Pearson Test for Reliability and Validity

	Lactate Mg/Dl	FC (B/min)	Rf	T (mmHG)	
				Sys	Diasys
Reliability	0.972	0.866	0.994	0.982	1
Validity	0.985	0.930	0.996	0.990	1

From Table (1), we observe that all reliability values are greater than (0.80), which is evidence of test and measured trait stability. Validity is the square root of reliability; all values shown in the table are close to or equal to one (1), confirming the validity of the tools and tests used in the experiment.

-The primary study sample consisted of (08) eight male middle-distance runners (under 21 years) from Amal Shabab Saleh Bay club, regularly training. They were chosen purposively and divided equally into two groups (control and experimental). Levene’s test was used to examine homogeneity.

Table (02): Levene's Test Results for Variance Homogeneity Based on Arithmetic Means

		Group 1	**Group 2**	**df1**	**df2**	**Levene Statistic**	**Significance Level**	**Observation**
The Anthropometric measurements	**Age**	18.5	19			0.429	0.537	Homogeneous
	Weight (Kg)	62.5	60.5			0.033	0.862	Homogeneous
	Height (Cm)	180.25	176.85	1	6	0.364	0.569	Homogeneous
	Sleep Hours (H)	8.25	7.75			1.6	0.253	Homogeneous
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	Lactate Conc.	15	15.175			0.160	0.703	Homogeneous
	Resting Pulse	62	62			0.429	0.537	Homogeneous
	Diastolic BP	82	82			1.929	0.214	Homogeneous
	Systolic BP	125.25	124			5.357	0.06	Homogeneous

Table (03): Normal Distribution of Test Results for the Sample Shapiro-Wilk Test for Pre-Measurements

Properties	Sig. Level	df	Statistic	Sig	Decision	Measurements
Weight (Kg)	0.05	8	0.954	0.657	Follows Normal Dist.	Anthropometric
Height (Cm)			0.978	0.953	Follows Normal Dist.	
Lactate Conc.			0.954	0.75	Follows Normal Dist.	Physiological

Resting Pulse			0.885	0.21	Follows Normal Dist.	
Diastolic BP			0.958	0.792	Follows Normal Dist.	
Systolic BP			0.358	0.911	Follows Normal Dist.	
Sleep Hours (H)				0.29	Follows Normal Dist.	

From the table above, all values are greater than the significance level (0.05), ensuring normal distribution and sample homogeneity; thus, Student's t-test can be applied.

A team of (05) five members was enlisted and applied the experimental protocol described previously. The process was repeated after (19) nineteen weeks with the experimental group exposed to an ultraviolet lamp in the bedroom for the experiment duration and consuming magnesium-rich meals.

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2. Results and Analysis:

2.1. Heart Indicators

Table (04): Pre-Measurement Differences Between Control and Experimental Groups for Heart Indicators

Resting Pulse		Sig	Calculated T	Tabulated T	Decision
T	Diasys Sys	1	0	1.94	Not Significant
		0.801	0.264		Not Significant
		0.651	0.467		Not Significant

According to the table above, all p-values exceed 0.05, and all calculated t-values are less than tabulated t-values, indicating no statistically significant differences.

Table (05): Pre- and Post-Measurement Differences for Control Group - Heart Indicators

Resting Pulse		Sig	Calculated T	Tabulated T	Decision
T	Diasys Sys	0.08	2.61	2.35	Not Significant
		0.761	0.333		Not Significant

		0.29 7	1.26		Not Significan t

From the previous table, it is evident that the calculated t-values are less than the tabulated t-values, and the significance levels exceed (0.05), indicating that there is no statistically significant differences between pre- and post-measurements for the control group regarding heart indicators.

Table (06): Pre- and Post-Measurement Differences for Experimental Group - Heart Indicators

Resting Pulse		**Sig**	**Calculate d T**	**Tabulate d T**	**Decision**
T	**Diasy s Sys**	0.00 7	6.789	2.35	Significan t
		0.03 2	3.806		Significan t
		0.03 8	3.53		Significan t

From the table above, it is evident that all calculated t-values exceed tabulated t-values and p-values are less than 0.05, indicating statistical significance favoring the post-measurement.

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2.2. Ruffier Test and Blood Lactate Concentration

Table (07): Pre-Measurement Differences Between Control and Experimental Groups for Ruffier Test and Blood Lactate Levels

	Sig	Calculated T	Tabulated T	Decision
Ruffier Test	0.87	0.171	1.94	Not Significant
Blood Lactate	0.81	-0.244		Not Significant

Based on the table, all p-values exceed 0.05 and calculated t-values are less than tabulated t-values, showing no statistical significant differences.

