

# SIRIPOS

Società Scientifica Italiana  
di Riabilitazione e Posturologia dello Sport

## Ita.J.Sports.Reh.Po.

Italian Journal of  
Sports Rehabilitation and Posturology



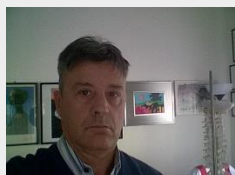
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*As Editor-In-Chief I want to welcome you to the Journal of Italian Journal of Sports Rehabilitation and Posturology In the last few years Rehabilitation and Traumatology Science applied to sports has passed gradually from empirical theories in the treatment and recovery of injured athletes to a significant enhancement of therapeutic strategies – thanks also to scientific contributions coming from all over the world. So a different approach to traumatology and rehabilitation as regards sports injuries has become possible thanks to the contribution of: a) a better understanding of the healing process of injuries and surgery techniques b) a more adequate understanding of the clinical biomechanical behavior c) postural strategies along with the studies and analysis of the gestural movement d) the different myo-osteoarticular structures in response to internal and external load. At present, most of the research highlights how important it is to treat injured athletes and to propose strategies and concepts based on an 'evidence-based approach'. So in a conceptual view of the rehabilitation of the injured athlete the therapist must choose those means and those strategies that reveal a clinic appropriateness, based on scientific data and aiming at an optimal return to sport.*


*The acquisition of new technologies for collecting clinical, physiological and rehabilitation parameters has allowed experts to improve their therapeutic abilities. The multidisciplinary treatment, now widely recognized by the scientific population, finds practical application difficulties because of the limited availability of rehabilitation specialists*


*Our editorial goal is to provide a tool for an adequate scientific update in the rehabilitation and sports posturology and to offer a modern, multidisciplinary point of view on traumatic injuries.*

Kind Regards,


**Rosario D'Onofrio,**  
Editor In Chief - Ita. J. of Sports Reh. Po.


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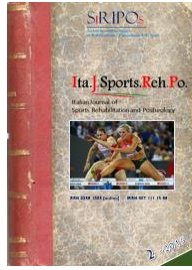
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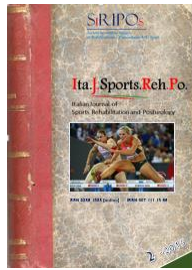
## Increased Muscle Strength in Professional Baseball Players Utilizing a Novel Rehydration Solution Consisting of Optimized Electrolytes with Meglumine

Authors : Demetri Menegos<sup>1†</sup>, Jason P. Kopec<sup>3</sup>, Dan Byrnes<sup>3</sup>, Arturo Bravo Antón<sup>2</sup> and Arturo Bravo-Nuevo<sup>2†</sup>

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### Abstract

*Objective* To evaluate the effectiveness of a novel formulated solution on improving muscle strength in professional baseball players. *Design* A prospective, randomized, double-blind, placebo-controlled trial to compare Megnify with placebo. *Setting* A professional, independent league baseball team in New Jersey, USA. *Participants* Subjects were recruited from a professional baseball team, regardless of position and playing experience. *Eighteen* subjects were initially recruited, 11 were included in the final analysis. *Interventions* Subjects were randomized into either the treatment or placebo arm. *Subjects* in both arms used either Megnify or placebo for a period of thirty days, given before practice or games on a daily basis. *Main Outcome Measures* Dynamometer testing was completed bilaterally to assess handgrip strength in all study participants, upon initiation and completion of the study. *Results* There was a significant increase in muscle strength of approximately 4.5% ( $p=0.04$ ), via hand grip dynamometer testing, in the Megnify group when compared to the placebo group. *Conclusion* These findings suggest that a sports rehydration solution, utilizing a combination of meglumine with an optimized electrolyte replacement solution, provides superior performance to placebo in professional athletes. This combination of meglumine with optimized electrolytes provides rehydration with the additional significant benefit of a rapid, significant increase in muscle strength. (Demetri Menegos<sup>1†</sup>, Jason P. Kopec<sup>3</sup>, Dan Byrnes<sup>3</sup>, Arturo Bravo Antón<sup>2</sup> and Arturo Bravo-Nuevo<sup>2</sup> Ita. J. Sports Reh.Po. , 2 ;2; 75 -85 :2015 ; ISSN 2385-1988 [online] IBSN 007-111-19-55 )



