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# REVIEW ON EFFECTS OF MAGNESIUM SUPPLEMENTATION IN RECOVERY AND PERFORMANCE OF ATHLETES

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**ABSTRACT:** Exercise-induced muscle damage (EIMD) is caused by skeletal muscle damage that is characterised by histopathological muscle tissue changes.The destruction of skeletal muscle fibres causes an inflammatory response that decreases the athlete's physical capacity and sports performance. Therefore, the body needs the right nutrients, such as magnesium to repair mechanisms for recovery in athletes that helps in improving their performance. This study is to review about the degree to which magnesium supplements aid in athletes' recuperation that helps in improving their massive performance.Magnesium reduces inflammation, which decreases the possibility of post-workout muscular discomfort and tiredness. Additionally, the energy that powers muscular contractions ATP(adenosine triphosphate) is produced more readily when magnesium is present. Athletes must be thoughtful in their recuperation approach because they have less time to relax. Supplementing their diet with extra magnesium makes it easier for their bodies to heal and recover. The study comes to the conclusion that taking magnesium supplements after working out, training, or playing a game aids in the body's quick recovery and helps in boosting up the performance.

**Keywords** : Magnesium, Supplementation, Exercise induced muscle damage, Performance, Recuperation, Recovery.

**INTRODUCTION**:

Magnesium is essential for both whole sports performance and muscle repair. Magnesium is an important mineral that is involved in many physiological processes. It is necessary for healthy muscle growth and repair. Magnesium levels may drop after vigorous exercise because of increased demand and perspiration loss. Recovery times may increase and muscular function may be compromised by this depletion. By controlling calcium ion channels, magnesium promotes muscular relaxation and lessens the likelihood of post-exercise cramps and spasms.

Magnesium also helps muscle cells produce energy, which makes it possible for muscles to contract effectively and maintains endurance throughout extended physical activity. Magnesium also helps with protein synthesis, which is how muscles renew and repair themselves after being damaged by activity. Magnesium guarantees that the muscles acquire the building blocks required for growth and recuperation by encouraging protein synthesis. In addition, magnesium contains anti-inflammatory qualities that may aid in lowering pain and inflammation brought on by exercise-induced muscle damage (EIMD).

Magnesium has a major benefit for muscle recovery and general athletic performance due to its effects on other minerals, especially its involvement in activating vitamin D. Known as the "sunshine vitamin," vitamin D is essential for preserving the health of the musculoskeletal system. But vitamin D needs to be activated in the body in order to start having a positive impact on strength and muscle function. This activation process which is necessary for the best possible muscle function is facilitated by magnesium, which turns inactive vitamin D into its active form. A low vitamin D level has been linked to weakness, soreness in the muscles, and decreased sports performance. [30]

An athlete's capacity to perform at their best may be hampered by low muscle mass and strength resulting from inadequate vitamin D levels. Athletes can boost the activation of vitamin D and consequently promote muscle health and recovery by making sure their magnesium levels are appropriate. Moreover, magnesium's significance in muscle recovery is further enhanced by its function in promoting the uptake and utilisation of other vitamins and minerals.

The minerals calcium, potassium, and vitamin K all necessary for strong bones, healthy muscles, and optimal athletic performance are aided in their absorption by magnesium. Magnesium ensures that the body gets the nourishment it needs to sustain muscle repair

and function properly by encouraging the body to absorb these minerals. Thus, consuming enough magnesium as part of an athlete's post-workout diet is essential to promoting the best possible muscle repair and improving your athletic performance.

Additionally, by adding foods high in magnesium, it improved its capacity to assist muscular function and recovery by restoring magnesium levels lost after exercise. Athletes can improve their recuperation, reduce their risk of injury, and maximise performance by comprehending the mechanisms underlying exercise-induced muscle injury and putting appropriate recovery tactics into practice. The best course of action for this issue is to ensure proper muscle recovery. The study aimed to offer athletes a quick and efficient post-workout recovery option by taking magnesium rich foods or supplements that would reduce inflammation, increase muscle regeneration, and improve overall performance by speeding up the recovery process of the body.