Table (08): Pre- and Post-Measurement Differences for Control Group for Ruffier Test and Blood Lactate

	Sig	Calculated T	Tabulated T	Decision
Ruffier Test	1	0	2.35	Not Significant
Blood Lactate	1	0		Not Significant

The previous table shows that the p-values are greater than 0.05, and the calculated t-values are less than the tabulated t-values. This indicates that there are no statistically significant differences between pre and post measurement for the control group.

Table (09): Pre- and Post-Measurement Differences for Experimental Group for Ruffier Test and Blood Lactate

	Sig	Calculated T	Tabulated T	Decision
Ruffier Test	0.012	5.4	2.35	Significant
Blood Lactate	0.177	1.75		Not Significant

The previous table shows that the p-value for the Ruffier test is less than (0.05), while the p-value for blood lactic acid concentration is greater than (0.05). Additionally, the calculated (t) value for the Ruffier test is greater than the tabulated (t) value, and the calculated (t) value for blood lactic acid concentration is also greater than the tabulated (t) value. This indicates the presence of statistically significant differences regarding the Ruffier test, and no statistical significance concerning blood lactic acid concentration.

Table (10): Effect Size for Pre- and Post-Measurements of Experimental Group

	Cohen's d Test			
	n	**T**	**D**	**Effect**
Ruffier Test	4	5.4	2.7	Weak
Heart Rate		6.789	3.4	

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Blood Pressure	**Diasys**		3.806	1.9	
	Sys		3.53	1.76	

From the table above, all are values less than 0.5 which indicate a weak effect of the independent variable (magnesium) on the dependent variable (recovery).

3. Discussion of Hypotheses:

- Based on the interpretation of the previous results, the use of magnesium improves cardiovascular efficiency in athletes but weakly, possibly due to the short duration of the 19-week experiment. Longer-duration studies are recommended. Cardiovascular physiological changes can be measured via blood pressure, defined as the difference between systolic and diastolic blood pressures (Saad Eldin, 2000, p.138). The second key indicator after blood pressure is heart rate. Many sources indicate that the normal adult resting heart rate ranges 50-90 bpm **(Aladin, 2014,p.114).**
- Analysis of Table (3) shows no significant differences between control and experimental groups as the calculated t-values are clearly less than tabulated t-values .Similarly,table (4) shows no differences between pre and post measurements in control group for all indicators, resting heart pressure, systolic blood pressure and diastolic blood pressure since all calculated t-values are less than tabulated ones. However,table (5) shows statistical differences favoring the experimental group in all measured properties, blood pressure and heart rate, where all calculated t-

values exceed tabulated t-values. Table 8 also indicates a weak effect which supports the hypothesis that magnesium has a positive effect on cardiovascular system efficiency.

- From the interpretation of the previous results, it is clear that magnesium contributes to improving neuromuscular efficiency in athletes, particularly in relation to muscular fatigue. This fatigue affects the nervous system by reducing the ability to respond effectively to stimuli. Muscular fatigue can be defined as a temporary decline in the body's physical and functional efficiency, resulting from repeated physical exertion that clearly affects an individual's performance and ability to continue (Sayed, 2014, pp.252–253). This is closely related to the levels of simple or complex sugars from glycogen or fructose.
- Training increases the muscle's ability to store glycogen. A lack of glycogen limits an athlete's ability to maintain high-intensity performance, especially during the final stages of a match. Without glycogen, muscles rely on fat as a fuel source during low-intensity exercise, causing the athlete to slow down (Madkour, 2011). This stimulates the muscle and the Krebs cycle, starting from glycolysis and leading to the production of lactic acid. The accumulation of lactic acid in the muscle, resulting from anaerobic glycolysis, leads to fatigue. Complete recovery from fatigue occurs only when the body eliminates this excess acid from the muscles and blood **(Bahaa El-Din Ibrahim Salama, p.102).**
- From the results of Tables (07, 08, 09) regarding lactic acid levels, we find no statistically significant

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differences. This indicates that ultraviolet radiation has no effect on the neuromuscular system.

Conclusion:

Sunlight is a natural source that offers numerous benefits to humans. Among its rays, ultraviolet (UV) radiation, specifically the medium-wavelength UVB, is used by the skin to produce vitamin D. Our study concluded that UV exposure is essential for improving cardiovascular efficiency by enhancing the absorption of magnesium, which in turn contributes to recovery in athletes.Therefore, it is recommended that every individual, whether athletic or not, spend at least 15 minutes daily in sunlight,the natural physician, due to the vital role vitamin D plays in the human body. It stimulates the absorption of magnesium and phosphate, regulates calcium levels in the blood, and helps reduce blood pressure, prevent arterial blockage, and protect against heart disease.Given the powerful impact of ultraviolet radiation, it is important to raise awareness of its benefits and incorporate it into training programs as a controlled exposure tool for athletes during specific hours of the day. Moreover, emphasis should be placed on training under sunlight and highlighting its importance in sports and medical workshops and seminars.

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