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## Introduction

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Optimal rehydration in the athletic population has been a point of discussion amongst physicians, athletic trainers and research scientists since the emergence of sports medicine. Research science has been progressively evolving over the last several decades to provide optimal rehydration solutions for athletes, in order to maximize performance. As such, it has been well documented in the literature that dehydration, defined as a water deficit in excess of 2% body weight, decreases exercise performance [1].

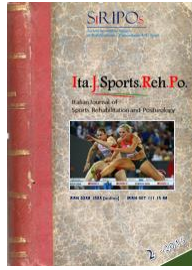
Adequate oral electrolyte replacement is directed at offsetting sweat deficit, which will conversely lead to dehydration and impaired exercise capacity. Exercise performance will be impaired when an individual is dehydrated by as little as 2% of body weight. While an individual dehydrated in excess of 5% of body weight, will experience a decrease in capacity for work by at least 30% and up to 45% [2, 3].

Oral Electrolyte replacement is aimed towards replacing electrolytes lost in sweat, as well as increasing endurance, so as to maximize athletic performance. The major cation lost in sweat is sodium, while chloride is the major anion. Other major electrolytes present in sweat are potassium, calcium, magnesium [4]. As magnesium is required for the absorption of potassium, we can surmise the importance of these electrolytes working in tandem. It is this constellation of electrolytes that should be replaced in any formulation geared towards increasing overall individual performance.

In formulating an electrolyte rehydration solution that optimizes the characteristics required for maximized performance, consideration is also given to osmolality, flavoring components, as well as other active ingredients. The formulation must be palatable to the individual so as to encourage intake prior, during and after exercise. In addition, the tonicity plays a major role as well, since an isotonic, or slightly hypotonic, solution will allow for better overall absorption and delivery of important electrolytes [4].

While mechanisms of insulin-induced glucose uptake in skeletal muscle are well established, the pathways driving muscle contraction-induced glucose uptake remain largely obscure. Indeed, exercise greatly benefits the management of blood glucose levels, but the reasons for this benefit are unclear. The master metabolic kinase AMPK has been one focus of studies in this area, and the AMPK-related kinase SNARK has been suggested recently as a key mediator of glucose uptake stimulated by muscle contraction [5].

Sorbitol is a slowly absorbed sugar alcohol found in certain fruits [6] that stimulates SNARK activity and increases glucose uptake by muscle cells [7]. Sorbitol has been explored as a supplement to increase glucose uptake in diabetic individuals, but its clinical use is impractical because its oral administration causes acute gastrointestinal distress and diarrhea [8, 9].



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Moreover, under diabetic conditions, sorbitol accumulation in some tissues, where it is slowly cleared by the polyol pathway, may promote diabetic complications including atherosclerosis, cataracts, nerve damage and retinopathy [10]. Thus, alternatives to sorbitol for clinical use have been desired and sought.

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Meglumine (N-Methyl-D-glucamine) is a derivative of sorbitol in which the hydroxyl group in position one is replaced by a methylamine group. Meglumine has been used widely in pharmaceutical formulations as an excipient. The utility of meglumine for this application relates to its ability to form adducts with organic acids, markedly increasing their aqueous solubility.