## 2. Review of Literature:

### 2.1. Magnesium as a nutrient:

Magnesium is the second most abundant cation in body cells, behind potassium, and the fourth most abundant element in the human body ($Ca^{2+} > K^{+} > Na^{+} > Mg^{2+}$). Magnesium levels in the human body start at 760 mg at birth and rise to 5 g at 4-5 months.[1,2]. The total magnesium amount in the body varies from 20 to 28g [2,3]. Less than 1-2 percent of the body's total $Mg^{2+}$ is found in blood and extracellular fluids, while over 99% of it is found in the intracellular space. It is primarily stored in bone (50–65%), where it contributes to the structure of the skeleton along with calcium and phosphorus. It is also present in muscle, soft tissues, and organs (34–39%). Erythrocytes have three times the amount of magnesium than plasma [6], which typically has concentrations between 0.75 and 0.95 millimoles (mmol)/L [7]. $Mg^{2+}$ in plasma can exist in the ionised (free) active state up to 70% of the time [8]. Hypomagnesemia is defined as a blood magnesium level of less than 1.7–1.8 mg/dL (0.75 mmol/L) [9]. Furthermore, as renal excretion lowers in this condition as a compensatory mechanism, a urine excretion of less than 80 mg/dL may suggest a risk of magnesium insufficiency [12]. Here, the involvement of magnesium in numerous cellular processes (Figure 1) is briefly summarised, elucidating why chronically low magnesium intakes cause biochemical pathway changes that over time may increase the risk of illness.

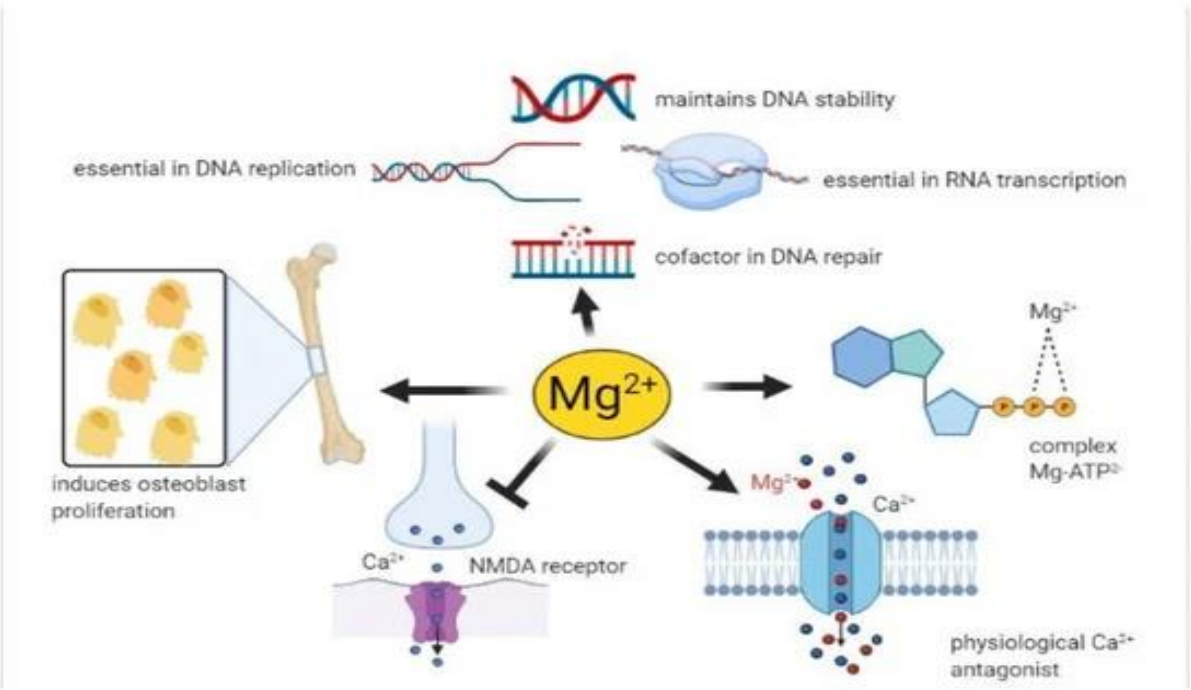


**Figure 1.** The biochemical involvement of magnesium in many cellular processes. (BioRender.com)

**2.2. The Recommended Dietary Allowance for magnesium:**

The RDA of Magnesium is taken from Nutrition atlas Indian Council of Medical Research which is given in the below figure 2, Where the sedentary work male should consume 340 mg and women 310 mg in a day. The recommended dietary allowance differs in infants and older children according to their age.[19]

**RECOMMANDED DIETARY ALLOWANCES**

Infants and Childrens

| 0-6 months | 6-12 months | 1-3 years | 4-6 years | 7-9 years |
|---|---|---|---|---|
| 30 mg | 45 mg | 50 mg | 70 mg | 100 mg |

Older Children

| Boys(10-12 years) | Girls(10-12 years) | Boys(13-15 years) | Girls(13-15 years) | Boys(16-18 years) | Girls(16-18 years) |
|---|---|---|---|---|---|
| 120 mg | 160 mg | 165 mg | 210 mg | 195 mg | 235 mg |