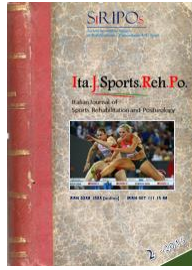
This property has been exploited by the pharmaceutical industry in making certain drug substances more soluble in water when taken in the form of an adduct with meglumine, without affecting the original activity of the drug. The most successful examples of such increased solubility are meglumine antimonate (for human use) and flunixin meglumine (for animal use) Meglumine is also widely used in the manufacturing of contrast media in combination with iodine-containing compounds [13]. More recently, meglumine was described as a useful agent of protein stabilizers in pharmaceutical compositions comprising antibody molecules [14].

Based on its structural similarity with sorbitol, we investigated whether a well-balanced electrolyte drink, in conjunction with meglumine, may optimize muscle development and strength by reducing exhaustion and optimizing athletes' work outs [15].

During vigorous exercise, dehydration results from the body's attempts to balance endogenous heat production with exogenous heat accumulation through heat dissipation [16]. The major mechanism by which the exercising individual is able to promote heat loss is through evaporation via sweat. This leads to the loss of the aforementioned major electrolytes found in sweat, mainly sodium and chloride.

As heat levels increase and place strain on the exercising individual, evaporation through sweat, may account for up to 98% of cooling by the exercising body [17]. Progressive and profound dehydration will subsequently occur with improper electrolyte replacement. This will lead to the altered cardiovascular and thermoregulatory responses associated with dehydration. At the muscular level this can signal a possible increase in the rate of glycogen degradation [18], which can lead to decreased overall performance, decreased muscle strength and decreased muscular stamina. In formulating an electrolyte solution that not only addresses hydration status, but also looks to improve overall performance, the effect at the muscular level cannot be understated.

In murine myoblasts, meglumine increased steady-state SNARK levels in a dose dependent manner more potently than sorbitol [15]. Preclinical evidence obtained in mice supported the hypothesis that meglumine could safely enhance muscle stamina. Normal mice (SV129) administered 18 mM meglumine orally for six weeks did not display any gastrointestinal or other remarkable adverse-effects, but had a marked effect on enhancing muscle stamina associated with elevation of steady-state levels of SNARK in skeletal muscle, reduction of fasting blood glucose and a reduction in serum triglycerides [15,19].



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Given the observed beneficial effects of meglumine on muscle strength and stamina in mice, it is conceivable that this compound may offer a novel supplement to safely enhance strength, stamina or energy, and to combat muscle fatigue in healthy or disease settings. Consequently, it is prudent to explore clinical evaluation of meglumine as a low-cost, safe supplement offering to improve muscle function.

Fluid and electrolyte replacement in exercising individuals has been documented to prevent the physiologic changes associated with dehydration.

When considering mild dehydration resulting in decreased athletic performance, there is decrease in urinary output with associated symptoms of dry mouth, flushing, nausea, and lethargy [20]. With accumulating fluid losses, the athlete may go on to develop a constellation of alarming symptoms that may include tachypnea, tachycardia, decreased concentration, dizziness, weakness and finally an alteration in mental status [20].

In formulating an ideal oral rehydration solution, the most important electrolyte in that process would appear to be sodium, with significant benefits also attributed to potassium, chloride, calcium and magnesium concentrations. Sodium may provide additional benefits when considering the functional goal of a rehydration solution, as it has been shown to enhance fluid absorption in the small intestine, while also promoting maintenance of plasma osmolality and maintenance of thirst [20].

In clinical application, decreased sodium levels have been demonstrated in endurance athletes and long distance runners to be a cause of mortality, making this electrolyte one of paramount importance in terms of rehydration. While maintenance of potassium, magnesium and calcium have long been discussed to be vital in promoting long term health and longevity. These characteristics highlight the superiority of an electrolyte replacement solution when compared to water in rehydration.

## **Materials and Methods**

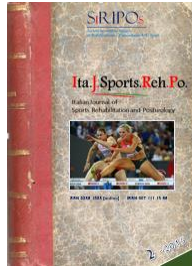
### **Participants**

The head athletic trainer, manager, coaches were contacted and players were recruited for participation from a professional baseball club in New Jersey, USA. All participants were injury free at the time of initial testing. Ultimately, 18 players participated in the study, on a volunteer basis. Eleven players were used in the final data analysis. Participants were excluded over the course of the study due to injury which prevented their participation in scheduled matches. Consent for study participation was obtained and participants were randomized into two groups, the treatment group and the placebo group.

### **Testing Procedure**

Participants were initially tested at the onset of the study utilizing a JAMAR Dynamometer (Model 1, ASIMOW Engineering Company) after a night of rest and prior to game play. The testing protocol consisted of dynamometer testing of all athletes, taking measurements bilaterally. Testing was completed at positions 1, 3 and 5 by a double blinded, certified athletic trainer.





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Dynamometer testing was repeated at the completion of the study after a night of rest and prior to the final game of the season. Testing was again completed at positions 1, 3 and 5 by a double blinded, certified athletic trainer. The dynamometer was factory calibrated prior to initiation of the study. Hand grip strength testing utilizing a hydraulic JAMAR Dynamometer was done according to the testing protocol set forth by the American Society of Hand Therapists.

### Study Treatment

This randomized, single-center, double-blind, placebo-controlled, 2-arm parallel group study, with a study duration of 30 days, compared daily administration of M-Lyte (2000mg of Meglumine (Supplement), Sodium 250mg, Potassium 200mg, Phosphorus 25mg, Magnesium 5mg, Calcium 25mg) vs Flavored water (Placebo).

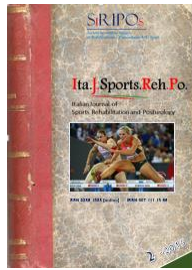
### Statistical analysis

Values shown are means  $\pm$  standard error of the means (SE). The significance of the differences between the two groups was analyzed by a student's t test. P values of 0.05 or less were defined as statistically significant.

### Results

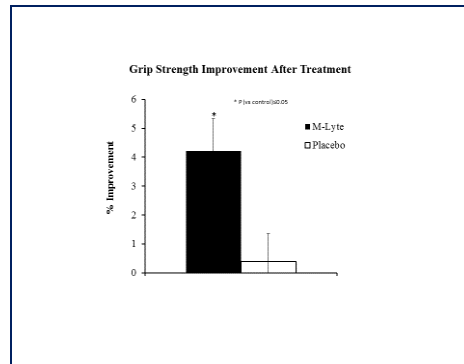
There was no significant difference in anthropometrics between the two study groups. The study groups represented a homogeneous population of professional baseball players that followed a rigid daily routine during the professional baseball season. Participants followed very strict diet and exercise regimens as part of their daily routine. Players that suffered significant injury during the study, that impeded their participation in competitive matches, were excluded from final analysis.

In analyzing the test results, there was a nearly 4.5% increase in muscle strength in the Megnify treated group when compared to placebo ( $p=0.04$ ), as measured via bilateral dynamometer testing. Testing was completed both pre and post-trial by a double blinded, certified athletic trainer utilizing standardized dynamometer testing protocol with a JAMAR dynamometer (Model 1, ASIMOW Engineering Company). These results reaffirm our hypothesis that a novel electrolyte solution in combination with meglumine would increase muscle strength.



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### Figure Legend

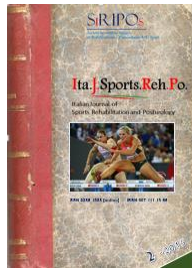
**Figure 1.** Megnify increases Muscle strength. Professional baseball players were treated either with Megnify solution or placebo daily for 4 weeks. Players on Megnify (black bar) showed a 4.21% increase in grip strength after treatment versus a 0.3% showed by placebo treated players (white bar). N=6 (Megnify group) and N=5 for Placebo group. P=0.04