Adults

| | Sendentary work | Moderate work | Heavy work |
|---|---|---|---|
| Men | 340 mg | 340 mg | 340 mg |
| Women | 310 mg | 310 mg | 310 mg |

Pregnancy / Lactating Mothers

| | Pregnant women | Lactating(0-6 months) | Lactating(6-12 months) |
|---|---|---|---|
| | 310 mg | 310 mg | 310 mg |

**Figure 2.** The Recommended Dietary Allowance of magnesium from ICMR

**2.3. Dietary sources of magnesium:**

Dietary sources rich in magnesium are cocoa, nuts, almonds, whole seeds, unground grains, legumes, bananas and green leafy vegetables. The green parts of plants are particularly rich in magnesium because it constitutes the prosthetic ion in chlorophyll. Another source is considered to be hard water which has been shown to benefit human health but not all parts of the world's hard water does have a high source of magnesium[17]. Including a range of these items in your diet can assist to guarantee that you're getting enough magnesium from natural sources. The different cooking techniques might have an impact on a food's magnesium content. In general, boiling and steaming preserve more nutrients than frying or microwaving.

**2.4. Forms of magnesium supplements and its benefits:**

There are many different types of magnesium (both organic and inorganic salts)that are widely available in the market right now, including capsules, effervescent pills, enteric-coated tablets and fat-soluble preparations.[13].

➢ Magnesium oxide: This form is less accessible than other forms, although it has one of the greatest quantities of elemental magnesium. Because of its capacity to ease intestinal muscle tension, it is frequently used as a laxative.
➢ Magnesium citrate: This form is frequently utilised for its laxative properties and is more bioavailable than magnesium oxide. It is frequently used to support muscular and bone health.
➢ Magnesium Glycinate: This form is more easily absorbed because it is bound to the amino acid glycine. Its bioavailability is higher compared to others that leads to less stomach induced problems. and is less likely to induce stomach problems. It's frequently used to promote rest, sleep, and the healing of muscles.
➢ Magnesium chloride: This form is easily absorbed by the body and is frequently applied topically to relieve discomfort and relax muscles.
➢ Magnesium L-Threonate: This form has the potential to improve brain health and cognitive function because it has been demonstrated to successfully penetrate the blood-brain barrier. In comparison to other types, it is relatively new, and further research is required to completely comprehend its advantages.
➢ Magnesium sulphate: Commonly referred to as Epsom salts, this type of salt is frequently used in baths to relieve discomfort and relax muscles. In addition, it can be used orally as a laxative, however this is not as popular as using magnesium citrate.
➢ Magnesium malate: This form, which aids in the body's synthesis of energy, combines magnesium with malic acid. It's frequently used to boost vitality and ease weariness and muscular soreness.
➢ MagnesiumTaurine: It is an amino acid that has soothing effects and is combined with magnesium to create magnesium taurate. It's frequently used to promote relaxation and cardiovascular health.

➢ Magnesium Orotate: This form is thought to improve the absorption and utilisation of magnesium by combining magnesium with orotic acid. It's frequently utilised to enhance both sports performance and heart health.[14,15,16].

**2.5. Side effects of magnesium supplements:**

A few studies estimate that the daily consumption of these compounds in the desired amounts will increase the risk of renal calculi formation of struvite from about 3- 14% of the people even in healthy individuals. It is important to evaluate a patient's renal function or find out if their renal function is normal before advising them to take daily oral magnesium supplements (glomerular filtration rate: around 120 ml/min). When a patient's glomerular filtration rate is less than 30 ml/min, it is best to avoid giving them magnesium supplements on a daily basis. This is because the high levels of magnesium in their blood might cause problems with muscle, heart, and nerve function [18].

**3. MATERIALS AND METHODS:**

Important findings were found based on the study of reviewed articles that the effect of magnesium supplementation on athletic performance is higher, helping in decreasing muscle soreness and build up recovery soon. A sample size of ten articles indicates a significant improvement in sports performance after taking magnesium supplements