### Discussion: The Biochemical Evidence

Insulin, as well as other oral and injectable diabetes medications combined with an exercise program, are the most common therapies prescribed to reduce blood glucose levels in diabetic patients. The mechanism by which glucose uptake occurs in skeletal muscle is well-established in the case of insulin, but how skeletal muscle contraction induces glucose uptake has remained obscure. Recent work has suggested that the AMPK-related kinase SNARK is a critical mediator of skeletal muscle contraction-stimulated glucose uptake[7]. While sorbitol can upregulate SNARK, its gastrointestinal side-effects make it unsuitable for routine treatment of diabetic patients. In a previous report, we documented the benefits of the sorbitol derivative meglumine in a murine model [19] as a potentially superior tool to improve glycemic control and muscle stamina and to delay the onset of diabetes complications such as nephropathy. Meglumine is regarded as safe by the U.S. FDA in concentrations as high as 100 mg/kg per day. It is commonly used as an excipient agent for drug formulations.

Compared to its structural relative sorbitol, we have shown meglumine to be a more potent stimulant of the AMPK-related kinase SNARK, which is implicated in mediating muscle contraction-induced glucose uptake[7]. In humans, SNARK levels have been reported to be elevated in diabetic patients[22], perhaps reflecting the chronic activity of futile stress signaling cycles. In cancer settings, SNARK can function as a tumor suppressor gene that prevents colon carcinogenesis, yet in frank cancer cells SNARK seems to limit susceptibility to cell death and to encourage invasiveness[24-27]. Our results warrant additional study of how Megnify improves muscle strength.





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### Discussion: The Clinical Evidence

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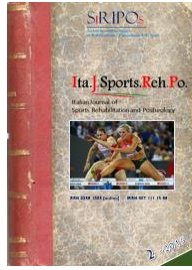
The main objective of our study was to establish the validity of utilizing Megnify in professional athletes, with the primary purpose of rapidly increasing muscle strength and therefore, improving overall athletic performance. It was our hypothesis that an optimized rehydration solution with the addition of meglumine, would give superior performance in professional athletes when compared to placebo. The effectiveness of this novel electrolyte-meglumine rehydration solution, was measured in terms of its effect on muscle strength following four weeks of daily administration. This effect was measured pre and post study with a JAMAR hydraulic dynamometer. This provided us with the most effective way of testing hand grip strength, providing our research team with an objective biomechanical measurement. When considering the three prevalent types of handgrip dynamometers for use in the study, it was decided that a hydraulic compression dynamometer would provide the most effective and accurate tool, to measure the force that is produced by handgrip strength.

Testing handgrip strength in professional baseball players provided an effective biomechanical measurement to support the use of an optimized electrolyte-meglumine rehydration solution in competitive, professional athletes. The skills specific to professional baseball, require extensive and intricate use of the flexor muscles of the upper extremities. It's the strength and intricate control of these muscles that allows professional baseball players to perform at such competitively high levels for over 200 days a year.

The flexor muscles of the upper extremity are responsible for this production of forces responsible for hand grip strength, the antagonist extensor muscles acting as the stabilizers during production of this force. Providing a rehydration solution that would increase handgrip muscle strength in professional baseball players allows for more effective dynamic control of the powerful hand and forearm musculature, so important in the sport specific activities of professional baseball players.

The choice of setting for the clinical research study was very important in terms of providing a homogeneous group of study participants, without significant variations in terms of anthropometric measurements, diet, exercise, workout routines or even sleep patterns. Anthropometric measurements such as height, weight and hand dimensions can have a significant impact on maximal handgrip strength. The variations that could be expected in the above dimensions in the general population were minimized with the group of professional baseball players that were recruited to partake in the study. In addition, due to the daily schedule of baseball games during the professional baseball season, there was very little room for variation in daily routine among the involved participants. This provided a study environment that minimized variables significantly, therefore maximizing the accurate assessment of the use of Megnify over a period of four weeks, during the course of the season.

The increase in muscle strength, as measured through handgrip testing, in professional baseball players over a period of four weeks, can therefore, be more accurately attributed to the administration of Megnify in the treated group, when compared to the placebo group. The increase of nearly 4.5% in a limited frame during the professional baseball season, can be seen as a very significant increase that could increase players' overall level of performance over an extended period of time.



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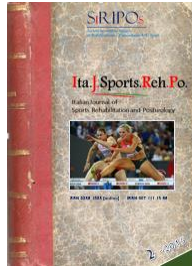
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In conjunction with the increase in muscle strength in this group of athletes, the associated improvement in glycemic control, as well as improved triglyceride levels that could be attributed to the meglumine component of Megnify, based on previous laboratory studies, could also account for improved energy levels, as well as overall improved health.

The important benefits of the meglumine component of Megnify, are correlated with a favorable side effect profile as well. Despite being a derivative of Sorbitol, meglumine lacks the unwanted side effect of diarrhea, which is a significant drawback to the clinical use of Sorbitol. This positions meglumine favorably in its application in competitive athletes.

## Conclusion

Although further study of Megnify should certainly be encouraged, the effectiveness of Megnify with its composition of optimized electrolytes and meglumine, could certainly provide a competitive advantage for all professional athletes. The benefits of Megnify as outlined in this research study, in addition to the fact that Megnify meets all criteria for use in professional athletics, should position this formulated solution favorably for use by professional athletes of all sports. The additional benefit of working through a non-hormonal, non-steroidal pathway position Megnify as an optimal rehydration solution that not only promotes increased muscle strength, as well as improved energy levels, but also provides the additional benefit of meeting all criteria for use set forth by the International Olympic Committee. This could position Megnify as a significant component of any future physical fitness regimen.

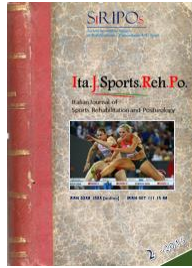


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## References

1. American Dietetic Association, Dietitians of Canada, American College of Sports Medicine. Position Statement on Nutrition and Athletic Performance. *Medicine and Science in Sports and Exercise* 41: 709-731
2. Saltin B, Costill DL. Fluid and electrolyte balance during prolonged exercise. In : Horton ES, Terjung RL, eds. *Exercise, nutrition, and metabolism*. New York : Macmillan, 1988:150-8.
3. Nielsen B, Kubica R, Bonnesen A, Rasmussen IB, Stoklosa J, Wilk B. Physical work capacity after dehydration and hyperthermia. *Scand J Sports Sc* 1982; 3:2-10
4. Maughan RJ. Fluid and electrolyte loss and replacement in exercise. In: Harries M, Williams C, Stanish WD, Micheli LL, eds. *Oxford textbook of sports medicine*. Oxford: Oxford University Press, 1994:82-93.
5. Lefebvre DL, Bai Y, Shahmoly N, Sharma M, Poon R, et al. (2001) Identification and characterization of a novel sucrose-non-fermenting protein kinase/AMP-activated protein kinase-related protein kinase, SNARK. *Biochem J* 355: 297-305.
6. Adcock LH, Gray CH (1957) The metabolism of sorbitol in the human subject. *Biochem J* 65: 554-560.
7. Koh HJ, Toyoda T, Fujii N, Jung MM, Rathod A, et al. (2010) Sucrose nonfermenting AMPK-related kinase (SNARK) mediates contraction-stimulated glucose transport in mouse skeletal muscle. *Proc Natl Acad Sci U S A* 107: 15541-15546.
8. Ravry MJ (1980) Dietetic food diarrhea. *JAMA* 244: 270.
9. Wang YM, van Eys J (1981) Nutritional significance of fructose and sugar alcohols. *Annu Rev Nutr* 1: 437-475.
10. Ramasamy R, Goldberg IJ (2010) Aldose reductase and cardiovascular diseases, creating human-like diabetic complications in an experimental model. *Circ Res* 106: 1449-1458.
11. Roberts WL, McMurray WJ, Rainey PM (1998) Characterization of the antimicrobial agent meglumine antimonate (glucantime). *Antimicrob Agents Chemother* 42: 1076-1082.
12. Kopcha M, Ahl AS (1989) Experimental uses of flunixin meglumine and phenylbutazone in food-producing animals. *J Am Vet Med Assoc* 194: 45-49.
13. Bleicher AG, Kanal E (2008) Assessment of adverse reaction rates to a newly approved MRI contrast agent: review of 23,553 administrations of gadobenate dimeglumine. *AJR Am J Roentgenol* 191: W307-311