**Table 1.** Reviewed articles result and assessment made

| S.NO | THE TITLE OF THE STUDY | STUDY DESIGN | ASSESSMENT MADE | MATERIALS REQUIRED | RESULT | STATISTICAL ANALYSIS |
|---|---|---|---|---|---|---|
| 1. | Effects of magnesium supplementation on muscle soreness and performance. et.,al Alyssum Reno | Experimental research design | Magnesium supplementation significantly reduces muscle soreness in recreationally active individuals due to frequent loss of magnesium | 22 Recreationally active college aged students | Performance measure of pre and post supplementation of magnesium shows difference. There is is more recovery in post supplementation of magnesium | Significant trial x group interaction ($p = 0.008$) |
| 2. | Impact of magnesium supplementation in muscle damage of professional Cyclists competing in a stage race. et.,al Alfredo Córdova | A randomised study design | It indicated that $Mg^{2+}$ supplementation exceeding RDA has a modest effect in maintaining muscle integrity | 18 professional male cyclists from two different professional teams participated in this study. | It seems that muscle status, fatigue and recovery were adequate in both groups. Therefore, it can be suggested that control of an adequate amount of Mg in the diet could be sufficient to maintain adequate muscle status and function | The mean scores obtained on the first day, and on the last day of competition in control group and magnesium supplemented group respectively, with no significant differences between the two groups during the study. A value of $p < 0.05$ was considered as significant. |
| 3. | One week of magnesium supplementation lowers IL-6 muscle soreness and increases post exercise blood glucose | Double-blind, placebo controlled, cross-over study, | This study investigated magnesium 28 intake on physiological responses and performance during | Nine male recreational runners (athletes) completed a counterbalanced | Magnesium supplementation reduced the IL-6 response, enhanced recovery of blood glucose, and muscle soreness | All data was expressed as mean and standard deviation (SD) with statistical significance was set at $P < 0.05$. |

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| | response to downhill running. et.,al Steward Charles | | eccentric exercise and recovery. | | after strenuous exercise, but did not improve performance or functional measures of recovery | |
| 4. | Effect of magnesium supplementation on muscular damage markers in basketball players during a full season et.,al Córdova Martínez Alfredo | Experimental research design | The supplemental Mg in elite athletes, during a competition season, could exert a protective effect on the muscle. This occurred without significant changes in cortisol and anabolic hormone levels | Twelve elite male basketball players from a team of Spanish Professional Basketball League have participated in the study | The results suggest that supplementation with Mg during the season of competition may prevent associated tissue damage. | Significantly positive correlations ($P < 0.05$) between Mg concentration and leukocytes, and between serum Mg and total protein concentrations, were observed |
| 5. | The effect of magnesium supplementation on high and low dietary magnesium intake on resting during and recovering from exercise on blood pressure performance and serum levels of magnesium. et.,al Luke William Pitkin | Randomised blind cross over controlled design. | It is worth taking $Mg^{2+}$ supplementation to aid in health and performance. | 9 males and 4 females participated in the study. | The results of the current study shows that 500mg/day of $Mg^{2+}$ supplementation will significantly decrease systolic and diastolic blood pressure and help in improving the performance of runners. | Statistically significant differences were observed ($P < 0.05$) in the running time trial, blood pressure readings pre and post 10 kilometre running trial (systolic and diastolic) and in heart rate recorded at 10 minute intervals during the running trial following $Mg^{2+}$ supplementation. |
| 6. | Decrease in ionised and total magnesium blood concentration in endurance athletes following an exercise bout restore within hours potential consequences for monitoring and supplementation. et.,al Rieneke Terink | A randomised control experimental design | Both ionised and total magnesium showed almost similar decrease and recovery patterns, indicating that both can be used to evaluate physiological changes after exercise. | 9 well-trained male and 9 well-trained female athletes (cyclists and triathletes) participated in this study. | The findings suggest that timing of blood sampling to analyse Mg status is important. | Concentrations decreased significantly after exercise $p < .001$. On the other hand, no significant decline was observed during that time-interval on control days. |
| 7. | Effects of transdermal magnesium chloride on recovery of force production and perceived muscle soreness after | A randomised, double blinded, crossover study design | $MgCl_2$ may be beneficial for the micro-cycle phase of training | 19 recreationally active men participated in the study | Future studies can be considered investigating using higher dosages or longer supplementation periods to determine if | $MgCl_2$ did not reduce perceived muscle soreness ($p=0.510$) or increase muscle force recovery ($p=0.742$). However, there was |

| | | | | | | |
|---|---|---|---|---|---|---|
| | eccentric exercise. et.,al Michael Bass | | | | $MgCl_2$ improves muscle force post eccentric exercise. | a slightly attenuated degree of pain. |
| 8. | Effects of magnesium citrate, magnesium oxide and magnesium sulphate Supplementation an arterial stiffness :A Randomised, Double-Blind, Placebo Controlled Intervention Trial et.,al Joëlle C Schutten | A Randomised, Double-Blind Placebo Controlled Intervention Trial study design | Oral magnesium citrate supplementation for 24 weeks did not significantly change arterial stiffness or blood pressure. Magnesium oxide and magnesium sulphate had similar nonsignificant effects. | 164 participants were included. | It should be further elucidated whether long-term oral magnesium supplementation is effective in individuals with increased arterial stiffness, such as patients with chronic kidney disease. | When compared with placebo, effects of treatment with magnesium oxide and magnesium sulphate augmentation index adjusted for heart rate, and blood pressure were non significant. Participants in the magnesium oxide and magnesium sulphate groups showed similar results to participants in the magnesium citrate group But showed higher 24-hour urinary calcium, potassium, and sodium levels during the treatment period when compared with placebo |
| 9. | The effect of acute magnesium supplementation on maximal intensity short term exercise e and subsequent effect on blood pressure and isokinetic knee extension during recovery. et.,al R. Pulford | The study was a double-blind repeated-measures crossover design | Magnesium supplements helps in recovery after maximal intensity short term exercise | 6 healthy male subjects were included in the study | The present study demonstrates that Mg supplementation increases peak and mean power during Wingate anaerobic test and can enhance recovery by reducing systolic blood pressure and improving peak torque in an isokinetic knee extension after maximal short-term exercise. | Mean peak power was significantly increased ($P<0.05$) during the wingate anaerobic test between the placebo condition and the Mg condition. However, there was no significant difference ($P>0.05$) in diastolic blood pressure between the placebo and the Mg condition during the 30 min recovery post wingate anaerobic test. |
| 10. | Effects of cooling and magnesium supplementation on the objective and subjective outcomes of acute high intensity rowing. et.,al Shu-Ting Li | A experimental study design | Body temperature and level of magnesium in the body can be important factors affecting the level of exercise activities. | 24 athletes with different backgrounds of sports were recruited | Data show that whole-body cryotherapy lowers body temperature and together with magnesium supplementation without affecting objective outcomes - | The standard significance level was set at $\alpha = 0.05$. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | However, beneficial effects of body cooling and magnesium supplementation are effective. | | improve the thermal sensation | |

## 6. RESULT AND CONCLUSION:

The results of the examined publications indicate that taking magnesium supplements can help athletes recover more quickly, which may have a minor but significant impact on their performance. Consuming these magnesium supplements contributes to a larger degree of reduction in muscular soreness . Figure 3 shows the regulation of the magnesium homeostasis. In conclusion, magnesium supplements have their own set of adverse consequences despite helping athletes perform better. It is furthermore suggested that more research has to be done to determine the type and quantity of magnesium supplements that assist athletes to increase their performance.

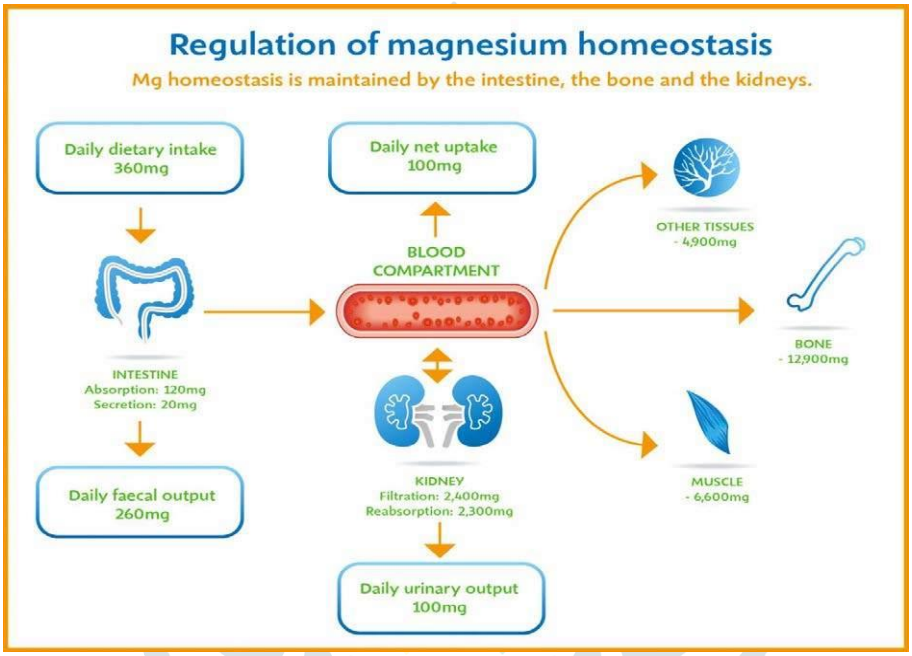


**Figure 3**. Regulation of magnesium homeostasis (https://www.aimspress.com/article/id/788)

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