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14. Igawa T, Kameoka D (2006) Stabilizer for protein preparation comprising meglumine and use there off In: Application EP, editor.

15. Arturo B-N, Alice M, Minzhou H, Frank K, Jennifer M, et al. (2013) Meglumine Exerts Protective Effects Against Metabolic Syndrome and Type II Diabetes. PLOS ONE Submitted.

16. Werner J. Temperature regulation during exercise: an overview. In: Gisolfi CV, Lamb DR, nadel ER, eds. *Exercise, Heat and Thermoregulation*. Dubuque, IA: Brown and Benchmark; 1993: 49-77.

17. Armstrong LE, Maresh CM. The exertional heat illnesses: a risk of athletic participation. *Med Exerc Nutr Health*. 1993; 2: 125-134.

18. Hargeaves M, Dillo P, Angus D, Febbraio M. Effect of fluid ingestion on muscle metabolism during prolonged exercise. *J Appl Physiol*. 1996; 80: 363-366.

19. Bravo-Nuevo A, Marcy A, Huang M, Kappler F, Mulgrew J, et al. (2014) Meglumine exerts protective effects against features of metabolic syndrome and Type II diabetes. PLOS ONE: 2014 Feb 27; 9(2)

20. Brukner P, Khan K. *Clinical Sports Medicine*. New Delhi, India: Tata mcGraw-Hill; 2007: 691-705.

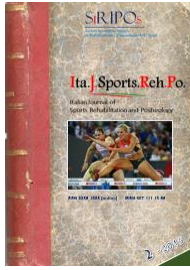
21. Ramasamy R, Goldberg IJ (2010) Aldose reductase and cardiovascular diseases, creating human-like diabetic complications in an experimental model. *Circ Res* 106: 1449-1458.

22. Rune A, Osler ME, Fritz T, Zierath JR (2009) Regulation of skeletal muscle sucrose, non-fermenting 1/AMP-activated protein kinase-related kinase (SNARK) by metabolic stress and diabetes. *Diabetologia* 52: 2182-2189.

23. Namiki T, Tanemura A, Valencia JC, Coelho SG, Passeron T, et al. (2011) AMP kinase-related kinase NUA2 affects tumor growth, migration, and clinical outcome of human melanoma. *Proc Natl Acad Sci U S A* 108: 6597-6602.

24. Tsuchihara K, Ogura T, Fujioka R, Fujii S, Kuga W, et al. (2008) Susceptibility of Snark-deficient mice to azoxymethane-induced colorectal tumorigenesis and the formation of aberrant crypt foci. *Cancer Sci* 99: 677-682.

25. Namiki T, Tanemura A, Valencia JC, Coelho SG, Passeron T, et al. (2011) AMP kinase-related kinase NUA2 affects tumor growth, migration, and clinical outcome of human melanoma. *Proc Natl Acad Sci U S A* 108: 6597-6602.



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ISSN 2385-1988 [online] - IBSN 007-111-19-55

26. Kusakai G, Suzuki A, Ogura T, Kaminishi M, Esumi H (2004) Strong association of ARK5 with tumor invasion and metastasis. J Exp Clin Cancer Res 23: 263-268.

85

27. Kusakai G, Suzuki A, Ogura T, Miyamoto S, Ochiai A, et al. (2004) ARK5 expression in colorectal cancer and its implications for tumor progression. Am J Pathol 164: 987-995.



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